October 2014

FINAL

GREAT COHARIE CREEK LOCAL WATERSHED PLAN

Watershed Management Plan

Prepared For: NC Ecosystem Enhancement Program

Prepared By: Triangle J Council of Governments

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Executive Summary

This *Watershed Management Plan* makes recommendations to improve the watershed functions of hydrology, water quality and habitat within the 53 square mile Great Coharie Creek (GCC) headwaters local watershed planning (LWP) area in northern Sampson County, including the Town of Newton Grove.

The purpose of this *Watershed Management Plan* is to (1) summarize the results of the watershed characterization and assessment tasks (Phases I and II) and (2) present the final recommendations developed during the Phase III process for the Great Coharie Creek LWP area; located within the Black River drainage of the Cape Fear River Basin (Cataloging Unit 03030006) in North Carolina. The stakeholder-driven LWP process for the GCC study area, comprised of three 14-digit hydrologic units (03030006090010, 03030006090015, and 03030006090020), was initiated by the NC Ecosystem Enhancement Program (EEP) in 2009 and included a total of thirteen meetings with the Local Advisory Team (LAT). The LAT consisted of representatives from a range of local government, conservation and recreation organizations, local resource agencies, and state programs.

The primary land use in the watershed is agriculture and silviculture including row crops, hog and chicken farms, several large sod turf farms and areas of extensive timber lands. The topography of the LWP study area is characterized by nearly level uplands that transition into wide, seasonally and permanently flooded riparian corridors along the four named streams – Great Coharie Creek, Beaverdam Swamp, Kill Swamp and Sevenmile Swamp, shown in Figure ES 1 below. Note that Great Coharie Creek was divided into two subwatersheds for analysis, Great Coharie Creek and Great Coharie Headwaters.

The mainstem channels are blackwater streams with a complex of natural and manmade impoundments. Blackwater streams are given their name because the water is deeply colored by the tannins in decaying vegetation as it flows through swamps and wetlands. Fallen trees along with active and historic beaver dams restrict flows and spread water onto the active floodplains. Beyond the four named mainstem channels, a vast, interconnected network of unnamed tributaries and manmade ditches extend the hydrologic network into the upland agricultural areas and serve to rapidly transport water into the mainstem channels, where it then slowly drains toward the outlet of the study area.

There is a nearly 5,000 acre protected riparian corridor along Great Coharie Creek that is owned and managed by the state Stewardship Program and has been designated as a Natural Heritage Program (NHP) Natural Area because it supports two populations of the Significantly Rare bluff oak (*Quercus austrina*) and contains an extensive area of Cypress Gum Swamp natural community. This corridor begins in the lower portion of the planning area. The Great Coharie Creek flows through the center of Sampson County and joins Little Coharie Creek and Six Runs to form the Black River. The Upper Black River Aquatic Habitat HNP Natural Area contains populations of two rare fishes, Federal and State Species of Concern broadtail madtom (*Noturus species*) and State Special Concern thinlip chub (*Cyprinella species*). There are also three rare freshwater mollusks: State Threatened eastern lampmussel (*Lampsilis radiata*), State Special Concern pod lance (*Elliptio folliculata*) and State Significantly Rare eastern creekshell (*Villosa delumbis*).

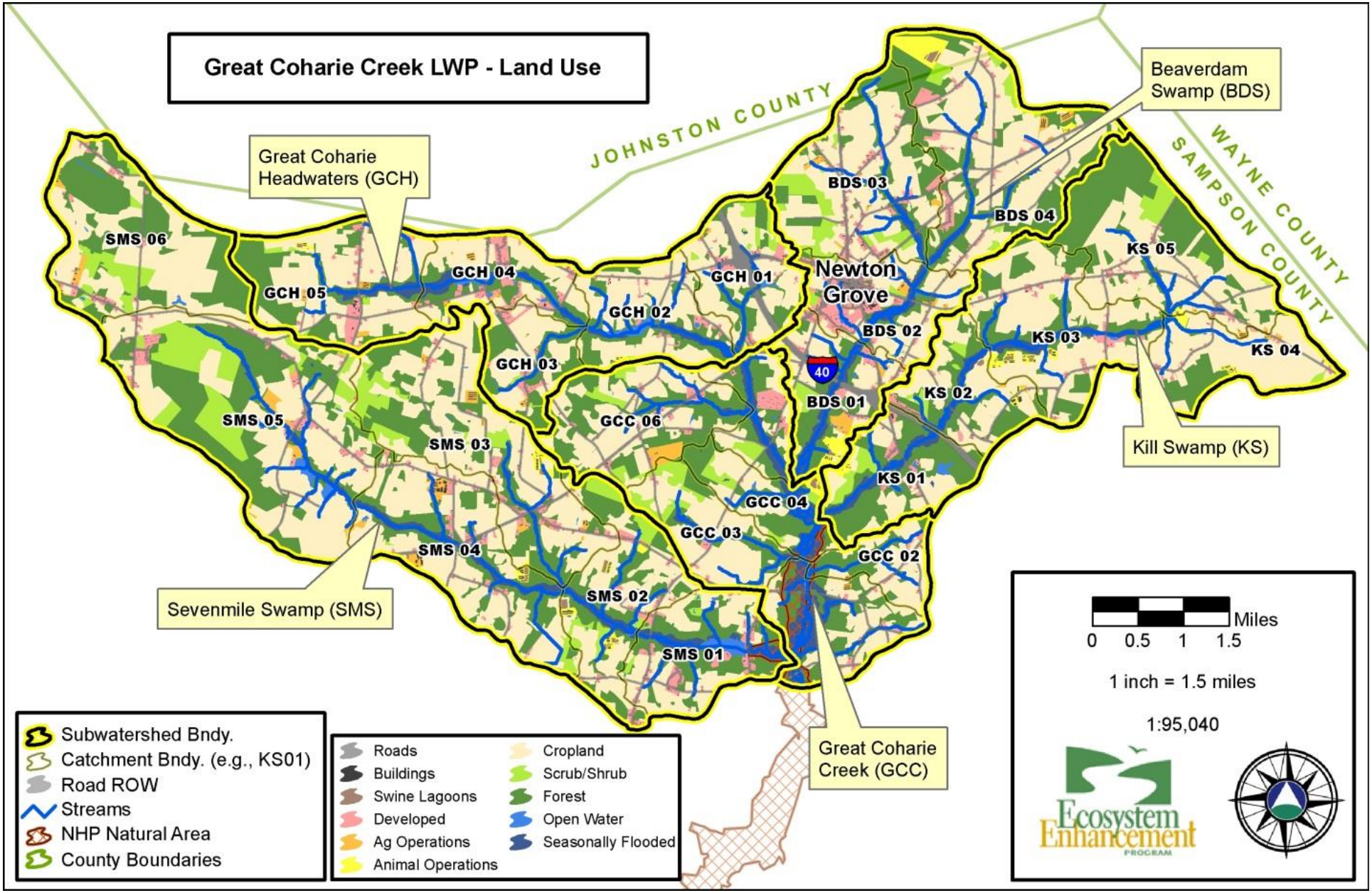

Figure ES 1. Great Coharie Creek LWP study area land use.

The primary water quality concerns in this watershed are nutrient and sediment inputs from agriculture. High nutrient and sediment loads enter the fluvial system from the network of ditches and waterways, especially where there are no buffers. The term waterways in this report refers to hydrologic features that were digitized in natural valleys in the transition zones between the flat uplands and the wide mainstem floodplains. The forests and seasonally flooded riparian floodplains along the mainstem streams provide the highest hydrology, water quality and habitat watershed functions within the study area. They slow flood waters, releasing water during lower flows; significantly improve water quality, especially in the saturated root zones of woody riparian vegetation; and provide important aquatic and riparian habitat. These wide mainstem swamps act as natural filters, sustaining and improving water quality as water moves through the system.

Efforts to restore and protect the Great Coharie Creek local watershed should focus on two primary goals.

1. Reduce runoff and erosion by slowing and filtering water, nutrients and sediment at their source in the fields. This could be accomplished through agricultural best management practices (BMPs), installing vegetated buffers along ditches and waterways, and allowing ditches to become naturally vegetated with plants.

2. Protect the riparian floodplains. These seasonally flooded mainstem riparian zones are the most important feature of the Great Coharie Creek and provide tremendous ecological functions. They help sustain the rich natural heritage in the Great Coharie Creek and the Black River.

In Section IV, Table 7 includes information on the sources of the various stressors, their primary functional impacts pertaining to water quality, habitat, and hydrology, and a summary of the recommendations developed to address the various categories of stressors and sources.

The watershed management recommendations contained within Section IV of the Plan include specific conservation projects cataloged in Appendix C. Stream and wetland restoration projects and agricultural BMPs were identified and prioritized. In order to conserve the natural and cultural heritage of the Great Coharie headwaters, preservation projects were also identified along the mainstem riparian channels. Recommended vegetation management sites are also included in Appendix C. A number of non-project related management activities are also recommended to address both existing and future threats to stream health.

During this project valuable water quality data was collected on a swamp system for which little was previously known. DWR, EEP, and the academic community should continue to research the ecology and function of the Great Coharie Creek headwaters. Additional research is needed about nutrient processing, dissolved oxygen cycles, beaver dams and sedimentation of blackwater systems such as this.

In order to improve and protect streams and rivers in the watershed, a coordinated effort to implement the management recommendations is described in Section V. A specific strategy has been developed to guide this effort, which recommends the establishment of an Implementation Team with a clear mission, established roles, and consensus goals and objectives to be achieved over the next several years. Implementation of plan recommendations can be achieved with the aid of technical resources and possible funding sources; these are compiled within Section VI of the Plan.

List of Acronyms and Abbreviations

BMPs	Best Management Practices
cfu/mL	Colony Forming Units/100 milliliters
DSWC	Division of Soil and Water Conservation
DWR	Division of Water Resources
DWQ	Division of Water Quality
EEP	Ecosystem Enhancement Program
EPA	US Environmental Protection Agency
GIS	Geographic Information System
IBI	Index of Biological integrity
IT	Implementation Team
LAT	Local Advisory Team
LIDAR	Light Detection and Ranging
LWP	Local Watershed Plan
NCDENR	North Carolina Department of Environment and Natural Resources
NCDOT	North Carolina Department of Transportation
NCWRC	North Carolina Wildlife Resources Commission
NHP	Natural Heritage Program
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
PFR	*Preliminary Findings Report*
SWCD	Soil and Water Conservation District
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USGS	United States Geological Survey
WAR	*Watershed Assessment Report*
WMP	*Watershed Management Plan*

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SECTION 1. Introduction

This section provides an overview of the North Carolina Ecosystem Enhancement Program (EEP) and its general approach to local watershed planning (LWP). It also provides context for the plan by providing some general characteristics of the Great Coharie Creek (GCC) watershed LWP study area and an overall timeline of the planning effort. The GCC watershed-specific goals, developed in conjunction with the Local Advisory Team (LAT), are also included in this section.

This *Watershed Management Plan* makes recommendations to improve the watershed functions of hydrology, water quality and habitat within the 53 square mile GCC headwaters planning area in northern Sampson County, including the Town of Newton Grove.

This plan was developed by Triangle J Council of Governments (TJCOG) in cooperation with staff from EEP and the NC Division of Water Resources (formerly the Division of Water Quality). The project was conducted with guidance and input from the LAT, which includes representatives from local government, conservation and recreation organizations, and local resource agencies.

1.1. EEP Background

EEP was established in 2003 through a memorandum of agreement between the US Army Corps of Engineers, the NC Department of Transportation and the NC Department of Environment and Natural Resources. EEP was created to provide a comprehensive program for effective compensatory mitigation for permitted impacts to streams, wetlands and riparian buffers based on local watershed priorities. In addition, EEP provides an in-lieu fee program for impacts from nutrient loading in watersheds with nutrient reduction mandates. EEP's mission is to provide cost-effective mitigation alternatives that improve the state's water resources.

From its inception, EEP has focused on a programmatic watershed approach to enhancing the key ecological functions of water quality, hydrology and habitat. EEP conducts watershed-based planning, both at a regional scale to determine targeted local watersheds, and at a local scale to address local watershed needs. EEP also conducts on-the-ground restoration, enhancement and preservation projects through mitigation providers.

1.2. EEP's Local Watershed Planning Approach

EEP develops local watershed plans with guidance from local stakeholders that typically include local natural resource professionals, local government staff and community leaders. The LWPs are intended to both meet EEP's mitigation needs as well as to address local interests and priorities. LWPs are developed through a phased approach that includes:

- Phase I: Watershed Characterization;
- Phase II: Watershed Assessment; and,
- Phase III: Watershed Management Recommendations.

The purpose of the LWP process is to develop a local watershed plan to assess the specific watershed conditions, identify the assets to and stressors on ecological functions, and develop a suite of potential actions to address the identified problems and improve watershed health. EEP uses LWPs to guide its

stream, wetland and buffer mitigation efforts, and involves local stakeholders who can help implement restoration and management measures identified in the planning process.

TJCOG provided geographic information system (GIS) and mapping support to EEP during Phase I and has been leading the effort in Phases II and III. Additionally, EEP contracted with the DWR Watershed Assessment Team (DWR-WAT) to conduct water quality monitoring, vegetation and habitat assessments during the Phase II assessment period.

1.3. Planning Area Description

The GCC LWP study area consists of 53 square miles in northern Sampson County, with a very small portion of land in Johnston County, and contains the headwater of Great Coharie Creek. The study area includes the Town of Newton Grove. The headwater of Great Coharie Creek is joined by Beaverdam Swamp, Kill Swamp and Seven Mile Swamp to form the mainstem of Great Coharie Creek before leaving the planning area.

The primary land use in the watershed is agriculture and silviculture including row crops, hog and chicken farms, several large sod grass turf farms and areas of extensive timber lands. Agriculture is the most important industry within the study area and across Sampson County. The study area land use is listed in Table 1 and shown in Figure 1. Approximately 50% of the land area in Sampson County is used for agricultural production, and the study area follows a similar pattern.

Table 1. Land use as a percent of subwatershed area. Colors correspond to land use colors on map in Figure 1. Color intensity/shading is used to visually show higher percentages as darker colors and lower percentages as lighter colors.

Subwatershed	Size (mi2)	open water	seasonally flooded	forest	scrub	cropland	animal operations	ag operations	lagoon	developed	road	building
Sevenmile Swamp	18.1	1%	3%	31%	8%	48%	1%	1%	0%	4%	2%	0%
Great Coharie Creek	7.7	0%	11%	30%	5%	45%	1%	1%	0%	3%	3%	0%
Kill Swamp	10.0	0%	5%	33%	3%	51%	1%	0%	0%	3%	3%	0%
Beaverdam Swamp	9.6	0%	5%	23%	5%	49%	2%	2%	0%	8%	5%	1%
Great Coharie Headwaters	8.1	2%	5%	27%	2%	53%	0%	1%	0%	7%	4%	1%
LWP TOTAL	**53.4**	**1%**	**5%**	**29%**	**5%**	**49%**	**1%**	**1%**	**0%**	**5%**	**3%**	**0%**

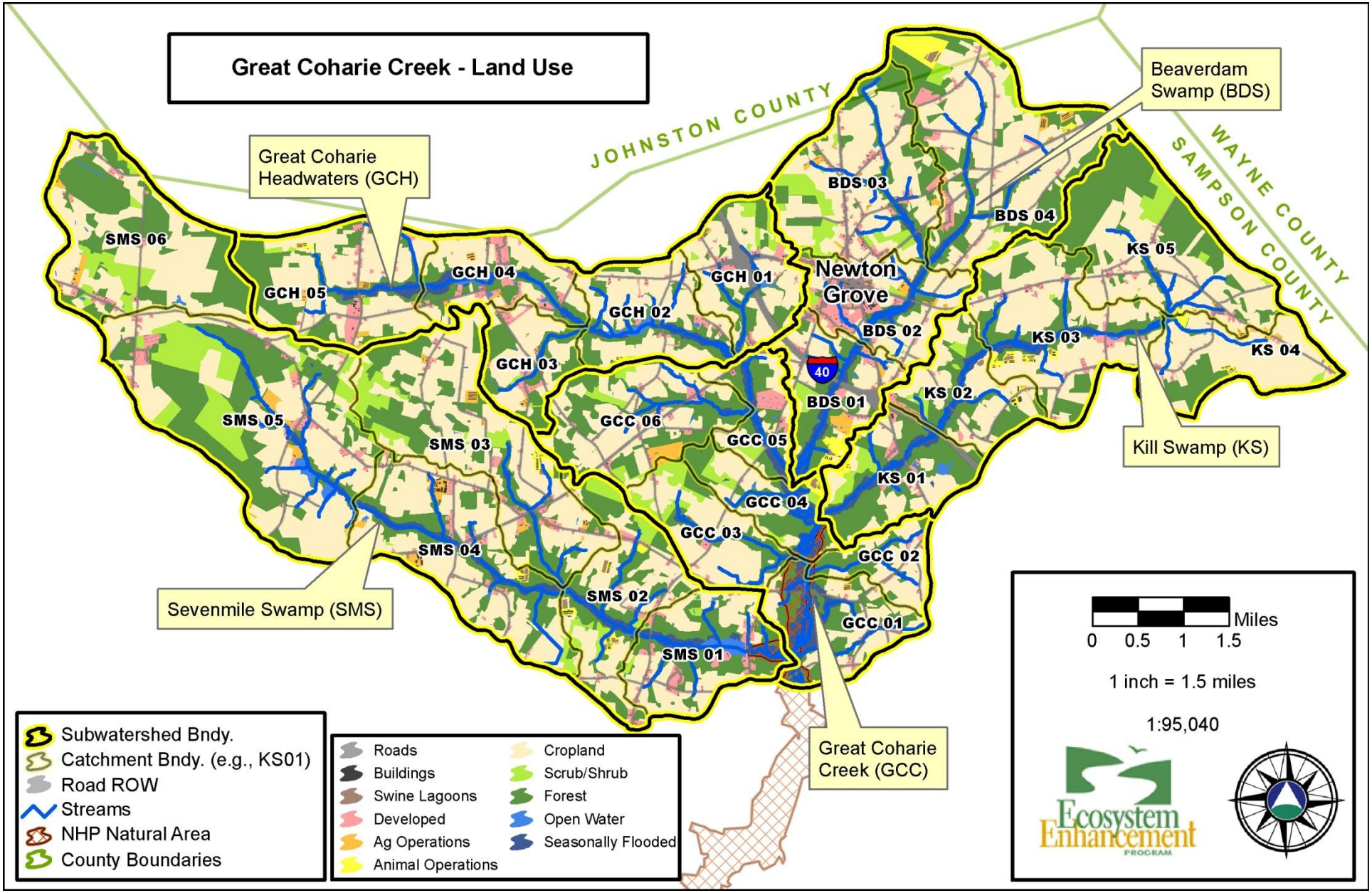

Figure 1. Map of land use in the Great Coharie LWP area. Subwatersheds are labeled with their abbreviations, which are used to label catchments through this document: GCC – Great Coharie Creek; GCH – Great Coharie Headwaters; SMS – Sevenmile Swamp; KS – Kill Swamp; and, BDS – Beaverdam Swamp.

The entire Great Coharie Creek LWP area is located in Catalog Unit (CU) 03030006 and includes three 14-digit hydrologic units (HUs):03030006090010, 03030006090015, and 03030006090020. There are four named streams (Great Coharie Creek, Beaverdam Swamp, Kill Swamp and Sevenmile Swamp) and a large number of unnamed tributaries and Carolina Bays. There are 4,704 acres of riparian corridor along Great Coharie Creek that are protected by the state and have been designated as a Natural Heritage Program (NHP) Natural Area because they support two populations of the Significantly Rare bluff oak (*Quercus austrina*) and contain an extensive area of Cypress Gum Swamp natural community. This corridor begins in the lower portion of the planning area.

The Great Coharie flows through the center of Sampson County and joins Little Coharie Creek and Six Runs to form the Black River. The Upper Black River Aquatic Habitat Significant Natural Heritage Area contains populations of two rare fishes, Federal and State Species of Concern broadtail madtom (Noturus species) and State Special Concern thinlip chub (Cyprinella species). There are also three rare freshwater mollusks: State Threatened eastern lampmussel (Lampsilis radiata), State Special Concern pod lance (Elliptio folliculata) and State Significantly Rare eastern creekshell (Villosa delumbis).

The topography of the LWP study area is characterized by nearly level uplands that transition into wide, seasonally and permanently flooded riparian corridors along the four named streams. The mainstem streams are blackwater channels with a complex of natural and manmade impoundments. Blackwater streams are given their name because the water is deeply colored by the tannins in decaying vegetation as it flows through swamps and wetlands. Fallen trees along with active and historic beaver dams restrict flows and spread water onto the active floodplains. Beyond the four named mainstem channels, numerous unnamed tributaries and extensive network of manmade ditches extend the hydrologic network into the upland agricultural areas and serve to rapidly transport water into the mainstem channels, where it slowly drains toward the mouth of the study area. The steepest slopes are found in the transition zone between the nearly level uplands and wide floodplains. The transition zone is bisected with a multitude of natural and artificial channels.

1.4. LWP Timeline

The Great Coharie Creek LWP effort began in January 2009, when EEP staff began work on Phase I and established the LAT. This was the first LWP that EEP staff conducted in-house, a departure from previous LWPs, which had been conducted by contractors. TJCOG provided GIS support to EEP staff in Phase I. Phase I was completed in December 2010, when the Great Coharie Creek *Preliminary Findings Report* (EEP 2010) was completed.

Phase II began in July 2010, and included support from TJCOG and DWR. Staff from the DWR Watershed Assessment Team (DWR-WAT) conducted several types of field assessments and water quality monitoring during Phase I and Phase II. These included watershed reconnaissance in Phase I in which DWR and EEP staff measured water quality field parameters, took photographs and worked to identify suitable longer-term water quality monitoring locations for Phase II (DWR-WAT 2010). DWR established 12 regular monitoring locations and collected field measurements and water samples monthly from July 2010 through June 2011 (DWR-WAT 2012a). Follow up single-event water quality assessments were conducted between December 2010 and June 2011 to identify major water quality stressors (DWR-WAT 2012b). Additional water quality monitoring was conducted in the spring of 2013 at five of the 12 regular monitoring locations, as well as at a reference site in the Colly Creek watershed to the south of the study area (see Figure 2) (DWR-WAT 2013a).

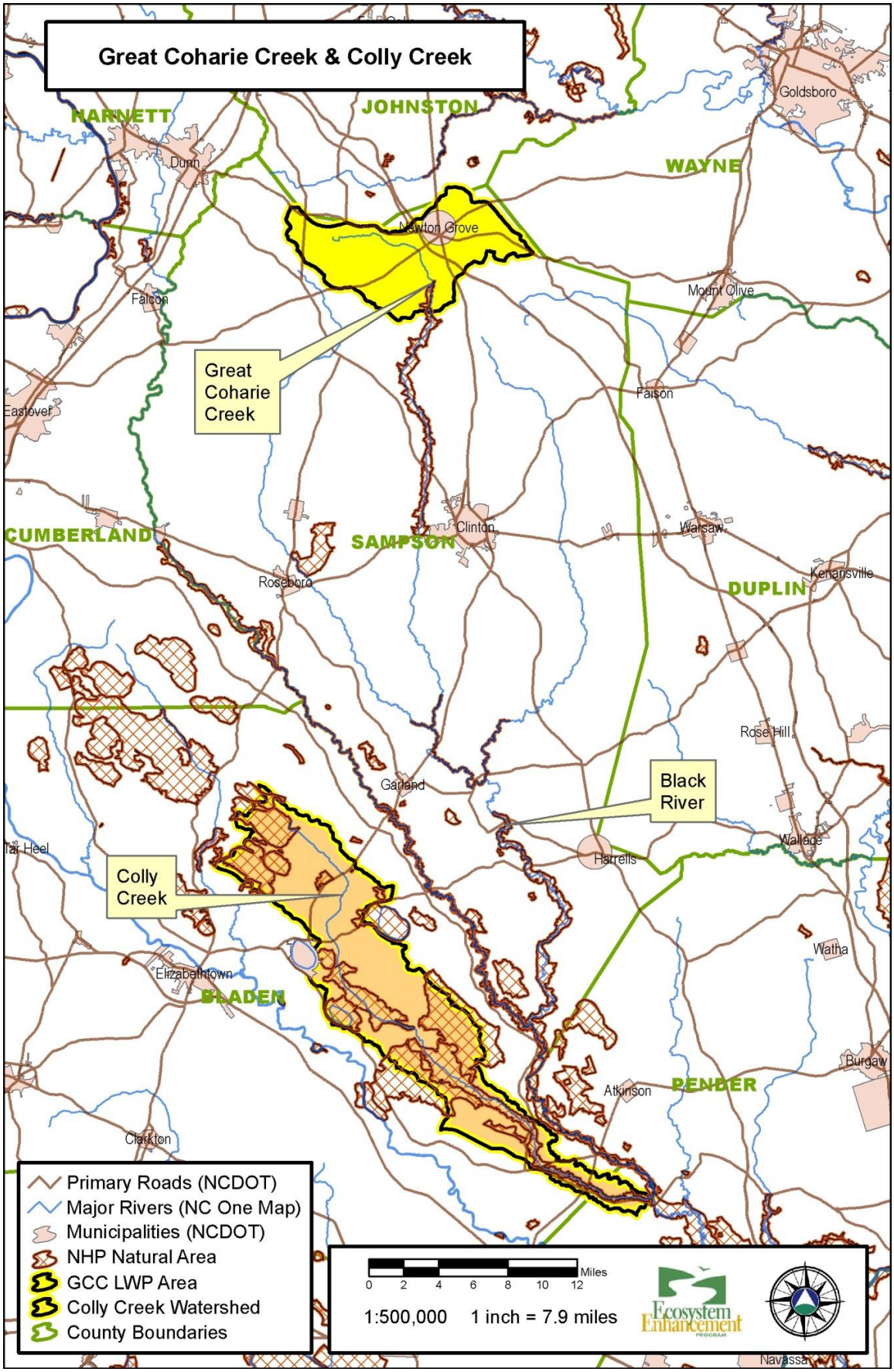

Figure 2. Great Coharie Creek and Colly Creek location.

DWR's Biological Assessment Unit (DWR-BAU) conducted benthic sampling in the LWP area in February and March of 2010 to "provide baseline data to help assess the biological response to future management plans" and "potentially identify impaired stream segments that may require immediate attention" (DWR-BAU 2010).

DWR-WAT also conducted visual surveys of aquatic vegetation in the Great Coharie Creek LWP area, primarily in August 2010 and 2011. The primary objectives of the survey effort were to assess dominant weedy vegetation within the study area and relate the potential impacts of dense growths of vegetation on water quality (DWR-WAT 2012c).

TJCOG was initially contracted to provide GIS support for Phases II and III, but was subsequently tasked to lead the Phase II and III effort following a reduction in EEP staff. TJCOG conducted field work to assess impacted stream sites in June 2012, developed detailed GIS data throughout 2013, and completed an assessment of watershed functions at the subwatershed level in early 2014. Table 2 shows the project timeline and major project activities.

Table 2. GCC project timeline and major activities.

Date	Project Activities
January 2009	GCC LWP Phase I began; LAT established
Summer 2009	DWR-WAT/EEP field reconnaissance
February-March 2010	DWR-BAU benthic macroinvertebrate study conducted
July 2010	DWR-WAT regular water quality monitoring began
August 2010	DWR-WAT aquatic vegetation surveys began
December 2010	*Preliminary Findings Report* completed; DWR-WAT follow up water quality assessments began
June 2011	DWR-WAT regular water quality monitoring and follow up water quality assessments concluded
August 2011	DWR-WAT aquatic vegetation surveys concluded
Spring 2013	DWR-WAT reference water quality monitoring conducted
Fall 2013	DWR-WAT/EEP/TJCOG wetland functional assessments conducted
June 2014	*Draft Watershed Assessment Report* completed
September 2014	*Final Watershed Assessment Report* completed; *Draft Watershed Management Plan* completed
October 2014	*Final Watershed Management Plan* completed

1.5. LWP Goals and Objectives

The overall goals of the Great Coharie Creek local watershed planning effort were to assess watershed conditions; determine the functional integrity of streams and other aquatic systems in the watershed; identify key stressors and their sources impacting water quality, habitat, and hydrology; identify ecological assets to watershed functions; and, develop a watershed management plan to protect and enhance local watershed functions including specific watershed restoration opportunities. These goals are the broad aims of the planning effort, but in conjunction with the LAT, more specific watershed assessment objectives were developed in Phase I. These are listed in Table 3.

Table 3. GCC local watershed assessment objectives.

Water Quality Objectives
WQ1. Assess water quality in the subwatersheds where stream and buffer restoration and BMPs may be most effective.
WQ2. Assess water quality at end points of subwatersheds, or where accessible, to isolate pollutant sources.
WQ3. Identify key sources and stressors in areas where biological monitoring has indicated limited biological communities.
WQ4. Enhance our understanding of how pollutants are processed from the headwaters to the mainstem of Great Coharie Creek.
Habitat Objectives
HB1. Better characterize in-stream habitat quality, identify most common habitat deficiencies and their causes and locate the areas of best in-stream habitat quality.
HB2. Better characterize riparian habitat quality, identify the most common riparian habitat deficiencies and their causes and locate areas of best riparian habitat quality.
HB3. Identify invasive aquatic species and better understand their impact on habitat, water quality and flow.
HB4. Locate existing high value forest and wetland and areas where these resources may be restored.
HB5. Identify where in-stream impacts occur due to excessive sediment inputs and investigate sediment sources of those impacts.
Hydrology Objectives
HD1. Field verify and correct hydrology GIS data and determine stream classification for streams with restoration potential.
HD2. Identify extent of channel modification and impacts to floodplain areas.
HD3. Assess flow patterns and identify sources of flow alteration.
Social Objectives
SL1. Enhance our understanding of how the community values and interacts with the aquatic resources.
SL2. Identify community's restoration goals and develop strategies to reach those goals.

During the course of this LWP, most of these objectives were achieved. Of the water quality objectives, WQ2 was somewhat limited by access to subwatershed outlets. The Project Team did, however, assess water quality where restoration is most needed, worked to isolate pollutant sources, identified key stressors, and better understands how nutrients are processed in the watershed. All of the habitat objectives were met. The Project Team and LAT better understand habitat problems and assets within the planning area, the types and locations of invasive species impacting the planning area, the locations of high-value forest and wetlands, and sources of sediment impacts. The hydrology objectives were mostly met. High-resolution GIS data has been created for the LWP area along with a data layer of seasonally flooded riparian areas. Sources of flow alteration include man-made impoundments, active and historic beaver dams, downed trees, and invasive aquatic plants. The precise extent of channel modification was not determined, but spatial data created for ditches and potential waterways suggests that extensive modifications have been made to the surface hydrology network to provide for more efficient drainage. The social objectives were met within the LAT.

There is a much better understanding among the LAT about community values and aquatic resources. The LAT's goals were identified and recommendations to address them are included herein.

SECTION 2. Stakeholder Involvement

Local stakeholder involvement is an important component in any EEP LWP effort. Within the GCC, local stakeholders represented natural resource, agricultural and extension professionals; local government staff and officials; community representatives; local residents; and cooperating state agency staff. Stakeholder involvement is critical to the success of an LWP effort, because local stakeholders help shape the goals and objectives of the project, provide local knowledge, help establish relationships with potential project sponsors and partners, and can become local champions for communicating and implementing the plan recommendations. There is no substitute for local knowledge, buy-in and involvement in EEP local watershed planning; the success of the planning effort hinges on engaging local professionals and interested community members.

There are several specific ways that the Great Coharie Creek local advisory team (LAT) was engaged in the LWP process:

- Helped establish local watershed assessment objectives;
- Identified specific problem areas within the LWP study area where impacts or degradation was occurring and where management measures, such as enhancement or restoration projects may be needed;
- Identified watershed assets and areas of local ecological and community value;
- Provided data to help characterize or assess watershed conditions;
- Provided input on and feedback to technical information being developed during the LWP;
- Understood results of water quality monitoring, benthic macroinvertebrate studies, vegetation surveys, stream and wetland assessment, and subwatershed functional determinations;
- Provided input to and feedback on potential watershed recommendations, management measures and watershed restoration project opportunities;
- Identified and help establish connections with potentially willing landowners whose properties have been identified for restoration or conservation projects; and,
- Understood watershed management recommendations that require or would benefit from local champions.

The GCC LAT was established in 2009, and met eight times to provide input and receive updates from the Project Team, which consisted of EEP, TJCOG and DWR staff. The GCC LAT members are listed below in Table 4, and the Project Team members are shown in Table 5. The LAT meeting dates and topics are shown in Table 6.

Table 4. GCC Local Advisory Team members.

LAT Member Name	Organization
Kristen Howell	Cape Fear Arch
Roger Sheats	Cape Fear River Assembly (previously)
Diana Rashash	Cooperative Extension Service
Dan Bailey	Cooperative Extension Service
Eileen Coite	Cooperative Extension Service
Kent Wooten	Cooperative Extension Service (previously)
Roger Hart	Division of Forest Resources
Grant Jones	Division of Forest Resources
Sarah McRae	Fish and Wildlife Service
Janet Gray	Fort Bragg
Carl Warren	Friends of Sampson County Waterways
Cebron Fussell	Friends of Sampson County Waterways
Don Meece	Friends of Sampson County Waterways
Ralph Hamilton	Friends of Sampson County Waterways
Richard Mason	Friends of Sampson County Waterways
Robert Von Hagel	Friends of Sampson County Waterways
Joel Rose	Local Citizen
R. Gerald Warren	Local Citizen
Camille Warren	Local Citizen
Raeford Daughtry	Local Citizen
Susan Cook	Local Citizen
Faye Lewis	Mid-Carolina Council of Governments
Jim Caldwell	Mid-Carolina Council of Governments
Joel Strickland	Mid-Carolina Council of Governments
Judy Ratcliffe	Natural Heritage Program
Jacob Giddens	Natural Resource Conservation Service (previously)
Renee Leech	Natural Resource Conservation Service
Eric Galamb	Office of Land and Water Stewardship
Grant Jones	Sampson County Division of Forest Resources
Raymond Spell	Sampson County Parks and Recreation
Mary M. Rose	Sampson County Planning
C. Lee Cannady	Sampson County Public Works
Melanie Harris	Sampson County Soil and Water Conservation District
Gary Herring	Town of Newton Grove
Gerald Darden	Town of Newton Grove

Table 5. GCC Project Team members.

Project Team	Organization
Nancy Daly	NC Ecosystem Enhancement Program
Steve Kroeger	NC Division of Water Resources
Stratford Kay	NC Division of Water Resources (previously)
Angie Ackerman	NC Ecosystem Enhancement Program
Kristin Miguez	NC Ecosystem Enhancement Program
Michele Drostin	NC Ecosystem Enhancement Program (previously)
Mike Schlegel	Triangle J Council of Governments
Sarah Bruce	Triangle J Council of Governments

Table 6. GCC Local Advisory Team meeting dates and summary of topics. From August 2010 through December 2012, the LAT did not meet, but the Project Team met regularly as fieldwork was conducted, EEP underwent staff change, and TJCOG took on a larger project role.

LAT Meeting Date	Meeting Topics
April 29, 2009	Initial LAT meeting. Discussed LWP process, LAT roles and interests, existing data sources, biological and water quality monitoring plans, outreach ideas. Brainstormed initial watershed problems, assets and barriers.
August 26, 2009	EEP presented LWP process, DWR presented monitoring activities and discussed initial observations, EEP discussed types of projects they conduct, and LAT developed initial watershed goals.
September 14, 2009	EEP, DWR and TJCOG provide project updates, LAT discussed potential outreach activities, Friends of Sampson County Waterways discussed their interest in creating a paddle trail and the problem of invasive aquatic plants, and the LAT conducted a field visit to discuss potential project types and criteria.
January 6, 2010	The main purpose of the meeting was to review progress on the *Preliminary Findings Report* and provide feedback on the direction. LAT reviewed watershed goals and stressors tables. LAT discussed priorities and listed beaver, invasive plants, reduced flow, sediment, nutrients and BOD.
August 11, 2010	LAT reviewed *Preliminary Findings Report*.
December 6, 2012	Project Team provided updates, TJCOG had been tasked to lead the Phase II/III effort. EEP reviewed planning process, TJCOG discussed Phase II objectives and activities, DWR presented the results of the vegetation study, TJCOG presented results of stream assessments.
November 22, 2013	Project Team provided updates, LAT discussed watershed functions and reviewed considerations used in the functional assessment, TJCOG presented preliminary results of functional assessment.
October 7, 2014	Project Team provided updates, LAT reviewed *Watershed Assessment Report* and *Watershed Management Plan*, discussed future efforts.

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SECTION 3. Watershed Characterization

This section provides a brief overview of the Great Coharie Creek study area along with the watershed assessment methodologies, general characteristics, focus areas, and results of the functional assessment. This information comes primarily from the Phase I *Preliminary Findings Report* (EEP 2010), Phase II *Watershed Assessment Report* (TJCOG 2014) and the Division of Water Resources *Water Quality Integrated Analysis Report for the Great Coharie Creek Local Watershed Plan* (DWR-WAT 2013a).

3.1. Assessment Methodology

To assess conditions in the Great Coharie Creek local watershed study area EEP, TJCOG, and DWR conducted several desktop and field assessments in Phases I and II. The subsections below summarize the assessments methods from Phase I and II including water quality, macroinvertebrate, and vegetation sampling; stream and wetland assessments; and, geographic information systems (GIS) desktop analysis and functional assessments. Field assessment sites are shown on Figure 2.

3.1.1. Phase I

The first phase of the project was designed to characterize watershed conditions based on exiting information, identify critical data gaps, identify preliminary functional assets and stressors, delineate subwatersheds and catchments, and identify preliminary priority areas and detailed assessment objectives. In Phase I, EEP staff conducted a preliminary "windshield" survey of the watershed to observe watershed conditions, and DWR-WAT staff performed a reconnaissance of potential water quality monitoring locations. Additionally, TJCOG staff provided GIS support, compiled existing GIS data layers, developed maps to help characterize watershed conditions, and delineated subwatersheds and catchments.

3.1.1.1. Watershed Reconnaissance

DWR-WAT staff conducted initial reconnaissance at over 100 locations where roads crossed steams and ditches. The purpose of the reconnaissance was to identify suitable locations for water quality monitoring. At each reconnaissance location, field meter data (water temperature, dissolved oxygen, specific conductance, and pH) were collected, photographs were taken, and notes were made about flow conditions. Water samples were collected at six locations in August and September 2009 and analyzed for fecal coliform bacteria and nutrients (Ammonia-Nitrogen, nitrite + nitrate Nitrogen, Total Kjehldahl Nitrogen, and total phosphorous).

3.1.1.2. GIS Data Compilation

TJCOG staff provided GIS support in Phase I and collected existing data layers from multiple sources including Sampson County and the NC Center for Geographic Information and Analysis, which provides a clearinghouse for NC geographic data layers from federal, state, and local sources. GIS data layers collected and characterized in the *Preliminary Findings Report* (EEP 2010) include surface hydrology, zoning, ecoregions, topography, soils, and land cover.

3.1.1.3. Subwatershed Delineation

TJCOG staff delineated the 53 square-mile study area into five subwatersheds and 26 catchments (see Figure 1) to provide smaller units for evaluation throughout the LWP. The five subwatersheds included the four named streams of Sevenmile Swamp, Kill Swamp, Beaverdam Swamp and Great

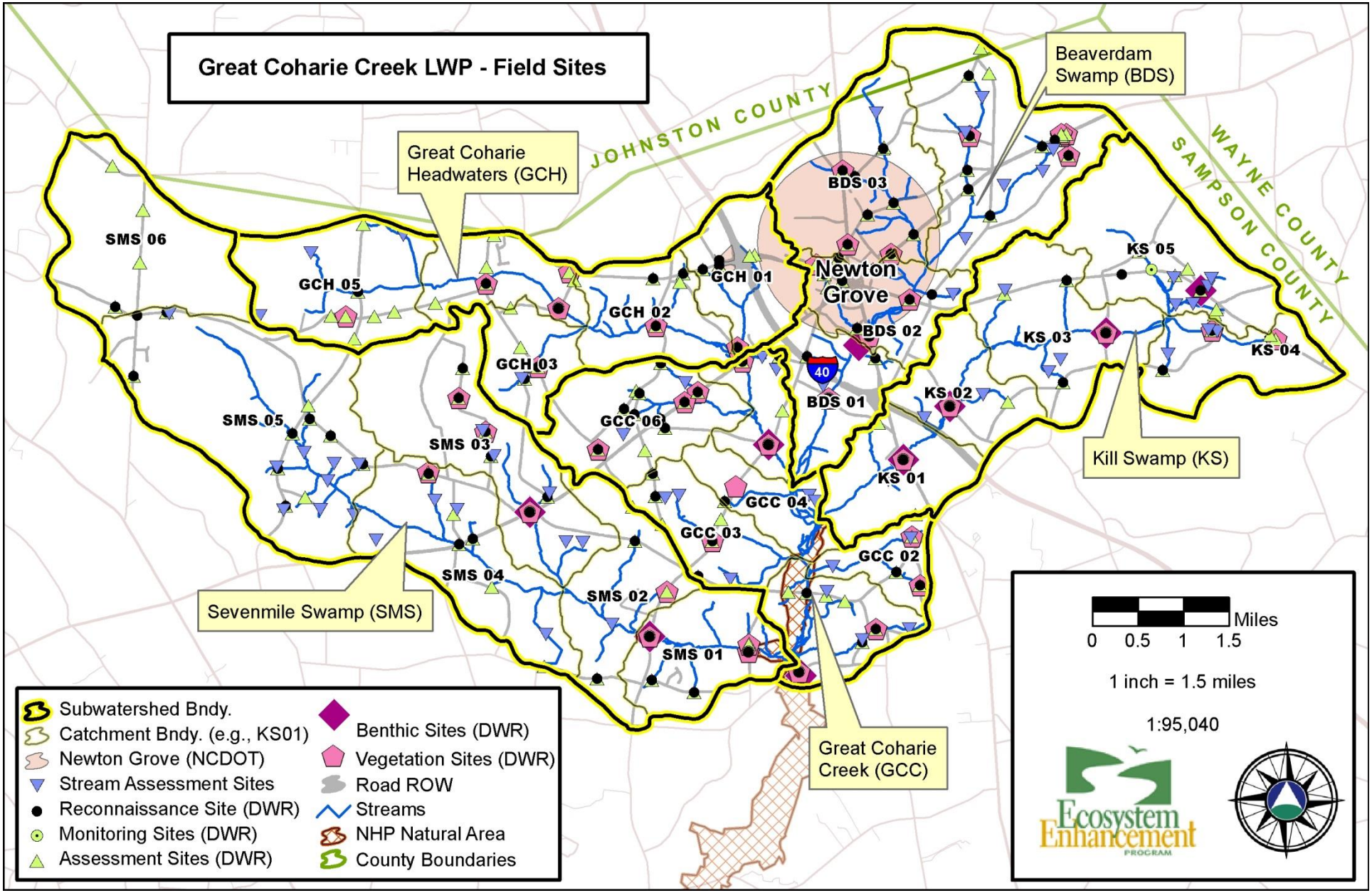

Figure 3. Great Coharie LWP field assessment sites.

Coharie Creek, which was split into two subwatersheds (Great Coharie Creek and Great Coharie Headwaters). A total of 26 catchments were delineated, ranging from 0.8 square miles to 5.0 square miles, with most catchments between 1.0 and 3.0 square miles.

3.1.2. Phase II

The second phase of the project was a detailed assessment of watershed stressors, sources and conditions designed to determine the problems and assets within the study area. The assessment objectives (Table 3) guided the work, which included both field assessments and desktop analysis. TJCOG, DWR-WAT and DWR-BAU, and EEP staff conducted the following field studies:

- Water Quality Monitoring and Assessments (DWR-WAT);
- Aquatic Vegetation (DWR-WAT);
- Macroinvertebrates (DWR-BAU);
- Stream Assessments (TJCOG); and,
- Wetland Assessments (DWR-WAT/TJCOG/EEP).

Additionally, TJCOG conducted the following desktop analysis:

- Land Use Analysis;
- Surface Hydrology Analysis;
- Wetland Analysis; and,
- Functional Assessment.

A summary of the field assessment and desktop analysis methods is provided below.

3.1.2.1. Water Quality Monitoring and Assessments

DWR-WAT staff conducted monthly water quality monitoring at 12 stations from July 2010 to June 2011 at mainstem locations identified in the Phase I reconnaissance (see Figure 3). Follow-up water quality assessments were done at 78 smaller-order sites from December 2010 to June 2011. A reference study was done in the spring of 2013 at five of the 12 monitoring stations along with two nearby streams, an agriculturally impacted one and a relatively unimpacted reference site. DWR produced three reports on the water quality monitoring and assessment activities in the Great Coharie Creek LWP area:

1) *Summary of Water Quality Monitoring Results for the Great Coharie Creek LWP Area: Technical Memorandum*. (DWR-WAT 2012a) Report dated March 29, 2012. This report briefly summarizes the findings of water quality monitoring at twelve sites within the Great Coharie Creek LWP area.

2) *Results of Water Quality Assessments in the Great Coharie Creek LWP Area: Technical Memorandum*. (DWR-WAT 2012b) Report dated June, 2012. This report summarizes findings of water quality follow-up assessments to locate potential sources of water quality degradation and nutrient enrichment across the LWP area.

3) *Water Quality Integrated Analysis Report for the Great Coharie Creek Local Watershed Plan: Final Report*. (DWR-WAT 2013a) Report dated November 2013. This report provides a discussion and interpretation of the significant findings of water quality investigations conducted within the Great Coharie Creek LWP area.

3.1.2.2. Aquatic Vegetation

DWR-WAT conducted visual surveys of aquatic vegetation in the Great Coharie Creek LWP area at 73 locations from August 2010 to August 2011. Objectives of the survey were to assess dominant weedy vegetation within the Great Coharie Creek LWP area and the potential impacts of dense growths of vegetation on water quality. In addition, the survey was intended to provide stakeholders with information to leverage funding for management activities, and provide additional information to examine the relationships between benthic macroinvertebrate populations and presence of vegetation. A description of the visual survey methods and results is included in the report, *Distribution of Vegetation in the Great Coharie Creek Local Watershed Planning Area: Final Report* (DWR-WAT 2012c).

3.1.2.3. Macroinvertebrates

The DWR Biological Assessment Unit (DWR-BAU) conducted benthic macroinvertebrate studies at several mainstem locations in the study area in February and March 2010. The purpose of their study was to identify potentially impaired stream segments that may require immediate attention, and to provide baseline data to help assess the biological response to future management strategies. Their report, *Results of Macroinvertebrate Assessment in the Upper GCC Watershed Conducted in February and March 2010* (DWR-BAU 2010) presents the process and results of benthic sampling.

3.1.2.4. Stream Reach Assessments

TJCOG conducted stream channel field assessments at 51 small channel locations in June 2012 that appeared on GIS to be likely impacted and degraded. The overall purpose of the Stream Reach Field Assessments was to assess stream sites that seem to indicate, via desktop analysis, potential for restoration or enhancement projects to improve hydrology, habitat, and/or water quality functions. The second purpose was to document baseline conditions at these sites to help evaluate functional uplift provided by future restoration or enhancement projects or watershed management activities. As such, sites were selected for field assessment that appeared to be impacted in some way.

3.1.2.5. Wetland Assessments

DWR and EEP staff conducted wetland functional assessments at nine locations in the study area in Fall 2013 using the NC Wetland Assessment Methodology (NCWAM 2010). The purpose of this work was to provide EEP with information regarding wetland condition and function and to help identify wetland enhancement opportunities in the planning area.

3.1.2.6. Land Use Assessment

A detailed field-scale land use GIS data layer was developed from aerial photographs in Phase I and refined in Phase II. Land use categories included forest, open water, seasonally flooded, scrub, cropland, animal operations, agricultural operations, swine waste lagoon, developed, roads, and buildings.

3.1.2.7. Surface Hydrology Assessment

The process for developing detailed hydrology layers for streams, waterways and ditches began with the USGS 24K surface hydrology dataset. The Carolina Bays, open water, swine lagoons, streams and ditches were separated into separate, individual data layers. A feature was classified as a ditch if no stream valley was indicated on the topography. Features within a stream valley were classified as streams. The spatial location of streams and ditches was corrected from aerial photographs.

Potential waterways were digitized using USGS 7.5' topographic quads such that the center line of valleys where two or more contour lines curved at a 90 degree or less angle. In the Great Coharie

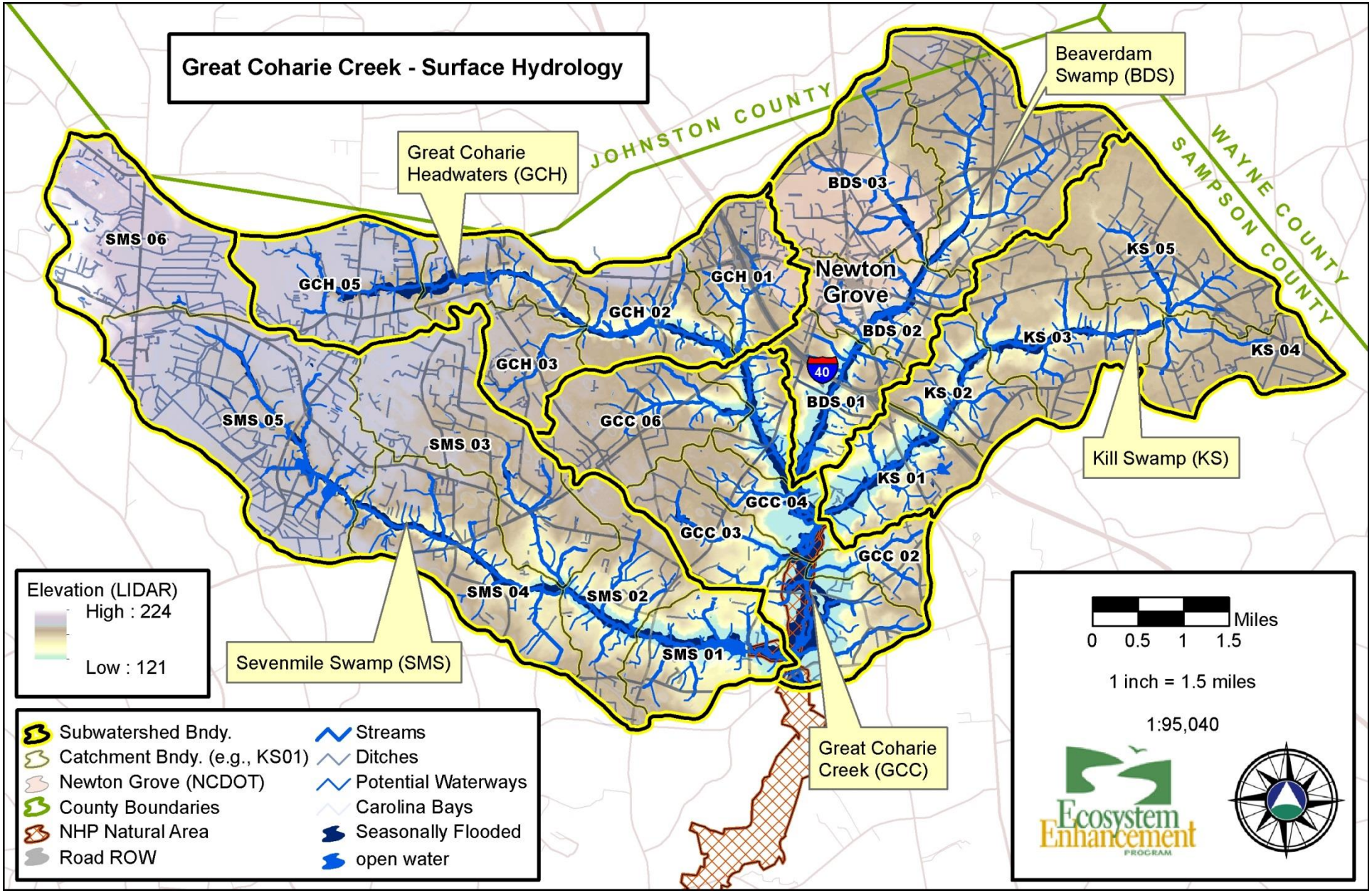

Figure 4. Surface hydrology features in the Great Coharie Creek LWP study area.

Creek (GCC) study area, these features exist exclusively in the transition zones between the flat uplands and the wide mainstem floodplains.

Additional ditches were identified and digitized from aerials at a scale of 1:2,000. The GCC watershed area had a tremendous amount of ditches along roadways, in developed areas, and within and along the edges of fields. In total, over a million feet of additional ditches were digitized from aerial photographs.

Using the aerial photographs overlaid with contour data and the 100-year floodplain, the boundaries of impounded and inundated areas were digitized from the aerials where visible, and inferred from contours and floodplain boundaries where they were obstructed with forest cover.

Figure 4 shows the vast interconnected network of stream, waterways and ditches.

3.1.2.8. Functional Assessment

The functional assessment considered hydrology, water quality and habitat conditions within the LWP area. This involved developing and applying a functional approach suitable for use in the beaver-complex conditions in the Great Coharie Creek study area. Functional approaches used in previous LWP efforts and EEP guidance documents were reviewed, and a rating-based approach was selected as the most suitable. The rating-based approach used a combination of qualitative and quantitative data along with manual spatial analysis based on a described set of conditions expected under different levels of function. The GCC functional rating tables (Tables 14-16 in the *Great Coharie Creek Watershed Assessment Report*, TJCOG 2014) included land use, surface hydrology and wetlands/floodplains. The manual spatial analysis considered the pattern, proximity, and connectedness of land uses and a dense network of ditches, waterways, streams, and seasonally flooded channels. For this approach, a multi-parameter descriptive rating table was developed for each function and for high, at-risk, and low functional conditions. At-risk+ and at-risk- were used when the catchment included indicators from both high and at-risk or at-risk and low, respectively The rating table included indicators of high functioning, at-risk functioning, and low functioning. Individual functional scores were determined for each catchment for hydrology, water quality, and habitat, and the three functional scores were averaged to determine an overall function score for each catchment (see Figure 6 in Section 3.3.1 for a map of the functional assessment results by catchment).

3.2. General Watershed Characteristics

The Great Coharie Creek local watershed planning area is characterized by nearly flat uplands that transition steeply into wide, forested floodplains. The uplands contain extensively ditched agricultural and managed pine lands. The transition areas are primarily forested and transected with small channels and waterways. The floodplain exists as an inundated complex of beaver dams and other man-made and natural impoundments. The LWP area, and Sampson County in general, have a long-standing agricultural heritage. Sampson County boasts the highest concentration of hog and poultry farms in the state, and the study area includes numerous hog and chicken farms.

The vast network of streams, waterways and ditches has a profound influence on the hydrology and water quality of the system. The high density of ditches means that precipitation and accompanying sediment and pollutants are rapidly transported from the uplands through the ditches and waterways to the streams. The forests and seasonally flooded riparian floodplains along the mainstem streams provide the highest hydrology, water quality and habitat watershed functions within the study area. They slow flood waters, releasing water during lower flows; significantly improve water quality, especially in the saturated root zones of woody riparian vegetation; and provide important aquatic and

riparian habitat. These wide mainstem swamps act as natural filters, sustaining and improving water quality as water moves through the system.

3.2.1. Hydrology

Hydrology is the movement of water from uplands through the ditches and waterways and streams to the outlet of the watershed planning area. Hydrology influences and drives the other watershed functions. For example, the magnitude, velocity, and timing of runoff and peak flows influence floodplain function, water quality, habitat, and geomorphology. In the Great Coharie Creek LWP area, water moves rapidly from uplands into ditches and waterways, but then moves slowly through the streams because of the gentle longitudinal slope and frequent flow obstructions. Most of the ditches in the watershed have little to no riparian vegetation to slow overland runoff. Additionally, many ditches are deep channels that intersect the groundwater table, increasing the flows to ditches.

Within the mainstem streams, frequent flow obstructions and impoundments slow the flow as it moves through the watershed. Flow obstructions also serve to cause water to move laterally into the floodplains. The wide, seasonally flooded riparian floodplains provide excellent hydrology function and retain flood waters, reducing flooding downstream and slowly releasing water back into the main channel as the water level drops. Slower moving water and inundated floodplains also help to process nutrients, the primary water quality concern in the watershed as described below.

3.2.1.1. Hydrology Problem Areas and Assets

Surface runoff from agricultural is quickly drained and transported to mainstem streams through a large, interconnected network of ditches and waterways. In the mainstem streams, water moves slowly and inundates the floodplain. The problem areas for hydrology are land uses that generate high runoff volumes and the network of ditches and waterways that transport it, especially those that are deep, devoid of vegetation, and with steeper slopes. These low-order channels collect surface water runoff and intercept groundwater moving both quickly to mainstem streams. The ditch density (as miles of ditch length per square mile of watershed land area) was particularly high in GCH01 (9.9 mi/mi^2), SMS05 (10.1 mi/mi^2), and SMS06 (11.0 mi/mi^2).

Hydrology assets are areas that provide good hydrology function; that is, they control the movement and retention of runoff and flow in channels. Specifically, the wide, seasonally inundated floodplains provide the best hydrology function in the planning area. These low-gradient riparian floodplains are mostly wooded and have multiple flow obstructions including fallen trees, active and historic beaver dams, culverts, aquatic plants, and man-made impoundments. The low gradient and the presence of flow obstructions force water laterally into floodplains where it is retained and released slowly as water levels drop. The mainstem floodplains are the primary hydrology assets in the study area and help moderate high flows and regulate baseflows downstream.

3.2.2. Water Quality

Water quality monitoring and assessments indicate that the conditions within the planning area are similar to other swamp systems. There is naturally low dissolved oxygen, sand and silt substrates, and high organic matter. Results also indicate that the primary water quality concern is nutrient enrichment. Nutrient levels are highest in the upper reaches of tributaries, decreasing downstream through the floodplains to the outlet of the study area.

Nutrients enter the ditches and waterways through overland runoff, subsurface flows and through airborne means when fertilizer is spread during windy conditions. Drainage tiles, which serve to increase drainage under agricultural fields, can greatly increase the export of nitrogen from

agricultural fields to ditches, and into waterways and streams. The lack of riparian vegetation on ditches exacerbates the problem by not providing any filtering function to overland runoff and increasing the likelihood of bank erosion. Additionally, deeply incised ditches intercept groundwater and concentrate flows. The lack of riparian vegetation increases sunlight penetration and results in increased water temperature and algal growth.

The mainstem channels and floodplains clean the water as it flows slowly through the swamp. There are multiple mechanisms that serve to process nutrients. Flow obstructions like downed trees and beaver dams along with man-made impoundments slow the flow and cause higher flows to spread laterally into the floodplains, and as nutrient-laden water inundates the floodplains, nutrients are taken up by plants. However, the primary denitrifying process occurs underground in the riparian areas. Under saturated conditions, bacteria on the roots of woody plants convert nitrogen in the water to harmless atmospheric nitrogen gas, which dissipates into the air. Within impounded reaches, especially where full sunlight reaches the channel, nutrients are processed and retained as algae and aquatic plants grow. This process can be temporary because when the plants die and decompose, the nutrients are released.

To summarize the water quality functions in the watershed, agricultural and developed areas with ditches void of riparian vegetation impact water quality by allowing nutrients and sediment to enter ditches, waterways and streams. The slow-moving mainstem streams with wide, inundated floodplains retain and process nutrients, essentially "cleaning" the water as it moves through the watershed.

3.2.2.1. Water Quality Problem Areas and Assets

Water quality monitoring indicated that nutrient and sediment loads were highest in low-order channels (streams, ditches and waterways) and decreased (i.e., improved) through the mainstem streams. Water quality at the outlet of the study area was better than in the headwaters (DWR-WAT 2013a). The problem areas for water quality correspond to those for hydrology – the agricultural areas that generate high runoff volumes and the network of ditches and waterways that transport it. Nutrients and sediment are entering from agricultural areas through overland runoff and subsurface drainage. Overland runoff, erosion and nutrient export are highest when fields are sloped, bare or freshly tilled, and where no buffers exist along ditches and waterways.

Ammonia nitrogen was elevated throughout the Kill Swamp subwatershed and in the Sevenmile Swamp SMS 03 catchment and appears to be the result of agricultural operations, particularly animal operations. Elevated total Kjeldahl nitrogen (TKN) corresponded with high ammonia nitrogen concentrations at the same sites. This reflects both the high ammonia nitrogen and considerable bound (organic) nitrogen. This most likely reflected agricultural fertilizer applications (DWR-WAT 2013a).

Nitrite + nitrate nitrogen (NOx) was also elevated, especially within the entire Sevenmile Swamp subwatershed, and to a lesser extent within the Kill Swamp (KS 04), Great Coharie Creek (GCC 02 and GCC 03), and Great Coharie Headwaters (GCH 03) subwatersheds. Elevated phosphorus concentrations occurred in the Kill Swamp (KS 01, KS 03, and KS 05) and Sevenmile Swamp (SMS 03) subwatersheds and appear to reflect the presence of animal operations in the watershed. Nutrient sources include agricultural field crops, turf grass production, and livestock operations (including pastures) that are present largely in headwater subwatersheds and along very small channels. NOx and TKN were significantly lower below House's Mill Pond, demonstrating that nitrogen from the headwaters is being retained or converted within the swamp and/or pond (DWR-WAT 2013a).

Water quality at the outlet of the study area was better than in the headwaters, largely because the mainstem channels are cleaning and filtering the water. A primary ecological process likely to occur under the conditions in the Great Coharie is bacterial denitrification within the saturated root zone of woody riparian plants. As the roots of woody plants become saturated, bacteria on the roots convert nitrogen from the water into harmless nitrogen gas that is released to the atmosphere. The seasonally inundated, wooded riparian zones along the mainstem channels are the most important water quality assets in the Great Coharie Creek headwaters study area.

3.2.3. Habitat

There were several assessments of habitat as part of this watershed study. The DWR-BAU conducted habitat assessments in conjunction with their biological assessments. DWR-WAT staff conducted habitat assessments at monitoring stations, along with an aquatic vegetation study. TJCOG staff conducted limited aquatic and riparian habitat assessments as part of the stream assessments.

One challenge with assessing habitat function in general is that habitat needs vary between different species. Nonetheless, habitat will be discussed within the context of in-stream habitat, riparian habitat and upland habitat. In-stream habitat conditions within the study area are negatively affected by the low dissolved oxygen. However, the low oxygen was determined to be naturally occurring and similar to other swamp systems, including the reference watershed (see Figure 2). Habitat functions are linked with hydrology and water quality functions. As an example, flows influence oxygen levels which affect habitat. Likewise, the high nutrient loads entering the watershed from agricultural areas lead to algal growth and dense aquatic vegetation, which decrease habitat function.

Riparian habitat conditions vary from the mainstem channels through the upper reaches. The wide, forested floodplains with intact wetland communities along the mainstem streams provide more habitat function. These corridors offer more habitat diversity and the wetlands are important to many aquatic and terrestrial animals during some portion of their life cycle. Likewise, the wide riparian areas provide important core interior habitat.

Upland habitat is somewhat limited within the study. A few larger forested areas exist, especially in the upper reaches of Sevenmile Swamp and the headwater of Kill Swamp, but agricultural land uses including row crops, sod farms, pasture lands and commercial hog and poultry farms dominate the upland landscape.

3.2.3.1. Habitat Problem Areas and Assets

The entire study area has naturally low dissolved oxygen, especially in the slow moving, seasonally inundated mainstem swamps. Also, the low velocity and frequent flow obstructions in the mainstem streams means that much of the sediment that enters from the ditches and waterways is deposited in the mainstem channel or on the floodplain. This keeps sediment from downstream reaches, but allows fine sediments to settle and increase the embeddedness of channel substrate, degrading habitat for aquatic macroinvertebrates and fish. Also, invasive aquatic plant species, both native and non-native, are extensive in the study area. Aquatic plants choke the stream channels in places, especially where flooding has created open water and direct sunlight. Additionally, invasive species are prevalent along the riparian areas within the study area, especially where there is a narrow buffer. This is most prevalent in the mainstem catchments along Great Coharie Creek, Sevenmile Swamp, Kill Swamp and Beaverdam Swamp (e.g., mainstem streams in GCC03, GCC05, GCH02, GCH03, GCH04, SMS03, KS01, KS02, BDS01, BDS02, and BDS04). More information about aquatic vegetation can be found in *Distribution of Vegetation in the Great Coharie Creek Local Watershed Planning Area: Final Report* (DWR-WAT 2012c).

Though the entire study area has low dissolved oxygen and extensive invasive species, both native and non-native; there are several large forests, numerous wetlands, and a largely, intact wooded riparian zone. The riparian corridor along the mainstem channels provides a diversity of habitat and provides corridors for movement. Additionally, vast wetlands, including Carolina bays and large contiguous forests in Sevenmile Swamp, are important habitat assets.

3.3. Subwatershed Prioritization

Priority catchments are summarized below based on the overall functional analysis.

3.3.1. Overall Functional Problem Areas and Assets

The functional assessment (see Section 3.1.2.8 for the outlined approach) identified three catchments where hydrology, water quality and habitat functions are the lowest, where stressors are high and problem areas are extensive. These catchments are Kill Swamp 04 (KS04), Beaverdam Swamp 02 (BDS 02) and Great Coharie Headwaters 01 (GCH 01). Beaverdam 02 includes virtually all of the Town of Newton Grove, and Great Coharie Headwaters 01 is bisected by Interstate 40 and the interchange with NC 50/55. See

Figure 5 for the functional assessment results by catchment.

Six catchments were identified in the functional assessment where hydrology, water quality and habitat functions were rated the highest, where stressors were fewer, and ecological assets were mostly intact. These catchments were Sevenmile Swamp 01 (SMS 01); Great Coharie Creek 01, 04 and 05 (GCC 01, GCC 04, and GCC 05); Kill Swamp 01 (KS01); and Beaverdam Swamp 01 (BDS 01). These catchments include the mainstem channels and outlet/confluence of all four named streams and the catchments. These areas have predominantly intact, forested, seasonally inundated riparian corridors along mainstem streams.

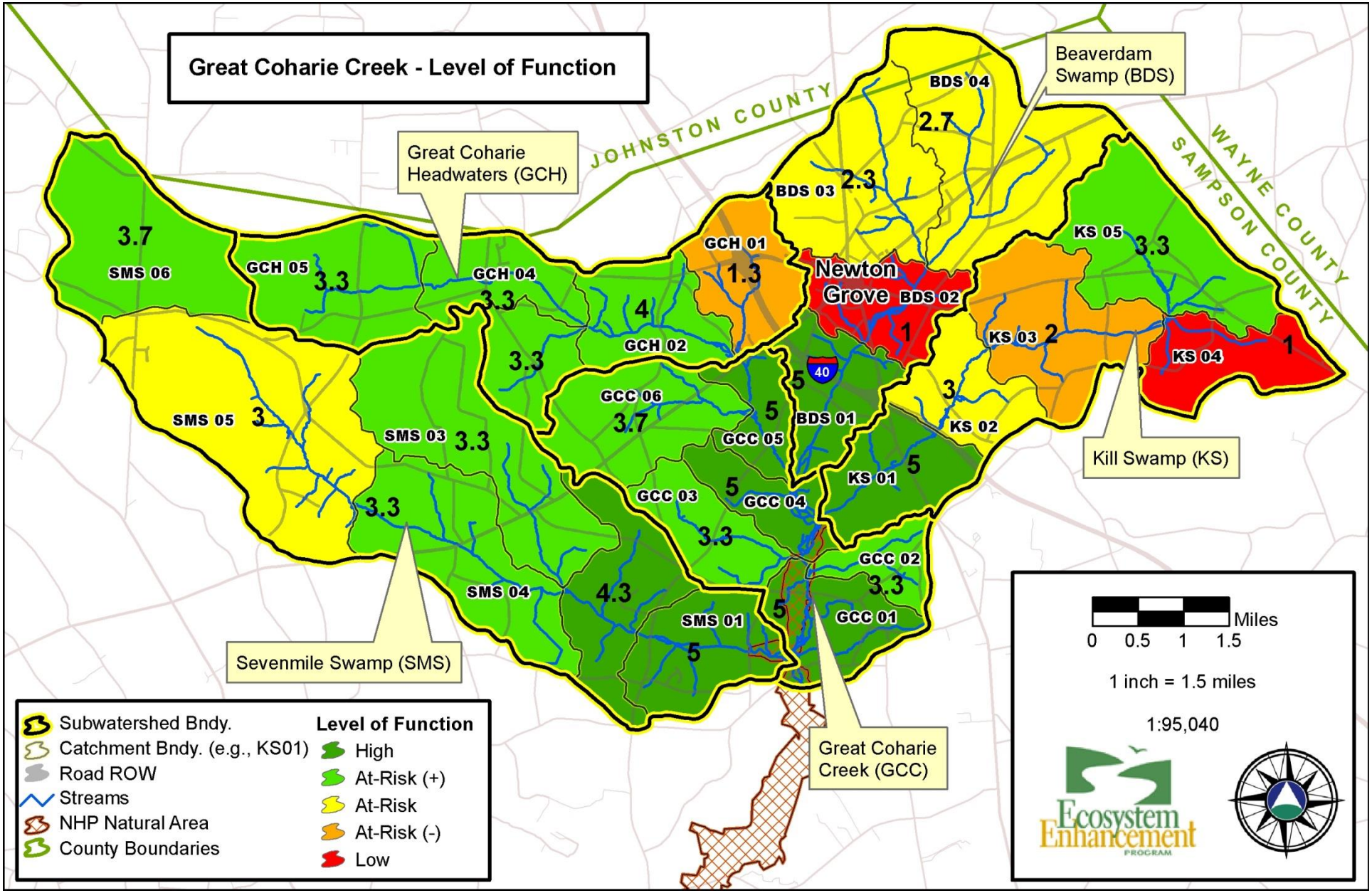

Figure 5. Functional assessment results by catchment for Great Coharie Creek LWP. Colors and numbers indicate level of function from High (5) to Low (1).

3.4. Stream, Wetland and Buffer Conditions

This section provides a summary of stream, wetland and buffer conditions and stressors within the Great Coharie Creek LWP area. Overall, the high density of ditches means that precipitation and accompanying sediment and pollutants are rapidly transported from the uplands through the ditches and waterways to the streams. The forests and seasonally flooded riparian floodplains along the mainstem streams provide the highest hydrology, water quality and habitat watershed functions within the study area. They slow flood waters, releasing water during lower flows; significantly improve water quality; and, provide important aquatic and riparian habitat. These wide mainstem swamps act as natural filters, sustaining and improving water quality as water moves through the system.

Table 7 summarizes land use and land use impacts by subwatershed, by 25- to 50-buffer (25 feet on ditches and waterways and 50 feet on streams) and by 300-foot buffer. The table also summarizes surface hydrology by length and density. Finally, potentially intact, degraded and former wetlands are shown by size and percent of subwatershed. A summary of the land use stressors, sources and functions in the Great Coharie Creek study area is provided in Table 8 and Table 10 in Section IV provides a list of major functional stressors along with impacts and management recommendations.

Table 7. GCC land use, hydrology, and wetland conditions by subwatershed.

	SMS	GCC	KS	BDS	GCH	LWP	
Size (mi2)	18.1	7.7	10	9.6	8.1	**53.4**	**Size**
Size (ac)	11,615	4,919	6,375	6,113	5,172	**34,176**	
Open Water	1%	0%	0%	0%	2%	**1%**	**Land Use**
Seasonally Flooded	3%	11%	5%	5%	5%	**5%**	
Forest	31%	30%	33%	23%	27%	**29%**	
Scrub	8%	5%	3%	5%	2%	**5%**	
Cropland	48%	45%	51%	49%	53%	**49%**	
Animal Operations	1%	1%	1%	2%	0%	**1%**	
Ag Operations	1%	1%	0%	2%	1%	**1%**	
Lagoon	0%	0%	0%	0%	0%	**0%**	
Developed	4%	3%	3%	8%	7%	**5%**	
Road	2%	3%	3%	5%	4%	**3%**	
Building	0%	0%	0%	1%	1%	**0%**	
(H) Low Impact	35%	41%	38%	28%	33%	**35%**	**Sub-WS**
(M) Moderate Impact	56%	50%	54%	54%	55%	**54%**	
(L) High Impact	9%	9%	8%	18%	13%	**11%**	
(H) Low Impact	41%	54%	43%	31%	39%	**41%**	**25-50' buffer**
(M) Moderate Impact	36%	23%	34%	31%	31%	**32%**	
(L) High Impact	24%	23%	23%	39%	30%	**28%**	
(H) Low Impact	66%	71%	60%	50%	65%	**63%**	**300' buffer**
(M) Moderate Impact	24%	23%	32%	36%	25%	**28%**	
(L) High Impact	10%	6%	8%	14%	10%	**10%**	
Streams (mi)	23.8	21.5	16	18.7	14	**94**	**Surface Hydrology**
Waterways (mi)	22	13.9	20.5	13.8	14.7	**85**	
Ditches (mi)	137.9	38	54.1	79	56.6	**366**	
Stream Density (mi/mi2)	1.3	2.8	1.6	2	1.7	**1.8**	
Waterway Density (mi/mi2)	1.2	1.8	2.1	1.4	1.8	**1.6**	
Ditch Density (mi/mi2)	7.6	4.9	5.4	8.3	7	**6.9**	
Intact Wetland (ac)	637	524	322	182	112	**1,775**	**Wetlands**
Degraded Wetland (ac)	1,910	167	314	161	519	**3,070**	
Former Wetland (ac)	1,361	385	715	542	443	**3,447**	
Intact Wetland (% of catchment)	5%	11%	5%	3%	2%	**5%**	
Degraded Wetland (% of catchment)	16%	3%	5%	3%	10%	**9%**	
Former Wetland (% of catchment)	12%	8%	11%	9%	9%	**10%**	

Table 8. GCC watershed stressors, sources, and functions.

	Source											Function		
	Ditches	Impervious surface	Land development	Roads	Riparian disturbance	Modified stream channels	Dams (beaver or mill)	Swine / poultry spray fields	Crop production	Livestock in streams	Atmospheric deposition	Water Quality	Hydrology	Habitat
Stressor														
Increased Biochemical Oxygen Demand and Sediment Oxygen Demand								x	x	x	x	x		x
High specific conductance (Uncharacterized pollution)	x	x	x	x				x	x	x				
Loss of forested buffer			x		x	x						x	x	x
Increase in invasive aquatic vegetation							x	x	x			x	x	x
Loss of in-stream habitat		x		x	x	x	x			x				x
Erosion / sedimentation		x	x		x	x			x	x		x	x	x
Loss of floodplain connection						x						x	x	x
Restricted aquatic species movement			x	x		x	x							x
Flow alterations	x	x		x		x	x					x	x	x
Elevated nutrients		x			x	x		x	x	x	x	x		x
Elevated pathogen load	x	x			x	x		x		x		x		x
Lower dissolved oxygen	x				x	x	x			x		x		x
Loss of riparian and non-riparian wetlands	x		x		x	x								
Loss of high value forest			x		x		x		x			x	x	x
Great Coharie impaired for Mercury											x	x		x

SECTION 4. Plan Recommendations

4.1. Management Strategies

This section describes the management recommendations to protect and restore hydrology, water quality and habitat functions in the Great Coharie Creek local watershed planning area. These recommendations have been developed to address both stressors and assets. Management recommendations are divided into projects and other management measures. Projects include stream and wetland restoration, enhancement, and preservation as well as best management practices to reduce agricultural impacts, erosion, and invasive aquatic plants. Other management measures include activities to engage the community in stewardship of the Great Coharie Creek watershed. Recommended watershed management measures include:

- Implement stream and wetland restoration and enhancement projects;
- Implement stream and wetland preservation projects;
- Implement agricultural BMPs, reduce erosion and control invasive aquatic plants;
- Encourage water-based recreation and community engagement;
- Promote natural heritage;
- Manage beaver impacts;
- Establish a ditch and buffer management education program;
- Recognize watershed stewards; and,
- Develop a landowner resource guide.

Efforts to restore and protect the Great Coharie Creek local watershed should focus on two primary areas.

1. Reduce runoff and erosion and by slowing water, nutrients and sediment at their source in the fields. This could be accomplished through agricultural BMPs, installing vegetated buffers along ditches and waterways, and allowing ditches to become naturally vegetated with plants.

2. Protect the riparian floodplains. These seasonally flooded mainstem riparian zones are the heart and soul of the Great Coharie Creek and provide tremendous ecological functions. They help sustain the rich natural heritage in the Great Coharie Creek and the Black River.

A summary of the management measures applicable to watershed stressors is shown in Table 10.

4.2. Projects

This subsection provides an overview of on-the-ground projects identified in the Great Coharie Creek local watershed planning area. Projects include stream and wetland restoration, enhancement, and preservation as well as best management practices to reduce agricultural impacts, erosion, and invasive aquatic plants. Collectively, these on-the-ground projects are referred to herein as Watershed Restoration Opportunities (WROs). Appendix B includes site-scale maps of the ten high priority/high feasibility sites, also listed in Table 9. Appendix C includes an index map and a table of all of the WROs identified. In total:

- There were 117 Watershed Restoration Opportunities (WROs) identified; three cross catchment boundaries and are therefore divided into parts “a” and “b”;

- There are 428 separate parcels that intersect with the WROs, with 265 unique property owners;
- There were 37 WRO sites with streams, 50 with waterways, 78 with ditches and 92 with wetlands, totaling 24 miles of streams, 9 miles of waterways, 38 miles of ditches, and 1,100 acres of wetlands; and,
- There were ten WROs classified as both high priority and high feasibility.

4.2.1. Stream and Wetland Restoration/Enhancement

Stream and wetland restoration or enhancement projects are designed to address watershed stressors and improve watershed functions of hydrology, water quality and habitat. These sites include hydrology features expected to qualify as jurisdictional streams and wetlands, but those determinations were not part of the scope of work for Phase III of the LWP.

Sites were identified several ways throughout the course of this project and generally involved field assessments and geospatial computer analysis. Potential wetland restoration, enhancement and preservations sites were determined from NC CREWS GIS data. As described in Section 3 above and in the *Watershed Assessment Report* (TJCOG 2014), streams were delineated as surface hydrology features from the USGS 24k hydrography GIS layers that also occur within a stream valley as indicated by LIDAR topography. Additional hydrology features, referred to as potential waterways or just waterways, were digitized from USGS 24k topographic quads. These features were not contained in the USGS 24k hydrography GIS layer, but are likely to be low-order ephemeral, intermittent or perennial streams. Many of these features are expected to qualify as jurisdictional waters and are therefore included in this subsection with stream and wetland restoration and enhancements. In contrast, ditches, which are surface hydrology features that do not exist within a stream valley and are not expected to qualify as jurisdictional waters, are included in the subsection containing agricultural BMPs.

During the stream assessment field work, several sites were identified for restoration or enhancement projects. Potential wetland WRO sites were identified through GIS analysis, visual interpretation of aerial photos, and stream and wetland field assessments. Additional WRO sites were identified in Phase III through a careful observation of high-resolution aerial photographs. The WRO sites were then refined, prioritized, and categorized as summarized below.

After field data collection and watershed assessments were complete, a detailed desktop analysis was conducted to identify potential project sites. Using ArcGIS, streams, ditches, potential waterways, erosional features and wetlands were examined using land use and aerial imagery to identify where degraded channels and wetlands (as well as historic wetlands) occur.

Analysis included a 50-foot buffer for streams and a 25-foot buffer for ditches and waterways. The "wets" and "rest" GIS data layers from NC CREWS was used for the wetland analysis. The NC CREWS data set contains several separate data layers. The "wets" layer contains information about wetland types as estimated by the NC CREWS analysis, and the "rest" layer contains information about wetland restoration potential. More information about the wetland analysis is included the *Great Coharie Creek Watershed Assessment Report* (TJCOG 2014).

Once potential stream, wetland, and waterway sites were identified and delineated, the sites were examined in context with parcel boundaries. An effort was made to focus on the core parcels needed to implement a project and minimize smaller, edge parcels. Some small parcel segments were still included in several WROs, where eliminating them may limit or hinder the project. After the sites were identified by parcel, projects were classified by type, feasibility, and priority.

Figure 6. Bank erosion at potential stream restoration site WRO-051.

With a thorough understanding of factors affecting feasibility, each WRO site was examined and classified as high, medium or low feasibility. Low feasibility sites often involved multiple landowners, confining infrastructure, and/or accessibility challenges, while high feasibility WRO sites typically require few landowners, have few site constraints, are easily accessible for construction equipment, and have limited upstream risk of hydraulic trespass.

Feasibility indicates the extent to which a project is practical with few barriers/constraints to its implementation. Factors that influenced feasibility included:

- Evaluation of constraints;
- Potential for hydraulic trespass;
- Number of landowners;
- Size and composition of the hydrology features; and,
- Site access.

The presence of constraints includes development and infrastructure such as buildings, roads, culverts, access roads, telephone or power poles and irrigation infrastructure (center-pivot irrigation). Feasibility was also influenced by the position of the site relative to upstream properties, with consideration of the restoration impact on upstream hydrology. WRO sites with upstream farms,

development, ditches, streams and wetlands with potential for upstream hydraulic trespass were given a lower feasibility rating.

The number of landowners needed to implement a project, along with the size and configuration of the parcel pieces were key factors in determining feasibility. In general, sites that exist within the interior of a single parcel were rated as higher feasibility. Sites requiring more landowners, especially when the parcel segments are small, were given a lower feasibility rating. The size and layout of parcels was important as well, because if a viable project could be implemented with one or two core landowners, even when the WRO site included additional landowners, then it was rated more feasible than a site that would require all the landowners to participate.

The size and composition of the hydrologic features also influenced feasibility. Taking into account, EEP's site scoring criteria, WRO sites with longer stream reaches or greater wetland areas were rated as more feasible.

Finally, potential site access influenced feasibility. Since, inundated, seasonally flooded lands are difficult to access with heavy machinery, they received a lower rating. Likewise, established development can limit construction access. Sites within agricultural fields were generally considered accessible and more feasible than sites existing within other types of land uses like shrub, forest or wetlands.

The sites were also classified with a priority of 1, 2 or 3, with 1 being the highest priority. The factors influencing priority included:

- Site conditions and severity of degradation;
- Knowledge/confidence of on-the-ground-conditions;
- Restoration uplift potential;
- Stressor reduction potential;
- Potential for nutrient and sediment reduction; and,
- Functional context of the catchment.

Like feasibility, priority was assessed through a desktop exercise using high-resolution aerial photographs and case-by-case site examination. Sites with severe active erosion were rated with a higher priority. In contrast, sites with less severe impacts were given a lower priority.

Some sites were identified as part of field observations, including the stream assessments, wetland assessments and general watershed reconnaissance. These field observations complemented the GIS analysis. Sites with confirmed field observations were generally rated higher for priority, because conditions observed in aerial imagery were verified on the ground. In some cases, knowledge of field conditions also influenced priority if field observations indicated a more stable channel than what would be indicated from aerial photos alone.

Priority was given to sites where the project could address underlying resource concerns on-site. For example, in the headwater area, where visible edge-of-field erosion is moving water, sediment and nutrients quickly to a nearby stream or waterway, addressing that problem will directly address the most common causes of impacts in the headwaters, and these WROs were rated with a higher priority.

Downstream delivery of nutrients and sediment was another factor in determining priority. This factor considers how the project would serve to reduce the velocity and volume of flow and minimize the delivery of sediment and nutrients to downstream receiving waters. If a WRO was just upstream of a large pond, it would be rated as a lower priority than a site that flows directly into a stream, since the pond is providing some treatment and implementing the WRO would have a lesser effect on minimizing delivery compared to the site without a downstream pond. In general, if an existing downstream impoundment was already providing some treatment, then the site was given a lower priority. Conversely, if the WRO would provide treatment for contributing areas upstream, then the site was given a higher priority.

Finally, another important factor in determining priority was the functional condition and uplift potential of the WRO site. This factor considered the WRO site's overall functional role, and how that function could be improved through the WRO project. Risk was also considered in this functional assessment of WRO sites; if a site has little risk of being impacted; it was generally given a lower priority. As an example, the seasonally flooded mainstem corridors included in the stream and wetland preservation subsection below provide exceptional water quality and hydrology function and good habitat function. They are some of the most important ecological assets in the watershed study area from a functional standpoint. As such, these mainstem riparian corridors are identified as preservation sites. However, because of the seasonal flooding and extreme inaccessibility of these areas, there are not at a high risk of being converted to other land uses or directly disturbed. Therefore, because of their lower risk, these sites were generally rated with a lower priority in the context of ranking the WROs. Because of the important functions the mainstem swamps provide, they should be protected and preserved in perpetuity, despite the lower priority ranking in this WMP.

In summary, the higher priority sites had severe impacts, were field verified, addressed the source of stressors and causes of impact, reduced downstream delivery of pollutants, and provided functional uplift. The lower priority sites had less severe impacts, were not field verified, could not address the root cause of stressors, had minimal influence or ability to reduce downstream delivery of pollutants, or provided limited potential for functional uplift.

There were ten WRO sites that were rated as both high priority and high feasibility. There sites are listed in Table 9 on Page 41, and site-scale maps are included in Appendix B. The first column provides the subwatershed and catchment of the WRO (GCC – Great Coharie Creek; SMS – Sevenmile Swamp; KS – Kills Swamp; BDS – Beaverdam Swamp; and, GCH – Great Coharie Headwaters). The length (in feet) of stream, waterway and ditch within each WRO is shown along with acres of wetlands. The notes column includes a brief description of the WRO. The last two columns provide the acreage within the WRO and the number of separate parcels, with darker shading indicating a higher number of parcels.

Other WRO sites are presented in Appendix C with an index map and database table of the 117 identified WRO sites.

The WRO sites in Appendix C are listed by tier. Tiers are classified as follows:

- Tier 1 – High Priority / High Feasibility;
- Tier 2 – Med-High Priority / Med-High Feasibility;
- Tier 3 – Med Priority / Med Feasibility (And Low / High);
- Tier 4 – Low-Med Priority / Low-Med Feasibility; and,

- Tier 5 – Low Priority / Low Feasibility.

4.2.2. Stream, wetland and buffer preservation

The riparian corridor along the four named mainstem streams exists as a wide, active, seasonally flooded swamp complex (see Figure 7). In general, the streams are low gradient, have low to no banks, and a well-connected floodplain that is inundated for all or most of the year. The blackwater streams have a complex flow pattern with multiple threads and frequent flow obstructions that cause the water to spread laterally into the forested riparian corridor. Flow obstructions include active and historic beaver dams, downed trees and manmade impoundments. Wetlands exist along the extent of the mainstem corridors with bottomland hardwoods and Cyprus-gum swamp communities. The well-connected floodplains and riparian wetlands provide very important flood attenuation functions, although there is a balance between retaining flood waters and flow obstructions causing upstream flooding. Dense aquatic plants, coupled with fallen trees and beaver dams significantly restrict flows. But with much of the floodplain undeveloped and forested with mature trees, this helps regulate flows downstream and provide more retention time for nutrient processing.

Figure 7. Seasonally flooded blackwater swamp along Great Coharie Creek.

Water quality monitoring indicates that these corridors are providing significant nutrient processing functions, since nutrient concentrations decrease toward the outlet of the watershed. The conditions within the mainstem corridors promote denitrification within the saturated root zones of the woody riparian trees. The watershed system, particularly within the slow moving mainstem channels, is

naturally low in dissolved oxygen, which limits the ability of aquatic life to survive and thrive. Mammals, reptiles, amphibians and birds have diverse habitats within the mostly natural and undisturbed mainstem corridors. The functional asset these mainstem corridors provide for hydrology, water quality and habitat are exceptional. The State of North Carolina owns a nearly 5,000 acre high-quality preservation tract that extends into the planning area along the mainstem of Great Coharie Creek. This site has been designated as an NHP Natural Area and includes two populations of the Significantly Rare bluff oak (*Quercus austrina*) (EEP 2010).

Mainstem riparian corridors are the single most important ecological asset in the local watershed, and are recommended for protection as preservation projects as shown in Appendix C. While they are high value sites, the WROs have been given a low priority because their inaccessibility decreases the threat of direct disturbance, and generally low feasibility because of a high number of parcels overlapping the WRO sites.

4.2.3. Best Management Practices (Agricultural, Erosion, and Invasive Aquatic Vegetation)

The third category of on-the-ground WRO projects are best management practices (BMPs) to reduce stressors from agriculture, erosion and invasive aquatic vegetation. This subsection describes these three types of BMP projects, which are shown in Appendix C. The BMP sites rated as both high priority and high feasibility are included in Table 9 on Page 41.

4.2.3.1. Agricultural BMPs

Agriculture is the most important industry in the LWP area, and agricultural land uses including row crops, pasture lands, hog and chicken farms, sod turf farms and commercial agricultural operations dominate the landscape. These types of land uses are very important to the local economy and way of life, but can also be sources for functional stressors to hydrology, water quality, and habitat. A vast network of ditches provides drainage for agricultural lands in the study area and can rapidly transport water, sediment and nutrients to receiving waters, especially if the ditches do not have buffers or have been cleared of vegetation along the banks. Many ditches are deeply incised channels that drain groundwater and flow nearly year round, except in very dry periods. Where ditches have shallow gradients and lack buffer vegetation, the warm, slow-moving, nutrient-laden waters can promote excessive algal growth which can be flushed into streams and waterways during precipitation events.

Nutrients applied as fertilizer to crop and pasture lands can enter ditches and subsequently streams and waterways through four primary pathways. First, when fertilizers like chicken litter or hog waste are sprayed during windy conditions, it can travel downwind directly into surface waters including ditches. This was observed by DWR field staff on several occasions during water quality monitoring events in 2010 and 2011. The second nutrient pathway is through overland runoff, when nutrients like phosphorous attach to soil particles and are washed into surface waters through erosion. The third nutrient pathway is through shallow groundwater. Nitrogen is water soluble and can travel though the soil with infiltrated water, and then drain into ditches. Deeper ditches that bisect the water table can collect nutrient-laden groundwater and transport it to receiving waters. The final primary nutrient pathway in agricultural lands is through artificial subsurface drains, i.e., drainage tiles. Drainage tiles are installed below the root zone of row crops and move water laterally to their exit points in ditches.

Livestock production can also be a source of stressors to watershed functions. Confined animal operations can be a source of nutrients and pathogens from runoff or leaking waste lagoons. Pasture lands can likewise be a source of nutrients and pathogens from runoff. Where cattle have direct access to streams, they can trample the banks, causing erosion, habitat degradation and wetland impacts.

Additionally, when cattle defecate or urinate directly into streams, fecal coliform bacteria and ammonia impact water quality. During 2011 DWR collected a water quality sample downstream from a pasture where cattle were observed wading in the stream. This water quality sample had very high ammonia nitrogen, Total Kjehldahl Nitrogen, and phosphorus, and an extreme fecal coliform count (DWR 2013a).

Figure 8. Headcut and erosion from an agricultural field in the LWP study area.

Agricultural BMP watershed restoration opportunities were identified to eliminate or minimize the stressors and sources summarized above. Proper agricultural nutrient management and fertilizer application has benefits both to local producers and to water resources. The list of agricultural WROs is not exhaustive, but includes the most significant opportunities to improve the functioning of agricultural catchments identified by TJCOG through analysis of high-resolution aerial photographs. The WROs containing ditches are void of riparian vegetation or have visible erosion as described in the Erosion BMPs subsection below. Adding vegetated buffer strips along agricultural ditches, even comprised of only grasses and herbs, can filter overland runoff, reducing flow velocities and capturing sediment and associated nutrients. Allowing vegetation to grow within the banks and bottom of ditches (i.e., not clearing or dredging ditches) can likewise help filter water, reducing flows, sediment and nutrients to downstream receiving waters. Vegetation within ditches can also uptake and process nutrients. Planting woody vegetation along ditches, especially where ditches are shallower than the root zone of the trees and shrubs, can provide denitrification in the saturated root zones of riparian

vegetation. Vegetation along and within ditches can also help stabilize the banks, minimizing erosion and mass wasting.

4.2.3.2. Erosion BMPs

While examining aerial photographs as part of the GIS data development, functional assessment and WRO identification, several areas of significant visible erosion were identified. These areas fall into two categories: erosion associated with agriculture and erosion associated with mass wasting. With agricultural production, land is disturbed with each planting cycle. From the time that a field is prepared for planting through the time plants emerge, the fields are susceptible to erosion. Without cover crops or plants to dissipate the energy of falling precipitation, soil can be dislodged and mobilized during rainfall events. Once dislodged, soil particles can be moved through overland flow, causing erosion. Overland flow can become concentrated in small rills and gullies increasing the velocity and erosive potential and leading to the formation of headcuts and significant erosion. Multiple WROs were identified where ag fields have substantial erosion visible in aerial photos. These sites often include agricultural ditches that transport sediment to streams and degrade habitat. As noted in the subsection above, agricultural soils can contain adsorbed phosphorus, which is a stressor to watershed functions. A lack of vegetation along or within the banks of ditches can also lead to bank failures, as shown in Figure 9.

Figure 9. Bank failure along a ditch with no vegetated buffer at a stream assessment site (SA008) in the Sevenmile Swamp subwatershed (SMS 04).

Erosion BMP sites associated with agriculture should employ cover crops to minimize the erosivity of falling rain, grading to correct concentrated flows, and buffer strips to filter runoff. Likewise, eroding ditches should be graded back to provide more surface area during higher flows, reducing the

velocities, and vegetation should be planted as a buffer to protect the soil and filter overland flow. Planting woody vegetation along ditches would further stabilize the banks and minimize erosion. Woody vegetation could also improve the nutrient processing, as well as provide shading and temperature moderation.

The second category of Erosion BMP sites are those associated with mass wasting. One site in Sevenmile Swamp (WRO-007) appears to be a concave depression, perhaps used as a borrow pit. The slopes within this site are severely eroding, and this site drains to the mainstem of Sevenmile Swamp. This site should be graded, runoff slowed or diverted, and stabilized with vegetation to reduce the impacts from this erosion.

Two other sites (WRO-063 and WRO-064) in the BDS01 catchment are reportedly old spoil areas from the construction of Interstate 40. WRO-063 is a site with massive erosion and headcuts, shown in Figure 10 and Figure 11. This site, informally referred to as "Sisters Canyon" is a major source of sediment and is considered the highest priority WRO within the Great Coharie Creek LWP area. The erosional features are over 15 feet deep and a tremendous volume of sediment has been washed from this site into Beaverdam Swamp. This site is near the mouth of Beaverdam Swamp, and the floodplain between WRO-063 and the channel has several feet of sediment accumulated from this erosional feature. The unconsolidated material was eroded from the energy of rainfall, as evidenced by small pillars of sediment that are perched under rocks and pebbles that protected the underlying soil from eroding as shown in Figure 12.

Figure 10. WRO-063 panoramic image showing massive erosion and headcuts. This site is near Beaverdam Swamp in BDS 01.

A 360-degree panoramic image was captured of the site, and can be viewed on Google street view imagery at the following link: https://www.google.com/maps/@35.229076,-78.360641,3a,75y,130.44h,90t/data=!3m5!1e1!3m3!1sBNjeRUhlo_4AAAQYanhIJQ!2e0!3e11.

Figure 11. Deep headcut at WRO-063.

Figure 12. Pebbles have protected the underlying pillars of soil from eroding at site WRO-063.

On the other side of Interstate 40, another old spoil pile with similar unconsolidated material is severely eroding as shown in Figure 13. Rather than a network of deep, connected headcuts like WRO-063, site WRO-064 exists as a plateau with severe erosion-forming gullies around the perimeter of the feature. Pine trees that have grown across the nearly level top are providing some stabilization and helping to reduce the erosive energy of falling rain, although erosion around the edges of the feature have caused trees along the edges to topple over. This site is more difficult to access, and farther from Beaverdam Swamp, but is still a high priority for stabilization or remediation.

Figure 13. WRO-064 with severe erosion of unconsolidated materials. This site is in BDS 01.

4.2.3.3. Invasive Aquatic Vegetation Control

As part of the field assessments, DWR-WAT staff conducted surveys of aquatic vegetation at 73 locations in 2010 and 2011. This subsection of the report has been adapted from information in the DWR Integrated Report (2013a) and the DWR-WAT Vegetation Study (2012c). Filamentous algae were present at most of the sites, usually as dense growths or mats. Four exotic invasive aquatic plant species were present at the vegetation survey locations. The exotic or non-native plants were alligatorweed (*Alternanthera philoxeroides*), Asian spiderwort (*Murdannia keisak*), creeping waterprimrose (*Ludwigia hexapetala*), and parrotfeather (*Myriophyllum aquaticum*). A native species of smartweed (*Polygonum hydropiperoides*) was present in nearly half of the vegetation survey sites and exist as a monoculture stand at several sites. Native wetland grasses occur at about a quarter of the sites and are very dense at a few sites with shallow, standing water. Other common weedy native species in the Great Coharie Creek LWP area include cattails (*Typha latifolia*), bladderwort (*Utricularia spp*.), and proliferating spikerush (*Eleocharis baldwinii*).

Figure 14. Submersed vegetation (left) and close up of vegetation mats (right). Photos from Distribution of Vegetation in the Great Coharie Creek Local Watershed Planning Area: Final Report (DWR-WAT 2012c).

Dense growths of algae and aquatic vegetation restrict flow (see figure 15), can be harmful to water quality and can impact habitat. Several contributing factors lead to such dense vegetation, including nutrient enrichment, shallow, elevated water temperatures, open areas void of canopy cover/shading, low flows, and frequently impounded water. As part of the DWR-WAT vegetation study, several sites were recommended as potential management sites to control invasive aquatic plants. Those sites are included as WROs in this report and listed in Appendix C.

Table 9. GCC high priority/high feasibility projects.

Catchment	SITE #	Stream (ft)	Waterway (ft)	Ditch (ft)	Wetland (ac)	Priority	Feasibility	Notes	Acres	Parcels
SMS 01	**WRO-008**	-	1,916	341	-	1	High	Highly erosive channel devoid of vegetation, site looks highly disturbed	2.6	1
SMS 03	**WRO-017**	-	-	1,957	27.8	1	High	Ditched wetlands, half of a Carolina Bay is used for ag, appears very wet	29.1	4
GCC 03	**WRO-042**	788	-	3,400	2.1	1	High	Headwater ditches and stream channel, two stream assessment sites were done here	5.6	1
KS 02	**WRO-050**	-	965	-	0.1	1	High	Visible erosion draining to waterways	2.6	2
KS 02	**WRO-051**	1,461	1,495	577	0.1	1	High	Ditch and waterways leading to highly eroded stream channel, livestock have access to stream	4.5	1
KS 03	**WRO-055**	-	723	-	0.0	1	High	Highly disturbed waterway with severe erosion and no riparian vegetation	0.9	1
BDS 01	**WRO-063**	-	-	1,098	-	1	High	"Sisters Canyon", this site has extreme erosion, old spoil piles from roadway construction	4.7	1
BDS 01	**WRO-064**	-	-	-	3.2	1	High	This site has extreme erosion, old spoil piles from highway construction	5.8	1
BDS 02	**WRO-070**	1,473	-	680	1.2	1	High	Highly impacted stream channel and ag ditches with visible erosion	4.4	2
GCC 05	**WRO-093**	366	-	1,168	0.1	1	High	Stream and upstream ditch with no riparian vegetation and significant visible erosion leading from the ag fields	1.8	1

4.3. Other Management Measures

This subsection describes other management measures and activities to engage the community in stewardship of the Great Coharie Creek watershed.

4.3.1. Encourage Water-Based Recreation and Community Engagement

Many individuals engaged in watershed stewardship, trace their initial interest to an experience where they connected with their natural surroundings. This recommendation therefore is to encourage water-based recreation. If people immerse themselves in the blackwaters of the Great Coharie Creek, they will connect with the river, and better understand the connections between how individual activities on the land influence the conditions of the streams and wetlands.

The Friends of Sampson County Waterways, a local river management organization, has aspirations to create a paddle trail that extends along the Great Coharie Creek and Beaverdam Swamp to the Town of Newton Grove. Local champions should continue to pursue this goal and work to increase access to the creek. A paddle trail will require both access to the creek, and access through the riparian system, which means clearing a narrow passage to permit kayaks and canoes access. Clearing a narrow passage should not have significant impacts on the functions of the watershed, and increased access and experiences on the water will undoubtedly lead to a growing sense of ownership, responsibility and a desire to become a steward of the local watershed. A paddle trail would also encourage eco-tourism, which would help the local economy.

4.3.2. Promote Natural Heritage

The Great Coharie Creek is home to a rich diversity of plants and animals. The headwaters study area includes a Significant Natural Heritage Area that supports two populations of the Significantly Rare bluff oak (*Quercus austrina*).

Downstream from the LWP area, the receiving waters for Great Coharie Creek have been identified by the Natural Heritage Program as the Coharie / Six Runs Creek Aquatic Habitat, which contains populations of two rare fishes, Federal and State Species of Concern broadtail madtom (*Noturus species*) and State Special Concern thinlip chub (*Cyprinella species*). There are also three rare freshwater mollusks: State Threatened eastern lampmussel (*Lampsilis radiata*), State Special Concern pod lance (*Elliptio folliculata*) and State Significantly Rare eastern creekshell (*Villosa delumbis*) (EEP 2010).

This diverse and rare natural heritage should be promoted and celebrated through a local watershed event and in tourism and economic development messages, as it provides an important reason to protect, enhance and restore the Great Coharie Creek headwaters.

4.3.3. Manage Beaver Impacts

Throughout this project, beaver were a polarizing topic among the local advisory team. LAT members typically felt quite strongly either that beaver are a natural part of the ecosystem or that they are a nuisance species that causes problems for landowners. There is truth in each of these positions. It is not the intent of this report to make a judgment on the value of beaver within the Great Coharie Creek local watershed. It is clear that there are thriving populations of beaver in the watershed and they have an impact on watershed functions. They also pose an ongoing challenge to riparian landowners.

Beaver influence the riparian system by building dams that slow the water and create large areas of open water, by inundating riparian areas, and by eating woody riparian vegetation. Anecdotal evidence from LAT members suggests that the open water created by beaver has established new

habitat types and the watershed has had an increase in migratory birds like ducks that utilize the open water habitats. Slower, warmer, open water conditions lead to lower dissolved oxygen, which is already naturally low. This can stress aquatic organisms and limit survivability of fish and macroinvertebrates. In addition, beaver dams can present a barrier that restricts the passage of aquatic organisms. In these ways, beaver can have a significant impact on habitat functions, for better or worse.

Beaver dams slow the movement of water and cause the streams to spread laterally onto the floodplains. In a low gradient system like the Great Coharie, it doesn't take much to obstruct flows, and this condition was observed not only from beaver dams but from fallen trees as well. The mainstem channels of the study area with their wide, well-connected, largely undeveloped floodplains attenuate floodwaters with limited risk of flooding. Increased flood risk is a valid concern with beaver, especially as they move higher into the watershed with smaller channels and shallower floodprone areas between the stream and roads and uplands. In the context of this LWP, the beaver dams coupled with other natural flow obstructions and manmade impoundments provide flood attenuation functions, regulating flows downstream. In this way beaver can have a net positive impact on hydrology.

Water quality data indicates that nutrient concentrations and turbidity are highest in the headwaters and decrease downstream toward the outlet of the study area. This means that water quality is improving from the top of the watershed to the mouth. There are a multitude of factors that influence this, but slow moving water and active, forested floodplains provide favorable conditions for nutrient uptake and denitrification. Similarly to hydrology, in the context of this LWP, the beaver dams along with other natural flow obstructions and manmade impoundments provide nutrient processing and pollutant reduction functions. In this way beaver can have a net positive impact on water quality.

It should be noted, however, that when it comes to riparian landowners, beaver can become a costly nuisance. Beaver dams cause streams and floodwaters to spread laterally into the riparian zone. Many forest species cannot tolerate permanent inundation and thus important timber trees may not survive once beaver have impounded a riparian area. In this way, timber resources are lost and made inaccessible, which can have negative economics on riparian landowners.

So, in summary, beaver are both a natural component of the ecosystem and a nuisance species for riparian landowners. Beaver can have a major impact on watershed functions, both positive and negative. Therefore, this recommendation is to manage the negative impacts from beaver. Landowners should be informed about the positive and negative ways beaver influence the aquatic and riparian systems and provided with resources and technical support to remove beaver that are causing undesired impacts on their property (see Section 6). A thoughtful, balanced approach should be employed, recognizing the strong feelings that are evoked about the topic of beavers and landowner rights.

4.3.4. Establish a Ditch and Buffer Management Education Program

As discussed in previous subsections, the way ditches and riparian areas are managed can have a profound influence on the conditions of the streams and the transport, delivery, and timing of water, sediment, and nutrients. Likewise, habitat conditions are greatly influenced by riparian management activities.

An education program should be established for agricultural operators and rural land owners to increase the understanding about the ways ditch and buffer management influence watershed functions. This program could be led by USDA NRCS, Sampson County SWCD or County

Cooperative Extension staff. There can be strong cultural attitudes about ditches, and many farmers value "clean" (unvegetated) ditches. From the single perspective of moving water quickly off the land, ditches void of vegetation will drain the land more quickly. However, in a watershed context there is a set of broader perspectives that should be considered. In the Great Coharie Creek LWP study area, the miles of ditches far exceed the miles of streams, and the way ditches are managed has a tremendous impact on watershed conditions and functions.

An education program should have multiple goals, including broadening the understanding of the connection and relationship of ditches to streams and watershed health as a whole. Additionally, an education program should have a goal leading to actions that are in line with a broader watershed understanding. Landowners and tenants should establish buffer strips along ditches and allow ditches to become naturalized. The personal benefits to landowners should be communicated, which include less erosion and maintenance, while still providing necessary drainage. Finally, the education program should have longer-term ecological goals like reduced nutrients and sediment in receiving waters. While the riparian swamp complex has demonstrated an ability to filter water and convert nutrients, the goal should be to have cleaner, slower water entering the system through headwaters and low order channels. Section 6 includes resources for creating and funding an educational program.

4.3.5. Recognize Watershed Stewards

A community-based partnership should be established to recognize good watershed stewards. Potential local partners include the Friends of Sampson County Waterways, USDA NRCS, Sampson County SWCD, Sampson County Cooperative Extension, the Farm Service Agency, Sampson County, and the Town of Newton Grove. Stewardship actions should be celebrated and a recognition program can help build social norms and community pride in those individuals, companies and organizations that actively make decisions in the context of the watershed. Everyone in the local community has an impact in the watershed. From small actions like conserving drinking water or exploring the natural heritage to more long-lasting actions like managing ditches in a watershed-friendly way or participating in on-the-ground projects like restoration or BMPs, the community should recognize, encourage and celebrate good watershed decisions.

A recognition program can provide social and peer incentives to make the connection between our actions on the land and the conditions of our waters. Everyone in the community has a role to play in the watershed. A recognition program can lead to a stronger sense of shared responsibility and a feeling of ownership in the watershed.

4.3.6. Develop a Landowner Resource Guide

The next recommendation is to create a watershed resource guide for landowners and residents. EEP may have a template that could be used, and potential partners include the NCDENR Stewardship Program, Friends of Sampson County Waterways, USDA NRCS, Sampson County SWCD, Sampson County Cooperative Extension, the Farm Service Agency, Sampson County, and the Town of Newton Grove. This could include a series of short, easy-to-understand documents on the conditions and importance of the watershed, as well as helping to make the connection about how their actions and decisions affect each other, the natural heritage, the stream and the watershed as a whole. The emphasis should be on short engaging messages and access to more information about the topics that interest the reader. It should include a list of people who can answer questions, provide technical support and help address concerns. A resource guide could also be an outreach mechanism for other management measures listed above, like opportunities for water-based recreation, the important natural heritage in the area, beaver management specialists, a ditch and buffer education program, and a stewardship recognition program.

4.3.7. Water Quality Monitoring

The final recommendation is to develop a long term water quality monitoring program. This project collected valuable water quality data about a swamp system for which little was previously known. DWR, EEP, and the academic community should continue to research the ecology and function of the Great Coharie Creek headwaters. Further study of nutrient processing, dissolved oxygen cycles, beaver dams and sedimentation in this planning area would be valuable. Additionally, monitoring should continue to fill in key data gaps about the specific sources and pathways for nutrients and sediment in the GCC headwaters. Long-term water quality monitoring can help measure the impact of and progress towards implementing the management recommendations in the WMP.

Table 10. GCC watershed stressors, sources, impacts and recommended management measures.

Stressors	Primary Sources	Impacts	Management Measures
Loss of riparian buffer	Removal of riparian vegetation; land use development	Stream bank erosion; increase in water temperature; lack of shading; loss of in-stream woody debris and leaf matter; reduced pollutant processing; increased overland sedimentation; higher overland flow velocities	Implement stream and wetland restoration and enhancement projects; implement stream and wetland preservation projects; implement agricultural BMPs; establish a ditch and buffer management education program; develop a landowner resource guide; restore native riparian buffer
Invasive aquatic vegetation	Native and exotic plant matter transported by flow and animals as well as natural propagation	Loss of habitat; restricted stream flows; poor aesthetics; reduced stream access; reduced DO	Control invasive aquatic plants; educate boaters, paddlers and fishermen about invasives and how not to spread them
Loss of in-stream habitat	Channel modifications and dredging; sedimentation	Habitat degradation	Implement stream and wetland restoration and enhancement projects; implement stream and wetland preservation projects; implement agricultural BMPs; establish a ditch and buffer management education program; develop a landowner resource guide
Erosion / sedimentation	Overland runoff from agriculture and spoil areas; stream bank erosion; livestock access to streams; channel modification; riparian disturbance	Habitat degradation; increased turbidity; increased nutrient loads	Implement stream and wetland restoration and enhancement projects; implement agricultural BMPs and reduce erosion; establish a ditch and buffer management education program; recognize watershed stewards; develop a landowner resource guide; restore native riparian buffers

Stressors	Primary Sources	Impacts	Management Measures
Loss of floodplain connection	Channel modification and dredging	Increased stream flow velocity; loss of habitat; reduction in pollutant processing; reduced flood attenuation	Implement stream and wetland restoration and enhancement projects; implement stream and wetland preservation projects; implement agricultural BMPs that increase the floodprone area of channels; establish a ditch and buffer management education program
Restricted aquatic species movement	Stream blockages; invasive aquatic plants; impoundments (beaver and man-made); exposed utility crossings	Reduced habitat range	Control invasive aquatic plants; encourage water-based recreation and community engagement; manage beaver impacts when appropriate; install utility crossings underground; clear flow obstructions
Flow alterations	Channel straightening and dredging; impoundments (beaver and man-made); overland runoff; subsurface drainage tiles; stormwater runoff; ditches	Reduced flood attenuation; increased flooding risk; pathway for pollutant transport and delivery	Implement stream and wetland restoration and enhancement projects; implement stream and wetland preservation projects; implement agricultural BMPs; control invasive aquatic plants; manage beaver impacts; establish a ditch and buffer management education program; recognize watershed stewards; develop a landowner resource guide; remove drainage tiles
Elevated inorganic nitrogen and total phosphorus	Livestock access to streams; agricultural runoff and subsurface flows; failing septic systems; improperly managed livestock operations or swine lagoons; wind-blown fertilizer	Nutrient enrichment, which can lead to excessive algae growth and decreased DO, especially when coupled with warm, slow moving water	Implement stream and wetland restoration and enhancement projects; implement stream and wetland preservation projects; exclude livestock from channels; establish a ditch and buffer management education program; recognize watershed stewards; develop a landowner resource guide
Elevated pathogen loads	Livestock access to streams; failing septic systems; improperly managed livestock operations or swine lagoons	Risk to human health	Exclude livestock from channels; establish a ditch and buffer management education program; recognize watershed stewards; develop a landowner resource guide

Stressors	Primary Sources	Impacts	Management Measures
Low DO	Stream blockages; excessive algae growth; invasive aquatic plants; impoundments (beaver and man-made); excessive nutrients	Habitat degradation	Implement stream and wetland restoration and enhancement projects; implement stream and wetland preservation projects; implement agricultural BMPs; control invasive aquatic plants; manage beaver impacts; establish a ditch and buffer management education program; develop a landowner resource guide
Loss of high value forest and wetlands	Sedimentation from agriculture, spoil areas, and stream bank erosion; livestock access to riparian zone; channel modification and dredging; riparian disturbance and removal of riparian vegetation; land use development; ditching and draining wetlands for agricultural or timber production; impoundments (beaver and man-made); timber harvesting	Habitat loss and degradation; Reduced flood attenuation; increased flooding risk; reduced pollutant processing; increased stream flow velocity	Implement stream and wetland restoration and enhancement projects; implement stream and wetland preservation projects; encourage water-based recreation and community engagement; promote natural heritage; establish a ditch and buffer management education program; recognize watershed stewards; develop a landowner resource guide; establish conservation easements on large forest tracts
Mercury	Atmospheric deposition	Increased toxicity in fish and other aquatic organisms leading to human health risk	Develop a landowner resource guide to communicate an understanding of the problem; encourage the reduction of fossil fuel emissions; limit consumption of wild fish

SECTION 5. Watershed Management Plan Implementation

Previous sections of the WMP discussed existing ecological problems, assets, and actions needed to alleviate the problems and protect the assets. This section discusses how the plan will be implemented. Broad organizational structure and processes are described that should help guide successful plan implementation over the long-term. This section focuses on the big picture of teamwork, organizational leadership and management, and community relations, which are foundational elements upon which long-term implementation successes depend. There are typically three distinct elements involved in implementing the WMP, known as Phase IV of EEP LWP initiatives:

1. EEP project implementation (as dictated by program mitigation needs);
2. Formal adoption or endorsement of the WMP by local authorities; and,
3. Coordinated watershed management strategy.

In addition, a Local Advisory Team (LAT) was established in the Great Coharie Watershed, which could be adapted into an Implementation Team (IT) that can work together to develop detailed goals, timelines related to the recommendations, and suggestions on which LAT member will be responsible for a particular recommendation. In doing so, the LAT and the local community can take ownership of the plan, solidify the partnership, and get projects on the ground to protect and restore the Great Coharie Creek.

5.1. General EEP Project Implementation Strategy

EEP project management staff are responsible for overseeing the implementation of traditional stream and wetland mitigation projects identified during the LWP effort, including those presented in the *Project Atlas* – should they prove to be technically feasible and cost-effective projects at sites with willing landowners. Implementation of Project Atlas-identified project sites and other potential mitigation project sites within EEP LWP areas are incentivized through EEP's Full Delivery procurement process. Through this process, EEP issues requests for stream and wetland mitigation. Full Delivery providers should familiarize themselves with the WMP and use the information presented in the WMP and *Project Atlas* to help identify suitable mitigation sites, as needed. Should mitigation needs not be met through the Full Delivery procurement process, EEP project managers may work with a local Implementation Team (IT) (more detail below) to identify projects from the *Project Atlas* that might have landowners willing to work with EEP (i.e., willing to allow permanent conservation easements). These efforts will continue indefinitely as mitigation needs within the Great Coharie Creek and all of the Black River Watershed of the Cape Fear Basin (Cataloging Unit 03030006) are identified over time.

5.2. Adoption of the Watershed Management Plan

This local watershed plan is based upon an assessment of the hydrology, water quality and habitat conditions within the LWP study area (Section III), as well as an intensive stakeholder involvement process (Section II) that spanned a five-year period. Recommendations contained within the WMP have been developed to help meet the overall goals of restoring watershed functions that have been degraded and protecting local watershed resources and assets. The recommendations contained within Section IV were developed through collaboration with the local stakeholders ((LAT) and are intended

to be complementary enhancements to local land use plans and watershed-related ordinances of the Town of Newton Grove and Sampson County.

A primary recommendation of the LAT may be to seek adoption of this local watershed plan by the Sampson County Board of Commissioners and the Newton Grove Town Council. The recommendations described in Section IV were developed with careful consideration of the needs of the local communities and would provide numerous environmental, health, economic, and aesthetic benefits to local residents. If adopted, certain recommendations could be incorporated into development rules or local ordinances. At a minimum, County Commissioners and Town Council Members are encouraged to formally *endorse* the WMP. In this case, the WMP could be referenced in future updates to land use plans or ordinances.

5.3. Coordinated Watershed Management Strategy Utilizing the Implementation Team

The final step in implementing the Great Coharie LWP could be the adaptation of the Great Coharie Creek LAT into the Great Coharie Creek IT. This group would be responsible for taking the lead on implementation of non-EEP projects and ensuring that the momentum developed under the EEP-led planning effort continues. This group would include existing stakeholders who wish to stay involved in the process in the future, including local resource professionals and municipal and county government representatives. The primary functions of the group would be to:

- Advocate for the adoption of the WMP by local and county officials;
- Coordinate prioritization, funding, and implementation of the recommendations;
- Track the implementation of projects in the *Project Atlas* and recommendations in the WMP;
- Coordinate with other groups as necessary;
- Reach out to citizens and landowners as needed to implement recommendations and projects; and,
- Interact with the local communities on watershed-related issues (both those documented in the WMP and future concerns).

This group would serve as the lead on working with local municipal groups and others to seek grant funding for implementation of watershed improvement projects and other specific recommendations in the WMP. Sources of grant funding include U.S. EPA 319 program, U.S. Department of Agriculture cost share programs, and many others (see Section VI for more information on funding sources).

This group would need a local champion to take leadership of the continued efforts in the watershed. One option would be to hire a Local Watershed Coordinator. This position would direct the efforts of the group and take the lead on ensuring that the primary objectives of the group are achieved. This could be established as time-limited positions administered through local non-profits (e.g., local organizations, County SWCDs, or regional Councils of Government). Given the current uncertainty of grant funding through federal, state and non-profit organizations, the Great Coharie Creek LAT stakeholders will have to be creative to find the necessary staff time and financial resources to accomplish priority watershed objectives.

5.3.1. The Implementation Team

For the purpose of implementing the *Watershed Management Plan,* the Great Coharie Creek LAT can be re-configured to serve as the Implementation Team (IT). The IT would ideally consist of two parts, each having distinct responsibilities. At the core would be *Local Implementation Partners*, possibly

including a Watershed Coordinator, who would have the primary responsibility of executing plan recommendations. Surrounding the Local Partners would be *Supporting Partners* who help execute plan strategies by representing their respective organizations, pulling from their financial, political, academic, and technical resources.

Local Implementation Partners may include local governments and non-profit organizations having close connections with the people and the land within the Great Coharie Creek project area. These organizations can utilize technical, political, and public relations expertise to administer conservation programs or policies, regulations, and educational activities that both directly affect the community and afford routine direct interface with the citizenry and landowners. Local partners should include Cooperative Extension Service, Friends of Sampson County Waterways, local citizens, USDA NRCS, NCDENR Office of Land and Water Stewardship, Sampson County Division of Forest Resources, Sampson County Parks and Recreation, Sampson County Planning, Sampson County Public Works, Sampson County Soil and Water Conservation District, Town of Newton Grove, Coharie Indian Tribe, and NC Ecosystem Enhancement Program.

EEP is included as a Local Partner because of its expected heavy involvement in funding watershed improvement projects and its routine, direct interface with landowners on those projects. Supporting Partners include state and federal agencies and private corporations, both for-profit and non-profit that may not have the routine, direct interface with the community that Local Implementation Partners have. Furthermore, their responsibilities outside of the Great Coharie Creek project area may prevent the same intensity and frequency of involvement within this project area as Local Partners. Regardless, they are critically important members of the team that have clout and experience at getting projects on the ground. Supporting Partners provide connections to certain resources and expertise vital to implementing this plan. Supporting partners should include Cape Fear Arch, Cape Fear River Assembly, Division of Forest Resources, Fish and Wildlife Service, Fort Bragg, Mid-Carolina Council of Governments, Natural Heritage Program, NC Division of Water Resources, NC Watershed Stewardship Network, and Triangle J Council of Governments.

The Implementation Team has been organized into these two groupings for the purpose of facilitating effective communication, task performance, and project management.

5.3.1.1. Team Function and Organizational Goals

The organization of the Implementation Team is important to the success of implementing the management plan. The IT may function as a loose affiliation of interested parties operating under non-binding agreements, as is the case now, or as an incorporated entity such as a 501(c)(3) non-profit operating under a governing charter and by-laws. Regardless of how the IT chooses to operate, organizational goals that are developed collectively help to ensure teamwork. Six key organizational goals are outlined below that, once achieved, will provide a solid foundation that can support *Watershed Management Plan* implementation over the long-term.

- **Goal A) Establish and Articulate Guiding Principles** – To strengthen the partnership and maintain interest, the IT should develop and articulate a shared vision, mission statement, and values.

- **Goal B) Refine and Articulate Organizational Structure and Roles** – Emphasizes the importance of having locally based partners serving as the primary public interface and implementers of the management plan recommendations. Sub-committees may be formed to implement or manage specific activities associated with a particular recommendation.

- **Goal C) Establish Specific, Measurable Goals from the Recommendations** – Prioritizing the goals will give the IT focus, and specific, measurable goals can help ensure progress is being made.

- **Goal D) Invest in Coordination** – Effective coordination of the Implementation Team is essential to the success of this plan. At some point in the future, the group may need to seek funding to hire a Local Watershed Coordinator to play a leadership role in keeping the Implementation Team on track to achieving its vision, maintaining trust among members, and managing day-to-day activities.

- **Goal E) Acquire Funding** – A function of Supporting Partners will be to help ensure that Local Partners have the funding and capacity to serve their roles in the implementation of this plan. The Implementation Team should explore non-traditional funding sources such as private corporations with a vested interest in the Great Coharie community and the Black or Cape Fear Rivers. See Section 6 for more on possible funding sources.

- **Goal F) Accommodate Change** – Assess the internal and external working environment in terms of strengths, weaknesses, opportunities, and threats. This will keep the team proactive and poised to respond well to changes that occur.

5.4. Public Outreach and Connection

This *Watershed Management Plan* represents a significant investment of time and thought from more than two dozen people over the course of the last five years. A large amount of technical and scientific details have been developed and are presented in this document with the ultimate purpose to improve and protect environmental quality and habitat for plants, animals and people in the Great Coharie Creek watershed planning area. It will be of interest to many people, and not just those responsible for developing this plan.

Local Partners are best equipped to know the communities' core values. For example, independence, farming, local pride, knowing and caring about your neighbor, taking care of our own, the economic vitality of the area, rural character, and cultural heritage are all values the Great Coharie local community embraces. The agricultural community has a long-standing heritage in the community, as does the Coharie Indian tribe, which derives spiritual, cultural and community value from the Great Coharie watershed. The Implementation Team will have more rapid and far-reaching success when it can implement recommendations that benefit not only the ecology of the watershed but integrate the broader interests of the people who live and work in the planning area.

SECTION 6. Technical Resources and Funding Sources

Technical resources and funding sources are often difficult to identify and tap into when implementing watershed management plans. This section is designed to complement the plan strategies by making those resources easier to find. This section is divided into two subsections, Technical Resources and Funding Sources. Each is categorized by type of resource or funding source. Each table contains the name of the resource, a description of what they can provide and a web link at which additional details and contact information can be obtained.

6.1. Technical Resources

Table 11. GCC Technical Watershed Resources

Resource/Group	Description	Website / Contact Info
Local and Regional Resources		
Town of Newton Grove	Administers all town planning activities.	https://www.facebook.com/pages/Town-of-Newton-Grove/430170845392?sk=timeline
Sampson County Division of Soil and Water Conservation (DSWC)	Administers DSWC funding programs (e.g., agricultural cost share) in Sampson County and works to promote conservation of natural resources. Provides access to the NC Beaver Management Assistance Program.	http://www.ncagr.gov/SWC/findyourdistrict.html (see Sampson Co.)
NC Cooperative Extension	The North Carolina Cooperative Extension Service partners with communities to deliver education and technology that enrich the lives, land and economy of North Carolinians. Provides technical resources, education, and outreach on forestry and environmental management, including beaver management.	http://www.ces.ncsu.edu/
Sampson County Public Works	Sampson County Public Works has three service divisions: Water Operations, Buildings and Grounds, and Road Sign Maintenance. The functions of the department are to maintain all county buildings and grounds, the erection and maintenance of all county and private road signs, and the operation of the county's two water districts.	http://www.sampsonnc.com/publicworks.asp

Sampson County Parks and Recreation	Improving services and enriching the lives of county residents through recreational structure.	http://www.sampsonnc.com/parksandrec.asp
NC Natural Heritage Program	The North Carolina Natural Heritage Program is part of the Office of Land and Water Stewardship within the N.C. Department of Environment and Natural Resources. The program serves as an information clearinghouse in support of conservation of the rarest and most outstanding elements of natural diversity in the state. These elements of natural diversity include plants and animals which are so rare or the natural communities which are so significant that they merit special consideration as land-use decisions are made.	http://www.ncnhp.org/
Mid-Carolina Council of Governments (MCCOG)	The MCCOG is the state-designated lead regional organization for Cumberland, Harnett, and Sampson Counties. Mid-Carolina is one of the seventeen North Carolina Regional Councils formed to provide a wide variety of programs and services to their local governments and citizens. The MCCOG provides technical assistance services to its member governments including land use planning, zoning administration, subdivision and zoning ordinances, water and sewer studies, annexation reviews, and community development workshops on timely issue.	http://www.mccog.org/
Friends of Sampson County Waterways	Friends of the Sampson County Waterways is a group of concerned citizens interested in preserving the waterways of Sampson County including the Black River, South River, Six Runs Creek, Great Coharie Creek and Little Coharie Creek and all its tributaries.	https://groups.yahoo.com/neo/groups/sampsoncountywaterways/info
Fort Bragg	Home of the Airborne and Special Operations Forces.	http://www.bragg.army.mil/Pages/Default.aspx
US Fish and Wildlife Service	Agency with mission of conserving, protecting and enhancing fish, wildlife, and plants and their habitats for the continuing benefit of the American people.	www.fws.gov/

NC Dept. of Agriculture & Consumer Services – NC Forest Service (NCFS)	The NC Forest Service's primary purpose is to ensure adequate and quality forest resources for the state to meet present and future needs. The forest products industry is the largest manufacturing business sector in the state, contributing approximately $24 billion annually to the state's economy and providing around 180,000 jobs for North Carolinians.	http://www.ncforestservice.gov/
Cape Fear River Assembly (CFRA)	The CFRA represents the views of diverse stakeholders from the entire Cape Fear River watershed. Their website seeks to be a convenient and accurate source of information about the Cape Fear River.	http://cfra-nc.org/
Cape Fear Arch	The Cape Fear Arch is a special geologic feature stretching from Cape Lookout, NC to Cape Romain, SC that contains nationally significant animal and plant communities. Created in 2006, the Cape Fear Arch Conservation Collaboration is a partnership of organizations and individuals interested in protecting this region while balancing the needs of man and nature. Its mission is to develop and implement a community conservation vision to build awareness, protection and stewardship of the region's important natural resources.	http://capefeararch.org/
Other Watershed Resources		
Green Growth Toolbox – NCWRC	Technical resources, handbooks, GIS data, and other information to support conservation minded development.	http://www.ncwildlife.org/GreenGrowth/
Community Conservation Assistance Program – DSWC	Provides financial and technical assistance to improve water quality through the installation BMPs on urban, suburban, and rural lands, not directly involved in agricultural production.	http://www.enr.state.nc.us/DSWC/pages/ccap_program.html
Center for Watershed Protection	Non-profit foundation providing a wealth of technical resources (e.g., reports, model ordinances, and training materials) to support healthy land and water management.	http://www.cwp.org/
NC State University Dept. of Biological & Agricultural Engineering and Stormwater Engineering Group	Their mission is to "learn and teach" stormwater management, including bioretention areas, green roofs, stormwater wetlands, permeable pavements, water harvesting systems, LID, and other innovative treatment practices.	http://www.bae.ncsu.edu/stormwater/

Stormwater Manager's Resource Center	Provides resources on stormwater ordinances, post-construction runoff model ordinance, BMP design, and other tools. Maintained by the Center for Watershed Protection.	http://www.stormwatercenter.net/
UNC School of Government	Provides a Universal Stormwater Model Ordinance.	http://www.efc.unc.edu/publications/2007/UniversalStormwaterModelOrdinanceNC.pdf
Use Restoration Watershed Funding Resources –NCDENR DWR	Provides technical assistance to restore the beneficial uses of impaired waters.	http://portal.ncdenr.org/web/wq/ps/bpu/urw/funding
Environmental Finance Center Network	A university-based organization at UNC–Chapel Hill along with other universities nationwide that is dedicated to creating innovative financing solutions for environmental protection. The Network includes public and private sector watershed resources.	http://www.efc.unc.edu/
NCDENR Office of Environmental Education	Serves as North Carolina's clearinghouse (central source) for all of the environmental education resources in the state. The office serves Pre-K-12 schools, colleges and universities, government agencies, non-profit organizations, environmental education centers, citizen groups, business and industry, libraries, and the general public.	http://www.eenorthcarolina.org/
NCDENR – Public Water Supply Section – SWP Program	The Source Water Protection (SWP) Program provides guidance and funding opportunities related to source water assessment and pollution prevention for public water supplies.	http://ncwater.org/?page=63
NC State University Water Quality Group	A multidisciplinary team that analyzes and evaluates nonpoint source (NPS) pollution control technologies and water quality programs in North Carolina.	http://www.bae.ncsu.edu/programs/extension/wqg/
NC State University WATERSHEDDS Program	WATERSHEDSS (WATER, Soil, and Hydro- Environmental Decision Support System) was designed to help watershed managers and land treatment personnel identify their water quality problems and select appropriate best management practices.	http://www.water.ncsu.edu/watershedss/
EPA Watersheds	Portal to resources on watershed planning, assessment, total maximum daily loads (TMDLs), and water quality information.	http://www.epa.gov/owow/watershed/
Sustainable Forestry Initiative – NCDENR NCFS	Provides information on sustainable forestry.	http://www.dfr.state.nc.us/Managing_your_forest/managing_sfi.htm

6.2. Funding Resources

The tables below represent an up-to-date compilation of potential funding sources and websites available to aid in the implementation of recommended management strategies within the Great Coharie Creek watershed.

Table 12. GCC Watershed Funding Resources

Resource/Group	Description	Website / Contact Info
General Funding		
NC Ecosystem Enhancement Program – NCDENR	Provides watershed planning and implementation of compensatory mitigation projects (e.g., stream and wetland restoration).	http://portal.ncdenr.org/web/eep/welcome
Clean Water Management Trust Fund	Offers grants to local governments, state agencies, and conservation non-profits to help finance projects that specifically address water pollution problems.	http://www.cwmtf.net/
NC Natural Heritage Trust Fund	Funds the protection of land with outstanding natural or cultural heritage values.	http://www.ncnhtf.org/
N.C. Parks and Recreation Trust Fund – NCDENR	Provides matching grants to local governments for parks and recreational projects to serve the public.	http://www.ncparks.gov/About/grants/partf_main.php
Community Conservation Assistance Program – NCDSWC	Funds non-agricultural management measures.	http://www.ncagr.gov/SWC/costshareprograms/CCAP/index.html
Non-point Source Section 319 Grants – NCDENR DWR	Funding grants for efforts to reduce non-point source (NPS) pollution including demonstration BMPs, education and outreach, and establishing Total Maximum Daily Load (TMDL).	http://portal.ncdenr.org/web/wq/ps/nps/319program
Planning Grant 205j – NCDENR DWR	Funding available to regional Councils of Government (COGs) for water quality management planning efforts.	http://h2o.enr.state.nc.us/pb/205jPlanningGrantHomePage.htm
Z. Smith Reynolds Foundation	Private Foundation providing grants dedicated to clean water, clean air, and environmental justice.	http://www.zsr.org/
Clean Water State Revolving Fund - Construction Grants and Loans – NCDENR	Funds grants to assist in improvements to wastewater treatment facilities and projects benefitting estuary and non-point source programs.	http://portal.ncdenr.org/web/wq/cgls/fap/cwsrf
The Cooperative Water Program – USGS	Provides cost-share funds to support water resource information gathering to wisely manage the Nation's water resources.	http://water.usgs.gov/coop/

Water Resources Development Project Grant Program – NCDENR	Provides cost-share funding and technical assistance to local governments in subject areas including navigation, water management, stream restoration, land acquisition, and aquatic weed control.	http://www.ncwater.org/Financial_Assistance/
Planning Assistance To States Program (Section 22) – US Army Corps of Engineers	Provides technical expertise in management of water and land resources to help States deal with water resource problems including floodplain management, watershed restoration, and water supply assessment.	http://www.saw.usace.army.mil/Floodplain/Section%2022.htm
Partners for Fish and Wildlife – USFWS	Offers technical and financial assistance to landowners who want to restore and enhance fish and wildlife habitats.	http://www.fws.gov/raleigh/pfw.html
EPA List of Watershed Funding Opportunities	List of links to a number of different watershed funding resources.	http://www.epa.gov/owow/funding.html
Southeast Aquatic Resource Partnership	Provides grant funds for habitat restoration, including aquatic barrier removal.	http://southeastaquatics.net/
Land and Water Conservation Fund	Provides funding to State and Federal agencies to conserve natural resources, including land acquisition.	http://www.nps.gov/lwcf/
Easement Program – USDA NRCS	Voluntary easement programs to landowners who want to maintain or enhance their land in a way beneficial to agriculture and/or the environment.	http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/
Agricultural		
Agriculture Cost Share Program – NC Assoc. of SWCD	Provides cost-share funding to protect water quality by installing BMPs on agricultural lands.	http://ncaswcd.org/?page_id=84
Agriculture Cost Share Program – NC Dept. of Ag. & Consumer Services	Funds agricultural management measures.	http://www.ncagr.gov/SWC/costshareprograms/ACSP/
Conservation Reserve Enhancement Program – NC Dept. of Ag. & Consumer Services	Funds long-term protection of environmentally sensitive agricultural lands through implementation of grassed filter strips, forested riparian buffers, tree planting, and wetlands restoration.	http://www.ncagr.gov/SWC/costshareprograms/CREP/index.html
Environmental Quality Incentive Program – USDA NRCS	Technical and financial assistance to install or implement structural and/or management practices on eligible agricultural land.	http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=stelprdb1242633

Farm and Ranch Land Protection Program - USDA NRCS	Offers matching funds to help purchase development rights to keep productive farm and ranchland in agricultural uses.	http://www.nrcs.usda.gov/programs/frpp/
Farm Bill Programs	Funds agricultural management and grassland, wetlands and wildlife preserve programs.	http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/
NC Agricultural Development and Farmland Preservation Trust Fund	Supports purchase of agricultural conservation easements (on farm, forest, and horticulture lands), including transaction costs. Funds public and private enterprise programs that will promote profitable and sustainable family farms through assistance to farmers in developing and implementing plans for the production of food, fiber, and value-added products, agritourism activities, marketing and sales of agricultural products produced on the farm, and other agriculturally related business activities. Funds conservation agreements (on farm, forest, and horticulture lands) targeted at the active production of food, fiber and other agricultural products.	http://www.ncadfp.org/index.htm
Other USDA Programs	Offers information on a number a different USDA grants and technical assistance programs including those mentioned here.	http://www.nrcs.usda.gov/programs/
State and Local Governments		
NC Attorney General's Office – Environmental Enhancement Grant Program	Immediate or long term environmental enhancement projects that improve air, water, and/or land quality of NC.	http://www.ncdoj.gov/EEG.aspx
Coastal		
APNEP Funding Resources Page	List of potential coastal funding sources.	http://portal.ncdenr.org/web/apnep/grants
Recreation		
Recreation Trails Program – NC Div. of Parks and Recreation	Trail construction and maintenance projects, trail side facilities, and land acquisition projects.	http://ncparks.gov/About/trails_RTP_project.php

Wastewater Infrastructure		
NC Clean Water State Revolving Fund – NCDENR DWI	Congress provides states with grant funds to establish revolving loan programs to assist funding of wastewater treatment facilities and estuary and nonpoint programs.	http://portal.ncdenr.org/web/wi/cleanwater/srf
NC Division of Water Infrastructure (DWI)	Integrated planning, design, and construction grants and loans for water and wastewater infrastructure programs in NC.	http://portal.ncdenr.org/web/wi/
Wetlands		
Wetland Protection Development Grant – USEPA	-Develop comprehensive monitoring and assessment programs; -Improve compensatory mitigation effectiveness; and, -Refurbish wetland, aquatic resources, protection.	http://www.epa.gov/owow/wetlands/grantguidelines/
Wildlife		
Partners for Fish and Wildlife – USFWS	Technical and financial assistance to landowners to restore and enhance fish and wildlife habitats on their property. Projects must benefit migratory birds, T & E species, anadromous, or migratory fish.	http://www.fws.gov/partners/
Endangered Species Grants – USFWS	Conservation efforts that benefit federally listed, proposed, candidate, or other at-risk species.	http://www.fws.gov/endangered/grants/grant-programs.html
Wildlife Conservation Lands Program – NCWRC	Program that allows landowners to receive tax benefits for managing lands for wildlife benefits.	http://www.ncwildlife.org/Conserving/Programs/LandConservationProgram.aspx

6.3. Reference/Resource Publications

In addition to the technical and funding information listed in the previous subsections, several reference and resource publications were found to contain information that may be useful in implementing the Great Coharie Creek *Watershed Management Plan*. These references and web links to them are provided below.

CWP (Center for Watershed Protection). 1998. Better Site Design: A handbook for changing development rules in your community. Center for Watershed Protection, Ellicott City Maryland. (Part 1: http://www.cwp.org/online-watershed-library/doc_download/92-better-site-design-a-handbook-for-changing-development-rules-in-your-community-part-1; and Part 2: http://www.cwp.org/online-watershed-library/doc_download/93-better-site-design-a-handbook-for-changing-development-rules-in-your-community-part-2).

NCDWQ (North Carolina Division of Water Quality). 2007. Stormwater Best Management Practices Manual. Raleigh. http://portal.ncdenr.org/web/lr/bmp-manual.

NCDWQ (North Carolina Division of Water Quality). 2010. Example of good stormwater treatment specification - Section 12 of Water Quality Certification No. 3821. http://portal.ncdenr.org/c/document_library/get_file?uuid=f58d0253-a423-4911-ae5a-7c6ea41b9c75&groupId=38364

NCSU-CES (North Carolina State University Cooperative Extension Service). 2009. Low Impact Development: a guidebook for North Carolina. Raleigh. http://www.ces.ncsu.edu/depts/agecon/WECO/lidguidebook/

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Appendix A: Glossary of Technical Terms

Aquatic habitat – the wetlands, streams, lakes, ponds, estuaries, and streamside (riparian) environments where aquatic organisms (e.g., fish, benthic macroinvertebrates) live and reproduce; includes the water, soils, vegetation, and other physical substrate (rocks, sediment) upon and within which the organisms occur; also includes micro-habitats such as undercut stream banks and woody debris found within healthy streams and wetlands.

Assets – Natural resources that are in a condition worthy of protection.

Basin – the largest watershed management unit for planning, consisting of a group of sub-basins; typically range in size from 500 to 10,000 square miles; there are 17 major river basins in NC, the largest being the Cape Fear and the Yadkin-Pee Dee, and the smallest the Savannah and the Watauga.

Benthic macroinvertebrates – organisms living in or on the bottom substrate of aquatic habitats; include insect larvae, worms, snails, crayfish and mussels; can be used as indicators of stream water quality and stream habitat condition.

Bioaccumulate – the process by which an organism absorbs a substance at a rate faster than at which the substance is lost.

Biochemical Oxygen Demand – the amount of dissolved oxygen that must be present in water in order for microorganisms to decompose the organic matter in the water, used as a measure of the degree of pollution.

BMPs (best management practices) – any land or stormwater management practice or structure used to mitigate flooding, reduce erosion & sedimentation, or otherwise control water pollution from runoff; includes urban stormwater management BMPs and agriculture/forestry BMPs.

Buffer – an area adjacent to a stream, wetland, or shoreline where development activities (e.g., buildings, logging) are typically restricted or prohibited; may be managed as streamside (riparian) zones where undisturbed vegetation and soils act as filters of pollutants in stormwater runoff. Buffer zone widths vary depending on state and local rules, but are typically a minimum of 25 to 50 feet on each side of perennial streams. In NC, buffer rules have been established for all, or portions of, the upper Cape Fear, lower Catawba, Neuse and Tar-Pamlico river basins.

Cataloging Unit (CU) – US Geological Survey-designated 8-digit Hydrologic Units (HUC), typically comprised of multiple smaller 14-digit HUs; total area of CUs ranges from about 300 to 2,000 square miles. There are 54 individual CUs in NC; they can be considered regional sub-basins within the larger river basins. They represent the watershed unit within which permitted impacts to waters and wetlands occur and where compensatory mitigation credits must be obtained.

Catchment – a single or small set of connected headwater streams that make up a portion of a subwatershed; for purposes of this report it refers to portions of the Sevenmile Swamp, Kill Swamp, Beaverdam Swamp, Great Coharie Creek, and Great Coharie Headwaters subwatersheds.

Channel modification – Activities conducted to change the flow characteristics of a channel including but not limited to straightening, widening, deepening, berming, or relocating existing stream channels and clearing or snagging operations. Channel modification is usually undertaken for the purpose of decreasing property damage (flood control), navigation, drainage improvement, and/or

channel stabilization, but could also include restoration activities. The resulting channel typically has more uniform channel cross sections, steeper stream gradients, and reduced average pool depths.

Conservation easement – a voluntary legal agreement between a landowner and a conservation organization (e.g., Land Trust) or public agency (e.g., EEP) that limits some portion of the land's uses; conservation easements are intended to preserve certain parcels/tracts in an undeveloped condition so as to provide a local or regional environmental benefit, such as water quality and habitat protection; landowners voluntarily agree to give up certain development rights on the land area in question while still retaining ownership of the land; certain tax benefits may accrue to landowners who sign conservation easements with qualified conservation organizations/agencies.

Compensatory Mitigation – an action taken to offset stream and/or wetland impacts associated with a 401/404-permitted project; includes Restoration, Enhancement, Creation and Preservation, with varying degrees of mitigation credit granted by the US Army Corps of Engineers (USACE) and the NC Department of Environment and Natural Resources (NCDENR). It is the basic regulatory tool by which "unavoidable" impacts to streams, riparian buffers and wetlands are intended to be minimized (or compensated for).

Enhancement (Enhance) – means the manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve a specific aquatic resource function(s). Enhancement results in the gain of selected aquatic resource function(s), but may also lead to a decline in other aquatic resource function(s). Enhancement does not result in a gain in aquatic resource area (40 CFR §230.92).

Fecal coliform bacteria – type of bacteria used as indicator of contamination by human or animal waste (and possible disease-causing pathogens).

Fee simple purchase –private ownership of real estate (land) in which the owner has the right to use it for any legal purpose.

Floodplain – area of land on each side of a stream channel that is inundated periodically by flood waters; important zone for dissipating the energy of peak storm flow discharges and for storing waters that otherwise might damage in-stream habitat and/or cause downstream flood damage; typically includes high-quality riparian habitat (if undisturbed). Waters flowing in incised (down-cut) streams may not be able to access the adjacent floodplain area to dissipate the volume and energy of higher storm flow events.

Functional assessment (see **Watershed function**) – a determination of the integrity or health of a watershed. Important mega-components considered are hydrology, habitat, and water quality, which are measured by multiple indicators such as the extent of forested riparian buffers, fish and benthic community integrity, extent of stream channelization, and extent of impervious cover.

Geographic Information Systems (GIS) - consisting of computer hardware, software and data designed for capturing, storing, updating, manipulating, analyzing and displaying all forms of spatial information. In EEP, desktop GIS is an important tool used in the assessment of various sets of watershed-related information (specific themes or coverages, e.g., land cover, property parcels, roads, municipal boundaries, streams, designated natural heritage areas, wetlands, soils, etc.) used in identifying the best locations for watershed project sites and management strategies.

Habitat degradation – physical destruction or deterioration of in-stream and streamside aquatic habitat due to erosion & sedimentation, pollutant inputs, unstable stream banks, channel scour due to

excessive storm flows, breaks in the riparian buffer zone, lack of woody debris in/along streams, loss of pools & riffles,

Hydrologic Unit (HU) – refers to the 14-digit Hydrologic Unit Codes used by the US Geological Survey (USGS) to identify local watersheds typically ranging from 10 to 100 square miles in total drainage area; used by NC EEP as synonymous with "local watershed".

Impervious cover – a human-created or –modified surface (e.g., concrete, asphalt) that does not allow water to percolate (or infiltrate) through it; examples include parking lots, rooftops, roadways, driveways, sidewalks, compacted soils. Urbanization and development are typically associated with significant increases in the impervious cover of a given area, which result in increased rates of stormwater runoff and inputs of non-point source pollutants into local streams.

Index of Biotic (or Biological**) Integrity** – calculated parameter for assessing the biological health of a given stream (or stream reach) by comparing the condition/status of multiple groups of organisms (e.g., benthic macroinvertebrates, fishes) against the conditions expected to be found in a healthy stream; used to assess the effects of stormwater runoff (or other sources of water quality impairment and habitat degradation) on local stream health, and to help prioritize areas/sites for stream, buffer or wetlands restoration projects.

Livestock operations – an agricultural activity in which concentrations of animals such as beef cattle, milk cows, goats, chickens, turkeys, and pigs are maintained, usually in fenced pastures or enclosures.

Local Watershed Planning (LWP) – process whereby local stakeholders (and/or a specific group of local resource agency professionals) are brought together to help EEP assess local watershed conditions, identify causes/sources of watershed impairment, identify high-priority sub-watersheds and potential watershed restoration project sites, develop solutions to watershed problems, and implement watershed management strategies for the long term protection of important watershed functions/components (streams, wetlands, riparian buffers); developed by EEP for specific Targeted Local Watersheds within 8-digit CUs where significant impacts are projected to occur.

Mitigation – see ***Compensatory Mitigation.***

NHP Natural Area – a site (terrestrial and aquatic) of special biodiversity significance. An area's significance may be due to the presence of rare species, exemplary or unique natural communities, important animal assemblages, or other important ecological features as designated by the North Carolina Natural Heritage Program.

Phase I (of a Local Watershed Plan) – the portion of the local watershed planning process whereby a preliminary characterization of watershed conditions is completed, based primarily on existing Geographic Information System (GIS), water quality, and aquatic habitat information. It culminates in a *Preliminary Finding and Recommendations Report*.

Phase II (of a Local Watershed Plan) - the portion of the local watershed planning process when a detailed watershed assessment is completed. Data gaps identified in Phase I are addressed, key stressors impacting watershed integrity and function are identified, and sources of these stressors documented. This work is summarized in a *Watershed Assessment Report*.

Phase III (of a Local Watershed Plan) – portion of the local watershed planning process where watershed assessment data and recommendations are integrated into a *Watershed Management Plan* [this document].

Preservation (Preserve) – means the removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources. This term includes activities commonly associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms. Preservation does not result in a gain of aquatic resource area or functions (40 CFR §230.92).

Reach - an individual segment of a stream that has beginning and ending points defined by identifiable features.

Restoration (Restore) **–** means the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource (40 CFR §230.92).

Riparian (buffers) **–** relating to the strip of land adjacent to streams and rivers, including stream banks and adjoining floodplain area; see also *Buffer*; important streamside zones of natural vegetation that, when disturbed or removed, can have serious negative consequences for water quality in streams and rivers.

Runnoff – water that flows overland as a result of precipitation; can flow as diffuse sheet flow over impervious surfaces (e.g., parking lots) and/or can be concentrated into ditches, gullies & swales or manmade conveyances such as storm pipes, culverts, or lined channels, stormwater can convey sediment, nutrients, fecal coliform and other pollutants directly into receiving waters.

Sediment (Sedimentation) **–** process whereby eroded soils (silt, clay, and sand) are deposited in streams, rivers, lakes; accelerated by any activity that disturbs the land surface or removes vegetation (e.g., road construction, agriculture/forestry, urban development); sediment source areas include upland sites, intermediate transition slopes, riparian zones, and stream banks and channel scour areas.

Sediment Oxygen Demand – the rate of oxygen consumption excreted by the bottom sediment on the overlying water. It can be broadly thought of as the usage of dissolved oxygen in the overlying water by benthic organisms.

Stakeholder – as pertaining to local watershed planning efforts, a stakeholder is any agency, organization, or individual involved in or affected by the decisions made in the development of a local watershed plan; typically includes: local stakeholders such as watershed residents, farmers, developers, local government or resource agency staff with a direct say in the planning process; and state or regional resource agency staff who can serve as technical resources/advisors to the local planning process.

Stormwater (Stormwater Runoff) **– see *Runoff***

Stressors – Physical, chemical, and biological factors that adversely affect aquatic organisms.

Subwatershed - a component drainage area within a local watershed (i.e., 14-digit USGS hydrologic unit); typically about one to five square miles in area, these areas are considered the most appropriate and effective geographic scale for local watershed assessment, planning, and management.

Turbidity – a measure of water cloudiness caused by suspended solids such as fine soil particles.

Watershed – all the land area which contributes runoff to a particular point usually along a stream or river; also known as a "drainage basin", although the term *Basin* usually implies a very large drainage

system, as of an entire river and its tributary streams. Watersheds are generally greater than five square miles in size, and contain multiple s*ubwatersheds*.

Watershed function – is related to the integrity or health of a watershed; includes the interaction of and between the physical, biological, and chemical components of a watershed. The three major functions that an EEP watershed assessment targets are habitat, hydrology, and water quality.

Watershed Management Plan – a document that provides assessment and management information for a geographically defined watershed, including analyses, actions, stakeholders, and resources related to development and implementation of the plan. This document is a *Watershed Management Plan* for the Great Coharie Creek headwaters study area.

Wetlands – by definition, these are areas characterized by three key features: hydrophytic (water-adapted) plants, hydric soils, and specific indicators of periodic saturation/inundation by water (*hydrology indicators,* e.g., water marks or water-carried debris on trees); in NC, several different types of wetlands are recognized, including tidal marshes, estuarine fringe forests, wet flats, pocosins, freshwater marshes, bottomland hardwood forests, headwater forests, bogs, and seeps.

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Appendix B: High Priority / High Feasibility Watershed Restoration Opportunity Site Maps

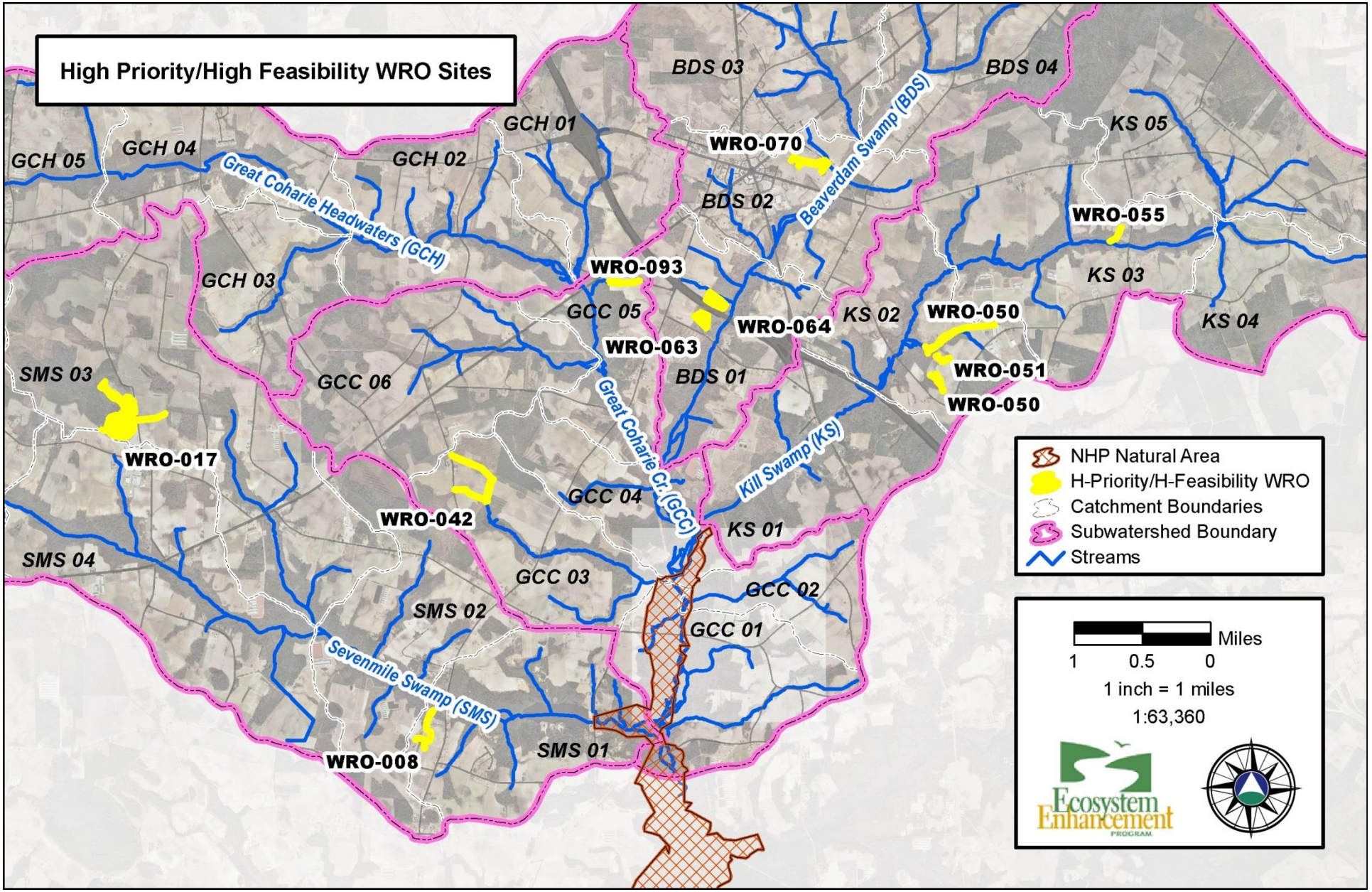
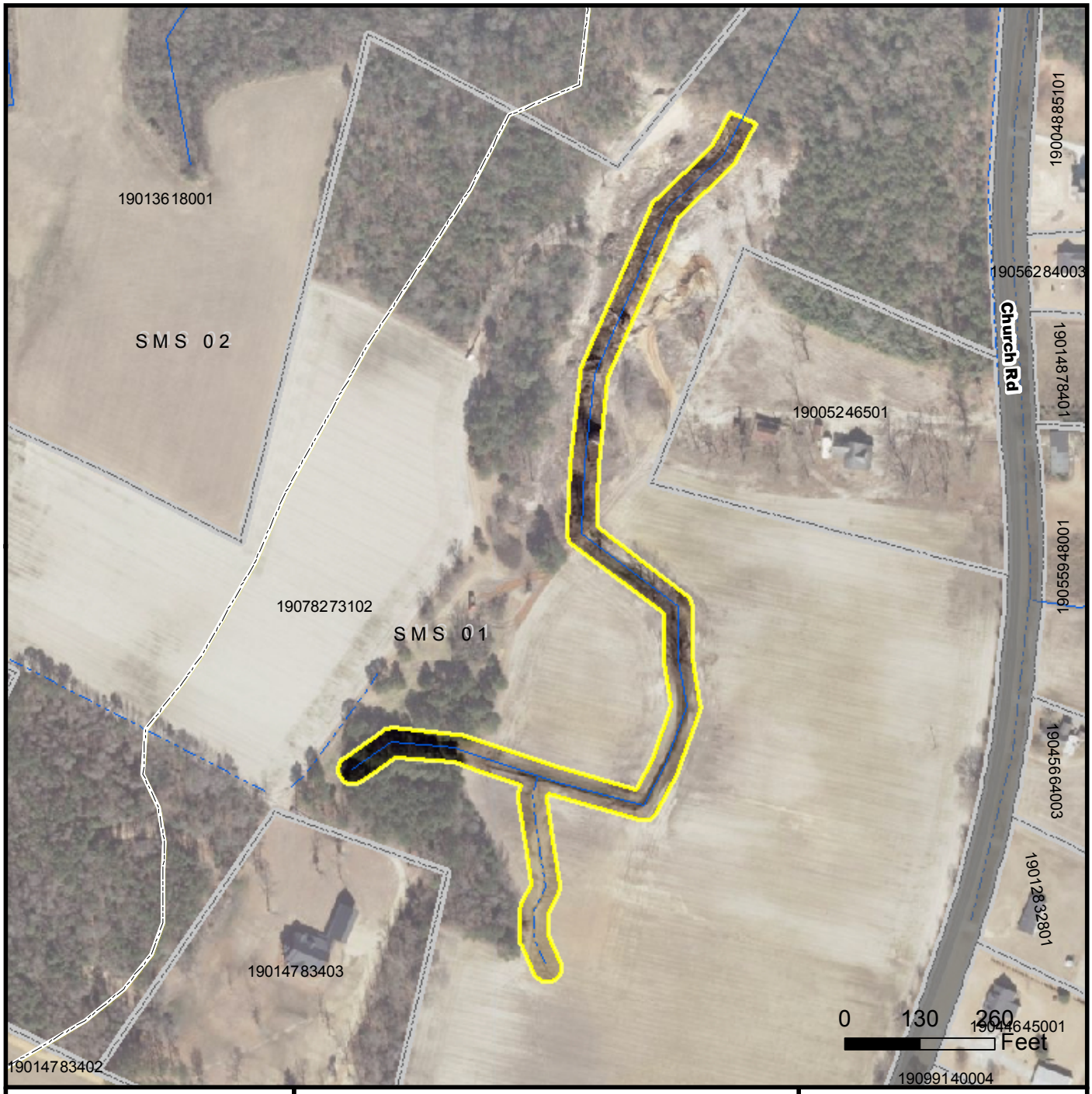


Figure B 1. Index map of high priority / high feasibility sites.



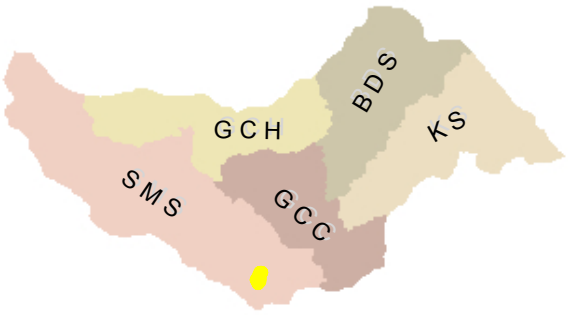
Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

Highly erosive channel devoid of vegetation, site looks highly disturbed

WRO-008

2.6 Acres

PRIORITY: 1
No. Parcels: 1
Feasibility: High



1:3,000
1 inch = 250 feet

Ecosystem Enhancement Program

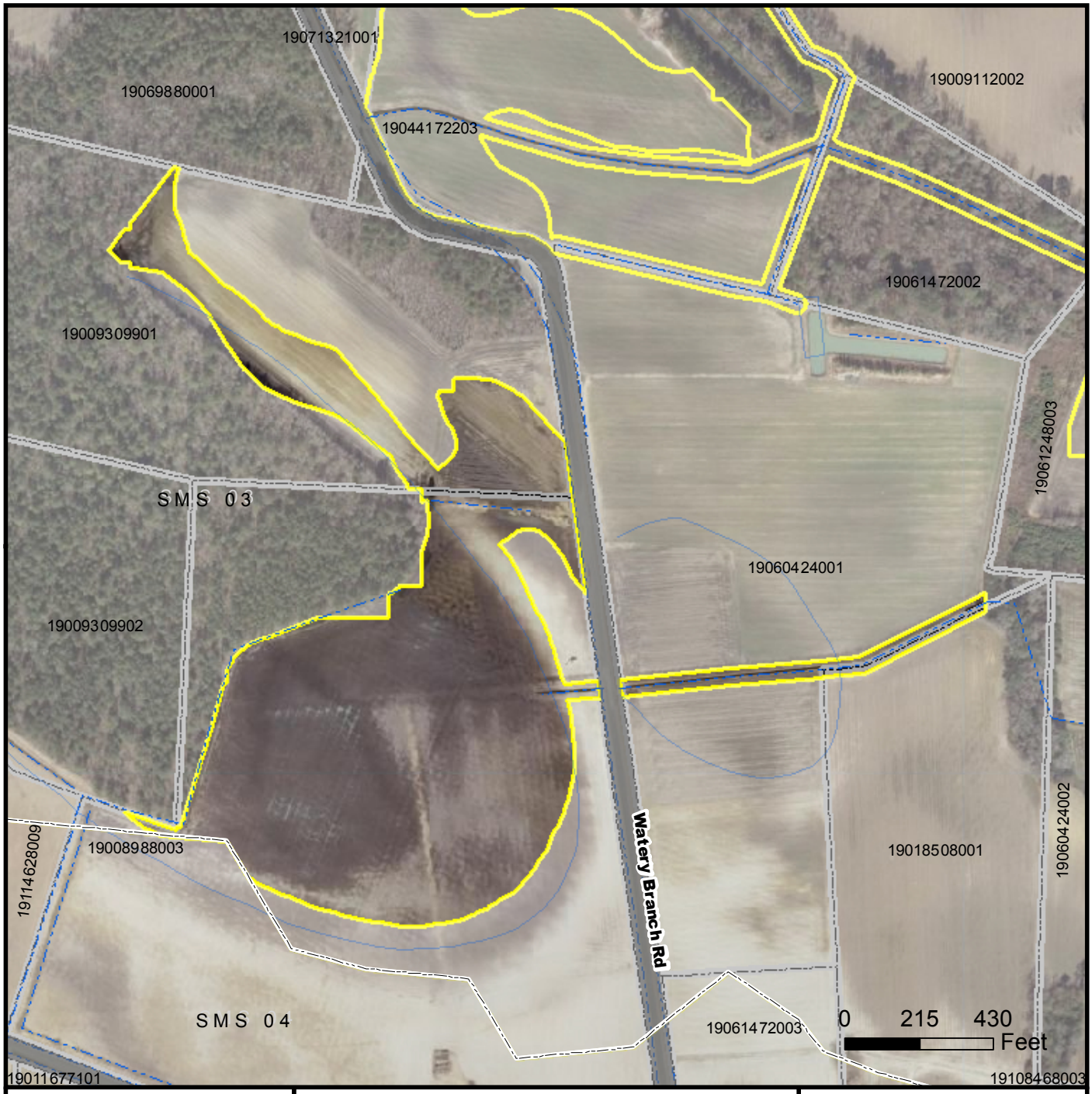
Map for reference only. October 21, 2014.

WRO-008

WRO-008

Priority:	**1**	Feasibility:	High	WRO Parcels:	1	Stream:	
	SMS 01	WRO Acres:	2.6	Veg_Mngt:		Ditch:	
Highly erosive channel devoid of vegetation, site looks highly disturbed				Wetland:		Waterway:	Yes
				Preserve:		Erosion:	

PIN	19078273102	Parcel Total Size:	65.5	Parcel in WRO:	2.6



Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

WRO-017

29.1 Acres

PRIORITY: 1
No. Parcels: 4
Feasibility: High

1:5,000
1 inch = 417 feet

Ditched wetlands, half of a Carolina Bay is used for ag, appears very wet

Ecosystem Enhancement Program

Map for reference only. October 21, 2014.

WRO-017

WRO-017

Priority: 1 | Feasibility: High | WRO Parcels: 4 | Stream:

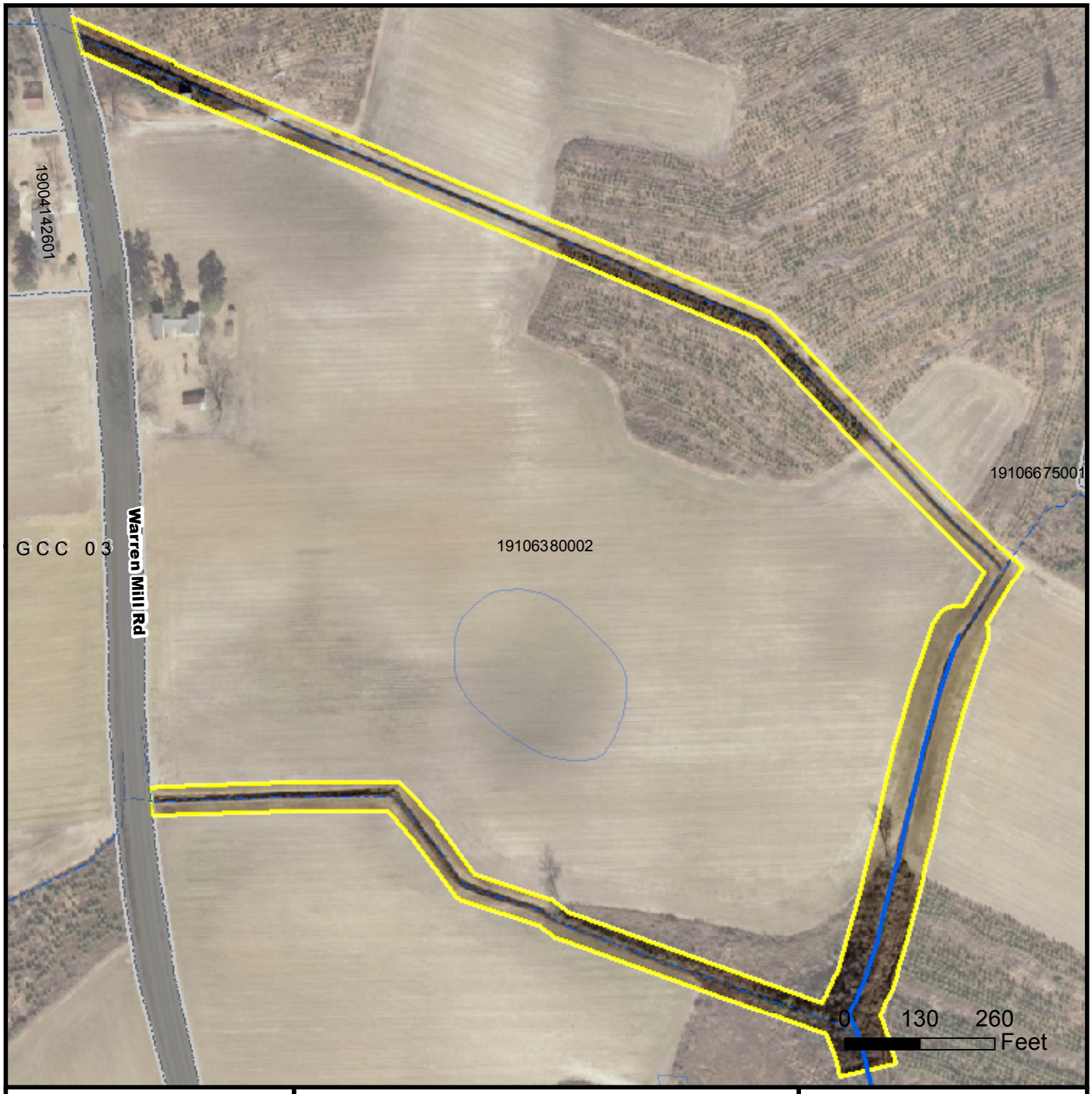
SMS 03 | WRO Acres: 29.1 | Veg_Mngt: | Ditch: Yes

Ditched wetlands, half of a Carolina Bay is used for ag, appears very wet

Wetland: Yes | Waterway:

Preserve: | Erosion:

PIN	19009309901	Parcel Total Size:	28	Parcel in WRO:	5.9
PIN	19060424001	Parcel Total Size:	40.39	Parcel in WRO:	1.1
PIN	19018508001	Parcel Total Size:	27.7	Parcel in WRO:	0.2
PIN	19008988003	Parcel Total Size:	69.51	Parcel in WRO:	21.9



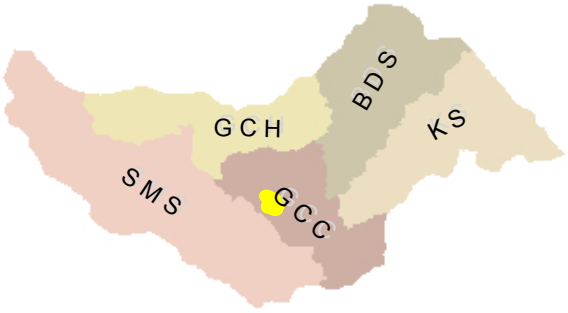
Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

Headwater ditches and stream channel, two stream assessment sites were done here

WRO-042

5.6 Acres

PRIORITY: 1
No. Parcels: 1
Feasibility: High



1:3,000
1 inch = 250 feet

Ecosystem Enhancement Program

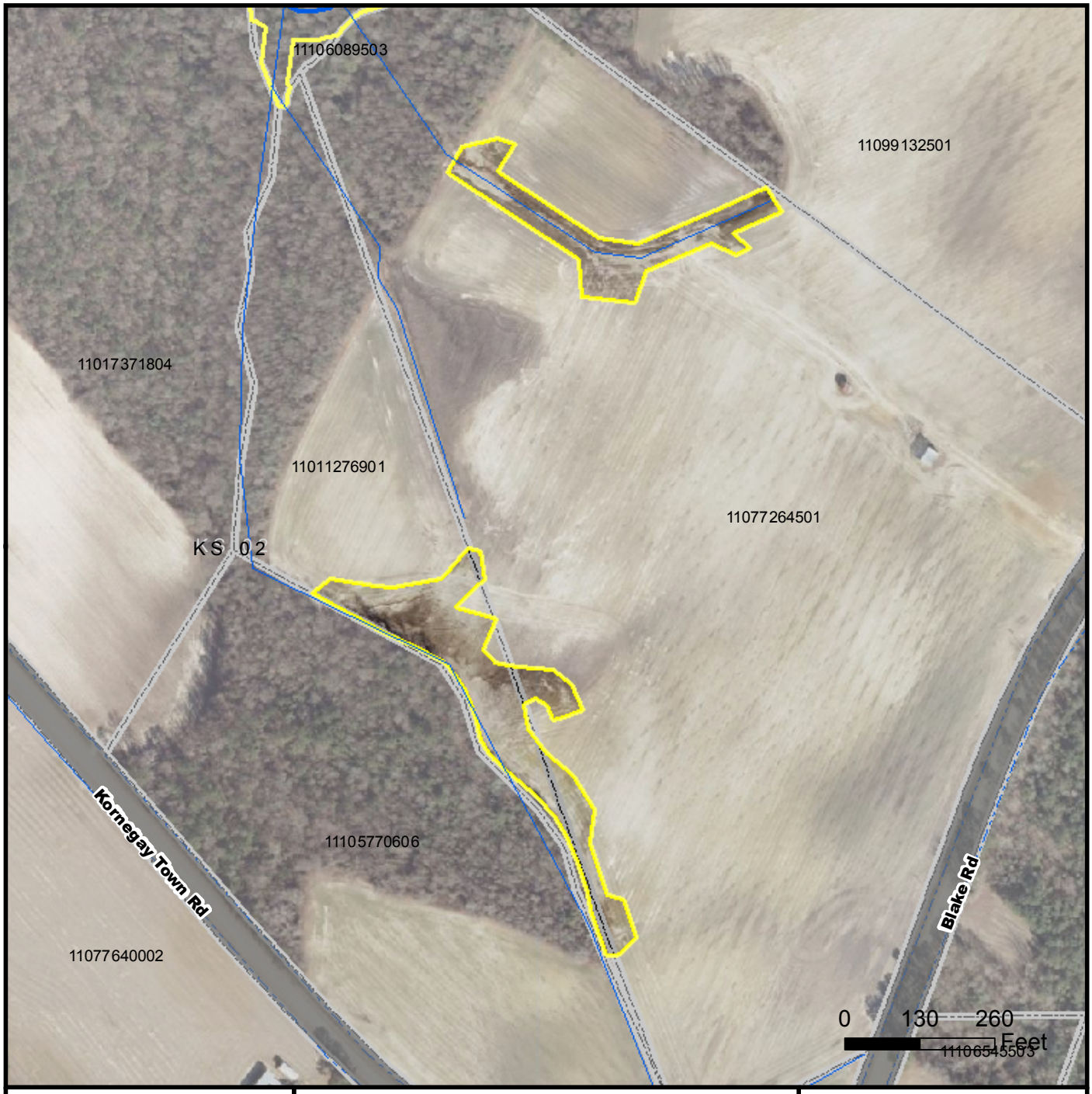
Map for reference only. October 21, 2014.

WRO-042

WRO-042

Priority:	**1**	Feasibility:	High	WRO Parcels:	1	Stream:	Yes
	GCC 03	WRO Acres:	5.6	Veg_Mngt:		Ditch:	Yes
Headwater ditches and stream channel, two stream assessment sites were done here				Wetland:		Waterway:	
				Preserve:		Erosion:	

PIN	19106380002	Parcel Total Size:	388.2	Parcel in WRO:	5.6



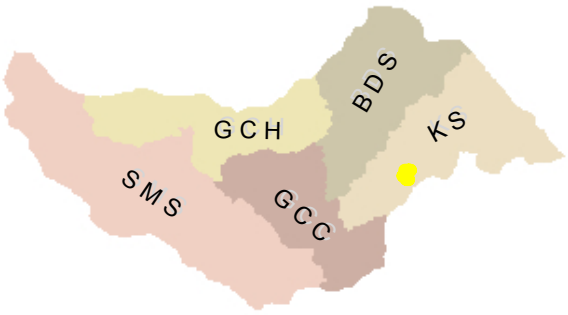
Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

Visible erosion draining to waterways

WRO-050

2.6 Acres

PRIORITY: 1
No. Parcels: 2
Feasibility: High



1:3,000
1 inch = 250 feet

Ecosystem Enhancement Program

Map for reference only. October 21, 2014.

WRO-050

WRO-050

Priority: 1 Feasibility: High WRO Parcels: 2 Stream:

KS 02 WRO Acres: 2.6 Veg_Mngt: Ditch:

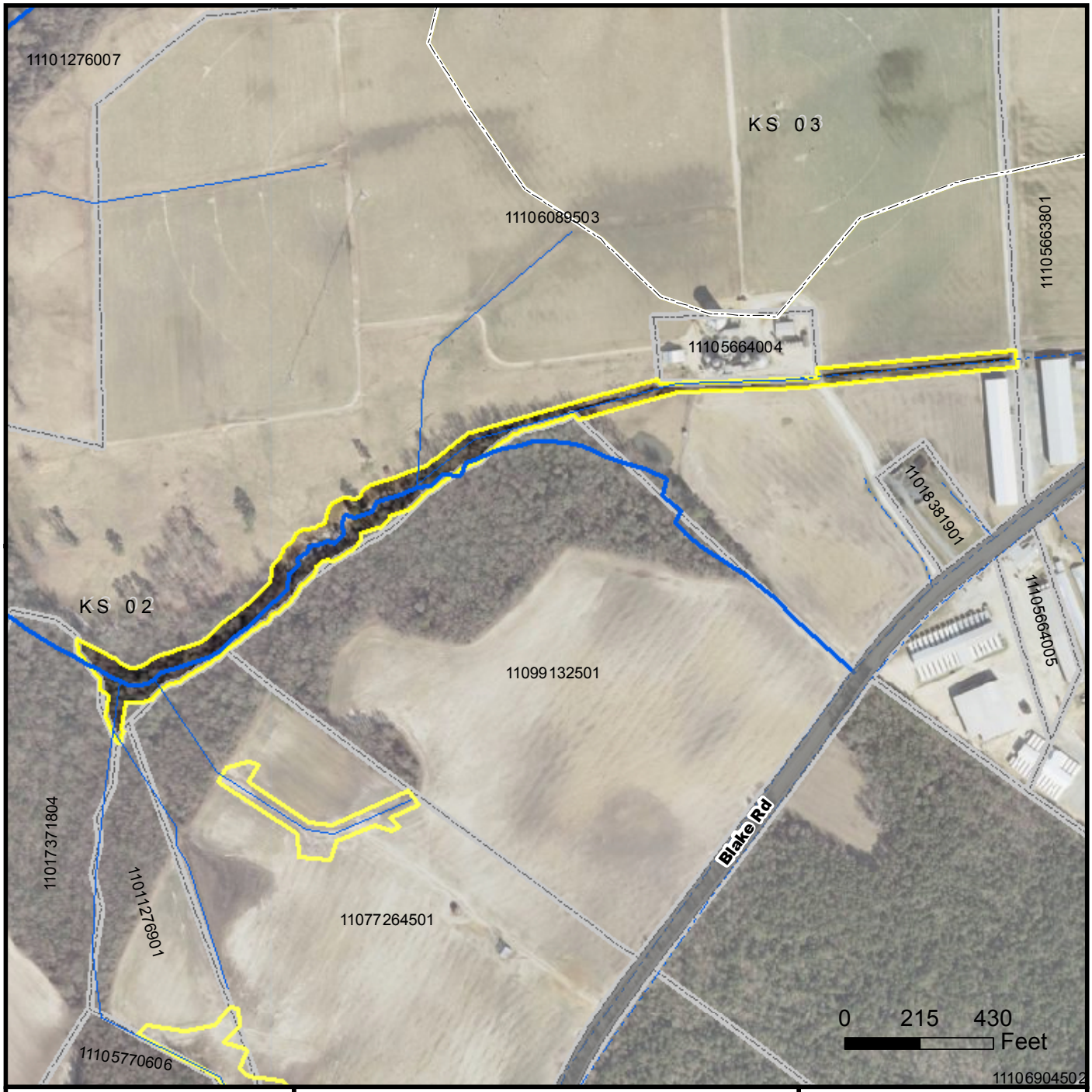
Visible erosion draining to waterways

Wetland: Waterway: Yes

Preserve: Erosion: Yes

PIN	11011276901	Parcel Total Size:	2.37	Parcel in WRO:	1.2

PIN	11077264501	Parcel Total Size:	60.98	Parcel in WRO:	1.4



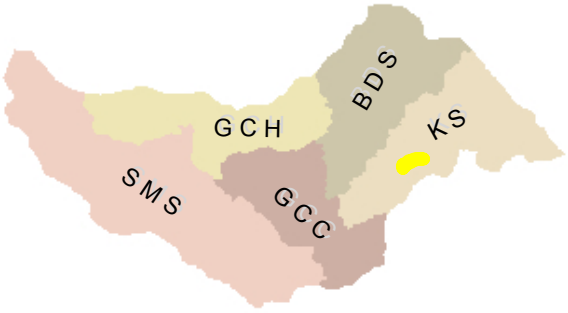
Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

Ditch and waterways leading to highly eroded stream channel, livestock have access to stream

WRO-051

4.5 Acres

PRIORITY: 1
No. Parcels: 1
Feasibility: High



1:5,000
1 inch = 417 feet

Ecosystem Enhancement Program

Map for reference only. October 21, 2014.

WRO-051

WRO-051

Priority: 1 | Feasibility: High | WRO Parcels: 1 | Stream: Yes

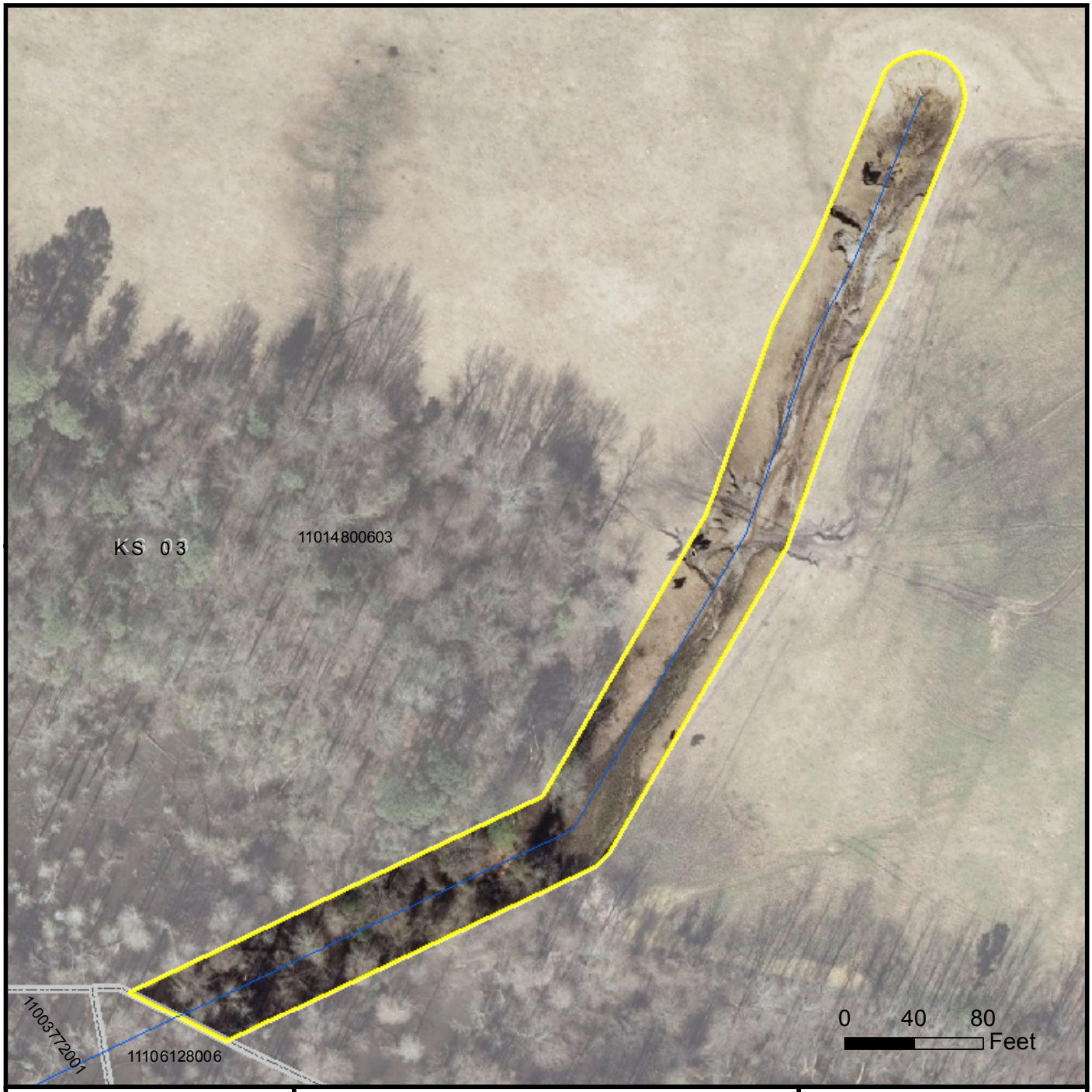
KS 02 | WRO Acres: 4.5 | Veg_Mngt: | Ditch: Yes

Ditch and waterways leading to highly eroded stream channel, livestock have access to stream

Wetland: | Waterway: Yes

Preserve: | Erosion:

PIN	11106089503	Parcel Total Size:	144.44	Parcel in WRO:	4.5



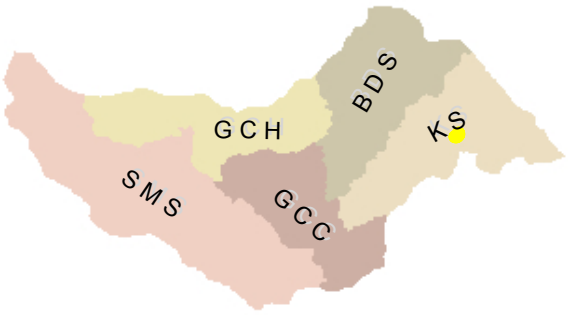
Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

Highly disturbed waterway with severe erosion and no riparian vegetation

WRO-055

0.9 Acres

PRIORITY: 1
No. Parcels: 1
Feasibility: High



1:1,000
1 inch = 83 feet

Ecosystem Enhancement Program

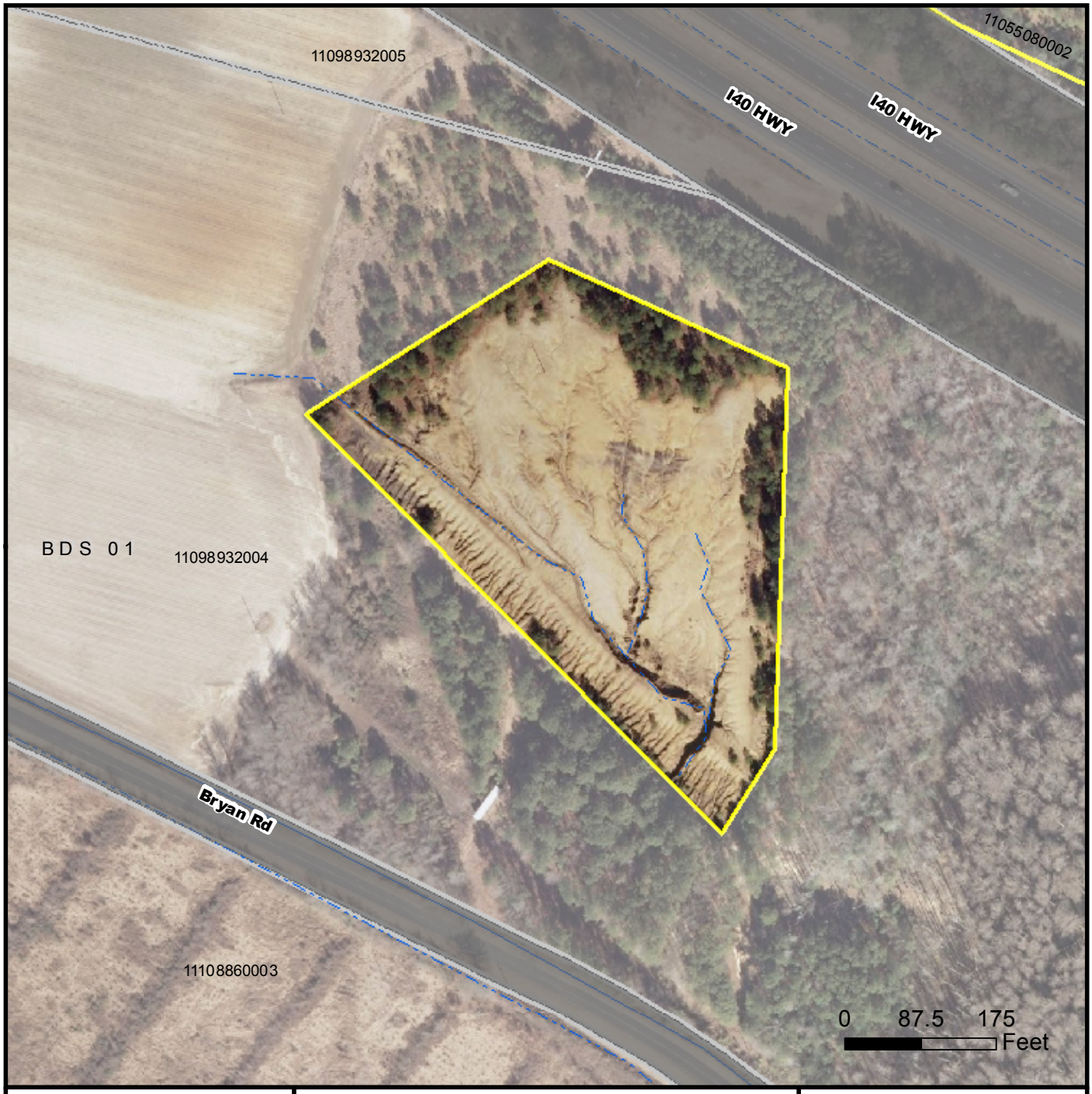
Map for reference only. October 21, 2014.

WRO-055

WRO-055

Priority:	**1**	Feasibility:	High	WRO Parcels:	1	Stream:	
KS 03		WRO Acres:	0.9	Veg_Mngt:		Ditch:	
Highly disturbed waterway with severe erosion and no riparian vegetation				Wetland:		Waterway:	Yes
				Preserve:		Erosion:	

PIN	11014800603	Parcel Total Size:	30.3	Parcel in WRO:	0.9



Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

"Sisters Canyon", this site has extreme erosion, old spoil piles from roadway construction

WRO-063

4.7 Acres

PRIORITY: 1
No. Parcels: 1
Feasibility: High

1:2,000
1 inch = 167 feet

Ecosystem Enhancement Program

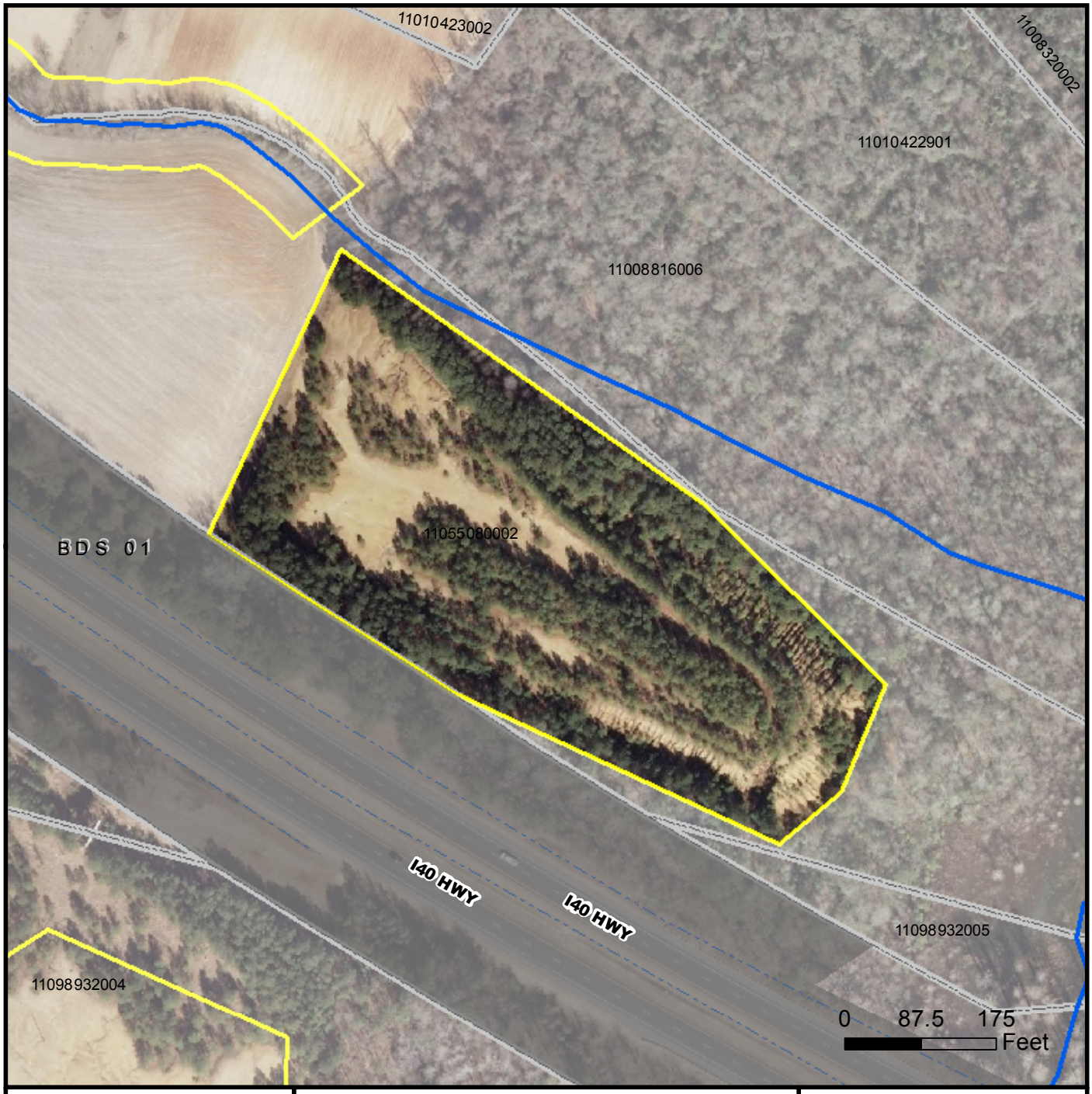
Map for reference only. October 21, 2014.

WRO-063

WRO-063

Priority: 1	Feasibility: High	WRO Parcels: 1		Stream:	
BDS 01	WRO Acres: 4.7	Veg_Mngt:		Ditch:	Yes
"Sisters Canyon", this site has extreme erosion, old spoil piles from roadway construction		Wetland:		Waterway:	
		Preserve:		Erosion:	Yes

PIN	11098932004	Parcel Total Size:	38.4	Parcel in WRO:	4.7



Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

This site has extreme erosion, old spoil piles from highway construction

WRO-064

5.8 Acres

PRIORITY: 1
No. Parcels: 1
Feasibility: High

1:2,000
1 inch = 167 feet

Ecosystem Enhancement Program

Map for reference only. October 21, 2014.

WRO-064

WRO-064

Priority: 1 | Feasibility: High | WRO Parcels: 1 | Stream:

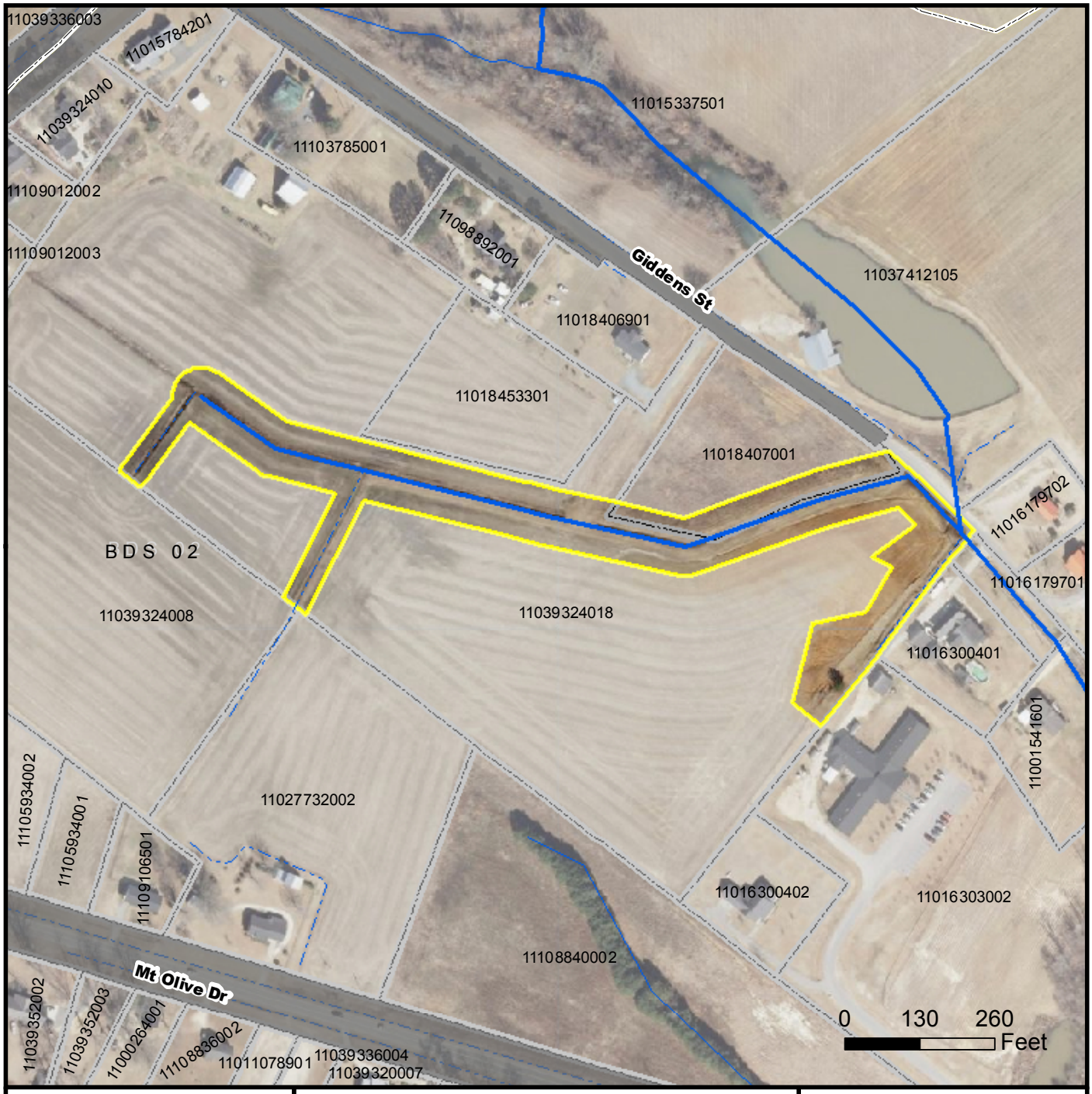
BDS 01 | WRO Acres: 5.8 | Veg_Mngt: | Ditch:

This site has extreme erosion, old spoil piles from highway construction

Wetland: | Waterway:

Preserve: | Erosion: Yes

PIN	11055080002	Parcel Total Size:	20.85	Parcel in WRO:	5.8



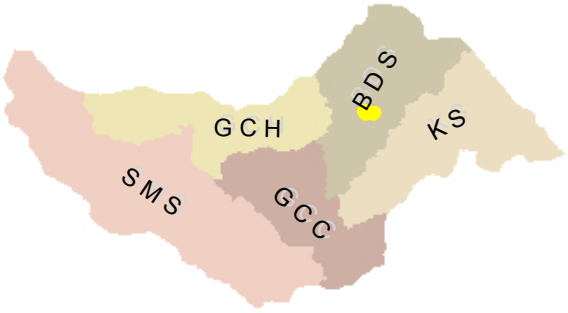
Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

Highly impacted stream channel and ag ditches with visible erosion

WRO-070

4.4 Acres

PRIORITY: 1
No. Parcels: 2
Feasibility: High



1:3,000
1 inch = 250 feet

Ecosystem Enhancement Program

Map for reference only. October 21, 2014.

WRO-070

WRO-070

Priority: 1 Feasibility: High WRO Parcels: 2 Stream: Yes

BDS 02 WRO Acres: 4.4 Veg_Mngt: Ditch: Yes

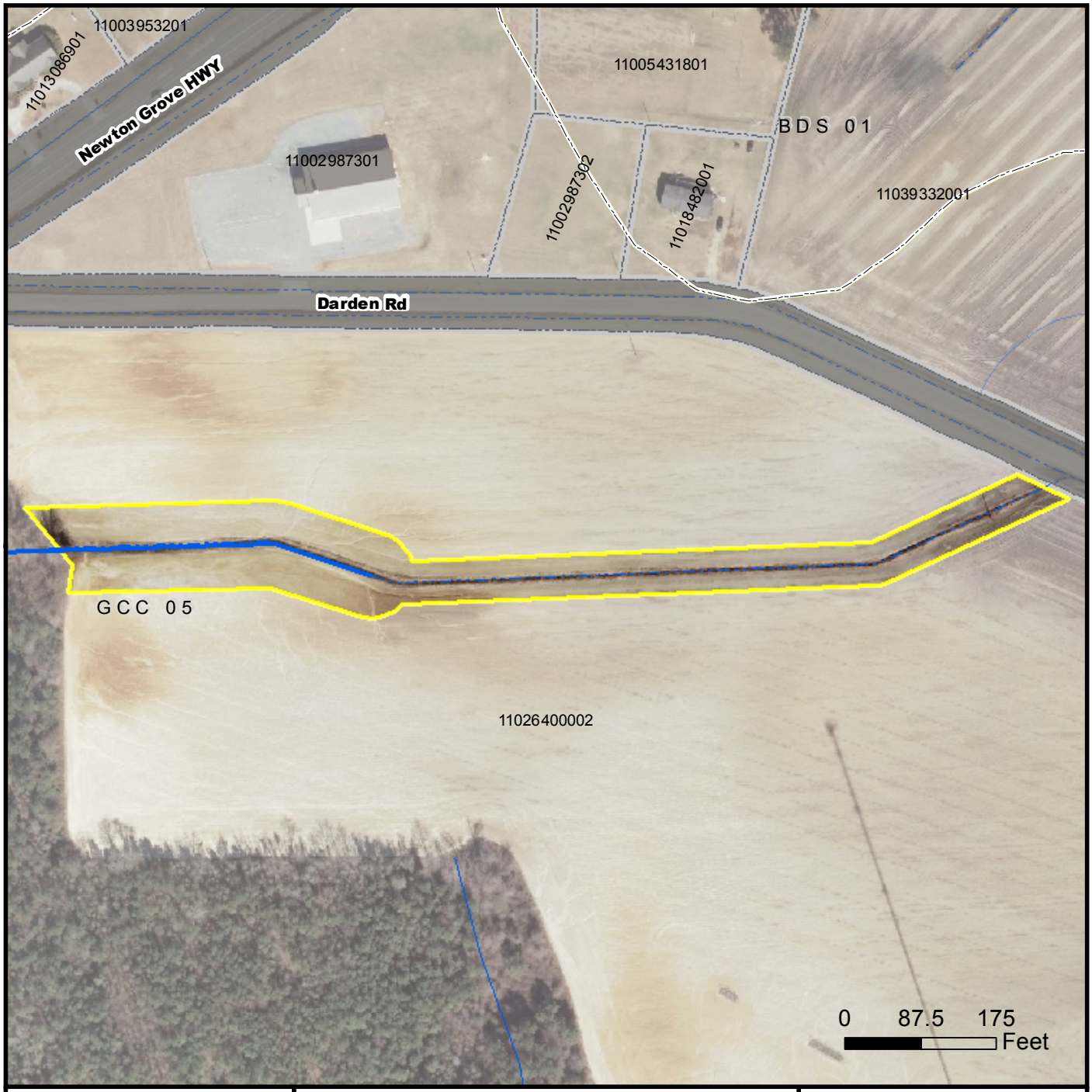
Highly impacted stream channel and ag ditches with visible erosion

Wetland: Waterway:

Preserve: Erosion: Yes

PIN	11018407001	Parcel Total Size:	1.99	Parcel in WRO:	0.5

PIN	11039324018	Parcel Total Size:	20.29	Parcel in WRO:	3.9



Streams
Ditches
Potential Waterways
Carolina Bays
WRO Project Sites
Parcel Bndy

Stream and upstream ditch with no riparian vegetation and significant erosion leading from ag fields

WRO-093

1.8 Acres

PRIORITY: 1
No. Parcels: 1
Feasibility: High

1:2,000
1 inch = 167 feet

Ecosystem Enhancement Program

Map for reference only. October 21, 2014.

WRO-093

WRO-093

Priority:	**1**	Feasibility:	High	WRO Parcels:	1	Stream:	Yes
	GCC 05	WRO Acres:	1.8	Veg_Mngt:		Ditch:	Yes
Stream and upstream ditch with no riparian vegetation and significant visible erosion leading from the ag fields				Wetland:		Waterway:	
				Preserve:		Erosion:	Yes

PIN	11026400002	Parcel Total Size:	60.31	Parcel in WRO:	1.8

Appendix C: Database of Watershed Restoration Opportunities

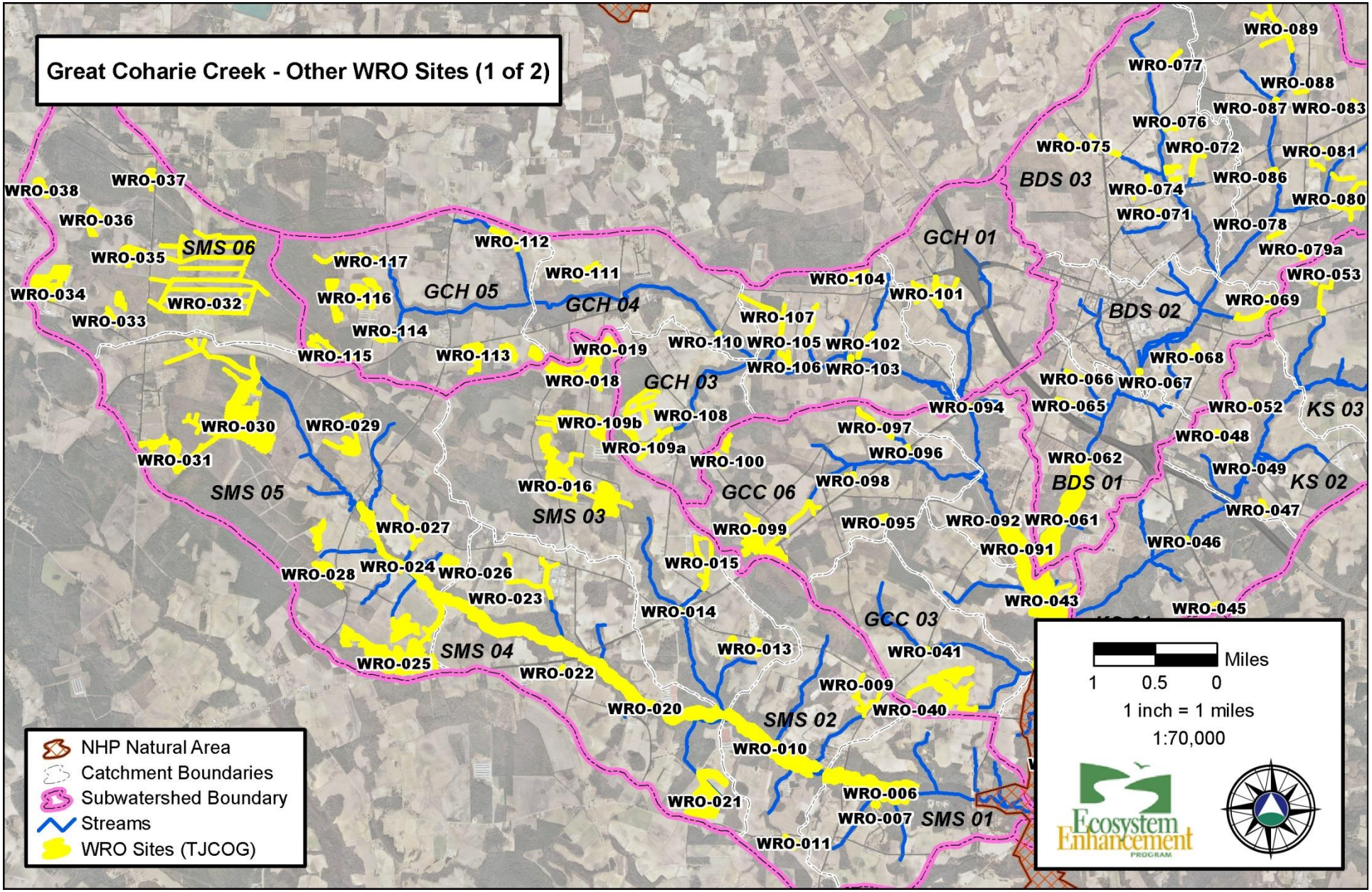


Figure C 1. Index map of watershed restoration opportunities (1 of 2).

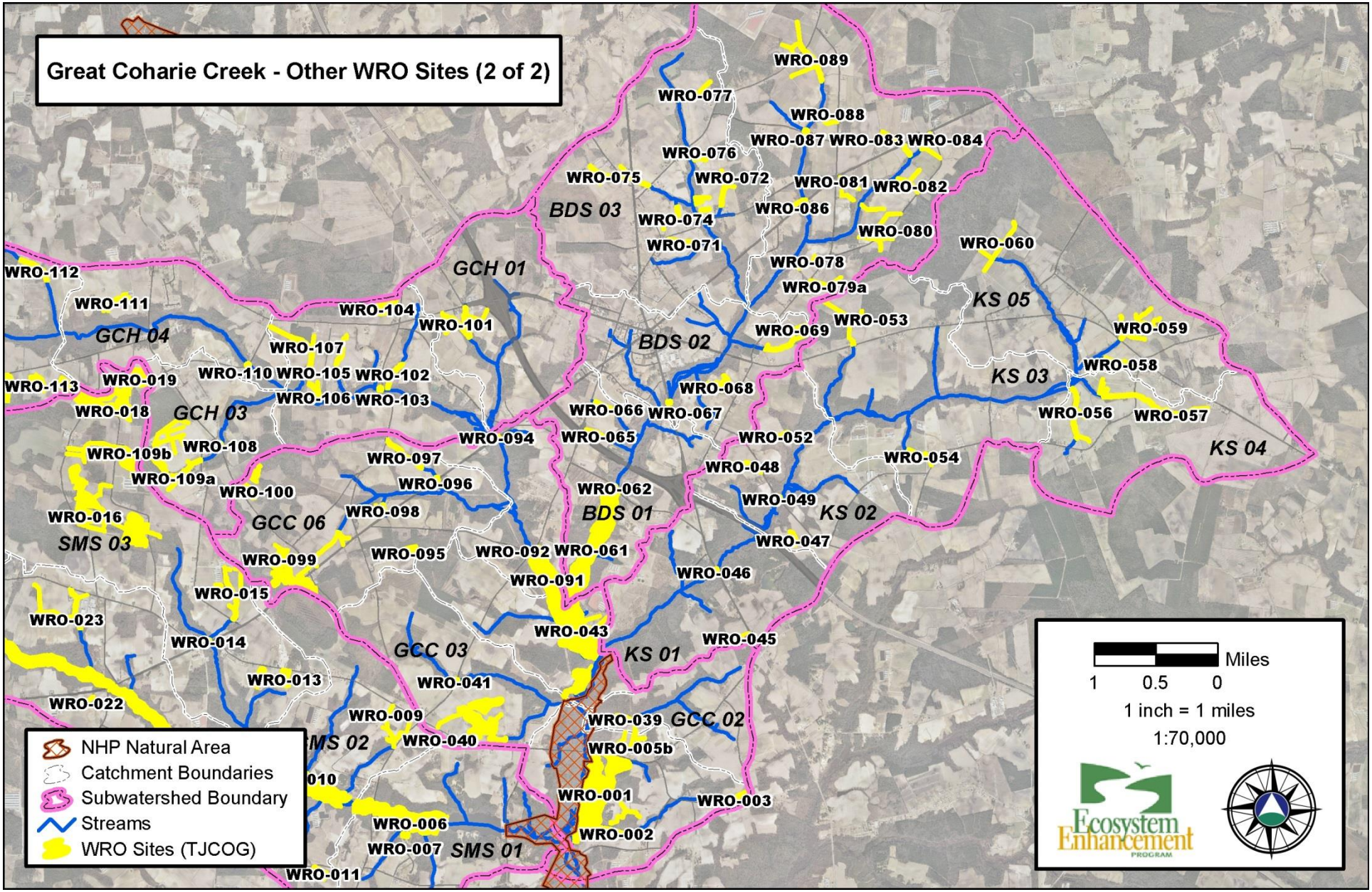


Figure C 2. Index map of watershed restoration opportunities (2 of 2).

Table C 1. WROs sorted by Tier, from Tier 1 (Highest Priority) to Tier 5 (Lowest Priority). Colors in Priority and Feasibility columns indicate best (green) to worst (red). Colors in Acres and Parcels columns indicates number, with darker shading for higher numbers. Colors in other columns is for orientation only.

TIER 1. High Priority / High Feasibility

Priority	Feasibility	SITE_NO	Acres	Parcels	SubWS	Catchment	Stream (feet)	Waterway (feet)	Ditch (feet)	Wetland (acres)	Veg Mngt	Preserve	Erosion	Notes
1	High	WRO-008	2.6	1	SMS	SMS 01	-	1,916	341	-				Highly erosive channel devoid of vegetation, site looks highly disturbed
1	High	WRO-017	29.1	4	SMS	SMS 03	-	-	1,957	27.8				Ditched wetlands, half of a Carolina Bay is used for ag, appears very wet
1	High	WRO-042	5.6	1	GCC	GCC 03	788	-	3,400	2.1				Headwater ditches and stream channel, two stream assessment sites were done here
1	High	WRO-050	2.6	2	KS	KS 02	-	965	-	0.1			X	Visible erosion draining to waterways
1	High	WRO-051	4.5	1	KS	KS 02	1,461	1,495	577	0.1				Ditch and waterways leading to highly eroded stream channel, livestock have access to stream
1	High	WRO-055	0.9	1	KS	KS 03	-	723	-	0.0				Highly disturbed waterway with severe erosion and no riparian vegetation
1	High	WRO-063	4.7	1	BDS	BDS 01	-	-	1,098	-			X	"Sisters Canyon", this site has extreme erosion, old spoil piles from roadway construction
1	High	WRO-064	5.8	1	BDS	BDS 01	-	-	-	3.2			X	This site has extreme erosion, old spoil piles from highway construction
1	High	WRO-070	4.4	2	BDS	BDS 02	1,473	-	680	1.2			X	Highly impacted stream channel and ag ditches with visible erosion
1	High	WRO-093	1.8	1	GCC	GCC 05	366	-	1,168	0.1			X	Stream and upstream ditch with no riparian vegetation and significant visible erosion leading from the ag fields

TIER 2. Med-High Priority / Med-High Feasibility

Priority	Feasibility	SITE_NO	Acres	Parcels	SubWS	Catchment	Stream (feet)	Waterway (feet)	Ditch (feet)	Wetland (acres)	Veg Mngt	Preserve	Erosion	Notes
1	Med	WRO-025	88.3	3	SMS	SMS 05	1,734	-	5,875	84.2				Historic headwater wetlands ditched and drained to a highly disturbed stream channel, good stream restoration project
1	Med	WRO-030	73.1	7	SMS	SMS 05	1,546	-	28,423	70.0				Large scale forestry operation with ag fields in the center, major ditch network from recent harvest, fields appear very wet
1	Med	WRO-047	2.9	1	KS	KS 02	-	-	350	-			X	Highly disturbed area with visible erosion and multiple channels visible, small buildings are present on this site
1	Med	WRO-054	3.1	3	KS	KS 03	1,357	53	417	-				Stream channel with eroding banks and no riparian vegetation
1	Med	WRO-057	13.1	7	KS	KS 04	4,708	651	42	0.8			X	Modified stream channel with some visible erosion, good stream restoration project
1	Med	WRO-069	5.7	6	BDS	BDS 02	1,319	-	2,589	1.3				Impacted stream channel with upstream ditches, little to no riparian vegetation and visible erosion
1	Med	WRO-115	9.2	5	GCH	GCH 05	-	-	4,298	7.4				Highly disturbed site in headwaters of GCC, site appears fairly wet, possible pasture
1	Med	WRO-117	4.9	3	GCH	GCH 05	-	2,299	1,170	0.6				Impacted waterway and ditch with buffer on one side, livestock have access to channel
2	High	WRO-002	3.7	1	GCC	GCC 01	1,654	-	-	0.2				Stream restoration along edge of field
2	High	WRO-004	2.7	1	GCC	GCC 01	-	408	1,908	0.7				Ditches draining to waterway with no buffer
2	High	WRO-005a	0.6	2	GCC	GCC 02	-	-	499	0.0				Ditches leading from chicken coops through fields
2	High	WRO-005b	3.5	2	GCC	GCC 01	-	-	3,127	1.9				Ditches leading from chicken coops through fields
2	High	WRO-019	9.0	1	SMS	SMS 03	-	-	456	9.0				Drained wetland, appears very wet
2	High	WRO-021	41.9	3	SMS	SMS 04	1,900	17	828	13.3				Stream has been modified and moved to edge of field, new channels reforming across fields, good stream restoration site
2	High	WRO-022	0.9	1	SMS	SMS 04	-	107	776	-			X	Visible erosion and field appears wet
2	High	WRO-036	6.7	1	SMS	SMS 06	-	-	847	6.7				Historic wetlands and Carolina Bay, field appears fairly wet
2	High	WRO-040	34.2	1	GCC	GCC 03	2,265	-	4,127	26.9				Ditches flow to stream, which is then impounded, no riparian vegetation, site used for grazing, fields appear fairly wet
2	High	WRO-044	2.0	2	GCC	GCC 04	-	-	1,625	0.4				Two ditches draining a sparsely vegetated hunting plot, no riparian vegetation
2	High	WRO-048	2.1	1	KS	KS 02	-	1,673	178	-				Ditch and waterway with no riparian vegetation
2	High	WRO-052	1.0	1	KS	KS 02	-	-	-	-			X	Visible erosion along edge of field draining to waterway
2	High	WRO-053	2.2	1	KS	KS 03	-	-	2,099	0.8				Large ditch with eroding banks
2	High	WRO-060	4.2	4	KS	KS 05	24	672	2,991	-				Headwater ditches draining visibly wet fields, could provide habitat corridor

Priority	Feasibility	SITE_NO	Acres	Parcels	SubWS	Catchment	Stream (feet)	Waterway (feet)	Ditch (feet)	Wetland (acres)	Veg Mngt	Preserve	Erosion	Notes
2	High	WRO-071	2.4	2	BDS	BDS 03	805	-	442	-				Stream and upstream ditch with no riparian vegetation
2	High	WRO-072	3.7	2	BDS	BDS 03	800	-	1,622	0.4				Stream and upstream ditches with no riparian vegetation
2	High	WRO-073	3.4	2	BDS	BDS 03	-	42	-	1.3			X	Significant visible erosion forming channels across fields
2	High	WRO-076	1.3	1	BDS	BDS 03	-	-	-	0.0			X	Significant visible erosion forming channels across field
2	High	WRO-077	1.8	2	BDS	BDS 03	-	1,566	-	0.4				Waterway with no riparian vegetation bisects field
2	High	WRO-078	1.1	1	BDS	BDS 04	-	935	-	-				Waterway with no riparian vegetation bisects field
2	High	WRO-086	1.2	1	BDS	BDS 04	-	1,046	-	-				Waterway with no riparian vegetation
2	High	WRO-100	9.7	1	GCC	GCC 06	-	-	-	9.7				Potential wetland restoration site, fields appear somewhat wet
2	High	WRO-102	3.1	1	GCH	GCH 02	1,339	-	-	2.6				Impacted stream channel with no riparian vegetation
2	High	WRO-104	9.0	1	GCH	GCH 02	-	-	874	9.0				Potential wetland restoration site, fields appear somewhat wet

TIER 3. Med Priority / Med Feasibility (and Low / High)

Priority	Feasibility	SITE_NO	Acres	Parcels	SubWS	Catchment	Stream (feet)	Waterway (feet)	Ditch (feet)	Wetland (acres)	Veg Mngt	Preserve	Erosion	Notes
2	Med	WRO-007	1.0	2	SMS	SMS 01	-	-	-	-			X	Visible erosion in what looks like a borrow pit of some kind, drains to mainstem of Sevenmile Swamp
2	Med	WRO-014	0.3	4	SMS	SMS 03	162	-	-	-	X			Recommended vegetation management site
2	Med	WRO-018	31.8	3	SMS	SMS 03	-	-	719	31.8				Drained wetlands
2	Med	WRO-026	8.3	3	SMS	SMS 05	-	550	-	8.3				Drained historic wetland, field looks fairly wet
2	Med	WRO-029	11.9	6	SMS	SMS 05	-	-	4,018	9.8				Historic wetlands, drained and ditched, field appears very wet, good wetland restoration project
2	Med	WRO-033	8.9	1	SMS	SMS 06	-	-	837	8.9				Historic wetlands, drained and ditched, field looks fairly wet
2	Med	WRO-034	24.9	3	SMS	SMS 06	-	-	2,344	24.9				Historic wetlands, ditched and drained, fields appear fairly wet
2	Med	WRO-039	1.9	2	GCC	GCC 02	862	-	-	0.8				Stream seems to have been modified and moved to edge of field, highly entrenched
2	Med	WRO-041	0.5	3	GCC	GCC 03	152	-	97	-	X			Recommended vegetation management site
2	Med	WRO-046	0.4	2	KS	KS 01	154	-	205	0.2	X			Recommended vegetation management site
2	Med	WRO-049	0.5	2	KS	KS 02	122	110	-	0.1	X			Recommended vegetation management site
2	Med	WRO-058	3.1	3	KS	KS 05	1,300	74	-	-				Impacted stream channel with no riparian buffer, good stream restoration project
2	Med	WRO-059	7.7	2	KS	KS 05	1,685	2,731	833	0.3				Modified stream channel with upstream waterways and ditches, highly incised
2	Med	WRO-062	0.3	5	BDS	BDS 01	78	191	84	0.0	X			Recommended vegetation management site
2	Med	WRO-065	2.7	2	BDS	BDS 01	1,170	-	-	0.5				Stream with little to no riparian vegetation
2	Med	WRO-066	2.7	2	BDS	BDS 01	1,178	-	-	1.1				Straightened stream with no riparian vegetation
2	Med	WRO-067	0.4	4	BDS	BDS 02	91	47	-	0.2	X			Recommended vegetation management site
2	Med	WRO-068	4.4	1	BDS	BDS 02	-	-	97	0.3			X	Visible erosion forming channels across field and along field edges
2	Med	WRO-074	3.0	3	BDS	BDS 03	762	-	1,206	-				Stream and upstream ditches with no riparian vegetation
2	Med	WRO-082	2.1	3	BDS	BDS 04	-	1,114	691	-				Waterway and ditch with no riparian vegetation, could provide habitat connectivity
2	Med	WRO-084	2.4	2	BDS	BDS 04	-	-	2,160	-				Ditches that drain ag fields and roads at the headwaters of Beaverdam Swamp
2	Med	WRO-085	0.3	3	BDS	BDS 04	94	-	15	-	X			Recommended vegetation management site

Priority	Feasibility	SITE_NO	Acres	Parcels	SubWS	Catchment	Stream (feet)	Waterway (feet)	Ditch (feet)	Wetland (acres)	Veg Mngt	Preserve	Erosion	Notes
2	Med	WRO-087	0.5	5	BDS	BDS 04	243	-	16	0.2	X			Recommended vegetation management site
2	Med	WRO-088	1.1	2	BDS	BDS 04	-	918	-	0.0				Waterway with no riparian vegetation
2	Med	WRO-092	0.3	2	GCC	GCC 05	114	-	-	0.1	X			Recommended vegetation management site
2	Med	WRO-094	0.3	1	GCC	GCC 05	94	-	-	0.1	X			Recommended vegetation management site
2	Med	WRO-095	4.5	1	GCC	GCC 06	-	-	-	4.5				Potential wetland restoration site, field looks fairly wet
2	Med	WRO-097	4.8	4	GCC	GCC 06	2,116	-	-	1.3				Impacted stream with no riparian vegetation
2	Med	WRO-103	0.7	1	GCH	GCH 02	184	-	-	-	X			Recommended vegetation management site
2	Med	WRO-108	0.5	2	GCH	GCH 03	175	-	175	-	X			Recommended vegetation management site
2	Med	WRO-110	0.4	3	GCH	GCH 04	135	-	223	0.4	X			Recommended vegetation management site
2	Med	WRO-113	26.4	5	GCH	GCH 05	-	-	1,869	26.4				Potential wetland restoration sites, historic Carolina bays, field appear fairly wet
2	Med	WRO-114	2.2	3	GCH	GCH 05	964	-	46	0.6				Stream with no buffer, could provide habitat connection
2	Med	WRO-116	27.8	6	GCH	GCH 05	-	944	-	27.8				Potential wetland restoration site, historic Carolina bay, fields appear fairly wet
3	High	WRO-001	82.9	6	GCC	GCC 01	6,790	520	-	82.4		X		Mainstem of GCC, adjacent to EEP easement, protect the riparian corridor
3	High	WRO-003	3.4	3	GCC	GCC 01	1,346	209	-	0.7				Headwater stream with upstream waterway
3	High	WRO-035	13.4	1	SMS	SMS 06	-	-	240	13.4				Historic wetland, field appears somewhat wet
3	High	WRO-038	6.5	1	SMS	SMS 06	-	-	209	6.5				Historic wetland, field appears somewhat wet
3	High	WRO-045	1.0	1	KS	KS 01	-	858	-	-				Waterway with no riparian vegetation
3	High	WRO-105	2.6	1	GCH	GCH 02	816	-	617	0.0				Stream and ditch with no riparian vegetation
3	High	WRO-111	3.0	1	GCH	GCH 04	-	135	2,412	0.0				Ditches with no riparian vegetation leading from chicken coops

TIER 4. Low-Med Priority / Low-Med Feasibility

Priority	Feasibility	SITE_NO	Acres	Parcels	SubWS	Catchment	Stream (feet)	Waterway (feet)	Ditch (feet)	Wetland (acres)	Veg Mngt	Preserve	Erosion	Notes
3	Med	WRO-012	4.0	2	SMS	SMS 03	-	-	740	4.0				Ditched historic wetland, not very visibly wet
3	Med	WRO-013	5.2	1	SMS	SMS 03	-	-	946	5.2				Ditched historic wetland, site appears somewhat wet
3	Med	WRO-031	18.6	2	SMS	SMS 05	-	-	3,047	18.6				Historic wetlands, ditched and drained, fields appear fairly wet
3	Med	WRO-032	41.6	6	SMS	SMS 06	-	-	37,101	9.1				Major ditch network in the headwaters of Sevenmile Swamp
3	Med	WRO-037	5.4	1	SMS	SMS 06	-	-	-	5.4				Historic wetland, field appears somewhat wet
3	Med	WRO-043	84.3	7	GCC	GCC 04	15,072	526	-	80.7		X		Mainstem of GCC downstream of BDS, this section includes the mouth of KS, protect the riparian corridor
3	Med	WRO-056	6.6	4	KS	KS 04	2,322	598	1,146	0.0				Impacted stream channel with narrow riparian buffer, upstream ditch and waterway
3	Med	WRO-061	73.6	14	BDS	BDS 01	9,004	1,731	96	54.9		X		Mainstem of Beaverdam Swamp, protect the riparian corridor
3	Med	WRO-081	2.1	2	BDS	BDS 04	-	1,833	-	-				Waterways with no riparian vegetation
3	Med	WRO-091	37.1	2	GCC	GCC 05	3,498	1,181	-	35.5		X		Mainstem of GCC, protect the riparian corridor
3	Med	WRO-098	1.8	3	GCC	GCC 06	460	281	-	0.5			X	Highly impacted stream channel and waterway with significant visible erosion in channel and leading from field
3	Med	WRO-106	2.2	1	GCH	GCH 02	739	460	-	-				Stream and waterway with no riparian vegetation
3	Med	WRO-107	6.2	2	GCH	GCH 02	1,924	-	1,543	1.1				Stream and ditches with no riparian vegetation
2	Low	WRO-015	8.6	4	SMS	SMS 03	1,934	-	3,646	2.8				Ditches and stream run adjacent to hog lagoons, visible erosion along stream channel
2	Low	WRO-023	8.2	7	SMS	SMS 04	1,866	1,605	1,906	2.7				Ditches and a waterway drain to an impounded stream segment, site is adjacent to agricultural operations site
2	Low	WRO-027	4.4	7	SMS	SMS 05	-	-	3,930	1.5				Ditch network carries roadside and ag ditches to mainstem of Sevenmile Swamp
2	Low	WRO-028	16.1	3	SMS	SMS 05	-	50	2,068	16.1				Historic wetlands, drained, site has two center-pivot irrigation systems
2	Low	WRO-075	7.9	8	BDS	BDS 03	2,649	-	4,063	4.6				Stream and upstream ditches with no riparian vegetation, stream has some erosion and sinuosity forming
2	Low	WRO-080	5.7	13	BDS	BDS 04	-	4,216	-	-				Waterways with some visibly eroding banks and no riparian vegetation
2	Low	WRO-083	3.5	5	BDS	BDS 04	1,530	-	2	-				Stream with no riparian vegetation
2	Low	WRO-089	8.0	10	BDS	BDS 04	1,754	-	3,695	0.8				Stream and ditches with no riparian vegetation
2	Low	WRO-099	34.0	8	GCC	GCC 06	59	570	9,427	28.5				Ditches and potential wetland restoration, channels have no riparian vegetation and fields appear somewhat wet

Priority	Feasibility	SITE_NO	Acres	Parcels	SubWS	Catchment	Stream (feet)	Waterway (feet)	Ditch (feet)	Wetland (acres)	Veg Mngt	Preserve	Erosion	Notes
2	Low	WRO-101	9.4	12	GCH	GCH 01	2,812	776	2,353	0.4				Impacted stream channels with waterways and ditches, some visible erosion
2	Low	WRO-109a	15.1	3	GCH	GCH 03	1,722	1,064	8,960	6.5				Ditches, stream and inline ponds with no buffer, draining fairly wet fields, center pivot irrigation

TIER 5. Low Priority / Low Feasibility

Priority	Feasibility	SITE_NO	Acres	Parcels	SubWS	Catchment	Stream (feet)	Waterway (feet)	Ditch (feet)	Wetland (acres)	Veg Mngt	Preserve	Erosion	Notes
3	Low	WRO-006	58.2	6	SMS	SMS 01	7,015	1,195	-	49.8		X		Mainstem of Sevenmile Swamp, protect the riparian corridor
3	Low	WRO-009	4.6	5	SMS	SMS 02	-	1,430	2,681	1.2				Ditches drain to waterway which drains to stream
3	Low	WRO-010	52.6	10	SMS	SMS 02	5,664	2,057	-	42.1		X		Mainstem of Sevenmile Swamp, protect riparian corridor
3	Low	WRO-011	1.1	3	SMS	SMS 02	-	-	929	1.0				Headwater ditch that drains a very wet area
3	Low	WRO-016	57.7	7	SMS	SMS 03	-	-	10,568	52.6				Ditched wetlands
3	Low	WRO-020	122.9	22	SMS	SMS 04	14,621	4,699	12	108.7		X		Mainstem of Sevenmile Swamp, protect the riparian corridor
3	Low	WRO-024	30.3	19	SMS	SMS 05	4,723	798	188	22.0		X		Mainstem of Sevenmile Swamp, protect the riparian corridor
3	Low	WRO-079a	2.4	6	BDS	BDS 04	-	-	2,090	-				Ditch with no riparian vegetation
3	Low	WRO-079b	1.6	6	KS	KS 03	-	-	1,367	0.5				Ditch with no riparian vegetation
3	Low	WRO-096	0.3	2	GCC	GCC 06	94	-	-	-	X			Recommended vegetation management site
3	Low	WRO-109b	18.3	6	SMS	SMS 03	-	-	5,249	17.0				Ditches draining fairly wet fields, connects with WRO-109a
3	Low	WRO-112	3.6	11	GCH	GCH 05	1,555	75	102	-				Impacted stream channel with no riparian vegetation in places