Great Coharie Creek
Preliminary Findings Report

Ecosystem Enhancement PROGRAM

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Cover Photo: Great Coharie Creek within the EEP High Quality Preservation Tract, also a NC Significant Natural Heritage Area

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EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) planning process is a watershed-specific evaluation of aquatic resource conditions developed in conjunction with local resource professionals that identifies and prioritizes potential project opportunities to address watershed needs through restoration, enhancement, preservation, and non-traditional strategies. The planning area covers 53 square miles in the northern portion of Sampson County, with a very small portion of land in Johnston County, and contains the headwater of Great Coharie Creek. The headwater of Great Coharie Creek is joined by Seven Mile Swamp, Beaverdam Swamp and Kill Swamp to form the main stem of Great Coharie Creek before leaving the planning area.

The planning process is broken into three phases. The first, which is addressed in this report, develops a preliminary characterization of the watershed using existing data, stakeholder input and field reconnaissance. The Local Advisory Team consists of local community members and local resource professionals who guide the process with the knowledge of the community's interests, as well as resource professionals from other regions who can provide the group with technical input. The Local Advisory Team determined the draft watershed goals for this project and reviewed all products to ensure that they are accurate and in line with local interests.

Channel and riparian conditions were documented by the EEP planner and Division of Water Quality-Watershed Assessment Team staff during field surveys in October and November of 2009 at all road crossings in the watershed planning area. In addition, the DWQ Biological Assessment Unit conducted habitat surveys at nine locations, providing more in-stream detail. Channels on the main stems of the four streams tend to be wide and deep and often braided and well connected to the floodplain. The sediments are sandy often with thick silt and detritus though some had a good portion of gravel. Banks are vegetated and little erosion is present. There are a variety of pool sizes and a good amount of woody debris. In some areas during the winter, the substrate is detritus dominant due to decomposing macrophyte beds.

Channels in the headwaters and tributaries, though rarely moved from their natural valleys, have in most cases been cleared and deepened to facilitate the movement of water. The channels are deep with little vegetation and often have signs of erosion. In some cases, a buffer of trees and shrubs has been left and these contain a mix of native and exotic plants.

The Great Coharie Creek watershed presents many water quality assessment interpretation challenges. Two primary challenges include the fact that the streams within the Great Coharie watershed are considered "blackwater" streams and have the supplementary water quality classification of "swamp waters." The second challenge is that the watershed has several impoundments (mill ponds) and beaver dams.

Field observations and GIS land cover data suggest that the major water quality issues affecting aquatic life in the Great Coharie Creek LWP area are likely to be sediment, nutrients, and low dissolved oxygen and pH. Low dissolved oxygen and pH are common in swamp streams and may be exacerbated by high nutrient influx and associated growth of algae and aquatic macrophytes in the streams and shallow impoundments. Substantial algal growth was observed in areas where little to no shade was present along the streams. Dense growths of aquatic macrophytes, including mats of submerged aquatic vegetation (SAV) were common in the impoundments as well as in some areas of the stream channels. During the winter, decomposition of the macrophyte beds contributes large quantities of organic matter and releases bound nutrients into the streams and impoundments. The organic matter and nutrients may have an adverse impact on water quality and habitat suitability for aquatic organisms.

The limited water chemistry and field meter data collected during reconnaissance activities suggest that nutrient enrichment may be the major water chemistry concern in parts of the Great Coharie Creek LWP area. The average fecal coliform bacteria and nitrite + nitrate levels were highest in Sevenmile Swamp; total Kjeldahl nitrogen also was high. Total Kjeldahl nitrogen is the sum of organic nitrogen and ammonia nitrogen. Total phosphorous concentrations were higher in Kill Swamp and Beaverdam Swamp than elsewhere. These limited data suggest upstream pollution sources possibly originating from animal operations and/or field crops production in the headwaters of these streams. The highest specific conductance (and lowest pH) values occurred in a headwater tributary in the most eastern part of the Kill Swamp watershed. The surrounding area was predominantly open fields and largely lacked riparian buffers. The observed high conductance readings suggested possible chemical pollutant influx from the headwaters of Kill Swamp.

Extensive GIS work was conducted. Twenty-six subwatersheds were delineated to make assessment more manageable. A new land use data layer was developed using 2008 aerial photography. Asset and stressor maps were developed for each of the 26 subwatersheds. The stressor maps included altered wetlands, impacted buffers and impacted land use. The asset maps highlighted intact wetlands, high-value habitat and natural land uses.

Assessment Objectives for water quality, hydrology and habitat were developed to guide the assessment phase of the plan. Water quality will be assessed in the headwaters to determine potential pollutant sources and efforts will be taken to determine the movement of pollutants downstream**.** Preliminary GIS analysis identified nearly half the streams are impacted and 3,000 acres of wetlands have been altered (with half of them now being pine plantations). This data will be refined in the next phase and field verified by EEP staff. Biological monitoring is being conducted and additional work will take place in the winter of 2011. Assessment work is expected to continue through 2011.

INTRODUCTION

Scope and Purpose of EEP Watershed Planning

The foundation of the North Carolina Ecosystem Enhancement Program (EEP) local watershed planning process is the identification of watershed assets as well as key factors contributing to degradation of watershed functions, focusing on water quality, hydrology and habitat. EEP defines a watershed plan as a watershed-specific evaluation of aquatic resource conditions developed in conjunction with local resource professionals that identifies and prioritizes potential project opportunities to address watershed needs through restoration, enhancement, preservation, and non-traditional strategies. At a minimum the watershed plan should include the following six elements: local stakeholder involvement, monitoring, identification of watershed stressors, development of comprehensive management strategies, prioritized project sites and post-plan monitoring.

Planning Area Description

The planning area covers 53 square miles in the northern portion of Sampson County, with a very small portion of land in Johnston County, and contains the headwater of Great Coharie Creek. The headwater of Great Coharie Creek is joined by Seven Mile Swamp, Beaverdam Swamp and Kill Swamp to form the main stem of Great Coharie Creek before leaving the planning area.

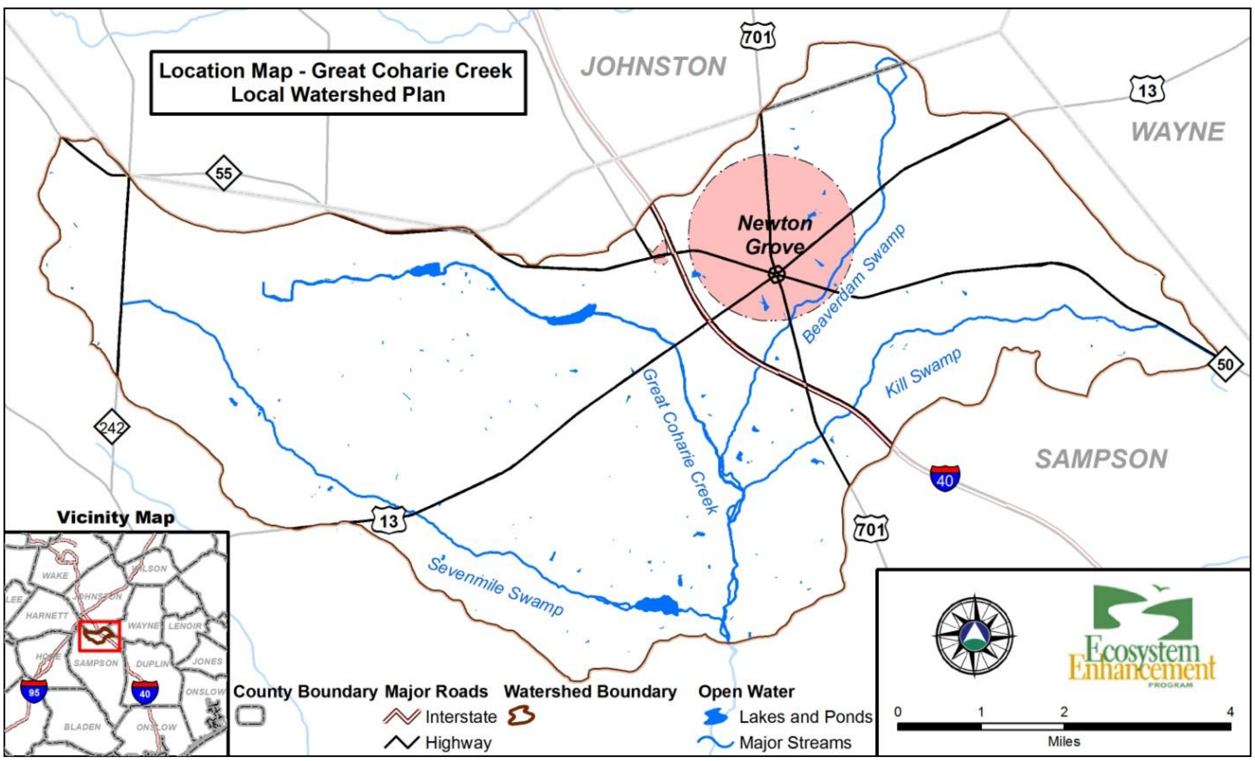

Figure 1. Map of Great Coharie Local Watershed Planning Area

The primary land use in the watershed is agriculture and includes one town, the Town of Newton Grove. The entire watershed is located in Catalog Unit (CU) 03030006 and includes three 14-digit hydrologic units (HUs):03030006090010, 03030006090015, and 03030006090020. It is also located in NC Division of Water Quality (DWQ) subbasin Cape Fear 19 (03-06-19). There are four named streams (Great Coharie Creek, Beaverdam Swamp, Kill Swamp and Sevenmile Swamp).

There are 4,850 acres of corridor along Great Coharie Creek that are protected by the state. This corridor has also been designated as Significant Natural Heritage Area because it supports two populations of the Significantly Rare bluff oak (*Quercus austrina*) and contains 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 Significant Natural Heritage Area contains populations of two rare fishes, Federal and State Species of Concern broadtail madtom *(Noturus* spp.) and State Special Concern thinlip chub (*Cyprinella* spp.). There are also 3 rare freshwater mollusks: State Threatened eastern lampmussel (*Lampsilis radiata*), State Special Concern pod lance (*Elliptio folliculata*) and State Significantly Rare eastern creekshell (*Villosa delumbis*).

Planning Approach

Through watershed planning, EEP identifies the best locations to implement stream, wetland and riparian buffer restoration. The planning process considers where mitigation is needed and how our mitigation efforts might contribute to the improvement of water and habitat quality in the state. Watershed planning requires GIS data analysis, stakeholder involvement, water quality and habitat monitoring and consideration of local land uses and ordinances. It is a process that includes science, policy and partnership.
Local Watershed Plans (LWPs) are developed collaboratively with representatives of local governments, environmental resource professionals, nonprofit organizations, and local communities. This provides an important opportunity for local stakeholders to shape the future of their watershed. Through the LWP planning process, these groups work cooperatively to identify issues, set priorities, develop management strategies, secure funding, and implement watershed protection and restoration projects within their communities.

The foundation of local watershed planning is the identification of watershed assets as well as key factors contributing to degradation of watershed functions, focusing on water quality, hydrology and habitat. The process is briefly described below.

Watershed Assessment: A technical watershed assessment inventories and validates information regarding historical and current watershed conditions, including problem areas within the watershed where functional improvements could be realized or protection measures should be applied.

Local Stakeholder Involvement: Local representation is critical to the process for the purposes of providing input and feedback on watershed assessment products and watershed restoration goals.

Project Implementation: A comprehensive suite of specific watershed improvement projects is identified through the planning process. Projects including wetland, stream and riparian buffer restoration, enhancement and protection are pursued by EEP or other state, federal, local or nonprofit resources. Other recommendations such as Stormwater Best Management Practices and policy recommendations are pursued through partnerships with state, federal and local programs for the long-term improvement and protection of watershed functions.

The planning process is broken into three phases. The first, which is addressed in this report, develops a preliminary characterization of the watershed using existing data, stakeholder input and field reconnaissance. The second phase is the watershed assessment, which inventories and validates information regarding historical and current watershed conditions, including problem areas within the watershed where functional improvements could be realized or protection measures should be applied. The third phase is when the planner and the stakeholders develop a Watershed Management Plan that describes strategies to address problems identified in the watershed assessment.

The primary objectives of the first phase of the plan are:

- develop a preliminary characterization of current watershed conditions and land use trends based on data compiled from a variety of sources;
- identify critical data gaps;
- identify assets and major functional stressors within the watershed;
- delineate subwatersheds;
- preliminarily identify priority areas for additional assessment and possible project sites;
- develop the *Preliminary Findings and Recommendations* report;
- scope out the recommended approach for conducting detailed assessment tasks during the second planning phase.

Stakeholder Participation

In the Great Coharie Local Watershed Plan there are four levels of participation. The most involved group of participants is those that have committed to sitting on the Local Advisory Team. This group (listed in Table 1) consists of local community members and local resource professionals who guide the process with the knowledge of the community's interests, as well as resource professionals from other regions who can provide the group with technical input. The Local Advisory Team determined the draft watershed goals for this project and reviewed all products to ensure that they are accurate and in line with local interests.

The second level of involvement for stakeholders is by those who participate in or receive information through Community Outreach. Community Outreach has included word-of-mouth by members of the Local Advisory Team, newspaper articles in the Sampson County newspaper, public meetings and letters to land owners in the watershed.

The In-House Planning Team is made up of staff from EEP, Division of Water Quality, Natural Heritage Program staff and a GIS consultant from Triangle J Council of Government (Table 2).

The purpose of this group is to develop methodology, collect data, interpret data and assist in all manners of the watershed assessment process.

Finally, there is the Technical Team, which brings a variety of knowledge to the planning process, including knowledge of fish, macroinvertebrates, wildlife habitat, geomorphology, hydrology, water chemistry, GIS, data analysis, modeling and restoration. This group varies depending on the technical needs and draws from multiple agencies to assist the In-House Planning Team when their specialty is required.

Table 1. Great Coharie Local Advisory Team

Name	Organization
Roger Sheats	Cape Fear River Assembly
Kristen Howell	Cape Fear Arch
Camille Warren	Friends of Sampson Co Waterways
Ralph Hamilton	Watershed Champion
Dan Bailey	Sampson Cooperative Extension
Kent Wooten	Sampson Cooperative Extension Director
Jacob Giddens	NRCS / Sampson County Soil and Water
Joel Rose	Community Representative
David Willis	Community Representative
Cebron Fussell	Community Representative
Gerald Darden	Newton Grove Mayor
Jim Caldwell	Mid-Carolina COG
Eric Galamb	DENR Stewardship for Great Coharie Tract
Sarah McRae	NC Natural Heritage Program
Jeff Vreugdenhil	Sampson County Planning Director
Gerald Warren	Landowner
Joel Strickland	Mid-Carolina COG

Table 2. Great Coharie In-House Planning Team

Name	Organization
Stratford Kay	DWQ-Watershed Assessment Team
Steve Kroeger	DWQ-Watershed Assessment Team
Michael Schlegel	Triangle J Council of Governments
Sarah McRae	NC Natural Heritage Program
Nora Deamer	DWQ Basinwide Planning
Greg Melia	NC EEP
Rob Breeding	NC EEP
Tracy Morris	NC EEP
Watson Ross	NC EEP
Kristin Miguez	NC EEP

Draft Watershed Goals

Goals are statements that provide the context for what a planning process is trying to achieve. Goals should be specific, measurable, agreed- upon, realistic and set a timeframe. The first set of goals below directly reflect EEP's statement of purpose, the purpose of EEP planning as defined in our Compensatory Planning Framework and the planner's recognition of local needs as defined by the Local Advisory Team.

EEP Planning Goals

- Identify major stressors to water quality, habitat and hydrology and develop strategies to address these watershed stressors.
- Ensure that projects are selected and located to achieve maximum long-term improvement to watershed.
- Provide outreach to local landowners, resource professionals and communities regarding the value of protecting aquatic resources.
- Identify sources of funding, including EEP for stream and wetland protection and restoration.
- Ensure the goals of the planning effort align with the conservation and economic goals of the community.

The second set of goals was developed by the Local Advisory Team. These goals reflect the interests of the community to better understand the aquatic resources in the watershed and how this information relates to their community. These goals help the In-House Planning Team identify issues specific to the local watershed that need to be evaluated and addressed. As we learn more about the watershed and community needs, these goals will most likely be refined.

Local Advisory Team Goals

- Increase awareness of local watershed issues among elected officials and community members.
- To understand the water quality issues in the watershed.
- To understand aquatic species distribution in the watershed.
- To identify invasive aquatic plants and animals and understand their distribution and impacts.
- Identify ecological, historical and cultural aquatic assets and develop strategies to protect them.
- Identify priority areas to focus agricultural BMPs.
- Make a clear connection between community interest and issues in the watershed.

WATERSHED CHARACTERIZATION

Location and General Description

The Great Coharie Local Watershed planning area is located in northern Sampson County and includes a very small portion of southern Johnston County. Land use in the watershed is predominantly agriculture (50% by area) and forested (30%). The few developed areas that are present are centered in the community of Newton Grove in the northeastern portion of the watershed. Several main roads pass through the watershed, including I-40, US701, US13, NC55 and NC50.

Trends in Land Use and Development

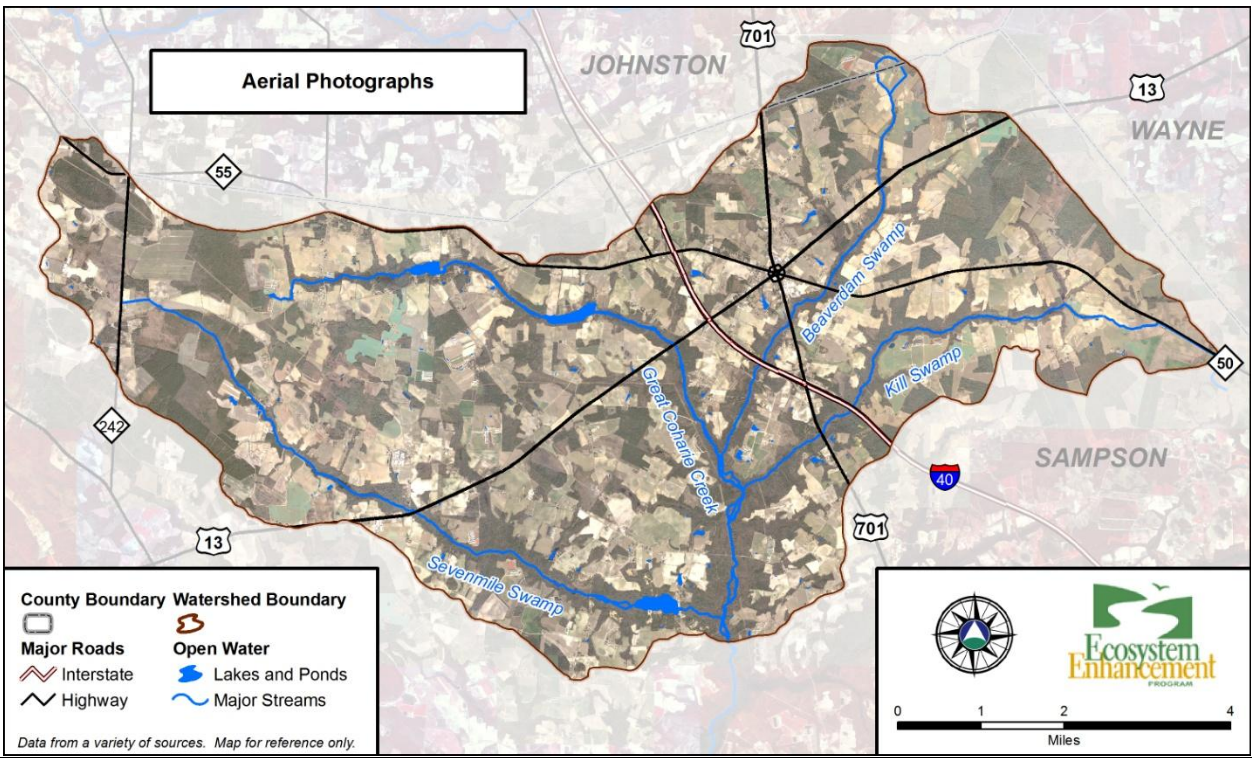

Figure 2. 2008 aerial photographs depicting current land use trends.

Sampson County

Settlers began arriving to Sampson County as early as 1740, when Scotch settlers moved up the South and Black Rivers from Wilmington. Farming took place along the terraces of the large streams and the remaining area was covered with pine forest. After the Civil War tar and turpentine became a large industry, utilizing the pine forests, until the 1880's when the supply began to wane. Until 1900, lumbering flourished. It is still an active industry but not as it was 100 years ago. After 1900, agriculture became the economic focus again (North Carolina's Sampson County Economic Development Commission, 2010).

Sampson County is the largest agricultural county in North Carolina. Agriculture is the largest contributor to the county's economy and tax base according to the *Sampson County Cooperative Extension, 2008 Plan of Work*. Top commodities include sweet potato, peppers, flue cured tobacco, turkey, hay, corn, cotton, peanuts, soybeans, wheat, oats and beef cattle. Sampson County is the nation's top producer of pork according to the Sampson County Economic Development Commission.

The county ranks 38th in population size in North Carolina with a 4.5% increase since 2000. The county has a high level of minority makeup with 44% of the population being minorities and 15% of these Hispanic (North Carolina's Sampson County Economic Development Commission, 2010).

<u>Newton Grove</u>

According to the *Town of Newton Grove Land Use Plan 2015*, Newton Grove began as a crossroads settlement and then transitioned to a postal depot. The town was established in 1879 and had several names over time including Williams, Blackmans Store, Coxes Store, New Town at the Grove and then finally Newton Grove. After World War II, four major roads were built through the center of Newton Grove. In 1990, I-40 came through the town with two interchanges. The population remains consistent since 1970 with a current population of 627.

Newton Grove operates a public water system that draws from two groundwater wells. Currently the town uses 80,000 gallons per day with 30,000 gallons coming from the wells and 50,000 per day purchased from Sampson County Water System. It also manages a waste water treatment plant that currently treats 48,000 gallons per day. The plant uses oxidation ditches to treat the sewage. The plant discharges treated sewage to Beaverdam Swamp.

Newton Grove occupies the low ground bounded by Great Coharie Creek, Kill Swamp and Beaverdam Swamp. Many of the soils in the town are classified as hydric soils. The soils limit the effectiveness of septic which necessitates the town's need to provide sewer services. Land use in the town includes row crops, forest and developed land. Newton Grove contains the floodplain of Beaverdam Swamp, which can range from ¼ to ½ mile wide.

<u>Watershed Planning Area</u>

Fifty-seven percent of the land area in the watershed planning area is occupied by agricultural activities which include row crop, animal operations, agriculture-based industry and timber cut-over. Economic drivers in the watershed planning area include the J.B Warren Industrial Site, Newton Grove Grain and Feed, Hog Slat, Inc and S&W Ready Mix Concrete. Agricultural operations including row crops, hog, and cattle processing operations are and will remain the main economic driver and land use in the watershed. The planning area contains the townships of Newton Grove, Westbrook and a small portion of Piney Grove and commission districts 1 and 5.

Applicable Local and State Programs

Agriculture

Since a large portion of the planning area is in agriculture, much of the land use is exempt from town and county regulations. This requires more in-depth consideration of the voluntary and regulatory agricultural programs that are in place. Leading issues within this land use are animal waste management, soil erosion and pesticide runoff.

The USDA Natural Resources Conservation Service (NRCS) and Sampson County Soil and Water Conservation District develop Conservation Plans for every farm with which they assist. A Conservation Plan looks at the natural resources on the farm and recommends conservation measures to address water quality loss, soil erosion, nutrient management, stormwater runoff, wildlife habitat, etc. Table 3 below shows a list of conservation practices that have been applied in Sampson County. An important aspect of a Conservation Plan is the implementation. Table 4 below highlights some of the conservation funding offered in Sampson County.

Table 3. Conservation Practices conducted in 2008-2009 by NRCS and Sampson County Soil and Water Conservation.

Conservation Practices in Sampson County			
Cover crop	Critical area planting	Deep tillage	Diversions
Early succession habitat development	Conservation crop rotation	Forage harvest management	Grade stabilizing structures
Forest Stand Improvement	Grassed waterways	Irrigation management	Manure transfer
Pasture and hay planting	Waste storage facilities	Tree/shrub establishment	Wildlife habitat management
Conservation cover	Water conservation	Composting facilities	Field borders
Residue and tillage management (no-till/ Strip till / direct seed)			

Table 4. Conservation Programs offered by NRCS and Sampson County Soil and Water Conservation Service.

Program	Purpose
USDA Conservation Reserve Program	Protect soil, water, wildlife and improve WQ
NC Conservation Reserve Enhancement Program	Improve WQ and wildlife habitat
NC Agricultural Cost Share Program	Reduce Ag. Nonpoint pollution and improve WQ
NRCS Environmental Quality Incentive Program	Address significant natural resource concerns on agricultural land
NC Conservation Stewardship Program	Reward producers who undertake and maintain conservation stewardship
NRCS Wildlife Habitat Incentive Program	Improve habitat for at risk species at landscape scale.
NC Forest Stewardship Program	Assist landowners with 10+ acres of forest who is committed to improving wildlife, timber, soil and water resources.

Many agricultural fields in North Carolina require certified Nutrient Management Plans. These plans must meet the USDA-NRCS 590 Nutrient Management Standard. USDA does not have a regulatory role for nutrient management but requires plans for animal operations participating in the Environmental Quality Incentives Program under the 2002 and 2008 Farm Bills. However, it may assist a farmer in meeting federal or state water quality regulations or permit requirements that regulate the storage, handling, and land application of manure and organic by-products.

A Comprehensive Nutrient Management Plan documents the owner's and/or operator's plan to manage manure and organic by-products by combining conservation practices and management activities into a conservation system that, when implemented, will achieve the goal of the producer and protect or improve water quality (NRCS, 2008). Nutrient Management Plans address manure and wastewater handling and storage, land treatment practices, nutrient management, record keeping, feed management and other activities.

North Carolina Water Quality Non-Discharge Rule, 1992 (*15A NCAC 2H.0200*) addressed operations with 100 head of cattle, 250 head of swine, 75 horses, 1,000 sheep and 30,000 birds and requires a Comprehensive Nutrient Management Plan and a NPDES permit. Those with less animals that do not discharge to surface waters require a general non-discharge permit.

The North Carolina Water Quality Non-Discharge Rule of 1992 requires animal waste management facilities or feedlots on new or expanded farms subject to registration be at least 100 feet away from perennial waters of the state. Land application of liquid animal wastes cannot exceed agronomic rates and must have a permanently vegetated buffer of at least 25 feet between the application area and perennial waters.

The North Carolina Livestock Farm Setback and Buffer Rule of 1995 (*Senate Bill 1080*) states that land application of livestock waste or wastewater must be at least 50 feet away from a perennial stream (NC State Cooperative Extension, 2010).

Water Supply Protection

Source Water Assessment Program Report for Newton Grove, Town Of, Community Water System states that both of the town's wells have a low susceptibility rating, inherent vulnerability rating and contaminant rating. The susceptibility rating is a combination of vulnerability and contaminant rating. Contaminant rating is based on the number of potential contaminant sources in the area and vulnerability rating is based on geologic conditions and existing conditions of the well. Well #1 is at 370 feet and well #2 at 280 feet. There are no other water supply designations in the planning area (Source Water Assessment Program, 2010)).

Local Planning, Zoning and Floodplain Programs

The land in the watershed planning area that is not in the Town of Newton Grove falls under the Sampson County Zoning Ordinance (Figure 3 and Table 5). However, most of the lands are active farms and are exempt according to Section 1.5 BONA FIDE FARMS EXEMPT that states: "*The provisions of this Ordinance shall not apply to bona fide farms (defined in Sec. 12 of this ordinance). This Ordinance does not impose nor exercise any controls over croplands, timberlands, pasturelands, orchards, or idle or other farmlands. Nor does it exercise control over any farmhouse, barn, poultry house, or other farm buildings, including tenant or other houses for persons working on said farms, as long as such houses shall be in the same ownership as the farm and located on the farm. Residences for non-farm use or occupancy and other non-farm uses shall be subject to the provisions of this Ordinance.*"

Development that does come under the County Ordinance must comply with Section 4.18 SCREENING AND BUFFERING which states; "*A. A minimum of thirty-five (35) foot vegetative buffer is required for development activities along all perennial waters indicated on the most recent versions of U.S.G.S. 1:24,000 (7.5 minute) scale topographic maps or as determined by local government studies. Desirable artificial stream bank or shoreline stabilization is permitted.*

B. No new development is allowed in the buffer except for water dependent structures and public projects such as road crossings and greenways where no practical alternative exists. These activities should minimize built-upon surface area, direct runoff away from the surface waters and maximize the utilization of storm water Best Management Practices."

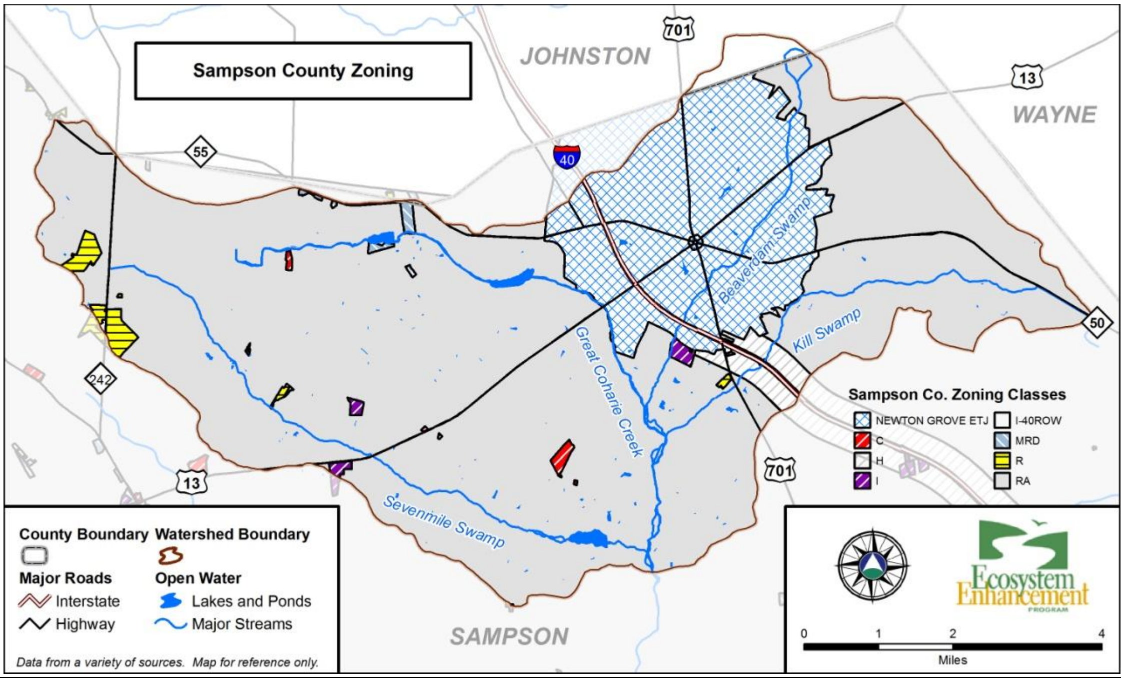

Figure 3. Current zoning in the Great Coharie Local Watershed Planning Area

Table 5. Key to Sampson County Zoning Classes

Key to Sampson County Zoning Classes	
ETJ	Extraterritorial Jurisdiction for Newton Grove
C	Commercial District
H	Highway Corridor Overlay District
I	Industrial District
I-40 ROW	I-40 Right of Way
MRD	Mixed Residential District
R	Residential District
RA	Residential and Agricultural District

The Sampson County Flood Damage Prevention Ordinance is required in order to participate in the National Flood Insurance Program. All structures, including those on agricultural lands, must comply with this ordinance. A permit is required if developing within the 100 year floodplain. This includes any structure or plans to adjust a waterway.

Zoning inside the Town of Newton Grove consists primarily of Residential (R-20) with 5% Thoroughfare Business and 3.7% Business or Industrial. Within the one mile extraterritorial jurisdiction the zoning is primarily Residential Agricultural with 4% Thoroughfare Business and 5% Industrial. Newton Grove's Subdivision Ordinance was amended in 2007 and the Zoning Ordinance was updated in 2009.

DOT Transportation Improvement Projects
There are no Transportation Improvement Projects scheduled in this watershed at this time.

Physical Characteristics

Ecoregion

The watershed planning area is located in Ecoregion Level III Southern Plains, Ecoregion Level IV Rolling Coastal Plain (EPA, 2010) and is also located in the Cape Fear Arch (Cape Fear Arch Conservation Collaborative, 2009). The boxes below provide a general description of each.

Table 6. Description of Ecoregions Level III and IV and Cape Fear Arch in watershed planning area

Ecoregion Level III Southern Plains	Ecoregion Level IV Rolling Coastal Plain	Cape Fear Arch
These irregular plains with broad inter stream areas have a mosaic of cropland, pasture, woodland, and forest. Natural vegetation was predominantly longleaf pine, with smaller areas of oak-hickory-pine. On some moist sites, especially in the far south near Florida, Southern mixed forest occurred with beech, sweetgum, southern magnolia, laurel and live oaks, and various pines. The Cretaceous or Tertiary-age sands, silts, and clays of the region contrast geologically with the older metamorphic and igneous rocks of the Blue Ridge and Piedmont. Elevations and relief are greater than in the Southern Coastal Plain, but generally less than in much of the Piedmont. Streams in this area are relatively low-gradient and sandy-bottomed.	The dissected Rolling Coastal Plain extends south from Virginia and covers much of the northern upper coastal plain of North Carolina. Relief, elevation, and stream gradients are generally greater than the ecoregion to the east, and soils tend to be better drained.	The Cape Fear Arch is a region distinguished by unusual geology and the greatest biological diversity along the Atlantic Coast north of Florida. This geological feature is higher than the surrounding coastal plain and, therefore, served as a biological refuge during times of sea level rise. The Cape Fear Arch appears to have served as a refuge for Coastal Plain plants and animals during the last Ice Age, and its isolated and specialized habitats may also have seen the development of new species during the same period.

Topography

The topography is best described as interstream terraces which are flat uplands. But there is a noticeable gentle slope in many areas of the watershed. The elevation in the watershed planning area ranges from 121 feet to 224 feet above sea level. The western half of the watershed contains a significant number of Carolina bays. Carolina bays are elliptical in shape and are primarily found in eastern North and South Carolina. They are depressional wetlands that are not typically connected to other water bodies and are hydrologically driven by rainfall and evapotransportation (Sharitz, 2003).

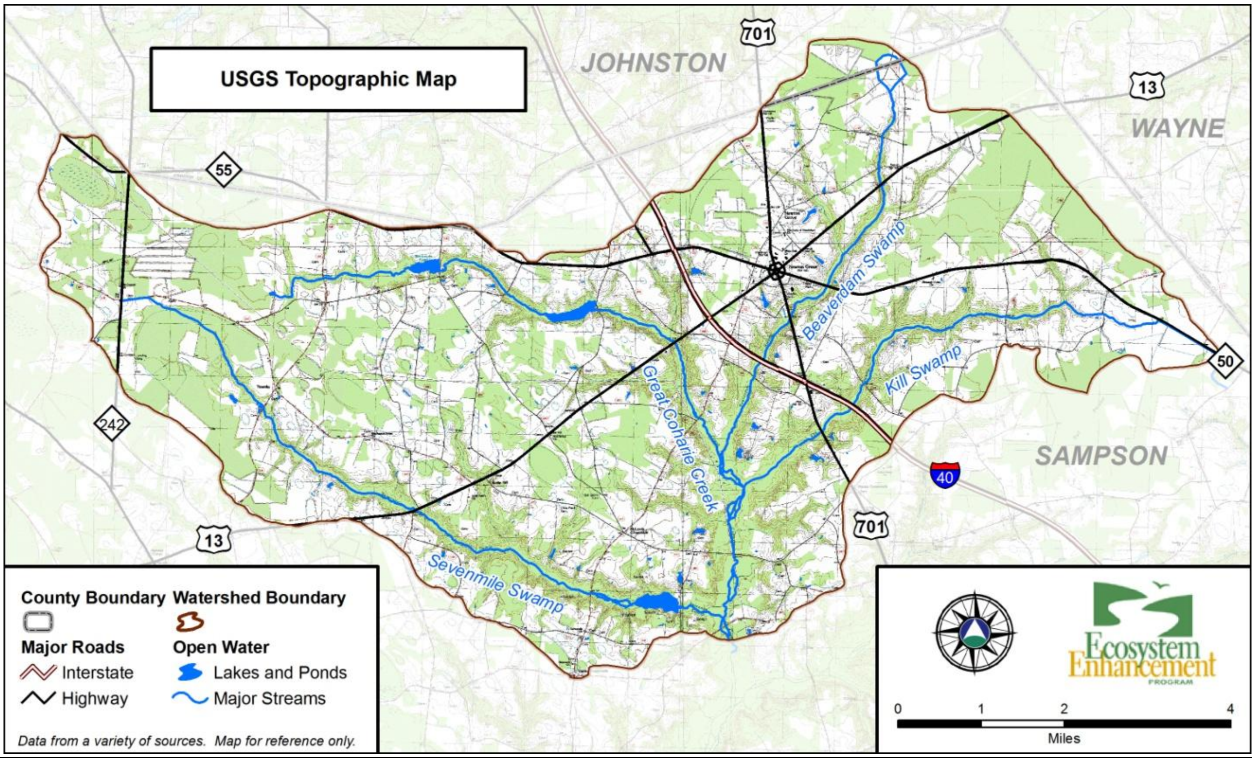

Figure 4. Topography of Great Coharie Local Watershed Planning Area

Climate

The State Climate Office of North Carolina has data on Climate Normals from 1971-2000. The closest NOAA weather station is located in Dunn, NC, approximately 15 miles from the planning area. This data provides the best approximation for the climate in the watershed planning area. The table below was provided by the State Climate Office of North Carolina , 2010.

Table 7. Climate data Dunn NC Weather Station (NOAA)

	Month												
Weather Summary	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ann.
Monthly Maximum Temperature (°F)	50.8	54.9	63.2	72.0	78.8	85.4	88.9	87.1	81.7	72.4	63.2	54.0	71.0
Normal Monthly Minimum Temperature (°F)	28.6	30.7	38.4	45.8	55.4	63.7	68.3	66.8	60.3	47.1	37.8	31.2	47.8
Normal Monthly Mean Temperatures (°F)	39.7	42.8	50.8	58.9	67.1	74.6	78.6	77.0	71.0	59.8	50.5	42.6	59.5
Normal Monthly Precipitation (in.)	4.13	3.65	4.57	3.24	3.86	4.44	5.64	4.81	4.50	3.19	3.05	3.50	48.50

Soils

Figure 5 and Table 8 below provide details on the types of soils found in the planning area. It should be noted that 95% of the watershed contains hydric soils. A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Hydric A soils are very poorly drained and hydric B soils are poorly drained. This means that wetlands or converted wetlands can be found in a majority of the watershed.

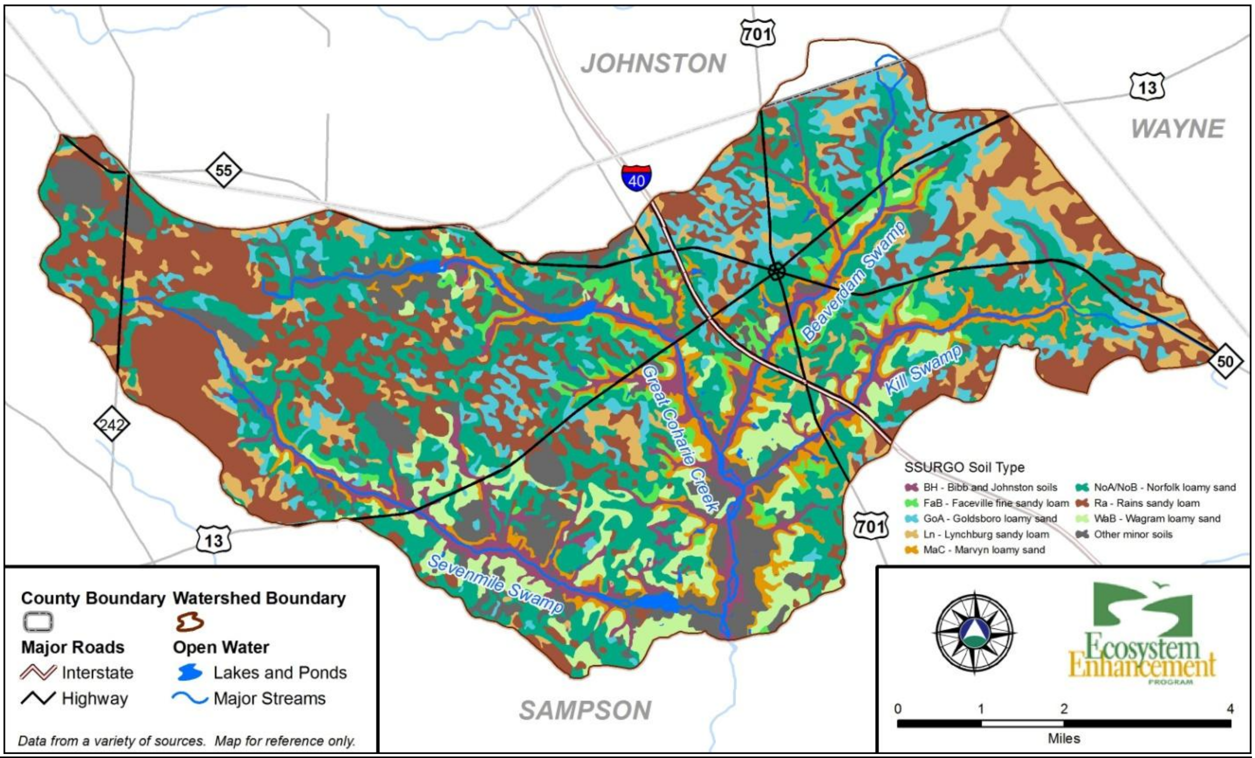

Figure 5. Soils Map for Great Coharie Local Watershed Planning Area

Table 8. Soils found in the Great Coharie Local Watershed Planning Area from the NRCS Soil Survey Geographic Database

SSURGO Soil Type	Area (acres)	% of Total Watershed	Hydric Class
Major Soils in the Local Watershed (>3% of total watershed)			
Ra - Rains sandy loam	7,497	22%	Hydric A
NoA - Norfolk loamy sand	6,528	19%	Hydric B
GoA - Goldsboro loamy sand	3,253	10%	Hydric B
Ln - Lynchburg sandy loam	2,791	8%	Hydric B
BH - Bibb and Johnston soils	2,623	8%	Hydric A
WaB - Wagram loamy sand	2,518	7%	Hydric B
NoB - Norfolk loamy sand	2,425	7%	Hydric B
MaC - Marvyn loamy sand	1,858	5%	Hydric B
FaB - Faceville fine sandy loam	959	3%	Not Hydric
SUBTOTAL	**30,451**	**90%**	

SSURGO Soil Type	Area (acres)	% of Total Watershed	Hydric Class
Minor Soils in the Local Watershed (<1% of total watershed)			
Au - Autryville loamy sand	350	1%	Not Hydric
JT - Johnston mucky loam	307	1%	Hydric A
Pn - Pantego loam	283	1%	Hydric A
Co - Coxville loam	268	1%	Hydric A
BoB - Blanton sand	264	1%	Hydric B
Jo - Gritney fine sandy loam	246	1%	Hydric B
FaA - Faceville fine sandy loam	238	1%	Not Hydric
Lm - Lumbee sandy loam	192	1%	Hydric A
Tn - Toisnot fine sandy loam	174	1%	Hydric A
W - Water	168	0%	Not Hydric
OrA - Orangeburg loamy sand	140	0%	Not Hydric
Wo - Woodington loamy sand	139	0%	Hydric A
Px - Paxville fine sandy loam	111	0%	Hydric A
Fo - Foreston loamy sand	104	0%	Hydric B
KaA - Kalmia loamy sand	90	0%	Hydric B
OrB - Orangeburg loamy sand	83	0%	Hydric B
ChA - Chipley sand	74	0%	Not Hydric
GtC - Gritney fine sandy loam	67	0%	Hydric B
Tr - Torhunta fine sandy loam	39	0%	Hydric A
UD - Udorthents loamy	32	0%	Not Hydric
Lu - Lynchburg-Urban land complex	4	0%	Not Hydric
SUBTOTAL	**3,373**	**10%**	
GRAND TOTAL	**33,824**	**100%**	

USGS Stream Gages

There are no USGS stream gages located in the LWP area. The closest active gage is located on the Black River (to which the Great Coharie is a tributary) near Tomahawk (USGS station 02106500). It has been active since 1951.

Land Cover

Land cover data is depicted below in Tables 9 and 10. The first are data calculated from the National Land Cover Database (NLCD) 2001 (MRLC, 2008). Definitions of these land classes area available at http://www.mrlc.gov/nlcd_definitions.php. The second data table summarizes land cover data developed by TJCOG for this Great Coharie Creek watershed planning effort. The data was derived from 2008 aerial photography. More information on this dataset is presented on page 28 of this document. Agriculture is the primary land use in the watershed and approximately 34% is in wetlands and forest.

Table 9. National Land Cover Data 2001 for the Great Coharie Watershed Planning Area

Aggregate land class	% of LWP area	NLCD land class	% of LWP area
Agriculture	49.7	Cultivated Crops	49.2
		Hay/Pasture	0.5
Developed High	0.2	Developed, High Intensity	0.0
		Developed, Medium Intensity	0.2
Developed Low	7.5	Developed, Low Intensity	1.5
		Developed, Open Space	6.1
Forest	30.3	Deciduous Forest	3.9
		Emergent Herbaceous Wetlands	0.5
		Evergreen Forest	9.0
		Mixed Forest	5.6
		Woody Wetlands	11.3
Herbaceous	12.0	Barren Land	0.6
		Herbaceous	7.0
		Shrub/Scrub	4.3
Water	0.3	Open Water	0.3

Table 10. Land Cover Data 2008 for the Great Coharie Watershed Planning Area developed by TJCOG

Great Coharie LWP land class	% of LWP area
Cropland	50
Developed	7
Roads and Right of Ways	3
Forest and Wetlands	34
Scrub/Herbaceous	5
Open Water	1

<u>Watershed Impervious Area</u>

Impervious surfaces, such as concrete, asphalt, roof tops and compacted soil, do not allow water to infiltrate the ground but create runoff that moves water off the area more quickly and in a greater quantity than it would if the impervious surface was not there. A study conducted by the Center for Watershed Protection showed a correlation between the amount of impervious surface and the quality of the aquatic systems found in that watershed. The study showed that stream function noticeably declined when the imperious area of the watershed exceeded 10% (Schueler, 1994). However, research also has shown that forest cover may be more important as an indicator in watersheds that are not urbanizing. Studies conducted by Booth (2000) and Goetz (2003) both found that watersheds needed at least 65% forest cover in order to have a healthy aquatic rating.

A rough estimate of the impervious surface in the total planning area was estimated. This was done by applying impervious values developed by Soil Conservation Service (1975) in the report *Urban Hydrology for Small Watersheds, Technical Release no.55*, to the land cover data developed by TJCOG and compared to the National Land Cover Data. Roads were given 50% impervious since the data includes the right of ways. For developed, the impervious cover for low density was used since many of the developed areas in the watershed are grassed fields. Cropland was not given an impervious value due to the variation of compaction to the soils. This calculation provides an estimate of less than 3% impervious surface in the 53 square mile planning area but only 34% forest cover.

Table 11. Summary of land use and their impervious coefficients

Land Class	% of LWP area	NRCS % Impervious
Cropland	50	--
Developed	7	20
Roads and Right of Ways	3	50
Forest and Wetlands	34	---
Scrub/Herbaceous	5	---
Open Water	1	---

<u>Channel Condition</u>

Channel and riparian conditions were documented by the planner and DWQ-Watershed Assessment Team staff during field surveys in October and November of 2009 at all road crossings in the watershed planning area. In addition, the DWQ Biological Assessment Unit conducted habitat surveys at nine locations, providing more in-stream detail. Channels on the main stems of the four streams tend to be wide and deep and often braided and well connected to the floodplain (Figure 6). The sediments are sandy often with thick silt and detritus though some had a good portion of gravel. Banks are vegetated and little erosion is present. There are a variety of pool sizes and a good amount of woody debris. In some areas during the winter, the substrate is detritus dominant due to decomposing macrophyte beds.

Figure 6: Photo. The main stem of Great Coharie Creek is wide and deep with significant vegetative buffer.

Channels in the headwaters and tributaries in most cases have been cleared (Figure 8) and deepened to facilitate the movement of water though channels have rarely been moved from the natural valley. The channels are deep with little vegetation and often have signs of erosion. In some cases, a buffer of trees and shrubs has been left and these contain a mix of native and exotic plants (Figure 10).

Figure 7: Photo. There are a handful of headwater streams with vegetated riparian buffer. This stream, at the headwaters of Kill Swamp, transports more sediment and water than would be expected in its location at the top of the watershed. This is due to land use and perhaps additional drainage ditches that cross over watershed boundaries.

Figure 8: Photo. Most of the headwater streams have been cleared and channelized, similar to this one in the photo.

<u>Riparian Buffer Condition</u>

Buffer conditions were assessed using land use data and GIS analysis. Methods of this analysis are discussed in the Methodology section. Based on GIS analysis, buffer conditions range from 86% buffered in one subwatershed to only 19% buffered in others. Total unbuffered waters in the watershed planning area are 49%. Most of the main channels of Seven Mile Swamp, Kill Swamp, Beaverdam Swamp and Great Coharie Creek have at least a 100 foot forested buffer left in tact because of the wet conditions in the floodplain (Figure 9). A significant amount of the headwaters and tributaries are not buffered because land is being farmed right up to the bank (see Figure 8).

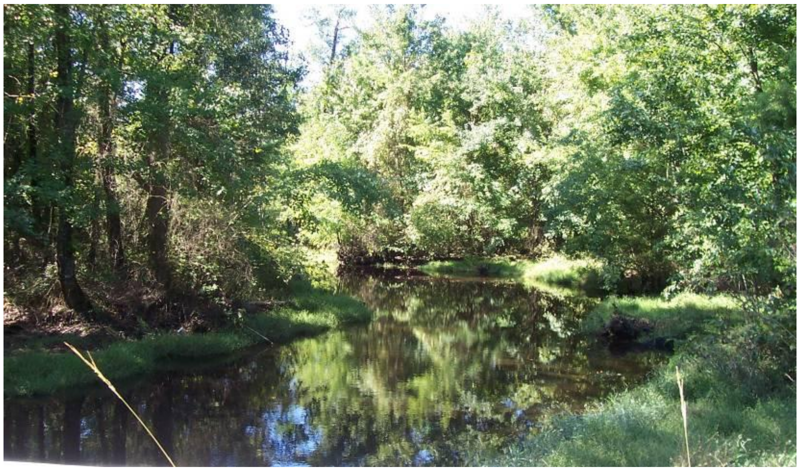

Figure 9: Photo. The main stem of Kill Swamp has a buffer of 1000 feet.

Figure 10: Photo. Headwater streams where a buffer has been retained often contains undesirable invasive species.

<u>Wetlands</u>

The main stems of the four named streams primarily contain cypress gum swamp and bottomland hardwood forest. The western half of the planning area contains many Carolina bays that are either still forested or in agriculture. However, wetlands that have been in cultivation for a long period of time may not be captured in the existing data. It is interesting to note that 95% of the watershed contains either Hydric A or Hydric B soils. Specific subwatersheds where wetlands should be protected or restored are called out in the Subwatershed Description section of this report.

Terrestrial Habitat and Species of Concern

The Great Coharie Swamp is an extensive cypress-gum swamp and Great Coharie Creek is part of a high-quality blackwater stream system feeding into the Black River. The 16-mile corridor is considered one of the largest and most important landscape corridors in Sampson County supporting a variety of neotropical songbirds, waterbirds, fishes and reptiles. The Great Coharie Creek and its associated floodplain are a priority area for conservation identified by the Cape Fear Arch Conservation Collaborative in the Cape Fear Arch Conservation Plan (CFACC, 2009). Prioritization is based on North Carolina Natural Heritage Program County Inventory data and the Landscape Habitat Indicator Guild analysis from One NC Naturally.

Figure 11. Photo. Great Coharie Creek, at the end point of the planning area, is identified as a Significant Natural Heritage Area and has been purchased by the state for preservation.

In the planning area, the headwaters of Great Coharie Creek are joined by Seven Mile Swamp, Beaverdam Swamp and Kill Swamp to form the main stem of Great Coharie Creek, where EEP has 4,850 acres of high quality preservation (Figure 11). This area has been designated as a Significant Natural Heritage Area because it supports two populations of the Significantly Rare bluff oak (*Quercus austrina*).

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*).

Terrestrial Habitat Issues

Though species of concern have been identified in the receiving waters of the Great Coharie Creek, little to no data are available for the watershed planning area for fish, mussels or terrestrial species. What have primarily been recognized at this point are the important habitats. Data from the Biodiversity / Habitat assessment compiled for the One North Carolina Naturally Conservation Tool was used to assess high value habitat in the subwatershed asset maps on pages 36-87 of this document (One NC Naturally, 2009). In most cases, the high value habitat identified in the planning area is forested floodplain or wetlands. A compilation of existing habitat and species data is located in Appendix B of this report.

Beaver

Impacts of beaver dams in the watershed were reported as a primary concern by the local stakeholders. Of particular concern in the Great Coharie LWP area is flooding of agricultural lands and bottomland hardwood timber. The Town of Newton Grove expressed concern of reduced flow, particularly on Beaverdam Swamp where the waste water treatment plant is located.

According to the North Carolina Wildlife Resources Commission, beaver (*Castor Canadensis)* was trapped to extinction in North Carolina with the last reported beaver taken in 1897. In 1939, North Carolina began a restocking program. Public demand continued the restocking from 1951 to 1959. Now, beaver occur in most watersheds in North Carolina (NCWRC, 2010).

Adverse impacts of beaver dams include flooding, obstruction of road structures, damage to tree and crop resources and bank weakness due to burrowing. When beaver activity does not interfere with anthropogenic resources, positive impacts include slowing run-off, retarding erosion, reducing downstream sediment loading and nutrients and creating wetland habitat for wildlife.

Information on beaver pond management, beaver control, trapping and beaver management assistance can be found at the North Carolina Wildlife Resources Commission webpage: http://www.ncwildlife.org/Wildlife_Species_Con/WSC_BMAP.htm.

A study conducted by Christopher W. Bason (ECU Masters Thesis Department of Biology, October 2004 under the direction of Dr. Mark M. Brinson) is informative to this watershed study as the conditions of the study were similar to the Great Coharie LWP watershed. The paper, *Effects of Beaver Impoundments on Stream Water Quality and Floodplain Vegetation in the Inner Coastal Plain of North Carolina*, looked at the plant communities of 15 beaver impoundments and examined the effects of 13 of these on water quality. A paired study determined impoundment effects on agriculturally influenced stream water concentrations of total suspended solids (TSS), nitrate, ammonium, and soluble reactive phosphorus (SRP) during the fall and winter. Results showed a decrease in nitrates and total suspended solids, increased ammonium concentrations and had no effect on soluble reactive phosphorous. The vegetation study showed that dam height and impoundment age were the most important variables influencing the transition from forest cover to herbs and dead wood. Herbaceous species richness increased with the age of the impoundment. Dominant species shifted to flood tolerant species and showed greater coverage of the invasive marsh dayflower (*Murdannia keisak).*

In Sampson County, impacts of the beaver have mostly been the loss of timber in the areas that have flooded. Some crop and pasture land has been lost due to flooding. The county estimated for 2008 that approximately 5% of the acreage in the county was affected (about 25,000 to 30,000 acres). Most of this timber land is in low lying areas along the creeks. While trapping in the past has helped individual land owners in the short run, the beavers come back quickly and it is a continuous battle.

Water Quality and Aquatic Habitat

Great Coharie Creek is one of the headwater streams of the Black River, which is one of the best remaining examples of a blackwater river system in the region. All waters in the planning area carry the stream classification C Sw, which protects them for C class uses (including aquatic life, secondary recreation, and fish consumption) but acknowledges their natural swamp characteristics (the "Sw" secondary classification). Swamp streams often show poor flow and low dissolved oxygen levels, particularly in the summer months, as part of their natural condition.

Great Coharie Creek was listed in the 2006 NC 303(d) list as impaired for fish consumption based on a Fish Advisory for mercury in fish tissue. Though this impairment was broadly applied by DWQ to all waters east of I-95 based on fish consumption advice issued by the NC Department of Health and Human Services (DHHS), fish tissue samples have been collected and analyzed for metals (including mercury) in the Great Coharie downstream at US 701 that showed exceedences of state and federal criteria for mercury concentrations.

Biological Communities and Aquatic Habitat

No records of any benthic macroinvertebrate, fish community, habitat assessment, or toxicological monitoring were found for the LWP area. Biological data is currently being collected for this plan.

Chemical and Toxicological Data

Chemistry data have been collected at five locations in the LWP area by DWQ and the US Geological Survey (USGS). Data collections by DWQ occurred at one location (station B8560000, Great Coharie Cr. at SR 1636 near Timothy) during the period of 1973-1979. Distributions of results for parameters of interest are shown in Appendix C. The results are notable in that they appear to indicate fairly good water quality, particularly as compared with other data collected in the state during that time period.

USGS records indicate that there have been four groundwater monitoring wells located in the LWP area. Three of these had 1-2 sets of associated chemistry data, though results date back to the 1950's. The remaining well (SA-125) had a single set of chemistry results from 1999. No other data appear to be available from these wells.

Fish tissue samples were collected downstream of the LWP area in the Great Coharie Cr. at NC 701 in June 2000. Samples were analyzed for mercury, arsenic, total chromium, copper, nickel, lead, and zinc. Only mercury exceeded any state (NC) or national (FDA) criteria. NC has a criterion of 0.4 ppm for total mercury and the FDA has an action limit of 1.0 ppm. Mercury results are shown in Table 3 of Appendix C. Thirteen of seventeen samples (76%) exceeded the NC criteria of 0.4 ppm and 5 of 17 samples (29%) exceeded the FDA criteria of 1.0 ppm. In discussions with Biological Assessment Unit biologists, they indicated that it is generally believed that the source for the great majority of mercury found in fish tissue in NC is from aerial deposition of emissions from coal-fired power plants.

Pollution Sources

Potential contaminant sources were identified using a GIS layer of regulated facilities and activities compiled by the NC Division of Environmental Health (Source Water Assessment and Protection [SWAP] program). There were 28 features listed as "Potential Contaminant Sources", which consisted primarily of animal operations and NPDES permitted facilities. Detailed information on these animal operations and NPDES permitted facilities can be found in the full document *Summary of Existing Data Great Coharie Creek Local Watershed Plan Area* prepared by NC Division of Water Quality Watershed Assessment Team April 30, 2009 and included in Appendix C.

METHODOLOGY

Water Quality Monitoring

The Great Coharie Creek watershed presents many water quality assessment interpretation challenges. Two primary challenges include the fact that the streams within the Great Coharie watershed are considered "blackwater" streams and have the supplementary water quality classification of "swamp waters." The second challenge is that the watershed has several impoundments (mill ponds) and beaver dams. Swamp streams are acknowledged as having low dissolved oxygen concentrations and low values for pH. Additionally, the low flow characteristics confounds whether water quality data collected should be interpreted as coming from a lentic (not flowing, e.g. lake, pond) ecosystem or a lotic (flowing, e.g. stream, river) ecosystem.

Data and Literature Review

To assist in data interpretation, data were obtained from the Ambient Monitoring System (AMS) and the Lower Cape Fear River Program (LCFRP) coalition monitoring sites having the supplemental "Sw" (swamp stream) classification between 2005 through 2009 in the Cape Fear River Basin near the LWP area. The purpose of this activity was to develop a baseline of swamp stream data which can be used for comparison with, and interpretation of, data collected in the Great Coharie LWP area during the next phase of assessment.

In addition, a review of the scientific literature was conducted to determine if there were published papers about the concentrations of nutrients, dissolved oxygen, etc, in blackwater streams. This review resulted in finding published research directed by Dr. Michael Mallin, (Center for Marine Biology, University of North Carolina – Wilmington) from study sites on the coastal plain of North Carolina, including a site on the Great Coharie Creek downstream of the local watershed planning area.

These papers (Mallin et al, 2002, Mallin et al 2004, Mallin et all 2006) indicated that high inorganic nitrogen was a concern in swamp streams. Nitrogen and phosphorus input stimulate microbial growth and increase the biochemical oxygen demand (BOD). High BOD, in turn, results in lowered dissolved oxygen concentrations (i.e. microbial respiration is consuming the oxygen). Extrapolation from this research would imply that naturally low dissolved oxygen concentrations in streams and tributaries within the LWP area could be the result of high BOD stimulated by nutrient input.

Preliminary Field Assessment

An initial watershed reconnaissance conducted by the Division of Water Quality – Watershed Assessment Team (WAT) personnel in February 2009 proposed 16 potential sampling locations within the planning area (noted as first reconnaissance points in Figure 12 below). Field meter data (water temperature, dissolved oxygen, specific conductance, and pH) were collected at all of these stations. During August and September 2009, field meter data were collected at the 16 sites and water samples were collected for fecal coliform bacteria and nutrients (Ammonia-Nitrogen, nitrite + nitrate N, Total Kjehldahl Nitrogen, and total phosphorus) at six of these locations (labeled as reconnaissance water chemistry in Figure 12). Further reconnaissance conducted jointly by WAT and EEP in late October and early November 2009 identified an additional 85 sites accessible from the road. Twenty-three of these sites had flowing water at the time and field meter readings were taken at each of these 23 sites. All of the 101 points were photo documented and field notes on channel and riparian condition and land use were documented.

In comparing recorded discharge rates for the time of the field visits in October and November of 2009, it is difficult to provide specific data for this watershed since the closest USGS gage, 02106500 on the Black River near Tomahawk, is located approximately 40 miles downstream. However, according to the record for this USGS gage, discharge rates (cfs) nearly tripled from October to November 2009 and continued to increase through February of 2010.

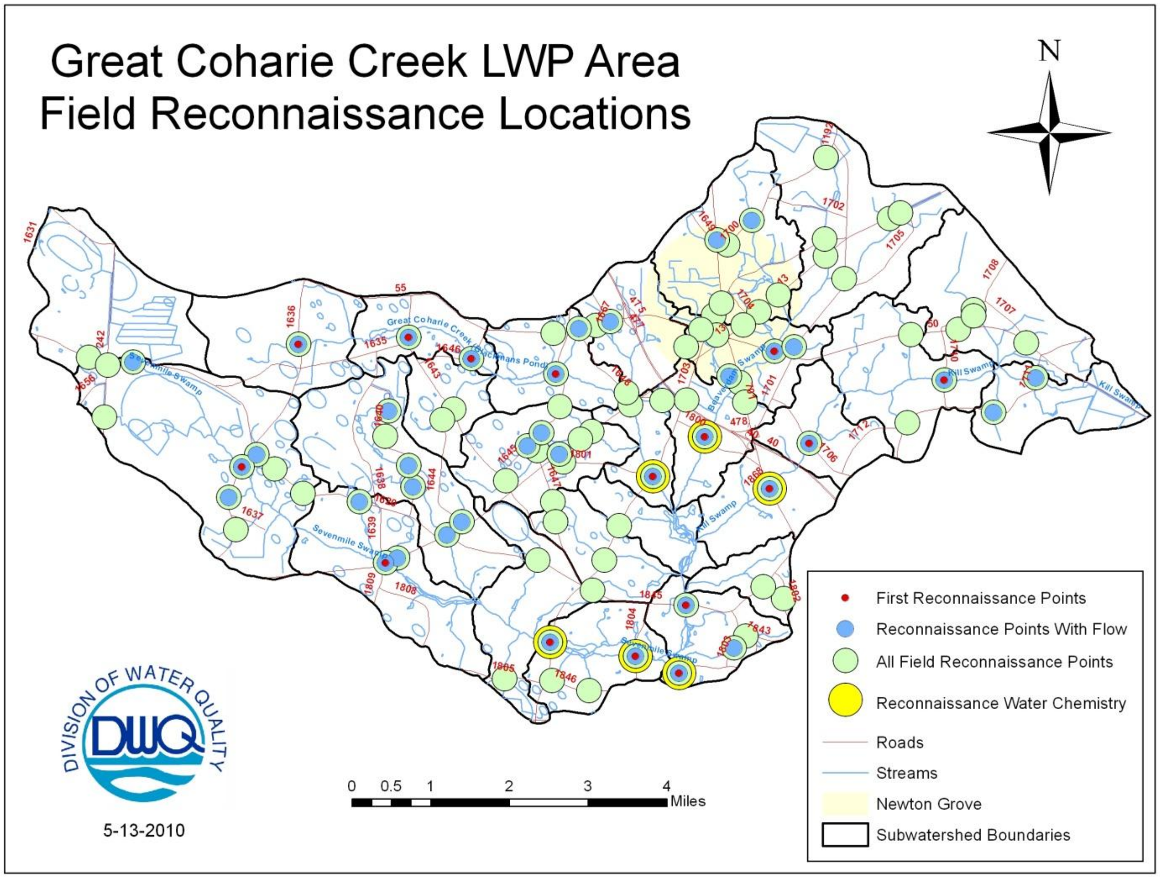

Figure 12. 101 points that were assessed in the field to varying degrees.

Field observations and GIS land cover data suggest that the major water quality issues affecting aquatic life in the Great Coharie Creek LWP area are likely to be sediment, nutrients, and low dissolved oxygen and pH. The sediment conditions very likely reflect common conditions in coastal plain streams, which are characterized by sandy bottoms, often with thick silt and organic muck deposits. Low dissolved oxygen and pH also are common in swamp streams and may be exacerbated by high nutrient influx and associated growth of algae and aquatic macrophytes in the streams and shallow impoundments. Substantial algal growth was observed in areas where little to no shade was present along the streams. Dense growths of aquatic macrophytes, including mats of submerged aquatic vegetation (SAV) were common in the impoundments as well as in some areas of the stream channels. Algae and dense growths of aquatic macrophytes cause large diurnal swings in dissolved oxygen and, often, pH during the growing season. During the winter, decomposition of the macrophytes beds contributes large quantities of organic matter and releases bound nutrients into the streams and impoundments. The organic matter and nutrients may have an adverse impact on water quality and habitat suitability for aquatic organisms.

The limited water chemistry and field meter data collected during reconnaissance activities suggest that nutrient enrichment may be the major water chemistry concern in parts of the Great Coharie Creek LWP area (Tables 12 and 13). The average (n = 2) fecal coliform bacteria and nitrite + nitrate N (NOx-N) levels were highest in Sevenmile Swamp; total Kjeldahl N (TKN) also was high. TKN is the sum of organic nitrogen and ammonia nitrogen. Total phosphorous concentrations were higher in Kill Swamp and Beaverdam Swamp than elsewhere. These limited data suggest upstream pollution sources possibly originating from animal operations and/or field crops production in the headwaters of these streams. The highest specific conductance and lowest pH values occurred in a headwater tributary in the most eastern part of the Kill Swamp watershed (Figure 13). The surrounding area was predominantly open fields and largely lacked riparian buffers. The observed high conductance readings suggested possible chemical pollutant influx from the headwaters of Kill Swamp.

Table 12. Ranges of nutrient, fecal coliform, and field meter data for the Great Coharie Creek LWP area during field reconnaissance conducted in 2009

Parameter	Date	N[1]	Ranges	Means	Medians
NH3-N (mg/L)	August - September	12	0.02 - 0.04	0.02	0.02
NOx-N (mg/L)	August - September	12	0.02 - 0.46	0.15	0.04
TKN (mg/L)	August - September	12	0.49 - 0.99	0.77	0.76
TP (mg/L)	August - September	12	0.03 - 0.21	0.09	0.07
Fecal coliforms (cfu/100 ml)	August - September	12	47 - 330	154	160
Temperature (^{o}C)	October-November	71	1.5 – 26.9	16.7	19.4
Oxygen saturation (%)	October-November	55	4 - 99	61.1	65.0
Dissolved oxygen (mg/L)	October-November	55	0.4 – 11.9	6.6	6.1
Specific conductance (µS/cm)	October-November	71	15 - 248	99	93
pH (s.u.)	October-November	71	4.1 – 7.0	5.5	5.6

[1]Nutrients and fecal coliforms samples were collected only two times at six stations.

Table 13. Means (n = 2) of fecal coliform and nutrient data by sampling station

Sampling Station	Subwatershed	Fecal coliform (cfu/100 ml)	NH3-N (mg/L)	TKN (mg/L)	NOx (mg/L)	Total P (mg/L)
BS1800	BDS 01	129	0.03	0.65	0.02	0.12
GCC1636b	GCC 01	138	0.02	0.85	0.13	0.08
GCC1703	GCC 05	130	0.02	0.60	0.02	0.04
KS701	KS 01	145	0.02	0.84	0.02	0.20
SS1703	SMS 01	195	0.02	0.73	0.36	0.04
SS1804	SMS 01	188	0.04	0.96	0.34	0.05

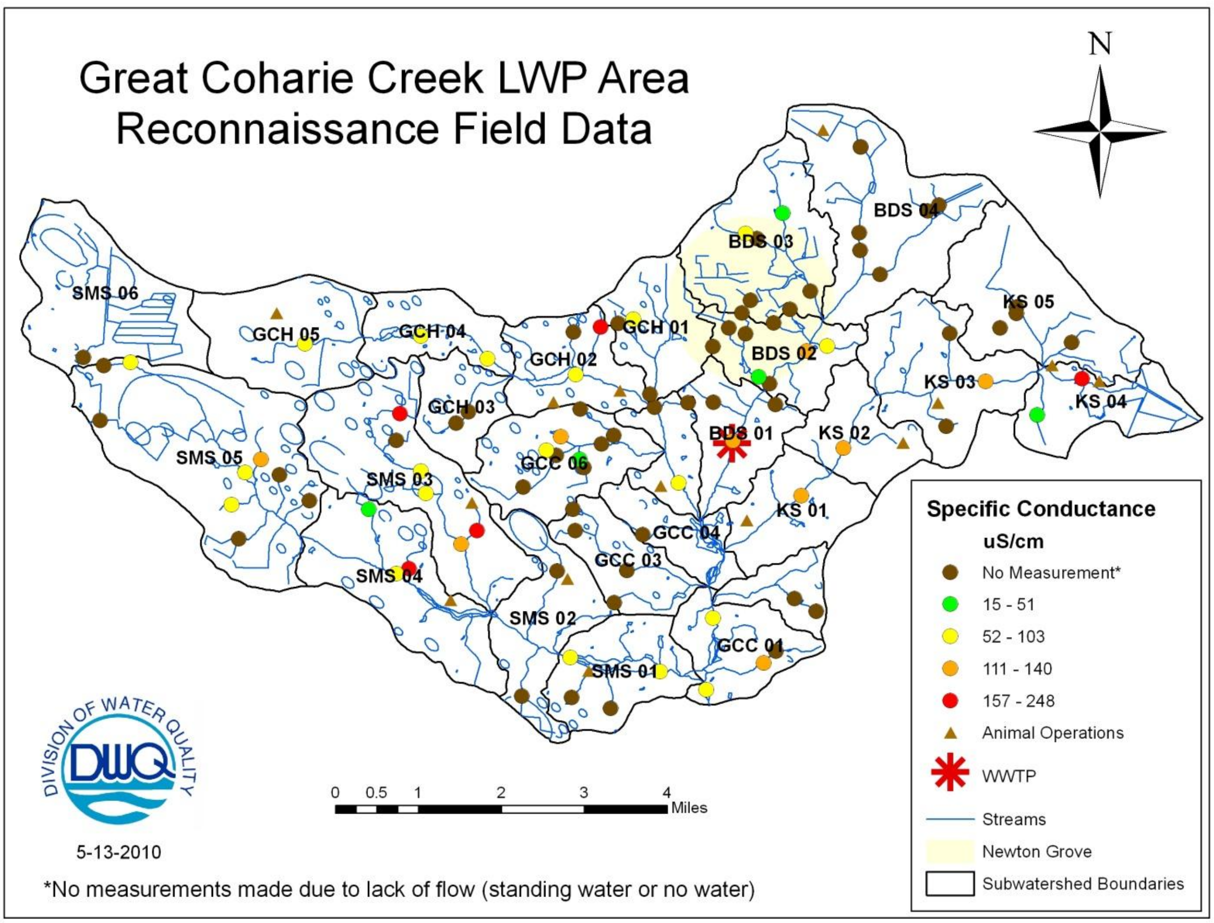

Figure 13. Range of specific conductance during October and November 2009.

Land Cover Data

A new land cover data set was developed specifically for this watershed (Figure 14 and Table 14). Using the USDA common land unit data for Sampson County, the land use within these polygons were identified using 2008 aerial photography and classified as Agricultural Operations, Cropland, Developed, Forest or wetland, scrub or open water. Any land unit not defined in the county parcel layer was designated road right of way. Agricultural Operations were then revisited to identify Animal Operations and Open Water was revisited to identify Swine Lagoons. Swine Lagoons were also identified using DWQ permit data. Any operations that could not be determined via aerial photography to be Animal Operations remained classified as Agricultural Operations. Developed classification included non-agricultural commercial and residential land units. These data have not yet been field verified. Details on the development of this dataset are described in Appendix A.

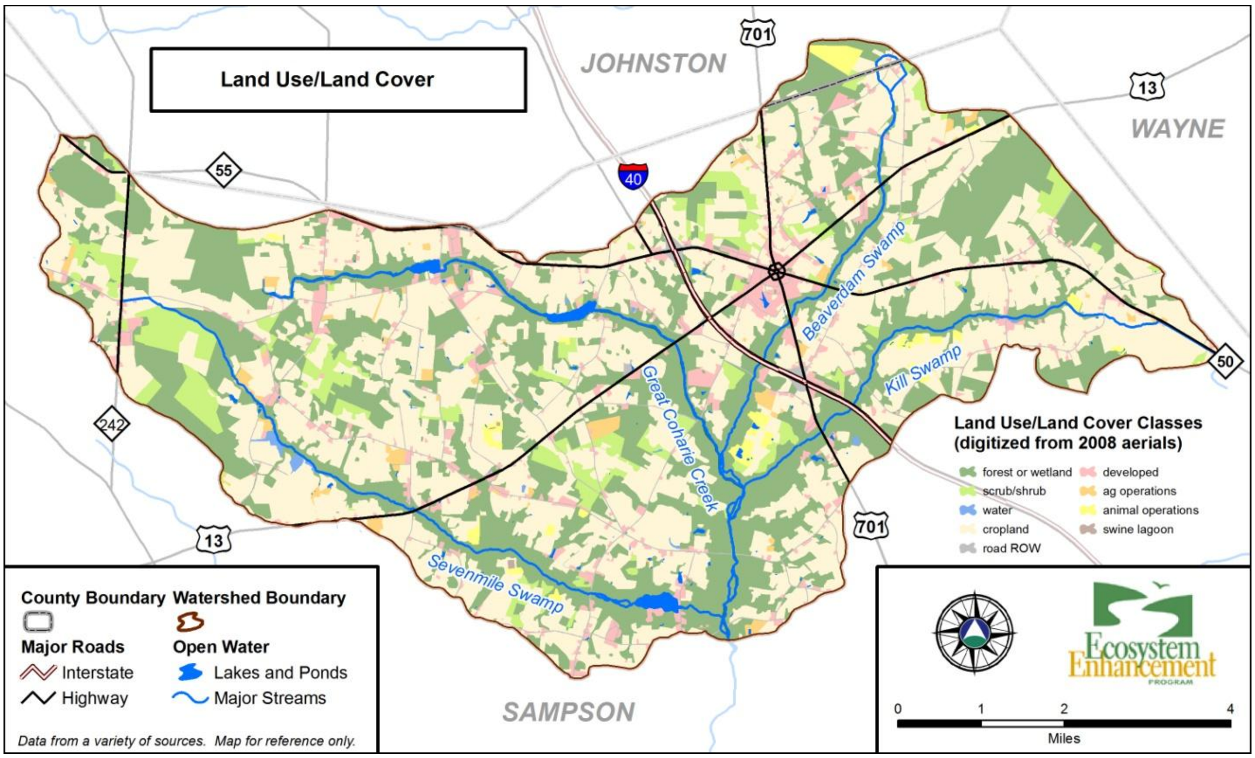

Figure 14. Range Land Use/ Land Cover data developed by TJCOG 2008 aerial photography.

Subwatershed Delineation and Characterization

Delineation of Subwatersheds

Subwatersheds are small areas of land that drain to a common stream. The subwatersheds in this plan range from 0.8 square miles to 5 square miles in size. The purpose of delineating these smaller land units is so that land use activities can more easily be connected to water and aquatic habitat conditions in a localized area. Subwatersheds were delineated first using the USGS 7.5 minute Digital Raster Graphics. Boundaries were compared to modeled catchments from the National Hydrography Dataset Plus data layer, 1 foot contours derived from LIDAR (Light Detection and Ranging) and the 12-digit watershed dataset. Final determination of the number of subwatersheds was based on land use and size. This resulted in a total of 26 subwatersheds (Figure 15). Each subwatershed has a code, or name, that begins with the initials of one of the major streams and then is followed by a number. The numbering system begins at the bottom of the watershed and works its way up. Because of its size and management implications, Great Coharie Creek was divided into Great Coharie Creek Headwaters (GCH) and the main steam of Great Coharie Creek (GCC). The other streams are Kill Swamp (KS), Sevenmile Swamp (SMS) and Beaverdam Swamp (BDS).

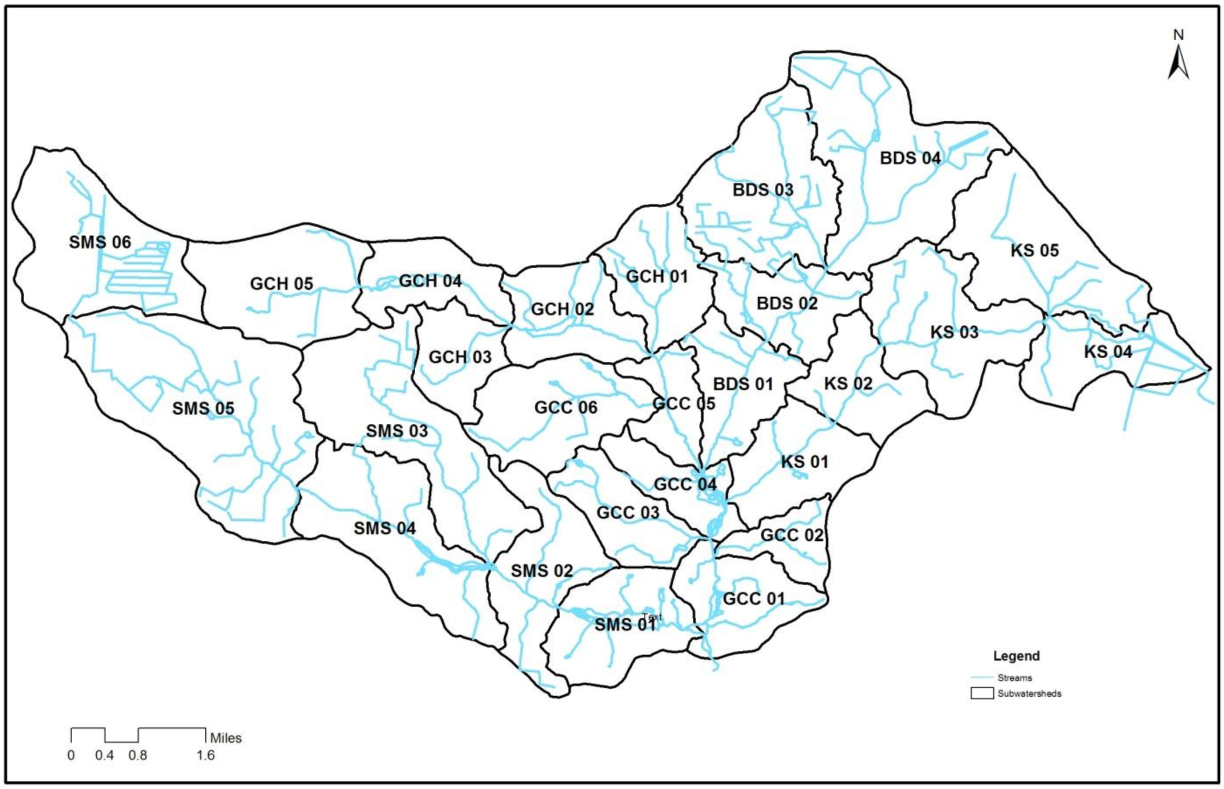

Figure 15. Map showing delineation and subwatershed naming codes.

<u>Subwatershed Tables</u>

Tables 14, 15 and 16 below contain information about the planning area broken out by subwatershed. Table 14 displays land use/land cover data that was developed from the TJCOG data described on page 28. Table 15 displays a summary of statistics developed from various GIS sources, all of which are depicted in several maps in this report. Table 16 shows the percentage of various land uses within 100 feet of all water features in each subwatershed.

Table 14. Land Use / Land Cover data for each of the 26 subwatersheds.

Subwatershed Name	Code	Agricultural Operations		Cropland		Animal Operations		Swine Lagoon		Developed		Road (w/ ROW)		Forest & Wetland		Scrub		Open Water		**Grand Total**
		(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)
Beaverdam Swamp 01	BDS 01	38	4%	340	35%	32	3%	3	0%	66	7%	107	11%	344	36%	30	3%	2	0%	**960**
Beaverdam Swamp 02	BDS 02	24	2%	434	45%					241	25%	78	8%	158	16%	28	3%	8	1%	**970**
Beaverdam Swamp 03	BDS 03	22	1%	993	55%					115	6%	65	4%	428	24%	177	10%	8	0%	**1,808**
Beaverdam Swamp 04	BDS 04	25	1%	1,210	51%	94	4%			107	5%	79	3%	766	32%	92	4%	2	0%	**2,375**
Great Coharie Creek 01	GCC 01	24	2%	363	37%			1	0%	25	3%	30	3%	536	55%			2	0%	**980**
Great Coharie Creek 02	GCC 02	2	0%	297	59%					21	4%	10	2%	172	34%					**503**
Great Coharie Creek 03	GCC 03	6	1%	496	58%					28	3%	18	2%	188	22%	107	13%	7	1%	**851**
Great Coharie Creek 04	GCC 04			206	32%	24	4%	5	1%	1	0%	4	1%	354	55%	50	8%	4	1%	**648**
Great Coharie Creek 05	GCC 05			204	35%					59	10%	23	4%	259	45%	29	5%	1	0%	**576**
Great Coharie Creek 06	GCC 06	39	3%	662	49%	4	0%	1	0%	39	3%	60	4%	488	36%	64	5%	4	0%	**1,361**
Great Coharie Headwaters 01	GCH 01	1	0%	514	51%					56	6%	112	11%	251	25%	60	6%	5	0%	**1,000**
Great Coharie Headwaters 02	GCH 02			612	59%	5	0%			46	4%	25	2%	312	30%	8	1%	36	3%	**1,044**
Great Coharie Headwaters 03	GCH 03	7	1%	361	51%					46	6%	16	2%	267	38%	8	1%	3	0%	**709**
Great Coharie Headwaters 04	GCH 04	12	1%	410	47%					109	12%	34	4%	282	32%			26	3%	**873**
Great Coharie Headwaters 05	GCH 05	30	2%	811	52%	9	1%	1	0%	112	7%	27	2%	536	35%	22	1%	1	0%	**1,547**
Kill Swamp 01	KS 01	4	0%	319	31%	21	2%	0	0%	39	4%	61	6%	525	51%	57	5%	11	1%	**1,037**
Kill Swamp 02	KS 02	3	0%	449	51%	17	2%	0	0%	32	4%	30	3%	324	36%	34	4%			**888**
Kill Swamp 03	KS 03	4	0%	949	58%	39	2%	1	0%	59	4%	26	2%	550	34%	3	0%	3	0%	**1,634**
Kill Swamp 04	KS 04	6	1%	698	71%	19	2%			24	2%	16	2%	216	22%	10	1%			**990**
Kill Swamp 05	KS 05	10	1%	834	46%	5	0%			42	2%	40	2%	795	44%	100	5%			**1,827**
Sevenmile Swamp 01	SMS 01	2	0%	466	40%	0	0%			109	9%	26	2%	490	42%	20	2%	47	4%	**1,161**
Sevenmile Swamp 02	SMS 02			538	42%	39	3%	5	0%	66	5%	28	2%	471	37%	126	10%	4	0%	**1,277**
Sevenmile Swamp 03	SMS 03	33	1%	1,199	54%	31	1%	1	0%	71	3%	53	2%	666	30%	152	7%	6	0%	**2,212**
Sevenmile Swamp 04	SMS 04	58	3%	1,040	57%	14	1%	0	0%	75	4%	49	3%	556	31%	27	1%	1	0%	**1,822**
Sevenmile Swamp 05	SMS 05	52	2%	1,399	43%					134	4%	64	2%	1,042	32%	492	15%	44	1%	**3,228**
Sevenmile Swamp 06	SMS 06	29	2%	892	47%					52	3%	27	1%	749	39%	163	9%	3	0%	**1,915**
	TOTAL	**431**	**1%**	**16,699**	**49%**	**352**	**1%**	**18**	**0%**	**1,773**	**5%**	**1,110**	**3%**	**11,726**	**34%**	**1,859**	**5%**	**226**	**1%**	**34,194**

Table 15. Summary statistics for each of the 26 subwatersheds

Subwatershed Name	Code	Subwatershed Size			100-yr. Floodplain		Streams & Ditches		Density	50-ft Buffer	Nonforested Buffer		Hydric A Soils		Unaltered Wetlands		Altered Wetlands	
		(mi2)	(ac.)	(% of total)	(ac.)	(% of sws)	(mi.)	(% of total)	(mi./mi2)	(ac.)	(ac.)	(% of buf.)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)
Beaverdam Swamp 01	BDS 01	1.5	960	3%	164	17%	4.4	3%	2.9	52	21	40%	230	24%	89	9%	1	0.2%
Beaverdam Swamp 02	BDS 02	1.5	970	3%	113	12%	5.8	4%	3.8	69	44	65%	195	20%	53	5%	14	1.5%
Beaverdam Swamp 03	BDS 03	2.8	1,808	5%	32	2%	10.8	7%	3.8	129	81	63%	447	25%	93	5%	6	0.3%
Beaverdam Swamp 04	BDS 04	3.7	2,375	7%	84	4%	11.0	7%	3.0	132	70	53%	616	26%	84	4%	2	0.1%
Great Coharie Creek 01	GCC 01	1.5	980	3%	343	35%	6.2	4%	4.1	71	17	24%	331	34%	250	26%	0	0.0%
Great Coharie Creek 02	GCC 02	0.8	503	1%	33	6%	2.5	2%	3.2	30	7	24%	101	20%	10	2%	0	0.0%
Great Coharie Creek 03	GCC 03	1.3	851	2%	3	0%	4.7	3%	3.5	55	29	52%	207	24%	61	7%	3	0.3%
Great Coharie Creek 04	GCC 04	1.0	648	2%	166	26%	6.6	4%	6.5	71	38	54%	241	37%	145	22%	1	0.1%
Great Coharie Creek 05	GCC 05	0.9	576	2%	118	20%	2.2	1%	2.4	26	4	14%	135	23%	89	16%	1	0.1%
Great Coharie Creek 06	GCC 06	2.1	1,361	4%	9	1%	5.0	3%	2.4	60	27	46%	487	36%	126	9%	3	0.2%
Great Coharie Headwaters 01	GCH 01	1.6	1,000	3%	9	1%	4.7	3%	3.0	57	34	60%	249	25%	89	9%	2	0.2%
Great Coharie Headwaters 02	GCH 02	1.6	1,044	3%	96	9%	5.1	3%	3.1	61	29	47%	182	17%	60	6%	15	1.4%
Great Coharie Headwaters 03	GCH 03	1.1	709	2%	3	0%	1.6	1%	1.5	19	4	20%	256	36%	97	14%	19	2.7%
Great Coharie Headwaters 04	GCH 04	1.4	873	3%	140	16%	3.3	2%	2.4	39	14	36%	191	22%	29	3%	55	6.3%
Great Coharie Headwaters 05	GCH 05	2.4	1,547	5%	20	1%	3.6	2%	1.5	43	15	34%	655	42%	230	15%	35	2.2%
Kill Swamp 01	KS 01	1.6	1,037	3%	164	16%	3.1	2%	1.9	36	5	14%	237	23%	124	12%	1	0.1%
Kill Swamp 02	KS 02	1.4	888	3%	168	19%	2.2	1%	1.6	27	6	21%	277	31%	73	8%	3	0.3%
Kill Swamp 03	KS 03	2.6	1,634	5%	203	12%	6.1	4%	2.4	74	25	34%	330	20%	138	8%	1	0.1%
Kill Swamp 04	KS 04	1.5	990	3%	13	1%	7.2	5%	4.6	85	69	81%	412	42%	50	5%	40	4.1%
Kill Swamp 05	KS 05	2.9	1,827	5%	20	1%	5.5	4%	1.9	66	33	50%	662	36%	150	8%	55	3.0%
Sevenmile Swamp 01	SMS 01	1.8	1,161	3%	177	15%	7.9	5%	4.4	92	46	50%	287	25%	92	8%	26	2.2%
Sevenmile Swamp 02	SMS 02	2.0	1,277	4%	74	6%	5.5	4%	2.8	66	15	22%	460	36%	180	14%	19	1.5%
Sevenmile Swamp 03	SMS 03	3.5	2,212	6%	9	0%	7.8	5%	2.3	94	49	52%	1,002	45%	296	13%	67	3.0%
Sevenmile Swamp 04	SMS 04	2.8	1,822	5%	126	7%	7.9	5%	2.8	94	43	46%	545	30%	177	10%	22	1.2%
Sevenmile Swamp 05	SMS 05	5.0	3,228	9%	106	3%	15.0	10%	3.0	178	90	50%	1,827	57%	316	10%	786	24.4%
Sevenmile Swamp 06	SMS 06	3.0	1,915	6%	0	0%	10.8	7%	3.6	128	96	75%	1,256	66%	263	14%	302	15.7%
	TOTALS	**53.4**	**34,195**	**100%**	**2,393**	**7%**	**156.4**	**100%**	**2.9**	**1,853**	**910**	**49%**	**11,819**	**35%**	**3,364**	**10%**	**1,481**	**4.3%**

Table 16. Land Use data within 100 feet of water for each of the 26 subwatersheds

Subwatershed Name	Code	Agricultural Operations		Cropland		Animal Operations		Swine Lagoon		Developed		Road (w/ ROW)		Forest & Wetland		Scrub		Open Water		**Grand Total**
		(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)	(% of sws)	(ac.)
Beaverdam Swamp 01	BDS 01	2	2%	17	17%	3	3%	3	2%	6	6%	12	12%	59	58%					**102**
Beaverdam Swamp 02	BDS 02	6	4%	34	26%					32	24%	7	5%	46	35%	2	2%	6	5%	**133**
Beaverdam Swamp 03	BDS 03	4	1%	102	40%					21	8%	12	5%	91	36%	20	8%	6	2%	**255**
Beaverdam Swamp 04	BDS 04	2	1%	88	34%	19	7%			11	4%	12	5%	119	46%	4	2%	2	1%	**257**
Great Coharie Creek 01	GCC 01			14	11%					2	2%	4	3%	111	84%			1	1%	**133**
Great Coharie Creek 02	GCC 02			12	21%					3	5%	1	1%	43	73%			0	1%	**59**
Great Coharie Creek 03	GCC 03			31	29%					1	1%	1	1%	53	49%	16	15%	6	5%	**108**
Great Coharie Creek 04	GCC 04			8	7%	6	5%	4	3%			0	0%	101	84%	2	1%			**120**
Great Coharie Creek 05	GCC 05			6	12%							2	3%	43	85%					**50**
Great Coharie Creek 06	GCC 06	3	2%	37	32%	1	1%	0	0%	7	6%	6	5%	59	51%	1	1%	2	2%	**116**
Great Coharie Headwaters 01	GCH 01			35	31%					6	6%	18	16%	43	38%	11	10%	0	0%	**113**
Great Coharie Headwaters 02	GCH 02			38	31%					5	4%	1	1%	60	50%			16	13%	**120**
Great Coharie Headwaters 03	GCH 03			1	3%					2	4%	1	1%	32	80%	2	6%	2	4%	**39**
Great Coharie Headwaters 04	GCH 04			3	4%					3	4%	1	1%	59	77%			10	14%	**76**
Great Coharie Headwaters 05	GCH 05	1	2%	19	23%					9	11%	1	1%	53	63%			0	0%	**85**
Kill Swamp 01	KS 01			1	2%					1	1%	3	4%	60	86%	1	1%	4	6%	**70**
Kill Swamp 02	KS 02			4	8%					2	3%	3	6%	40	76%	4	7%			**53**
Kill Swamp 03	KS 03	1	0%	41	28%	0	0%			8	5%	1	1%	95	65%			1	0%	**147**
Kill Swamp 04	KS 04	4	2%	102	64%	5	3%			6	4%	9	6%	29	18%	5	3%			**160**
Kill Swamp 05	KS 05	3	2%	56	42%	0	0%			5	4%	4	3%	62	47%	3	3%			**133**
Sevenmile Swamp 01	SMS 01	1	1%	8	5%	0	0%			13	8%	3	2%	130	76%			16	10%	**171**
Sevenmile Swamp 02	SMS 02			14	11%	1	1%			6	5%	1	1%	97	76%	4	3%	3	3%	**128**
Sevenmile Swamp 03	SMS 03	4	2%	77	41%	3	2%			3	2%	6	3%	87	47%	6	3%	1	0%	**187**
Sevenmile Swamp 04	SMS 04	7	4%	27	16%	0	0%			1	1%	2	1%	136	78%					**173**
Sevenmile Swamp 05	SMS 05	15	4%	121	34%					12	3%	13	4%	161	46%	14	4%	16	5%	**351**
Sevenmile Swamp 06	SMS 06	1	0%	153	63%					7	3%	10	4%	57	23%	16	6%			**244**
	TOTAL	**51**	**1%**	**1,048**	**29%**	**39**	**1%**	**6**	**0%**	**171**	**5%**	**135**	**4%**	**1,926**	**54%**	**112**	**3%**	**93**	**3%**	**3,583**

Subwatershed Descriptions (assets and stressors)

The following pages contain 26 sets of maps representing the assets and stressors in each subwatershed. Each set of maps is accompanied by a brief evaluation of each subwatershed based on the data derived from the tables on the previous pages and the GIS data depicted in the maps. The small amount of water quality and stream habitat quality data that is available is also considered in this evaluation. This evaluation helped formulate the Assessment Objectives discussed later in this report.

Asset and Stressor Maps

The stressor map includes three primary analysis layers. The first is a layer of altered wetlands as described in the Preliminary Restoration Opportunity Layer section in Appendix A. It included those features in the NC CREWS layer that have a W-Type indicating drained, impacted and cutover features. The second stressor layer was a layer of impacted buffers described in the Riparian Zone Condition section of this report on page 91. It includes non-forested (cropland, developed, agriculture operations, animal operations, swine lagoons and roads) land uses. The third stressor layer was a layer of impacted land uses. These land uses include: cropland, developed, agriculture operations, animal operations, and swine lagoons.

The asset maps were designed to highlight the valuable natural components in the local watershed planning area. Three layers were created for the asset maps. The first was a layer of intact wetlands, based on the NC CREWS data layer. The specific class features are described in Appendix A. The second layer created for the asset maps was a layer of high-value habitat based on the Biodiversity/Wildlife Habitat Assessment (BWHA) layer created as part of DENR Conservation Planning Tools (Appendix A). The third layer used in the asset maps was a layer of natural land uses. The features classified as forest or hydro other (a surrogate class for wetlands and wet forested areas) were included in the forest land use layer. In addition, the asset maps included a layer of NC Significant Natural Heritage Areas.

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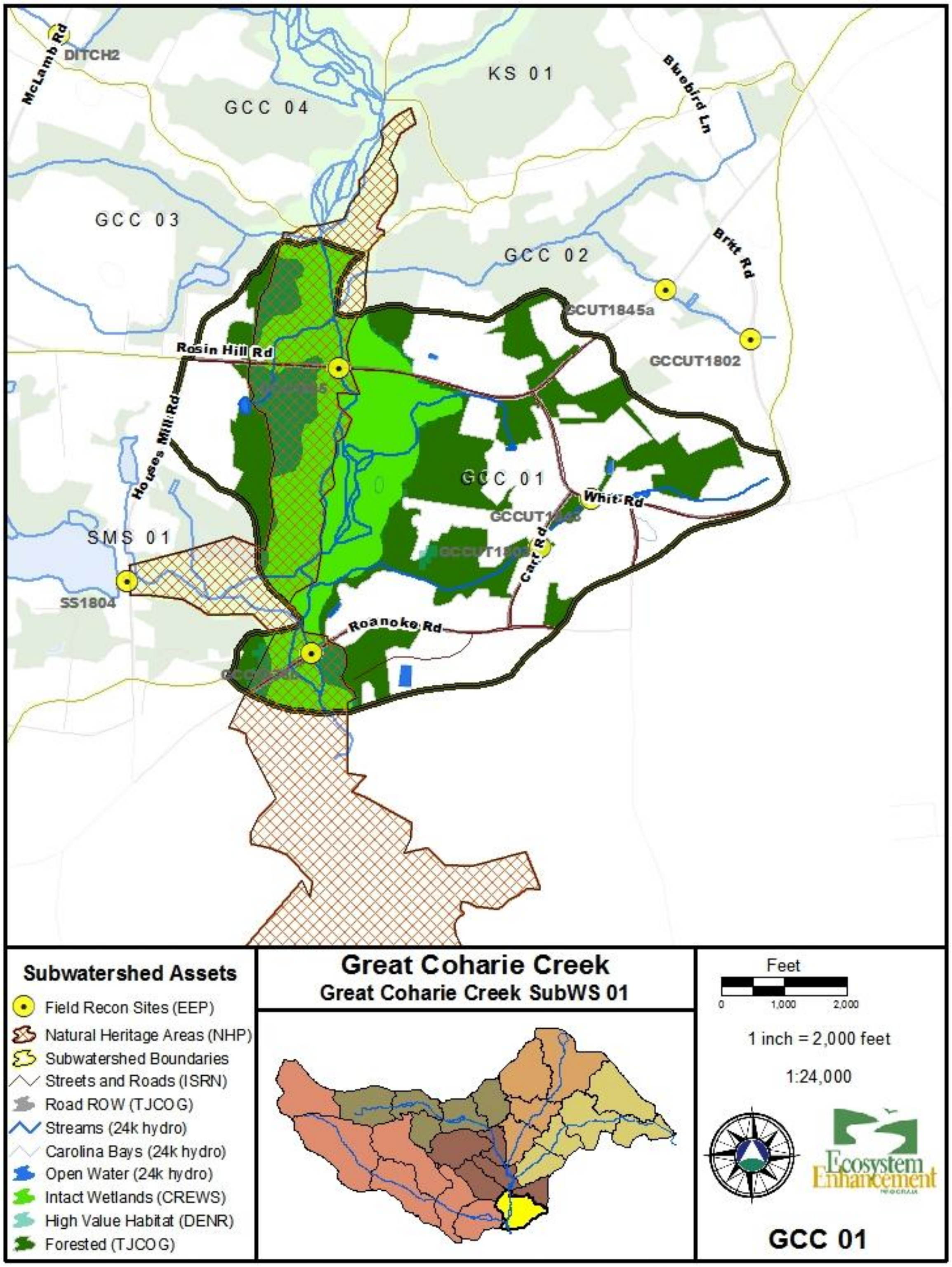
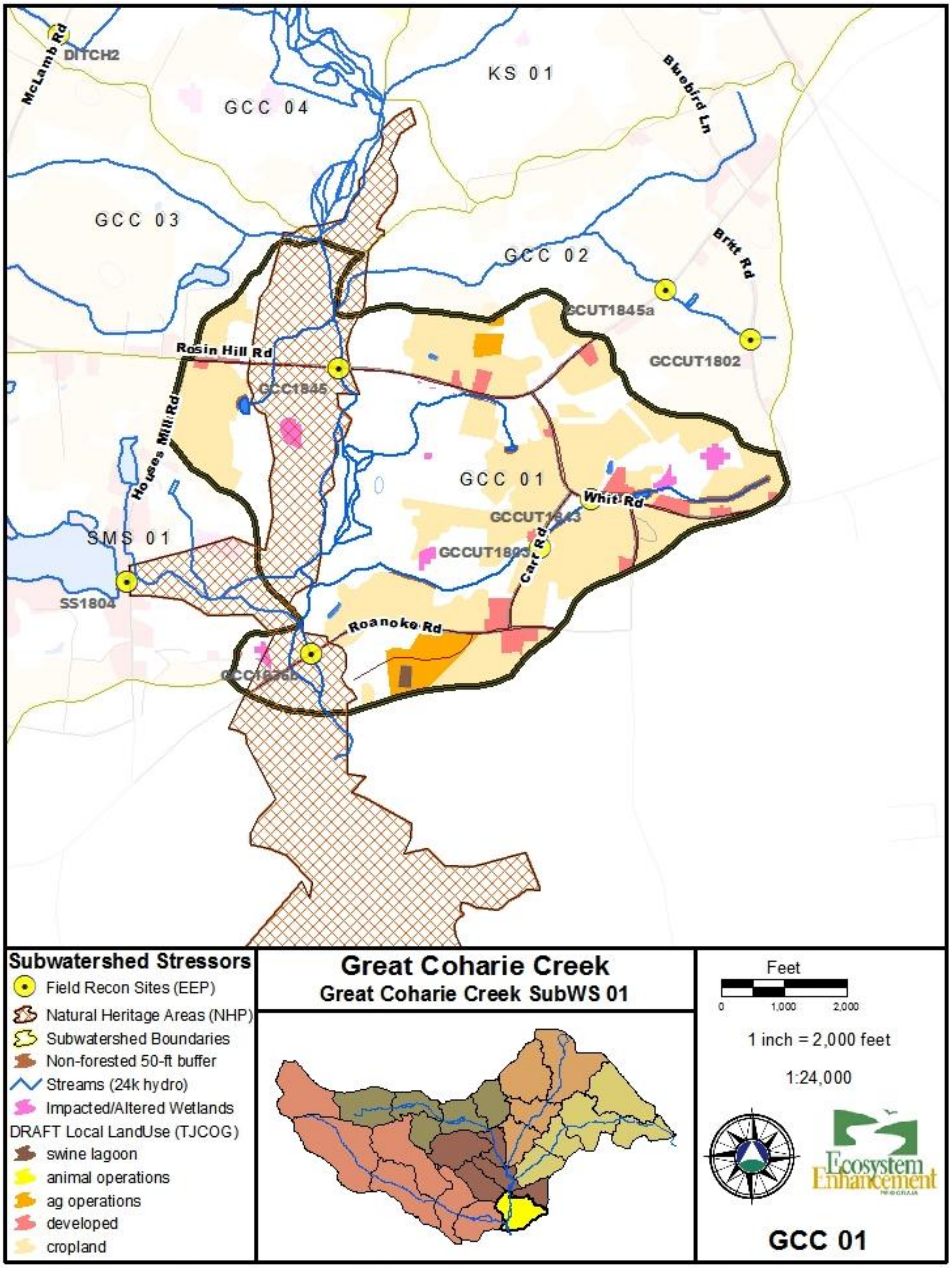
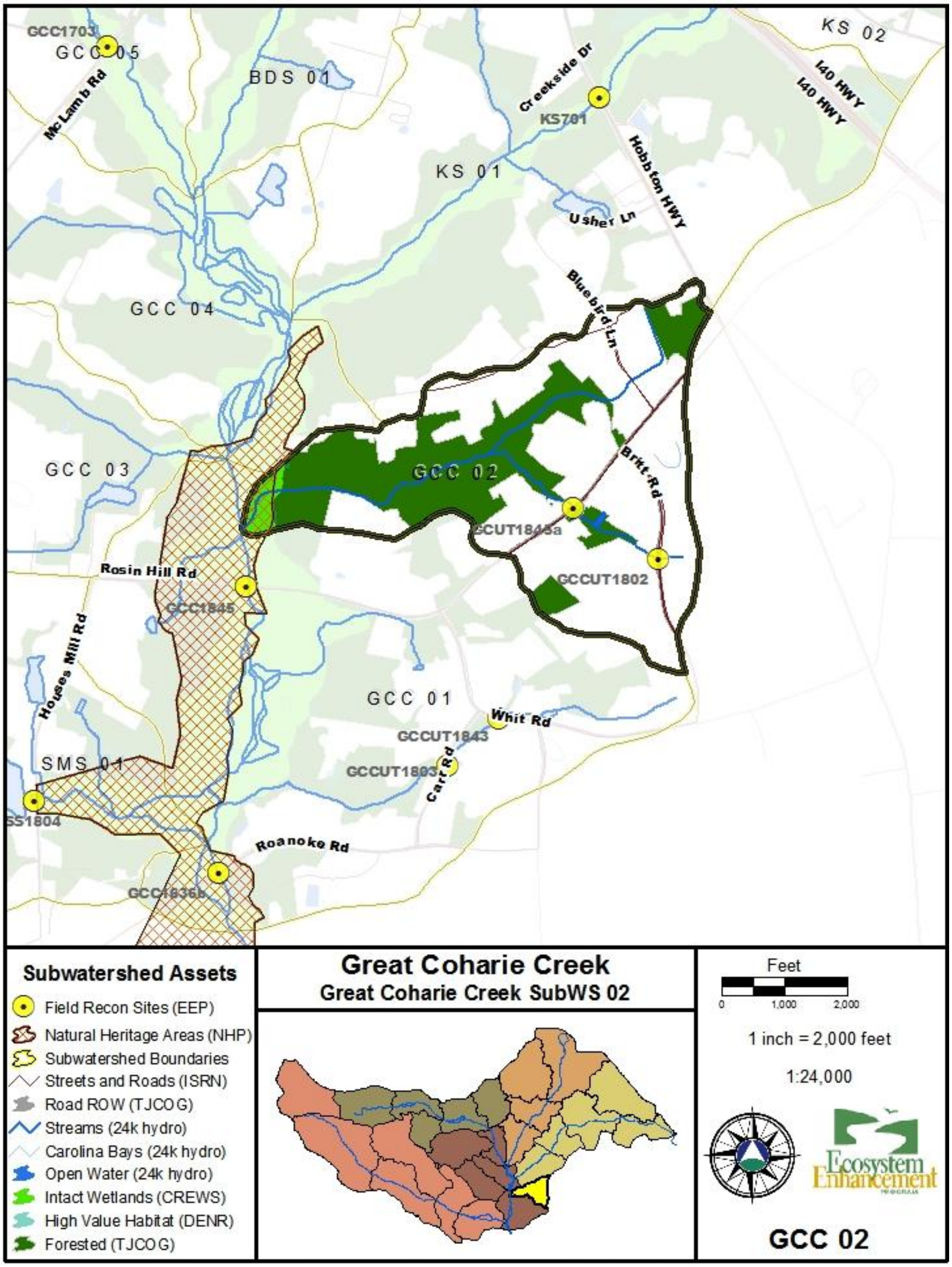


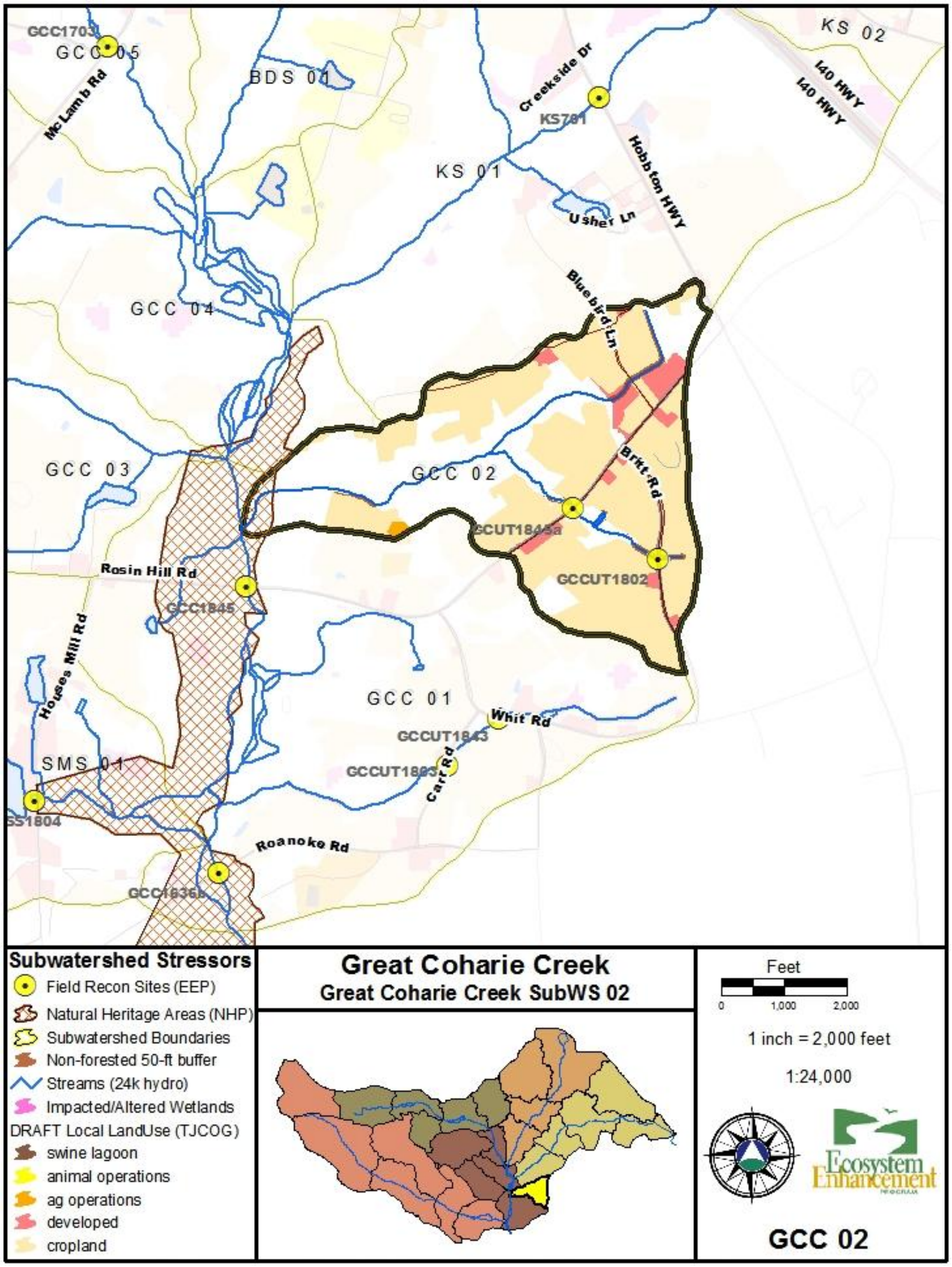
Great Coharie Creek 01: Assets. This subwatershed is at the bottom end of the planning area. It contains Significant Natural Heritage Area and state protected land. The channel, at this point, is well defined and the substrate contains some gravel – which makes good aquatic habitat. Eighty-four percent of the buffers in this subwatershed are intact.



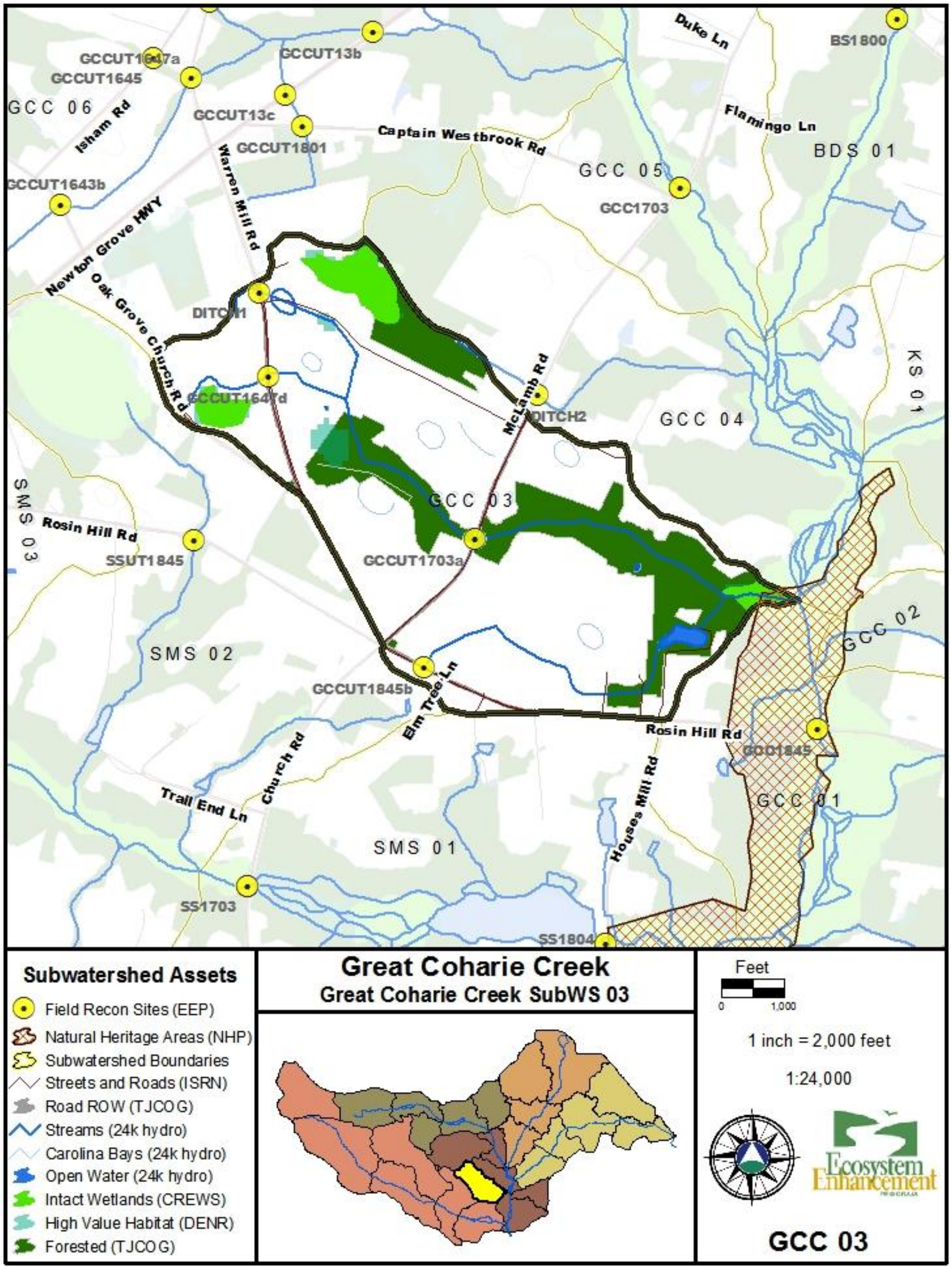
Great Coharie Creek 01: Stressors. The primary land use in this subwatershed is cropland which is concentrated on the east side of the subwatershed. There is 24% impacted buffer. A swine lagoon has been identified and mapped in this watershed.



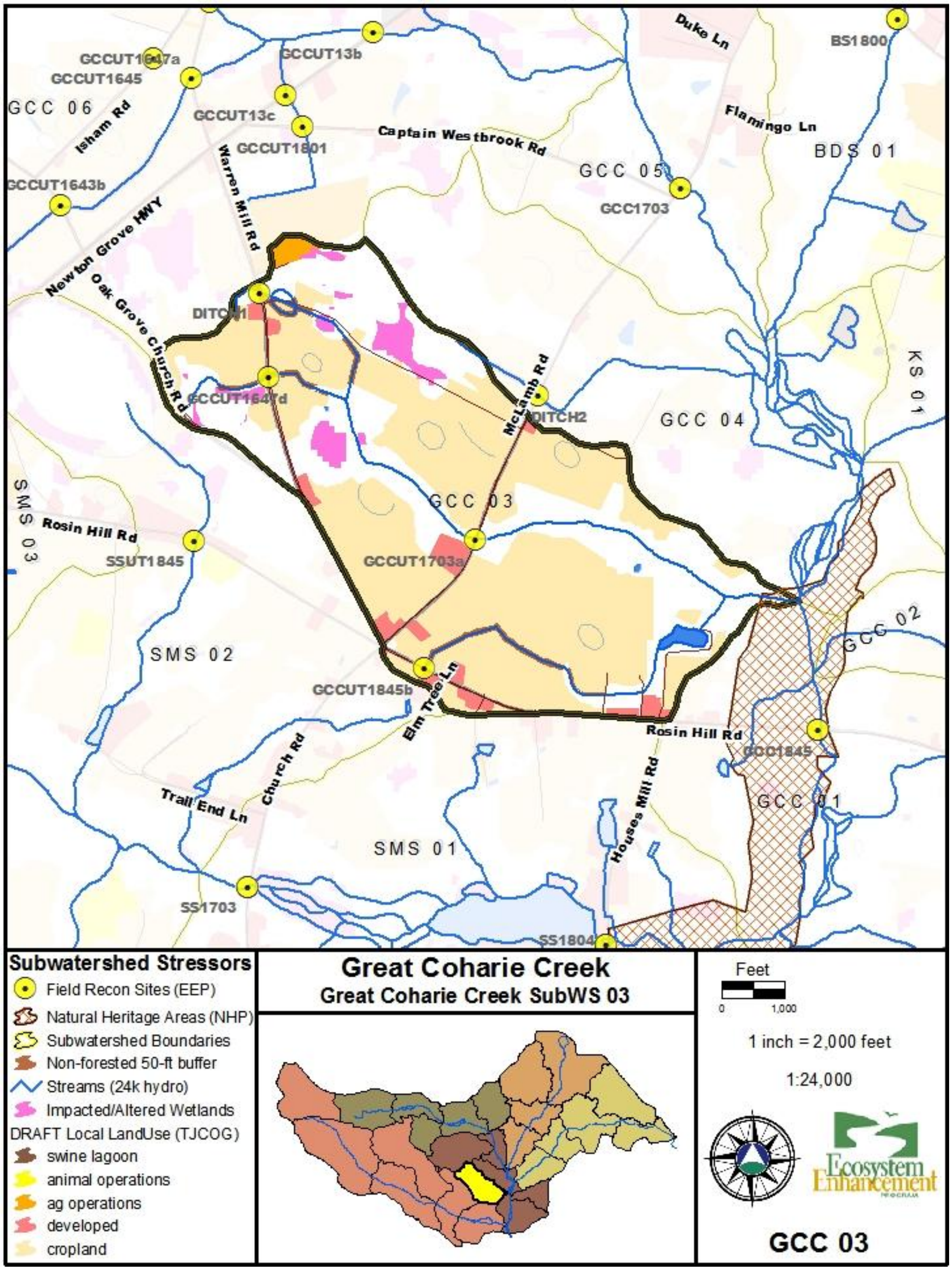
Great Coharie Creek 02: Assets. This subwatershed contains a small tributary. It is the smallest subwatershed in the planning area at 0.8 square miles. This tributary is well buffered with 73% forested 100 foot buffer.



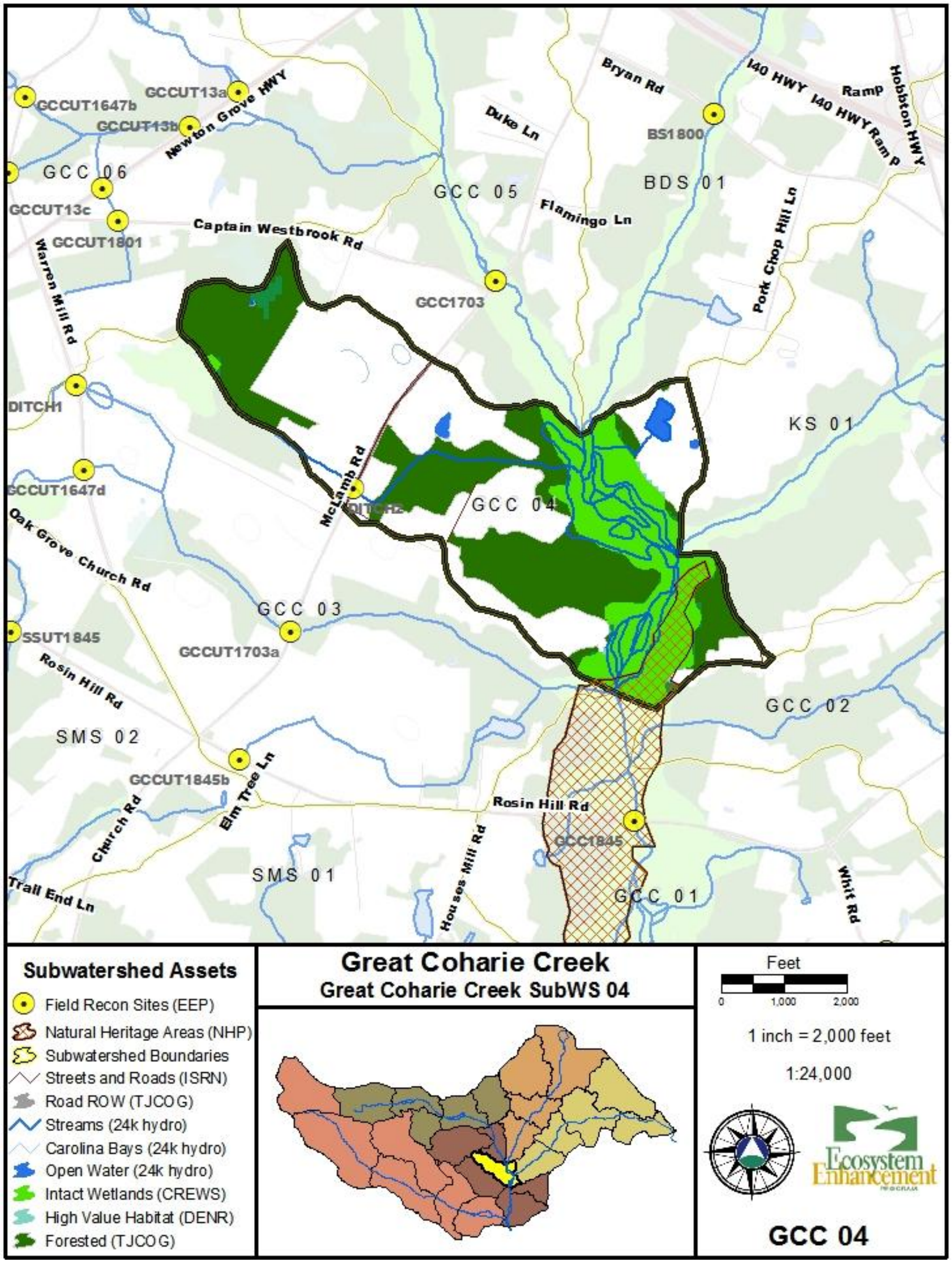
Great Coharie Creek 02: Stressors. Land use in this subwatershed is primarily cropland. There are unbuffered ditches in the headwaters that feed into the tributary.



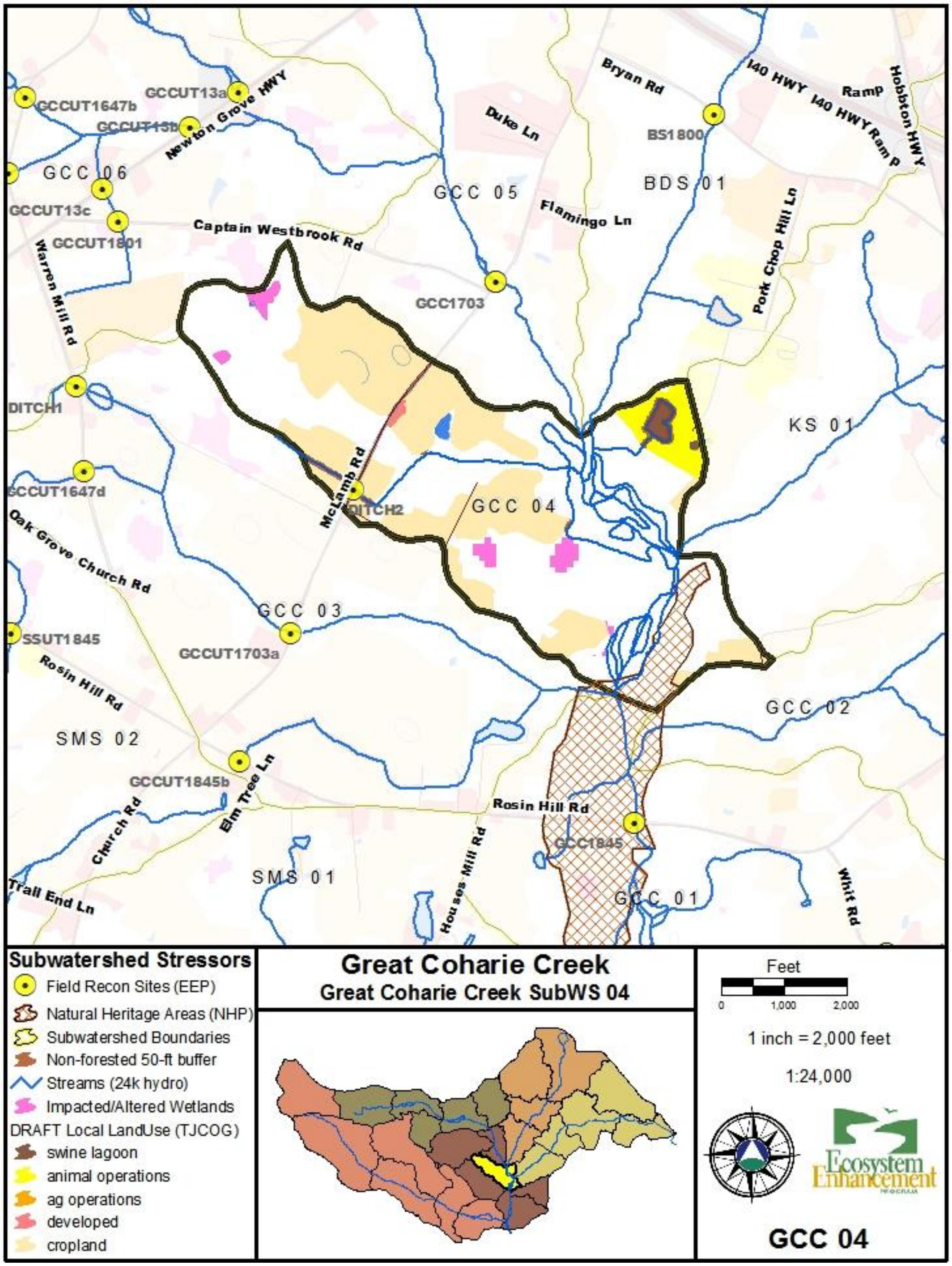
Great Coharie Creek 03: Assets. This subwatershed contains a small tributary that is 50% buffered. The land use is 58% cropland with indication that 13% of the area was timbered in the near past. It is interesting to note that only 3 acres in this 851 acre subwatershed is in the 100 year flood plain.



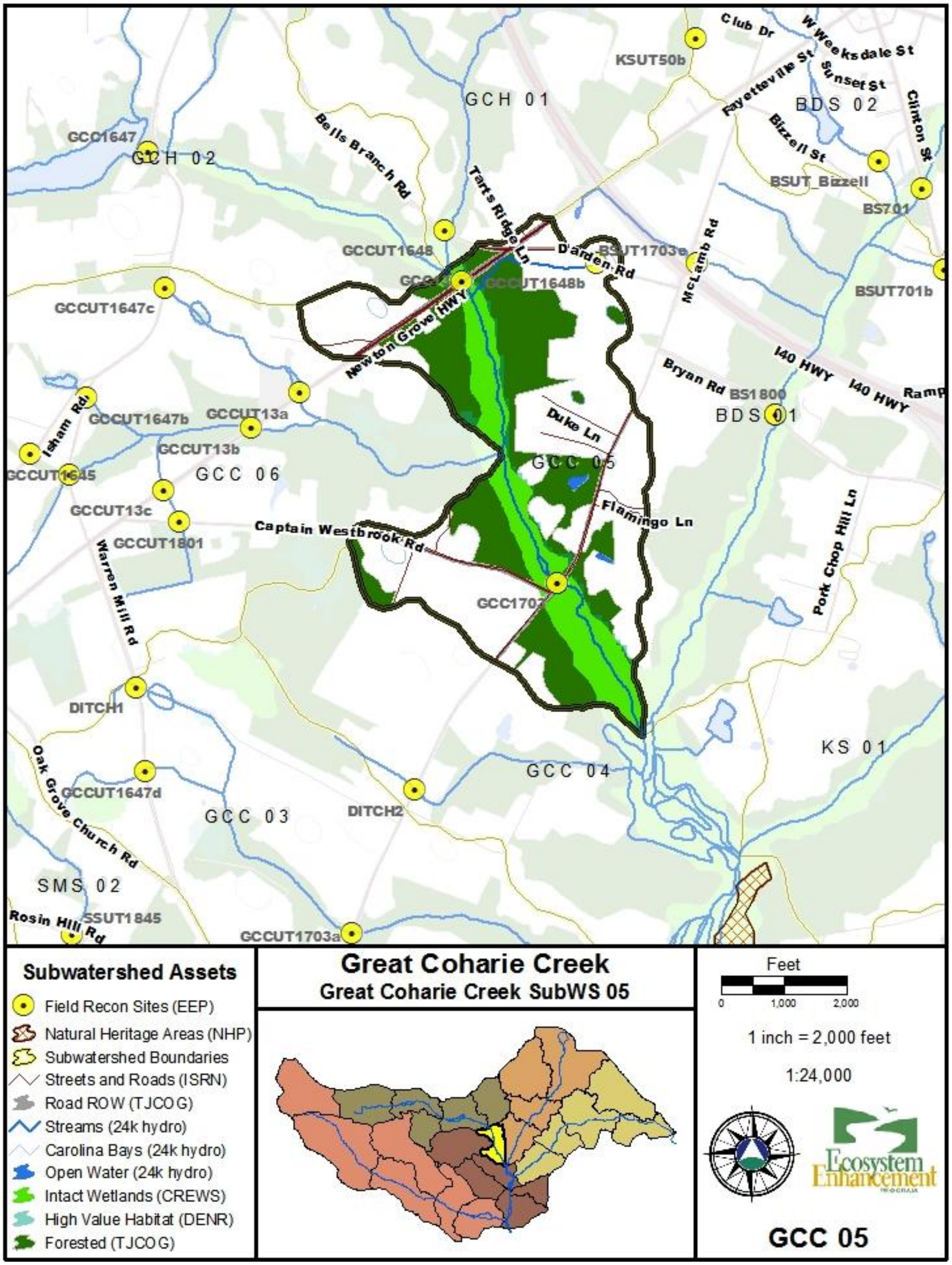
Great Coharie Creek 03: Stressors. There are several Carolina bays that are in farm cultivation in this watershed. One particular bay between Oak Grove Church Road and Warren Mill Road has been designated as high value habitat. It is currently identified as scrub.



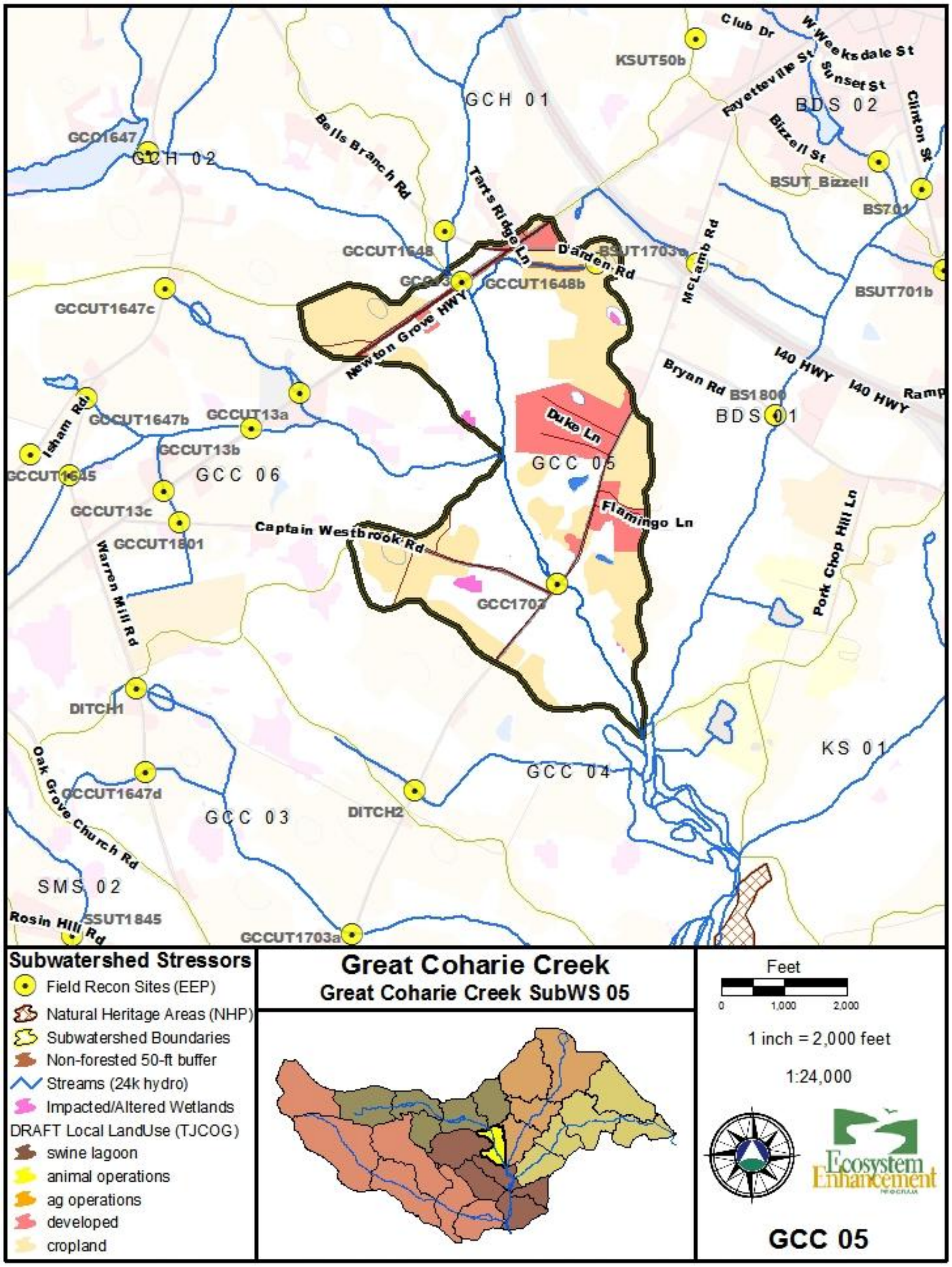
Great Coharie Creek 04: Assets. 26 % of the land area in this subwatershed is in the 100 year floodplain. The main stem of the creek in this subwatershed is designated as Significant Natural Heritage Area by the Natural Heritage Program. Protection of the area above this existing designation should be considered.



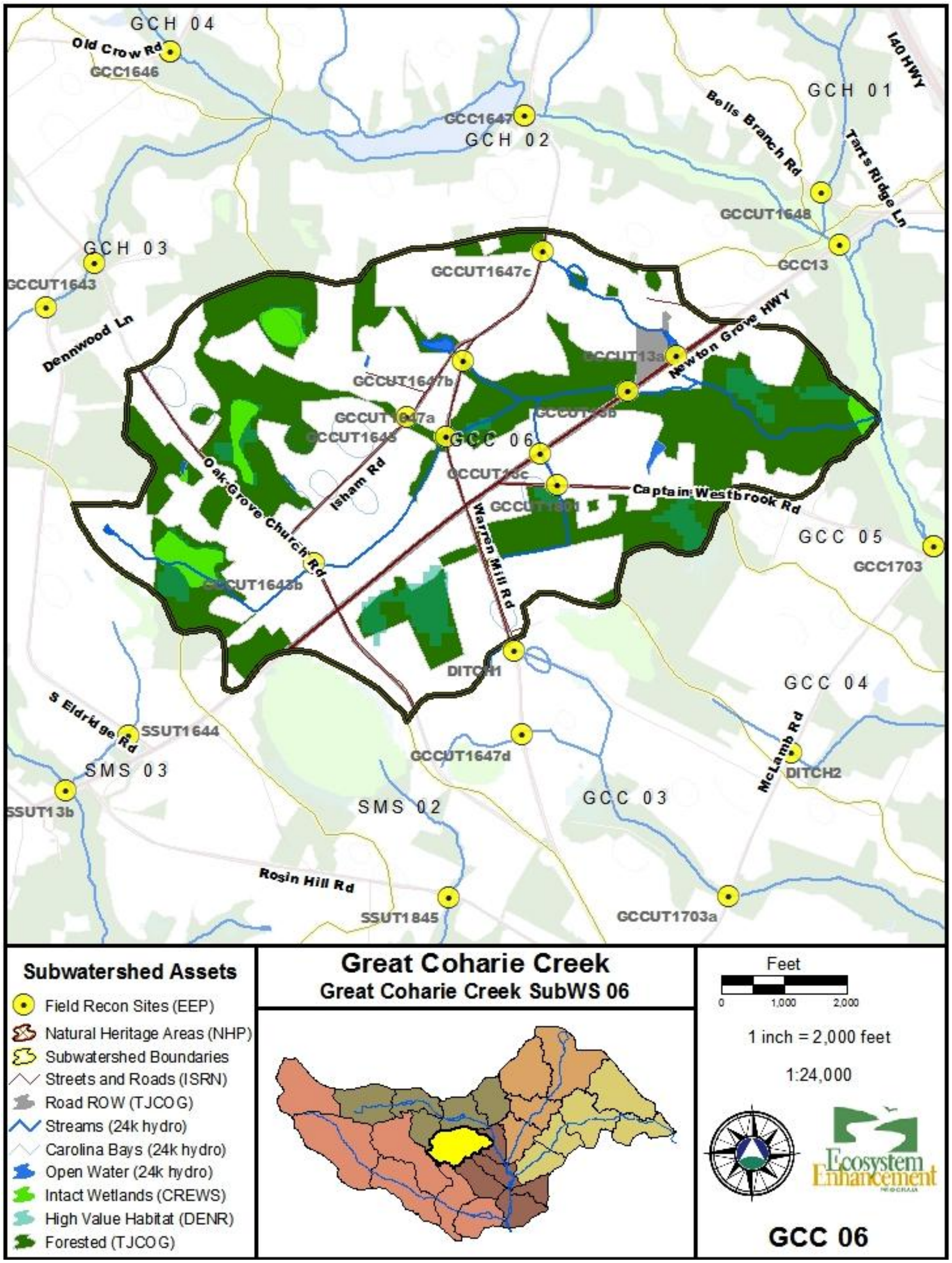
Great Coharie Creek 04: Stressors. Most of this subwatershed is forest, wetlands or scrub. Most of the stream is well buffered with a few exceptions in the headwaters of two small tributaries. At the headwater of one of the small tributaries is a large hog operation.



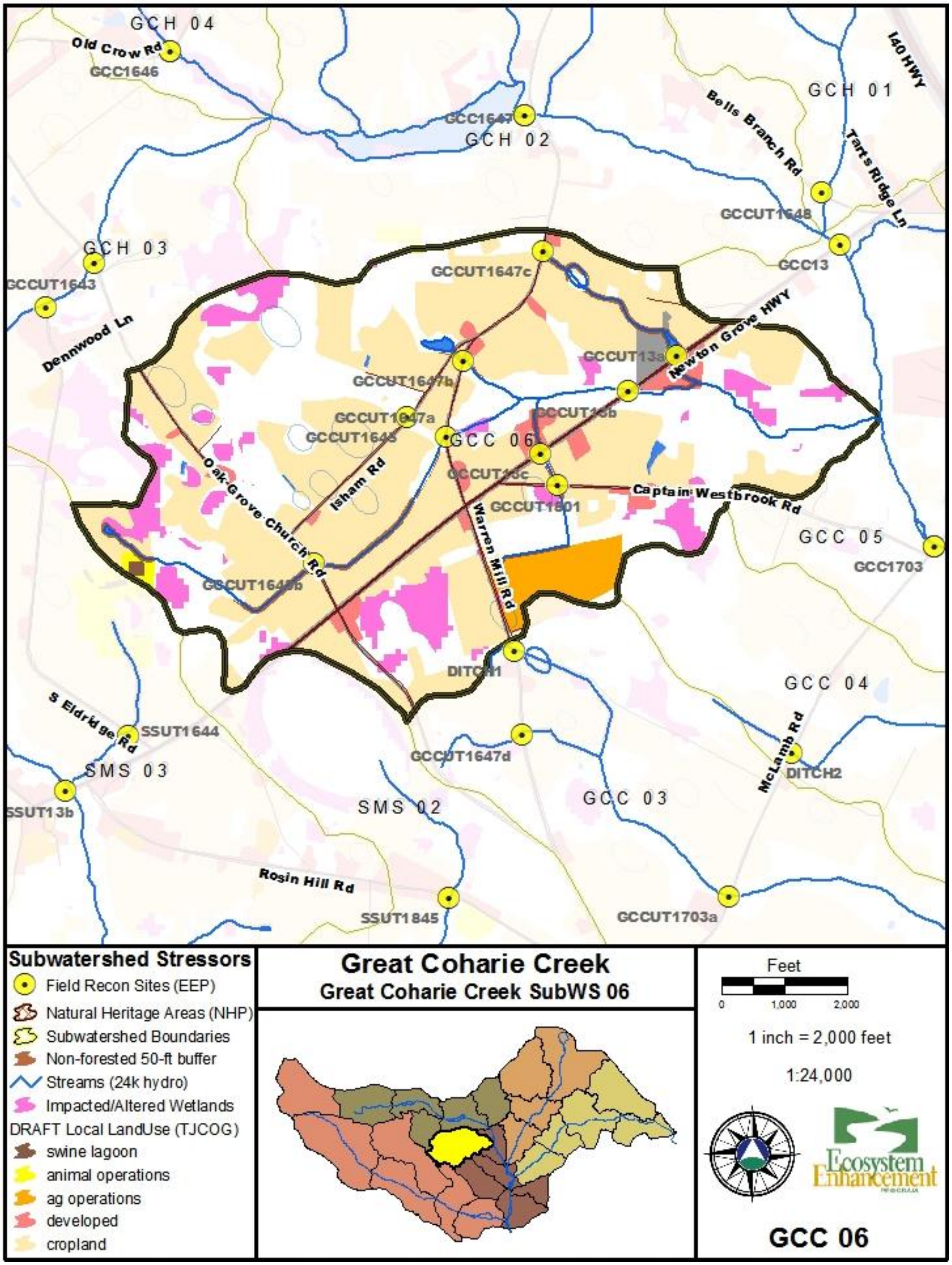
Great Coharie Creek 05: Assets. This watershed contains the main stem of Great Coharie Creek with one small tributary. The stream is well buffered. Twenty percent of the subwatershed is in the 100 year flood plain. Visual habitat assessment revealed significant vegetation decaying in the stream in the winter.



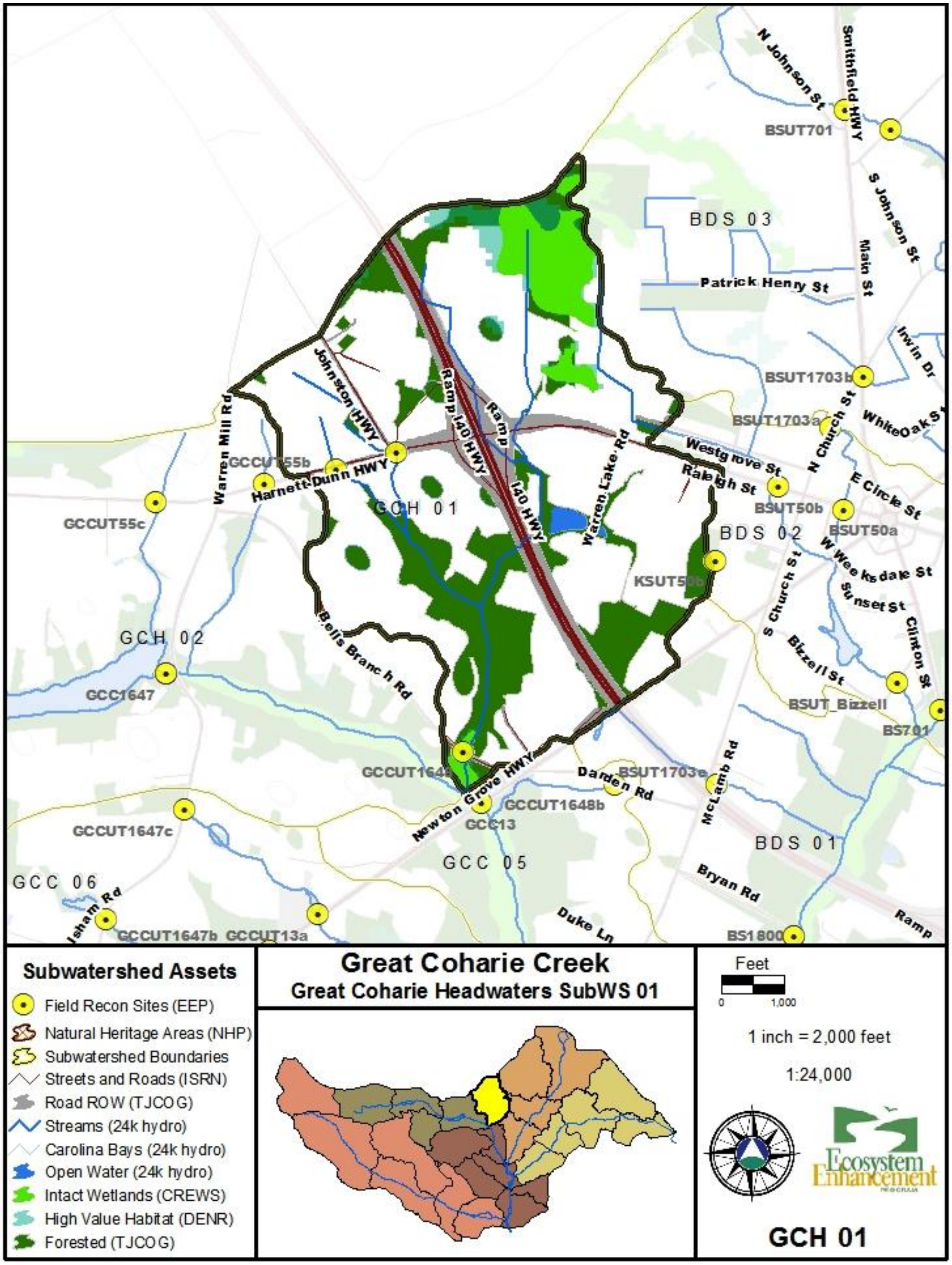
Great Coharie Creek 05: Stressors. Roads in this and other watersheds should be considered as possible stressors since the smaller roads show indications of impounding sediment and large woody debris. Roads, such as Highway 13, in this subwatershed, may contribute vehicular pollutants through stormwater inputs during rain events.



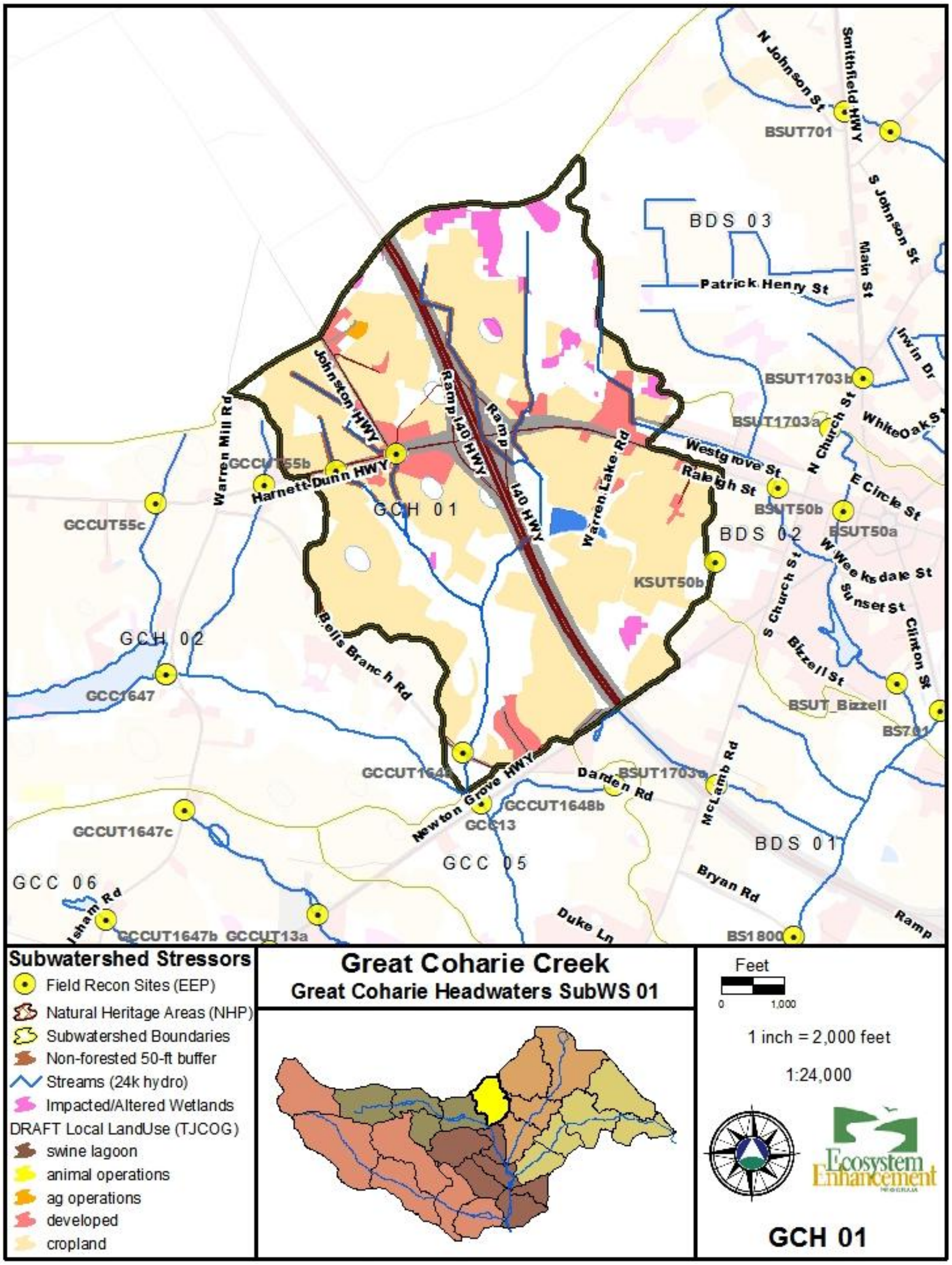
Great Coharie Creek 06: Assets. This watershed contains a tributary and a series of ditches that are not yet mapped. Most of the land cover is cropland, agricultural operations or forested and wetland. Less than 1% of the land in this subwatershed is in the 100 year flood plain.



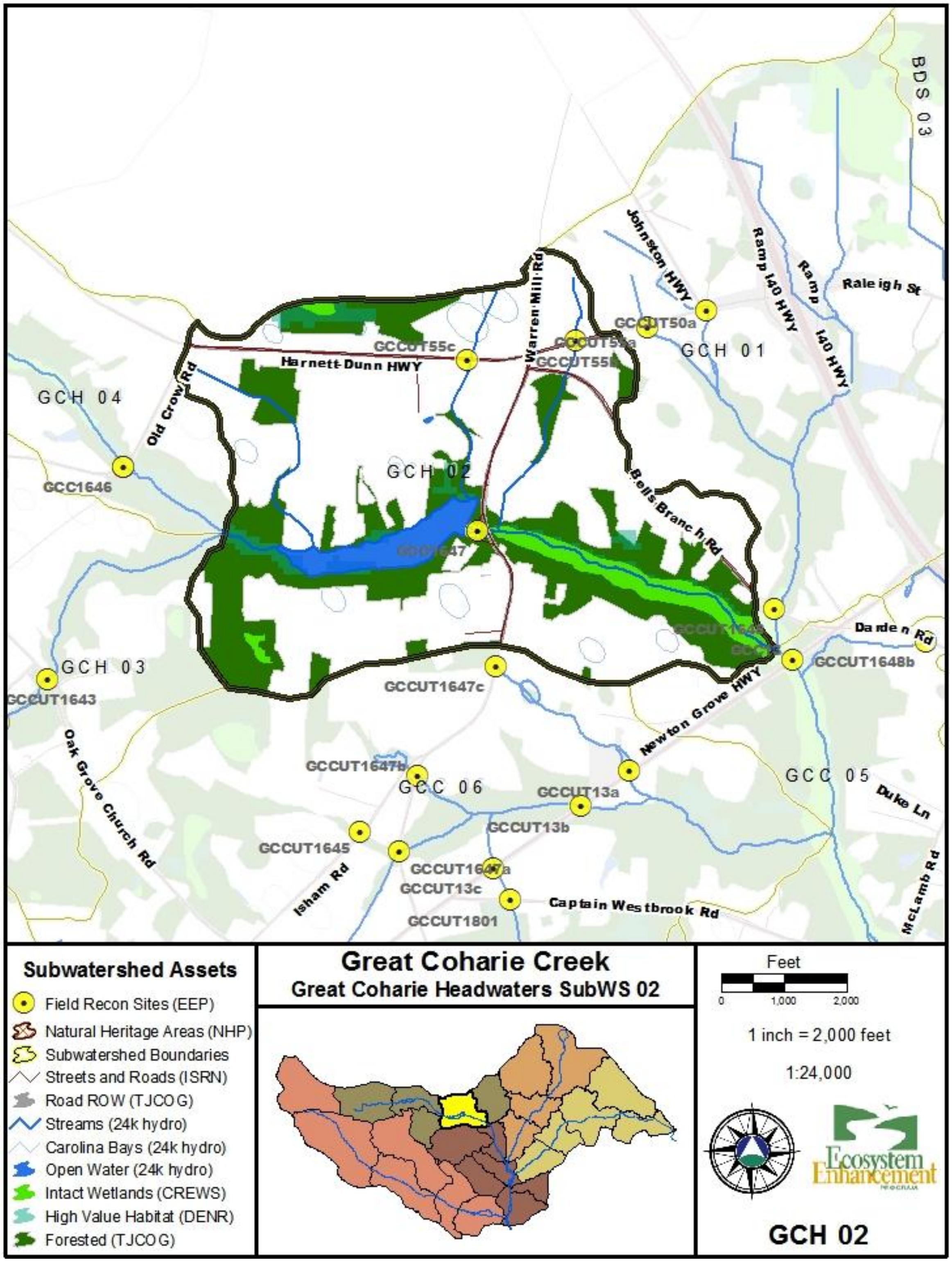
Great Coharie Creek 06: Stressors. Hwy 13 runs right through the center of this subwatershed. Commercial development takes place along this road though still a small amount. The initial GIS data reveals significant impacted wetlands that should be further assessed for restoration opportunities.



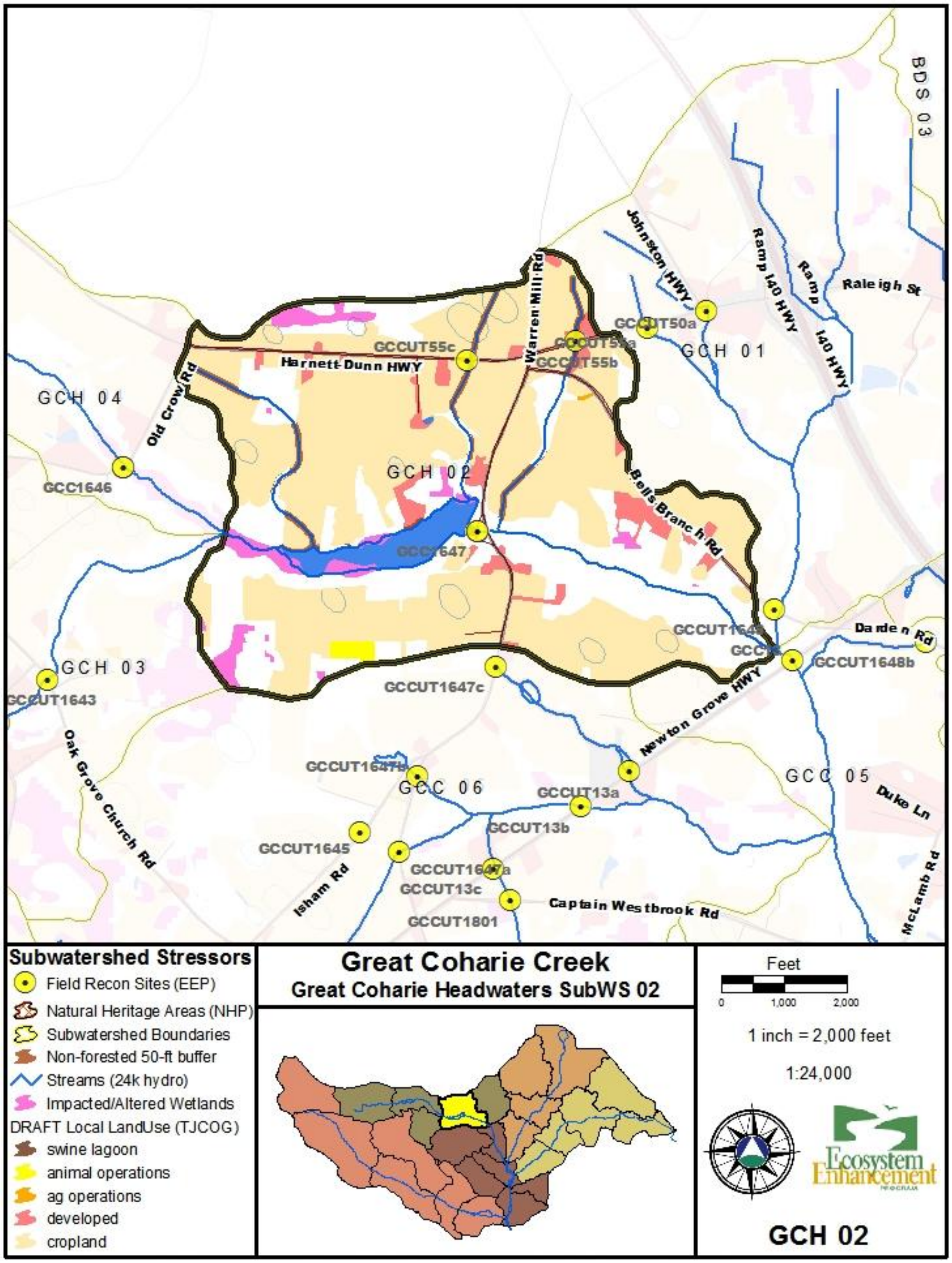
Great Coharie Creek Headwaters 01: Assets. This subwatershed contains a large unnamed tributary to Great Coharie Creek and the Town of Newton Grove. There is a wetland area of high habitat value in the northern corner of the subwatershed. This area looks primarily forested. However, there is a ditch or straightened stream running through this wetland.



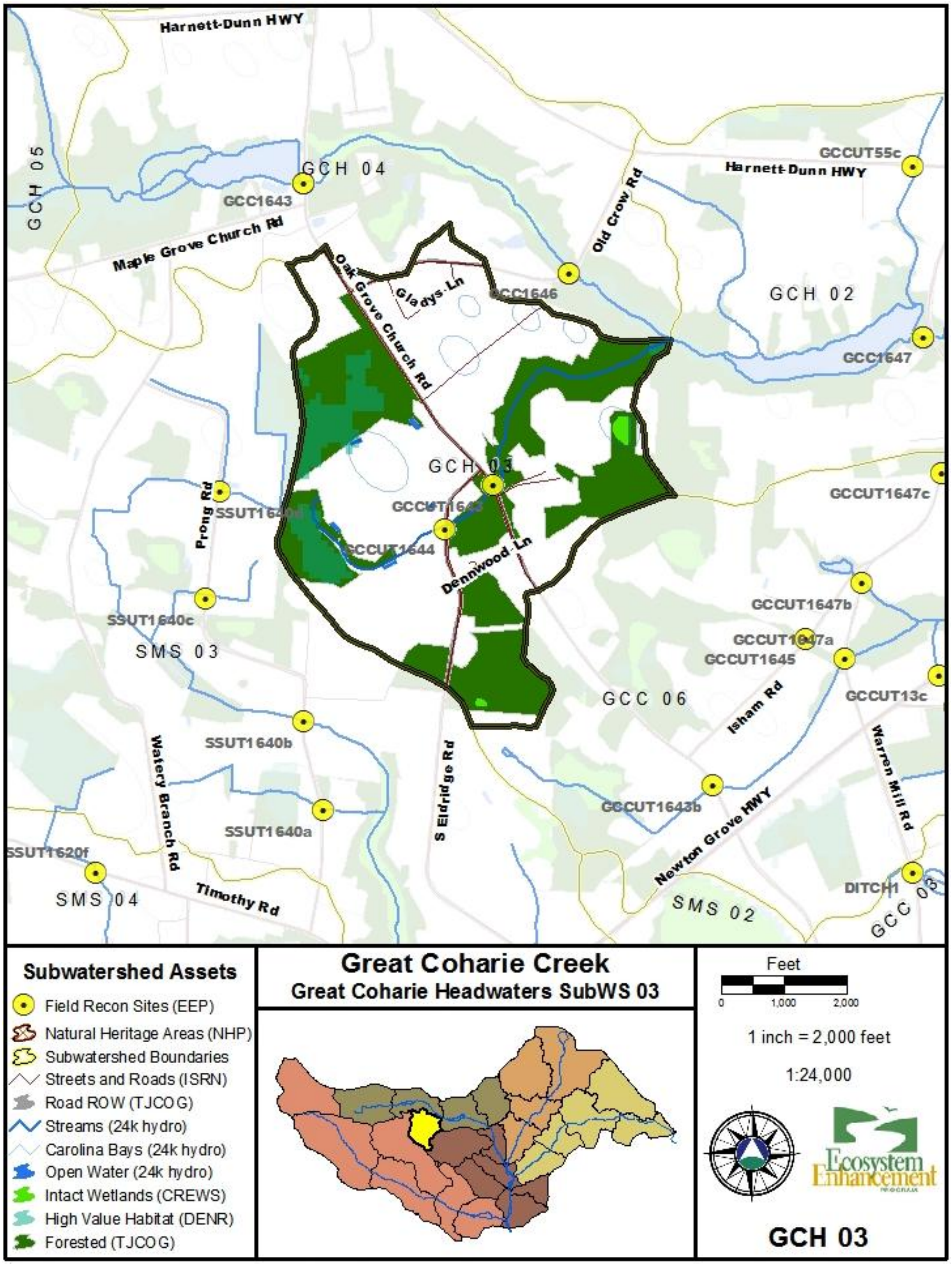
Great Coharie Creek Headwaters 01: Stressors. I-40 bisects this watershed and covers 11% of the land area of the subwatershed. The highway and the town make this the subwatershed with the highest impervious surface area. Only 25% of this subwatershed is in forest or wetland. The rest is road, development or cropland.



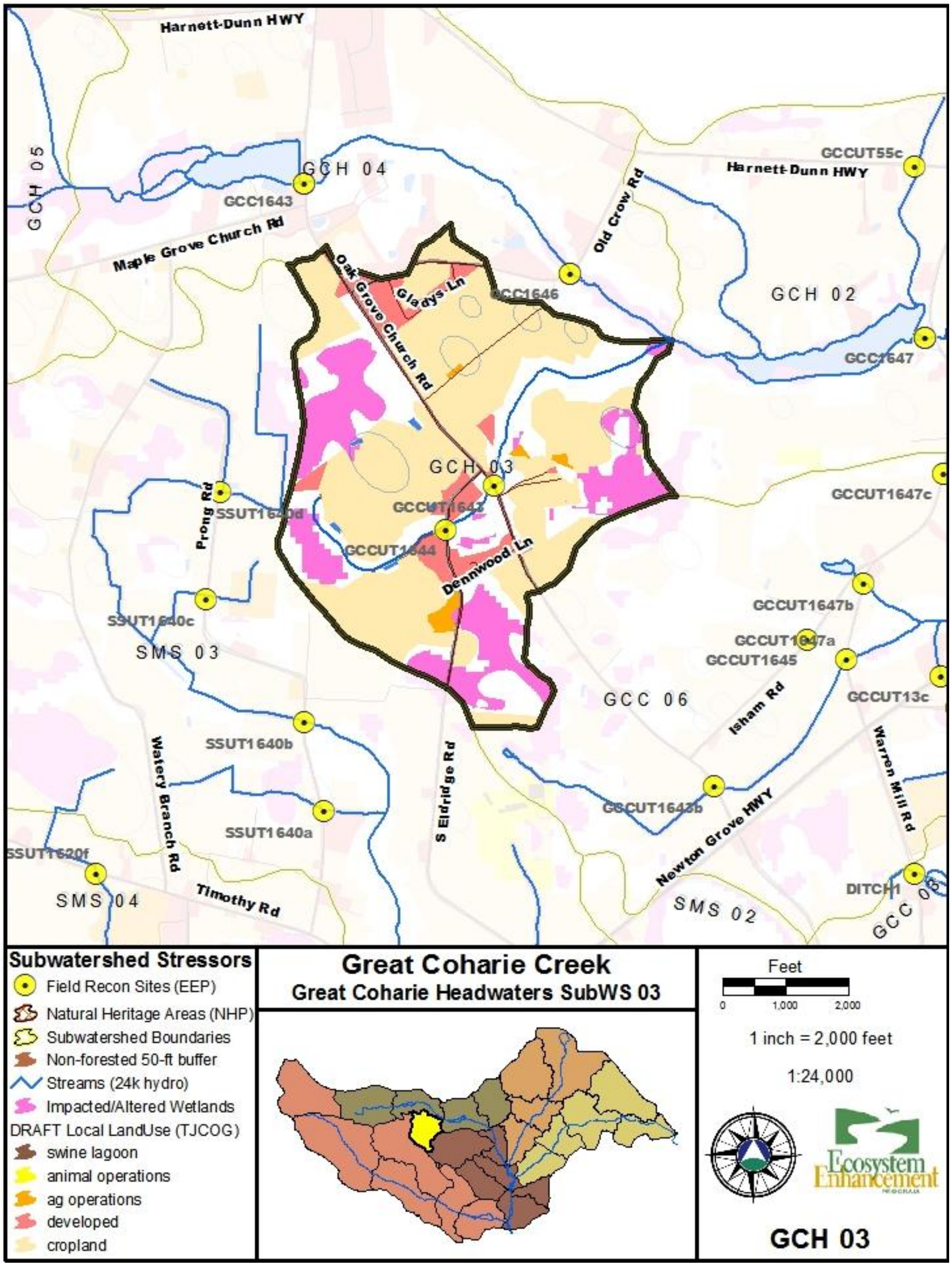
Great Coharie Creek Headwaters 02: Assets. This subwatershed contains both the main stem of Great Coharie Creek, 3 tributaries and Warrens Pond. Land use is primarily cropland.



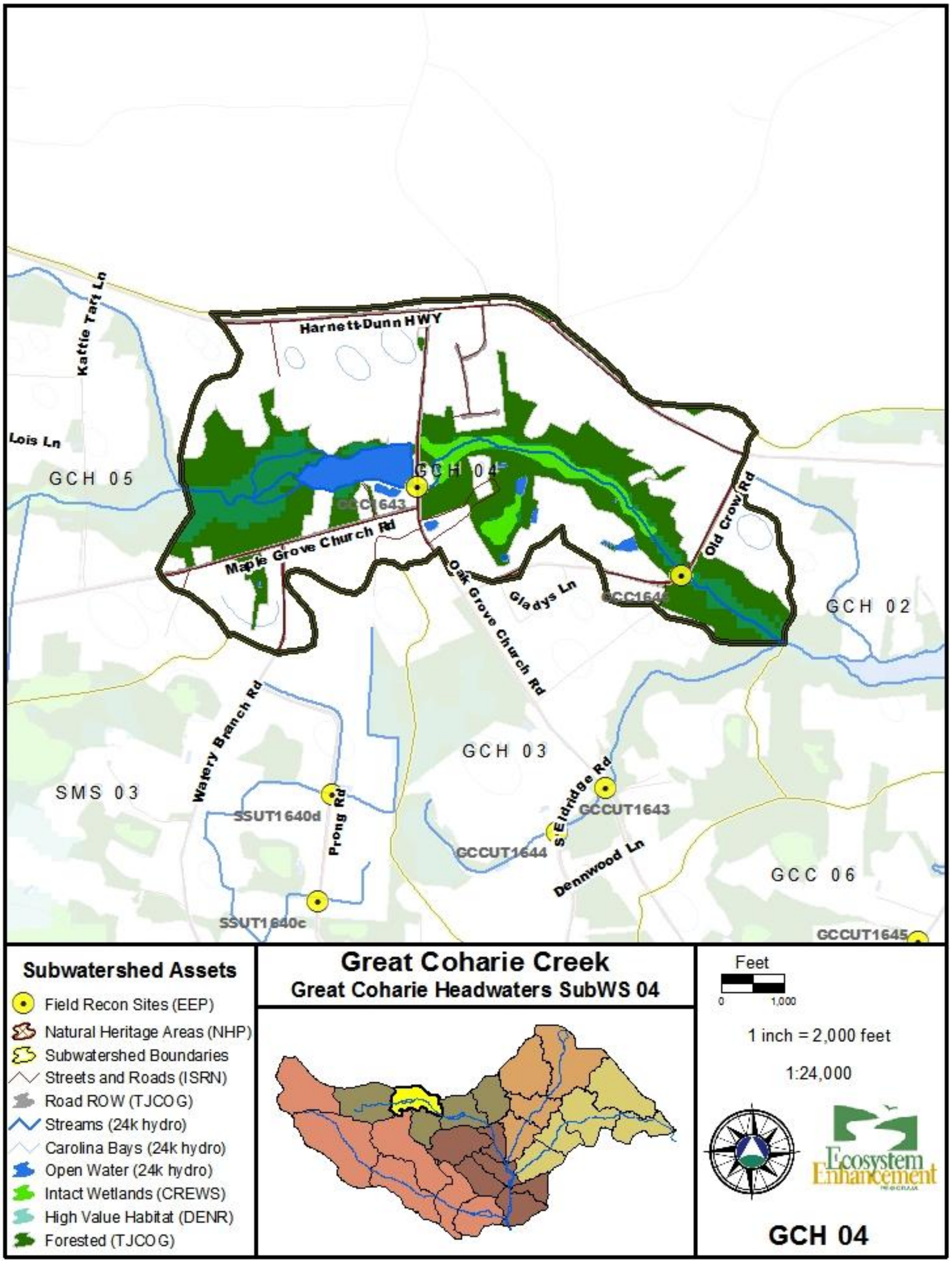
Great Coharie Creek Headwaters 02: Stressors. Approximately half the streams are not buffered. The 24k hydrology data indicates nine Carolina Bays but the NC CREWS data does not identify these areas.



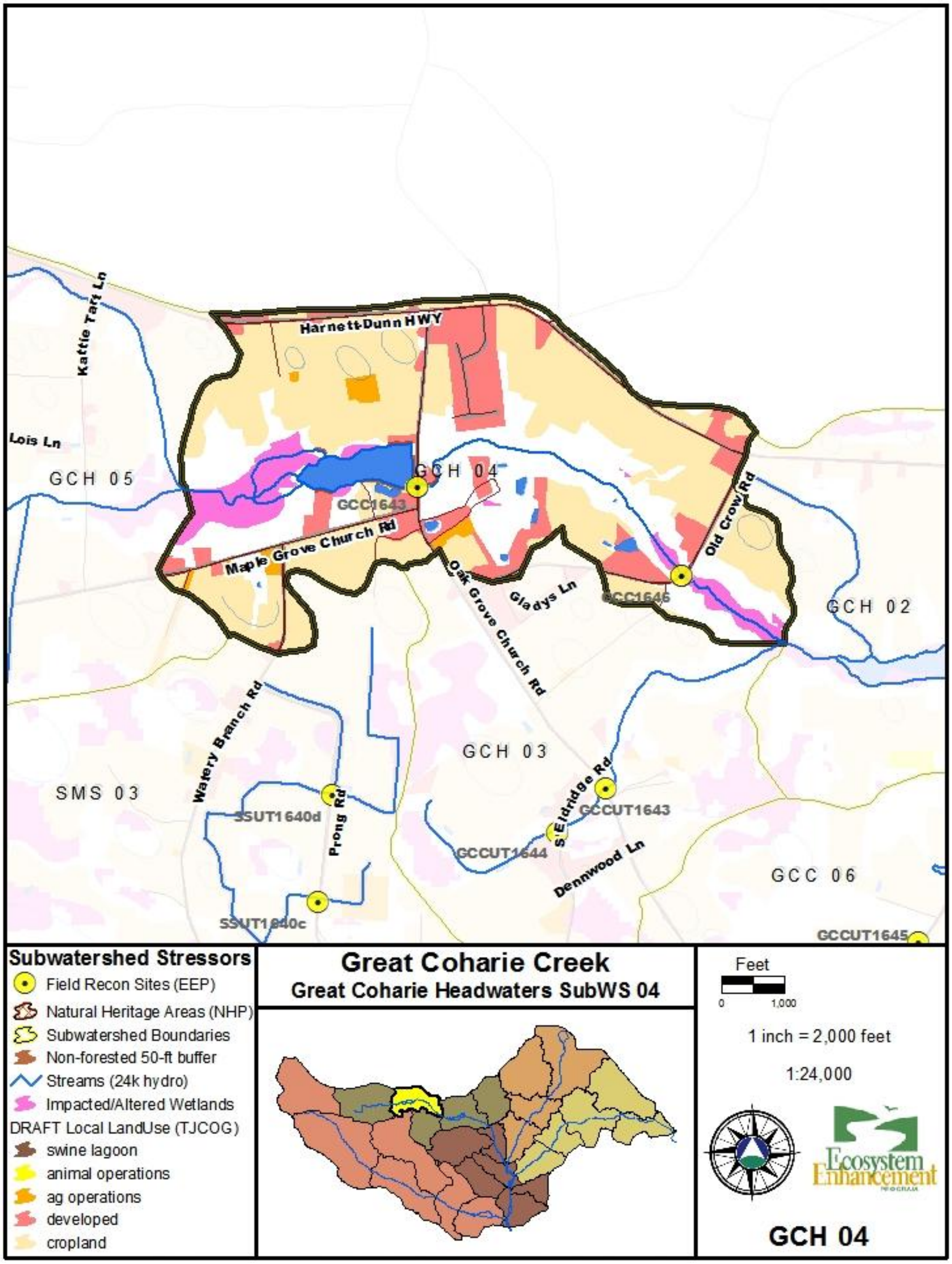
Great Coharie Creek Headwaters 03: Assets. This subwatershed contains a tributary to Great Coharie Creek. This tributary is mostly buffered though there is some farming and homestead activity within the buffer along Dennwood Lane.



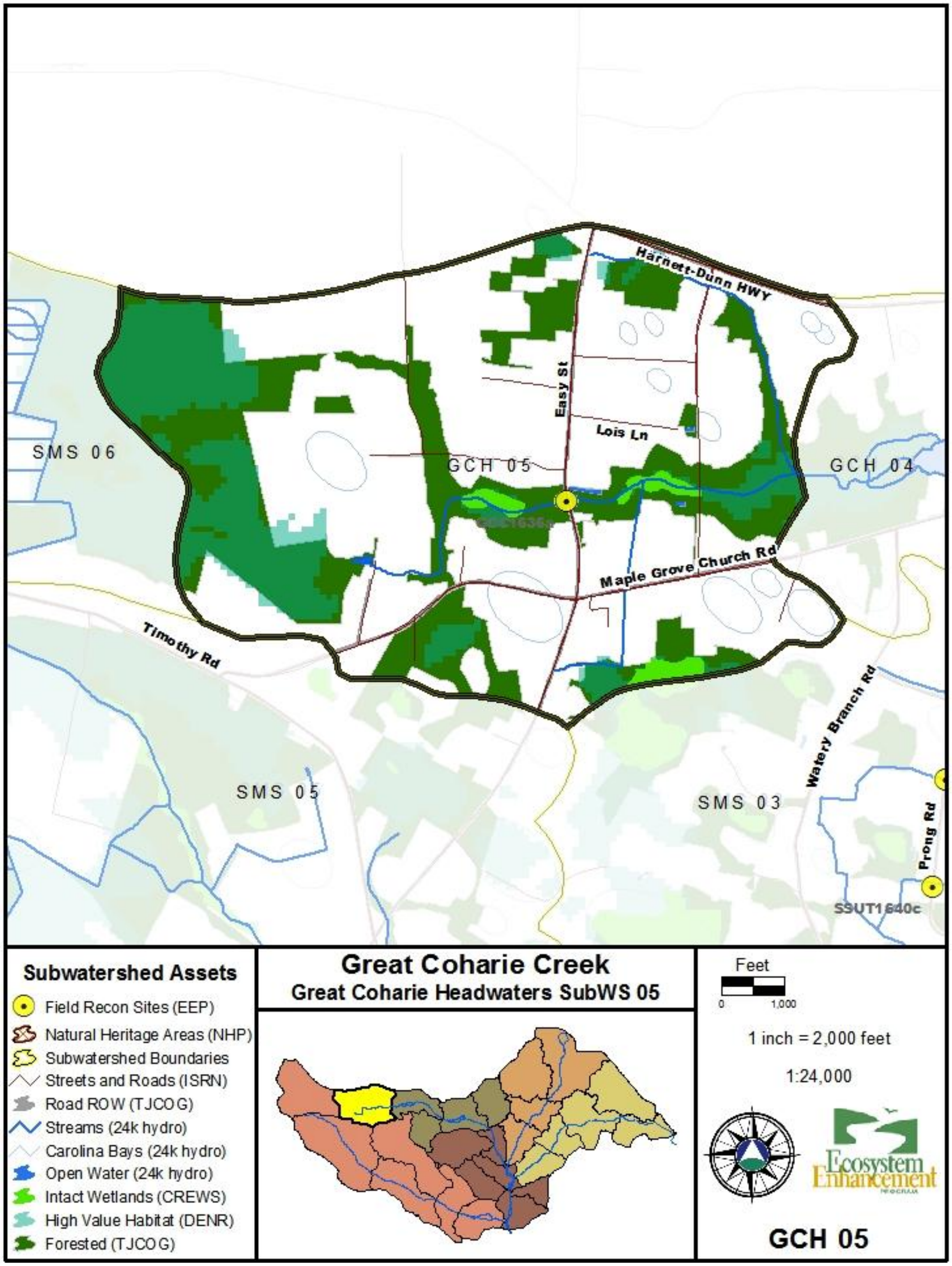
Great Coharie Creek Headwaters 03: Stressors. The GIS data identifies impacted wetlands in this subwatershed. The hydrology data identifies six impacted Carolina Bays though they are not identified by NC CREWS.



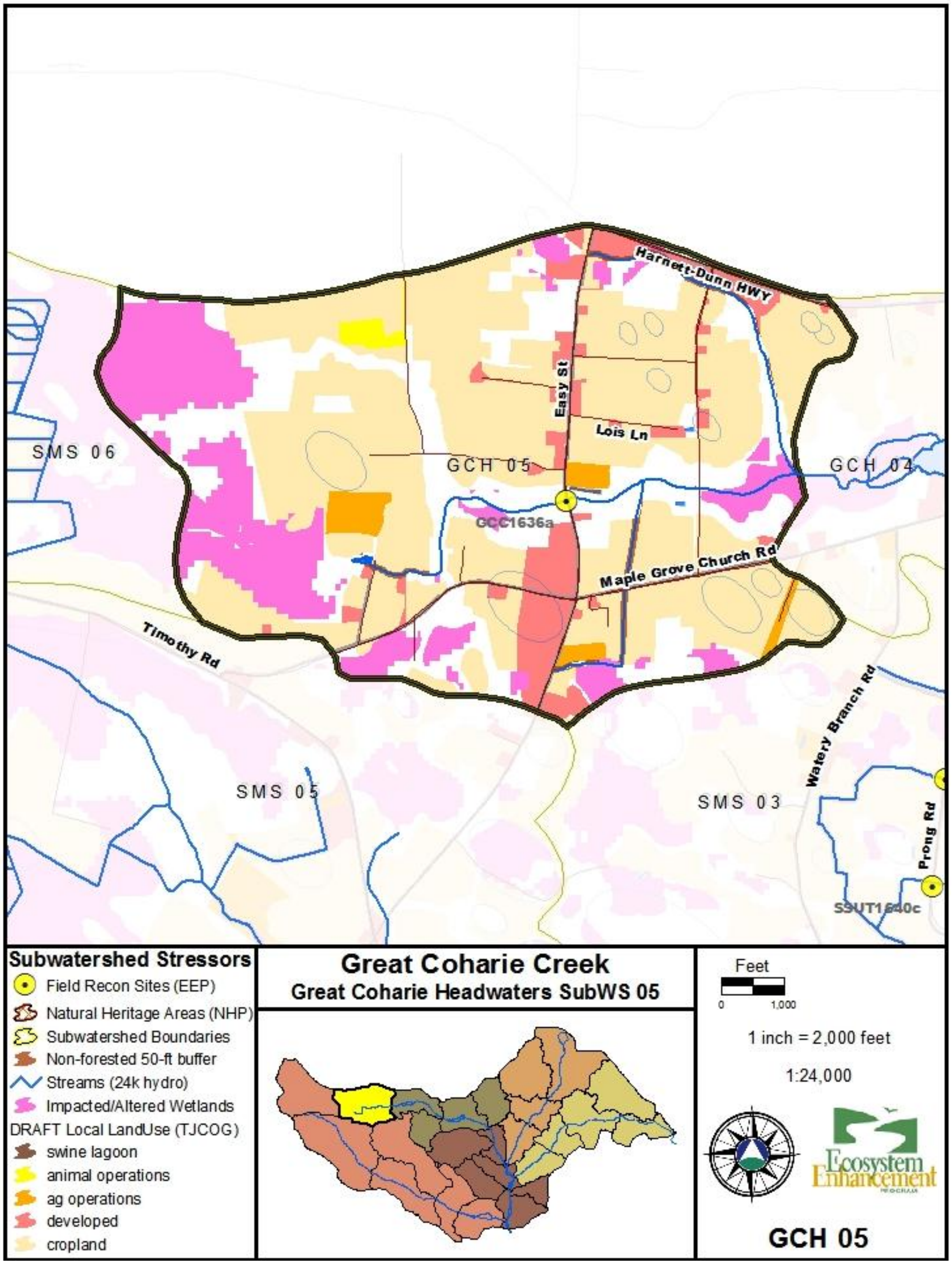
Great Coharie Creek Headwaters 04: Assets. This subwatershed contains the main stem of Great Coharie creek as well as Blackmans Pond. The stream is well buffered.



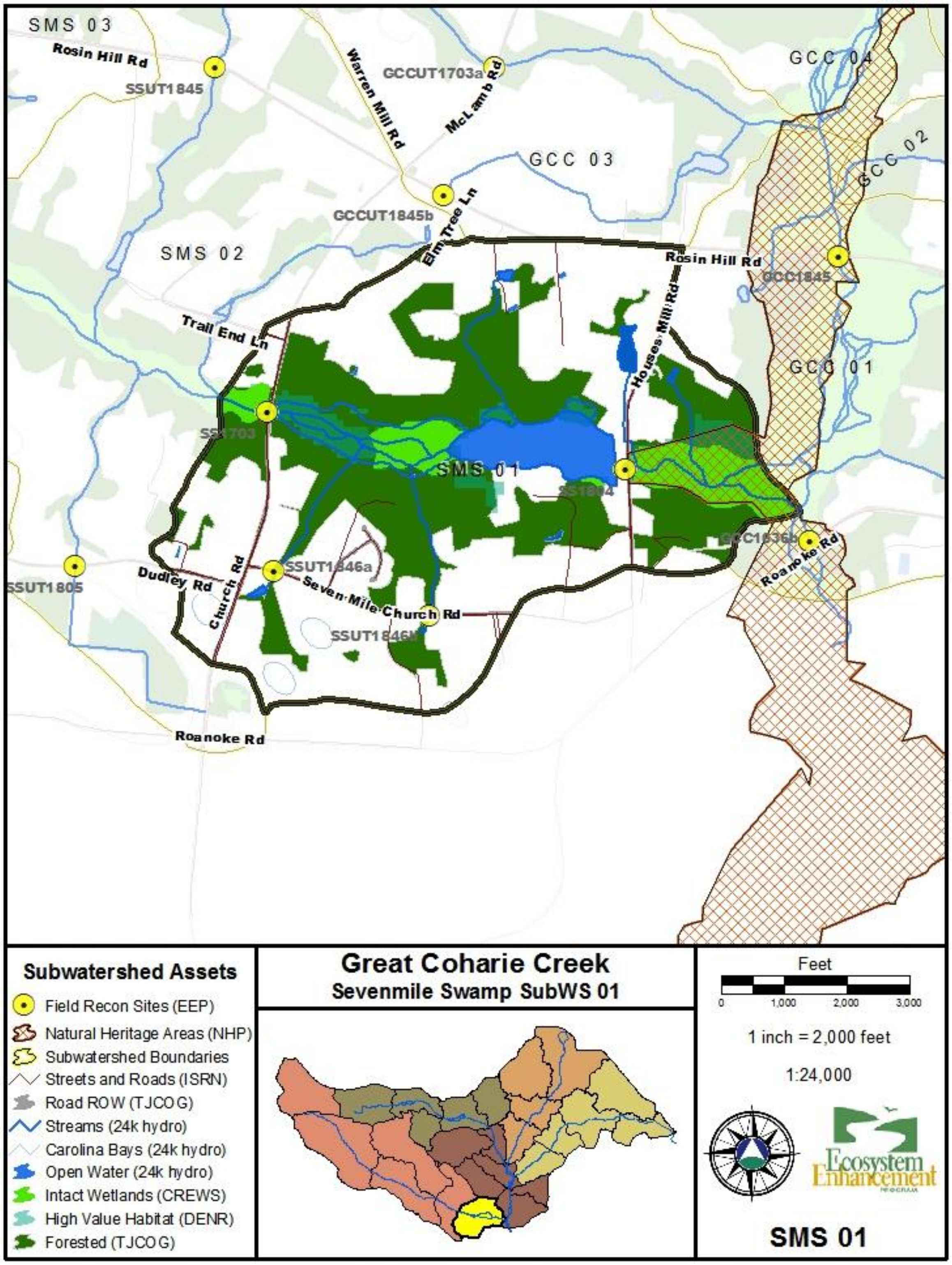
Great Coharie Creek Headwaters 04: Stressors. Land use is primarily cropland. There is a subdivision in this subwatershed.



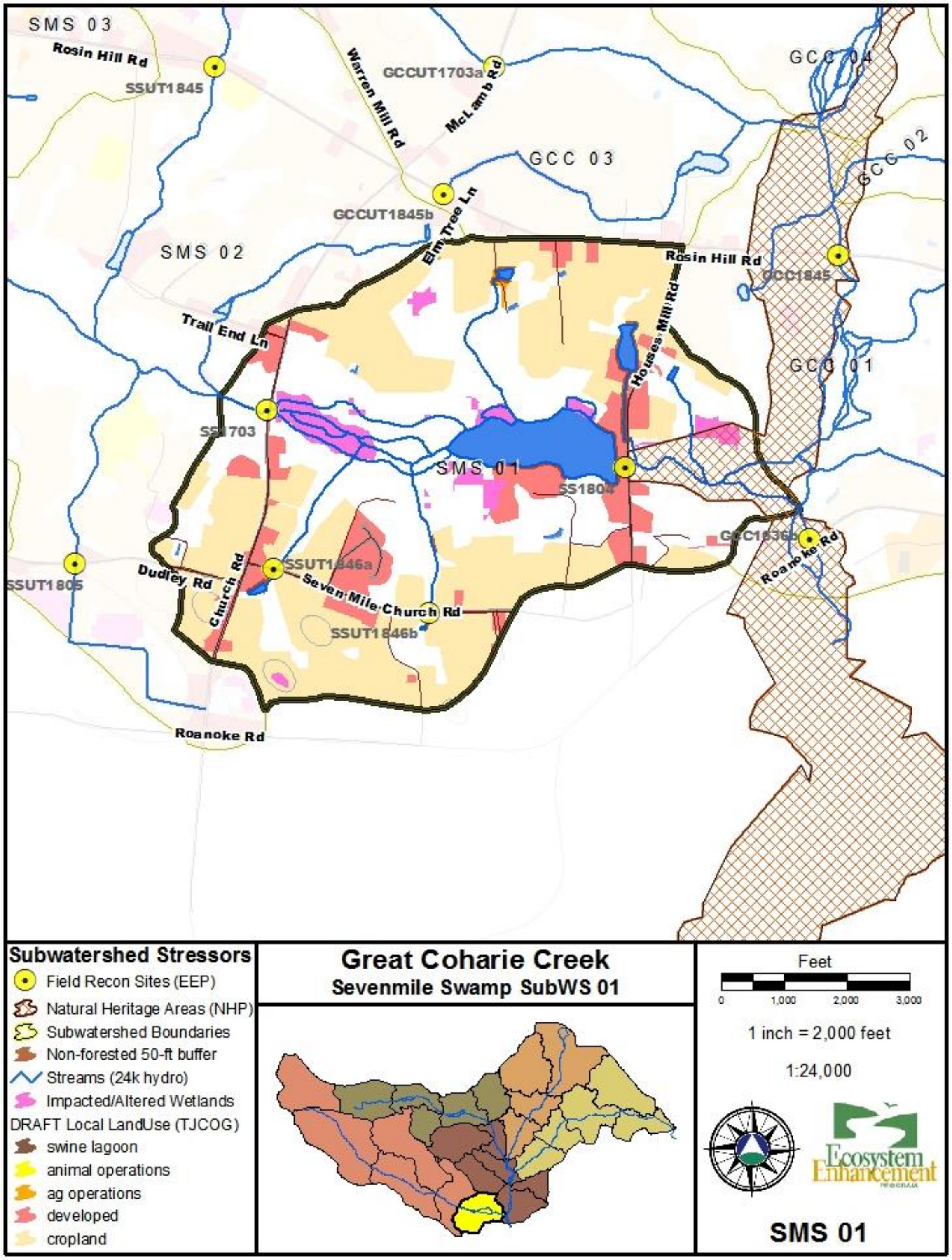
Great Coharie Creek Headwaters 05: Assets. This subwatershed contains the beginning of Great Coharie Creek as well as two small tributaries. Most of the streams are buffered though there are some opportunities for buffering in agricultural fields behind the development along NC 55.



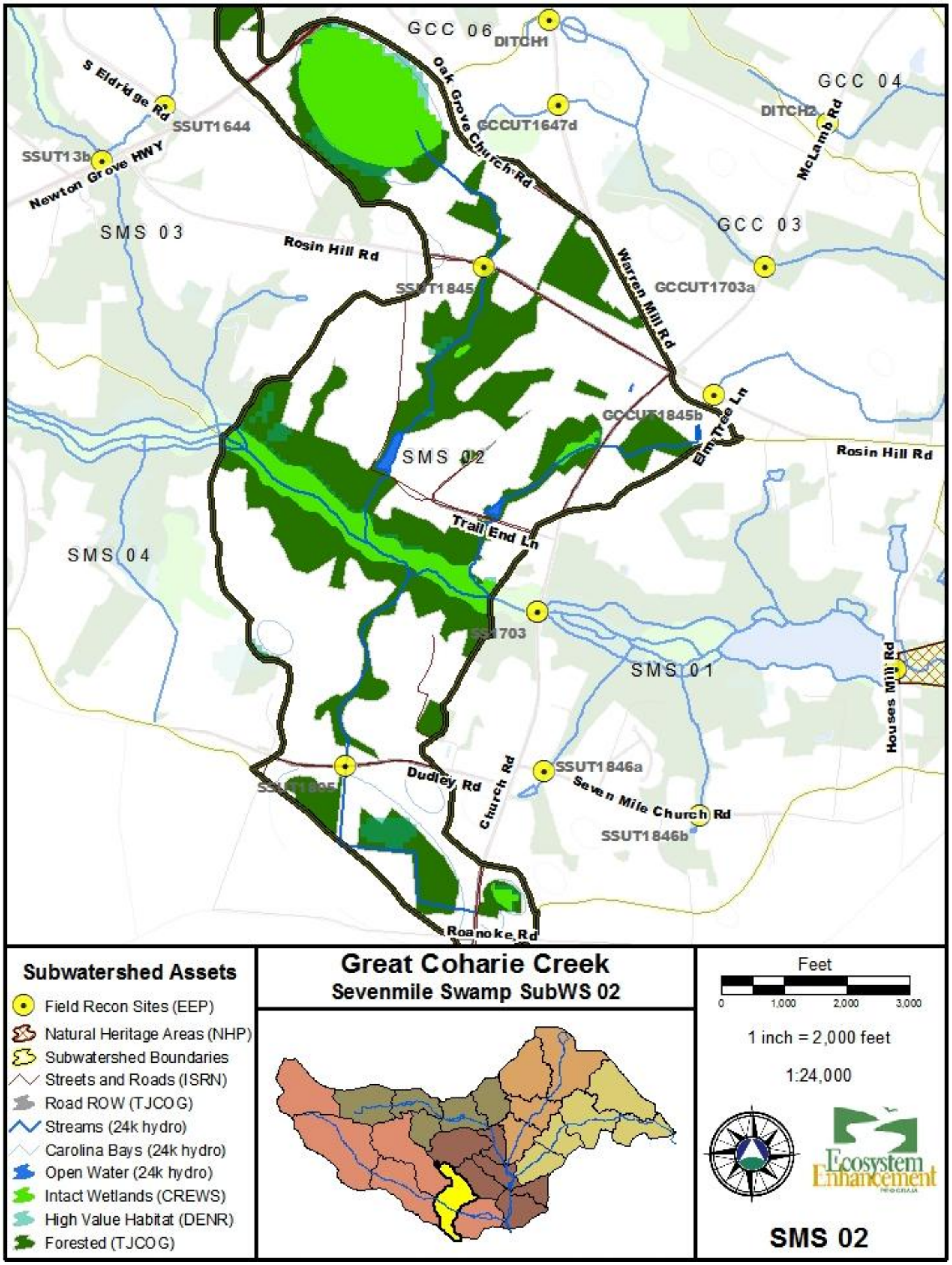
Great Coharie Creek Headwaters 05: Stressors. Forested wetlands exist on the western portion of the watershed though it appears they are ditched. The primary land use is cropland.



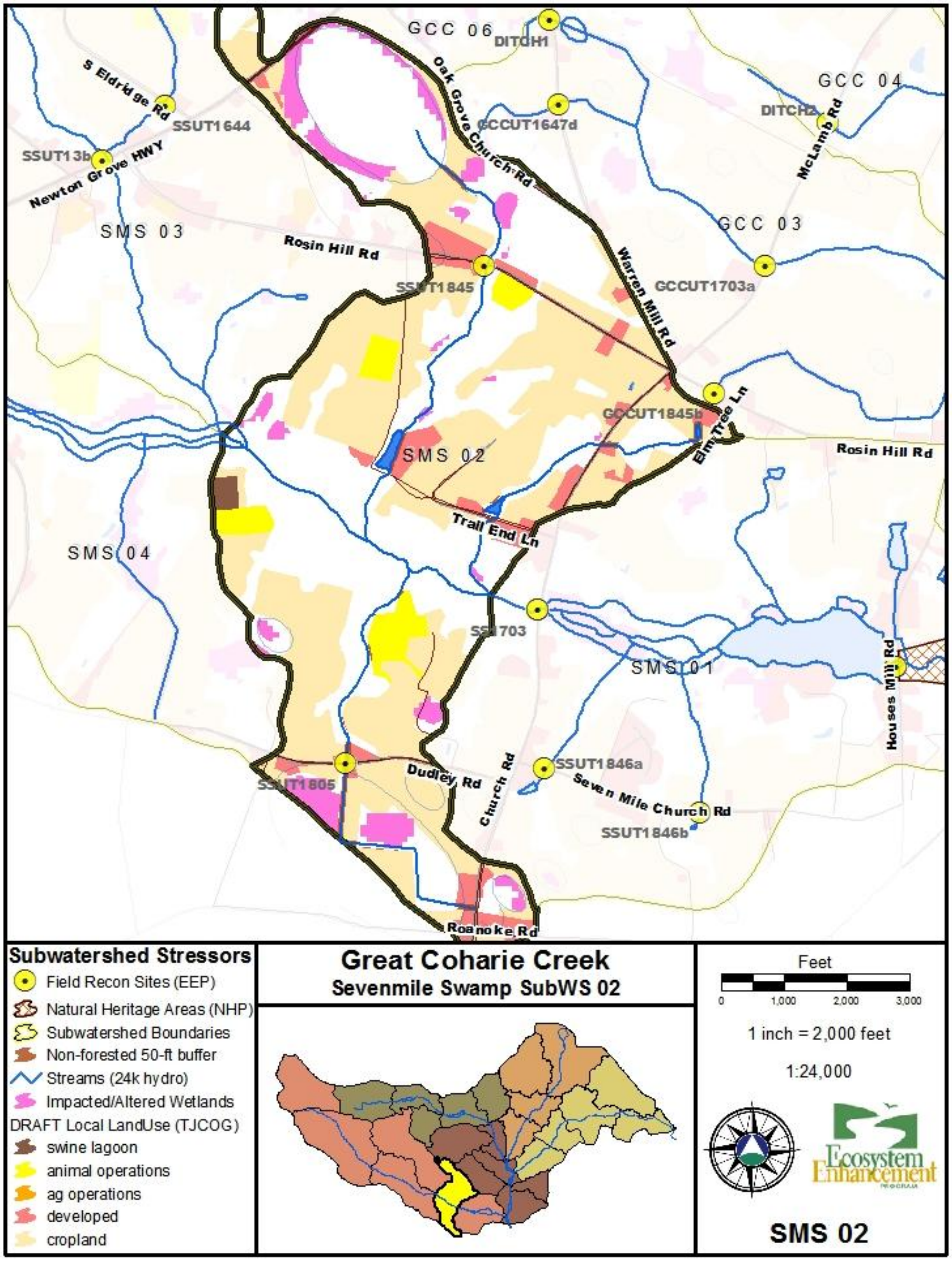
Seven Mile Swamp 01: Assets. This subwatershed contains the bottom portion of the main stem of Seven Mile Swamp along with five tributaries. The portion of the creek below Houses Mill Pond is designated as Significant Natural Heritage Area. Additional field work should be done to assess the habitat quality and preservation opportunities in this subwatershed.



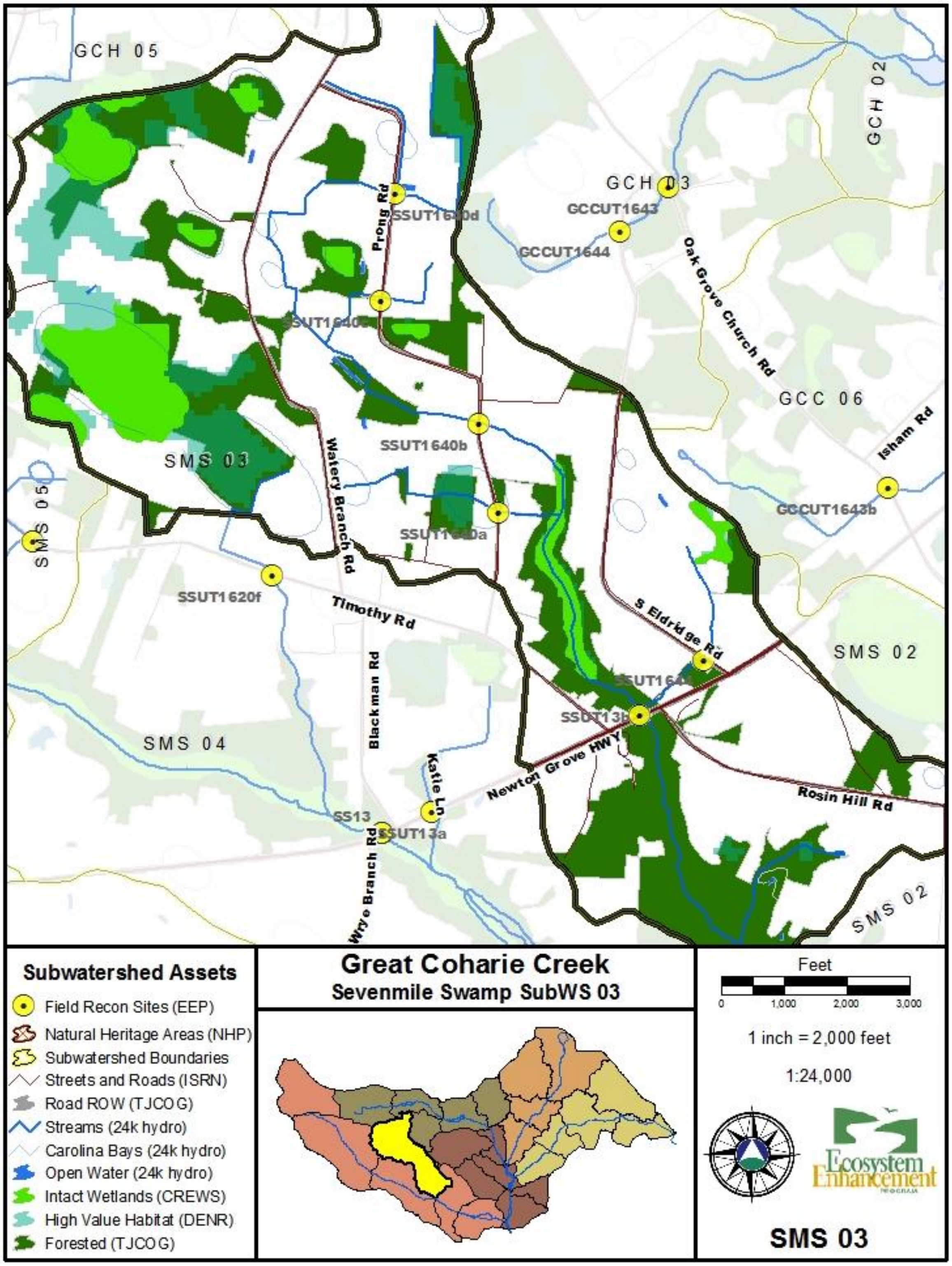
Seven Mile Swamp 01: Stressors. Above Houses Mill Pond is a large forested wetland with braided streams.



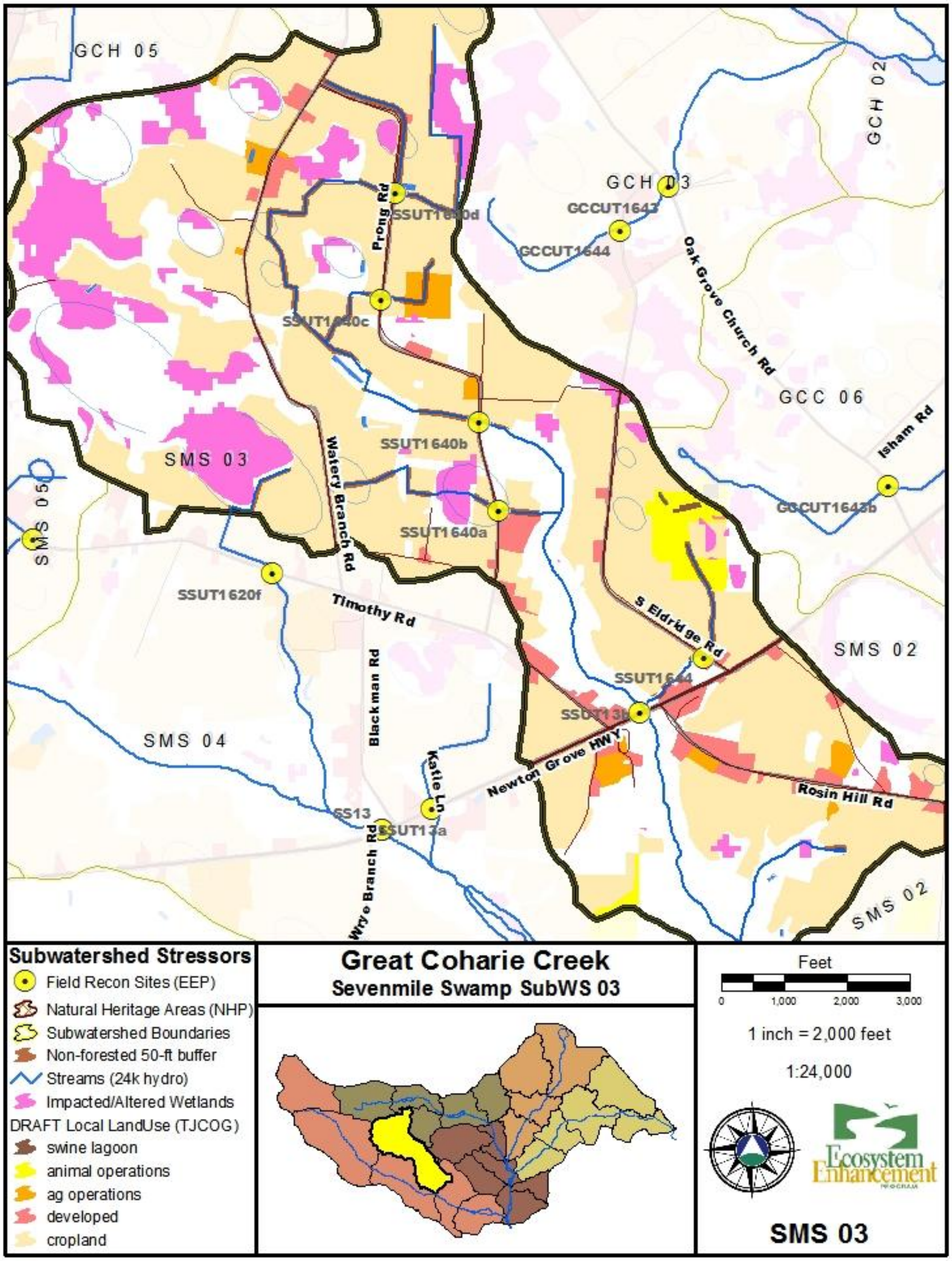
Seven Mile Swamp 02: Assets. This subwatershed contains a portion of the main stem and three tributaries. The streams are buffered in most cases. There is a large Carolina Bay on the north and south portions of the watershed. .



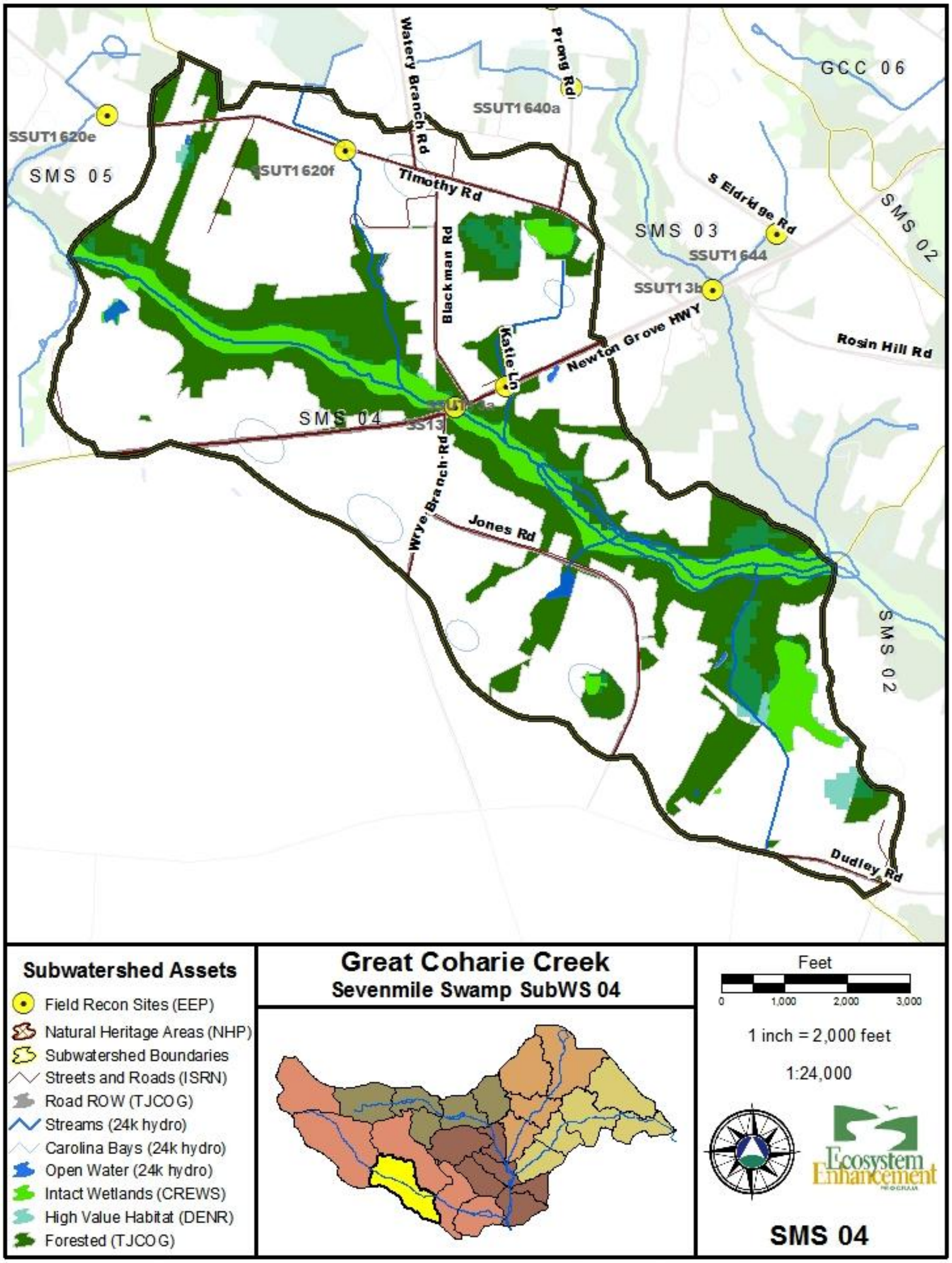
Seven Mile Swamp 02: Stressors. Several large farm operations occupy this watershed. None are near the blue line streams but may have some connection through a series of ditches. Both Carolina bays appear to be drained and in cultivation.



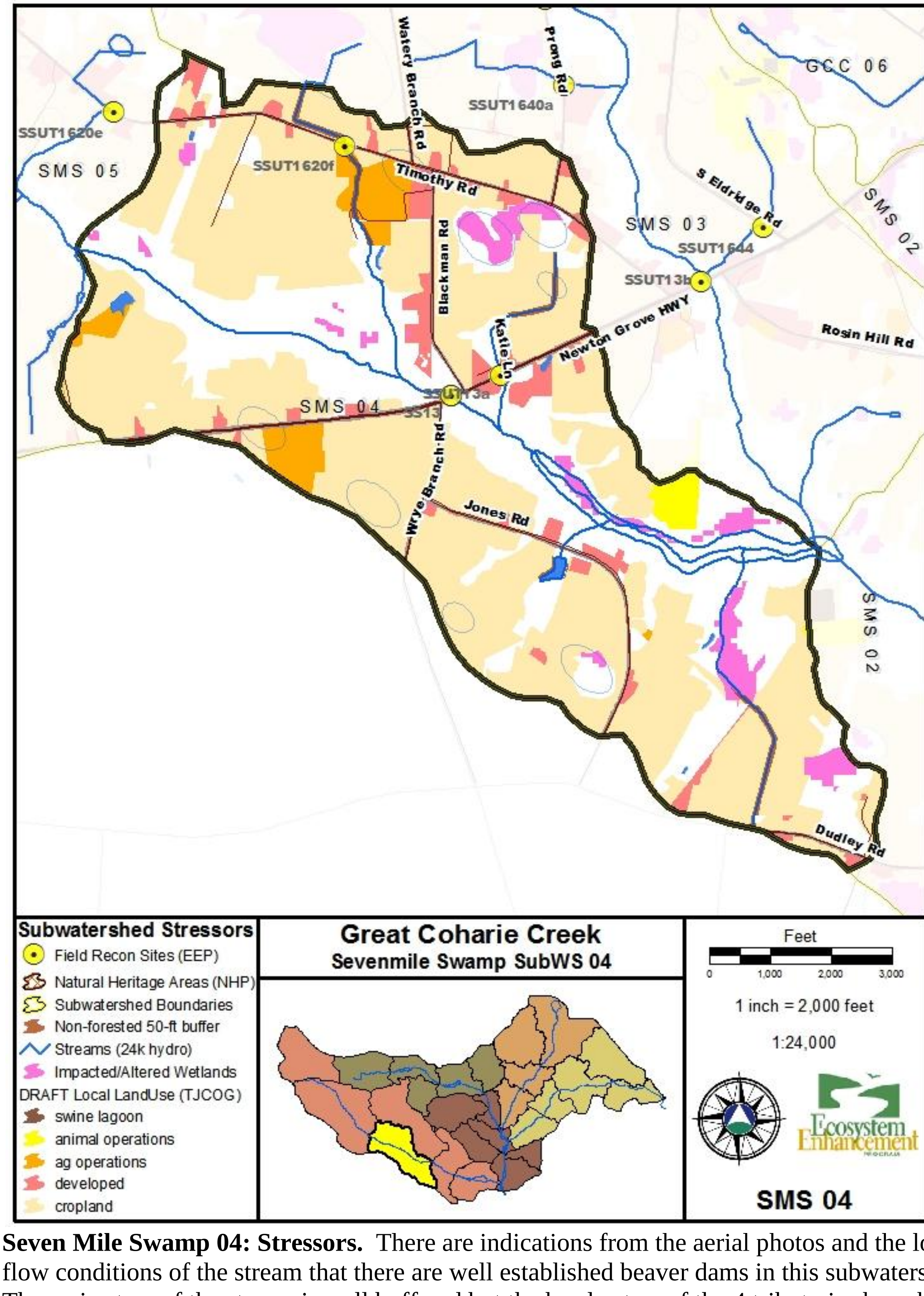
Seven Mile Swamp 03: Assets. This is the third largest subwatershed in the planning area and contains a tributary to Seven Mile Swamp that drains 3.5 square miles.



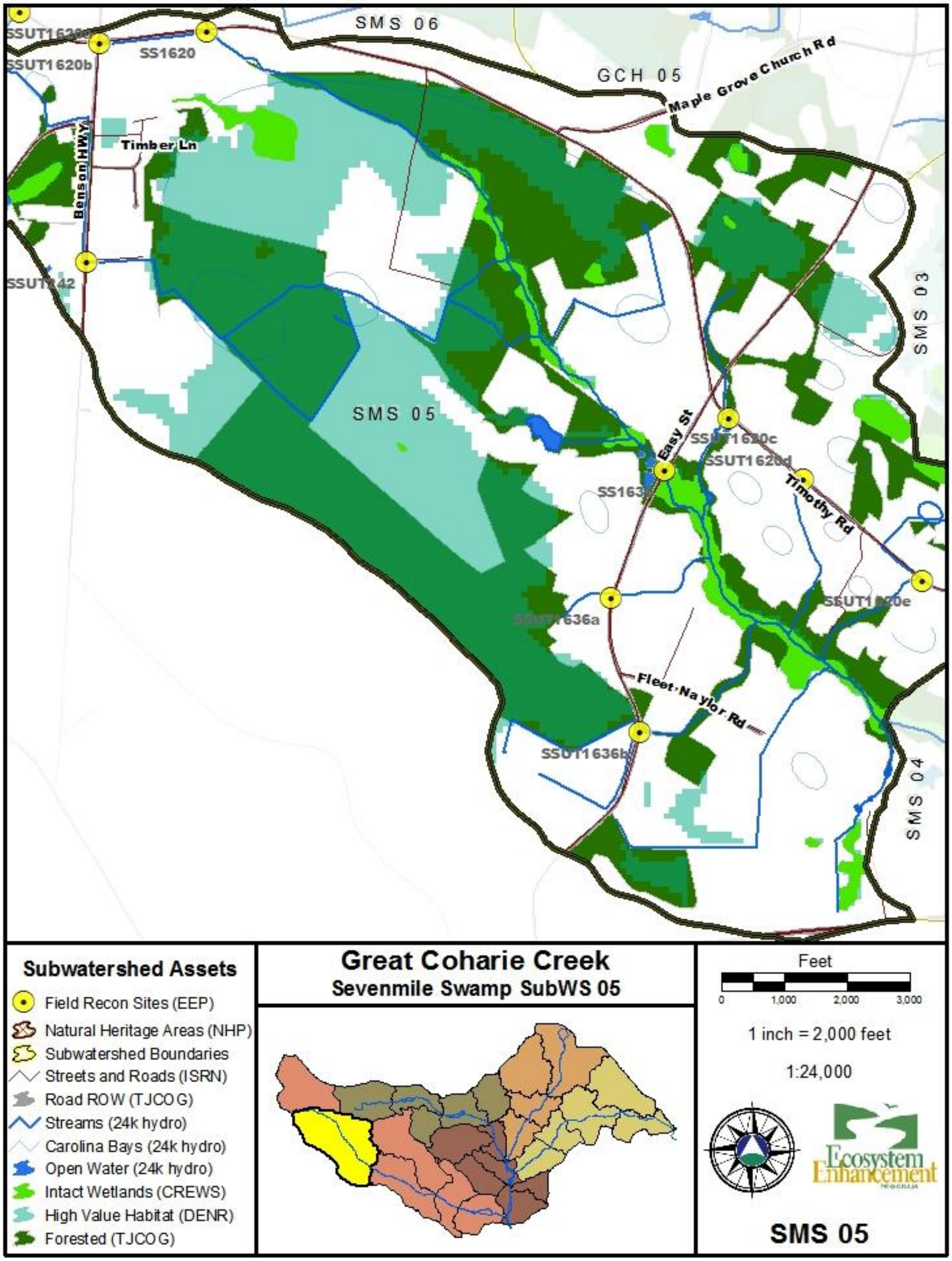
Seven Mile Swamp 03: Stressors. There is a smaller tributary that is not buffered and has two hog lagoons at the headwaters. The upper portions of the subwatershed contain a network of ditches and ditched streams as well as opportunity for wetland restoration. The channel contains decomposing vegetation, algae and silt substrate. Algae suggest an abundance of nutrients and silt suggests erosion from upstream.



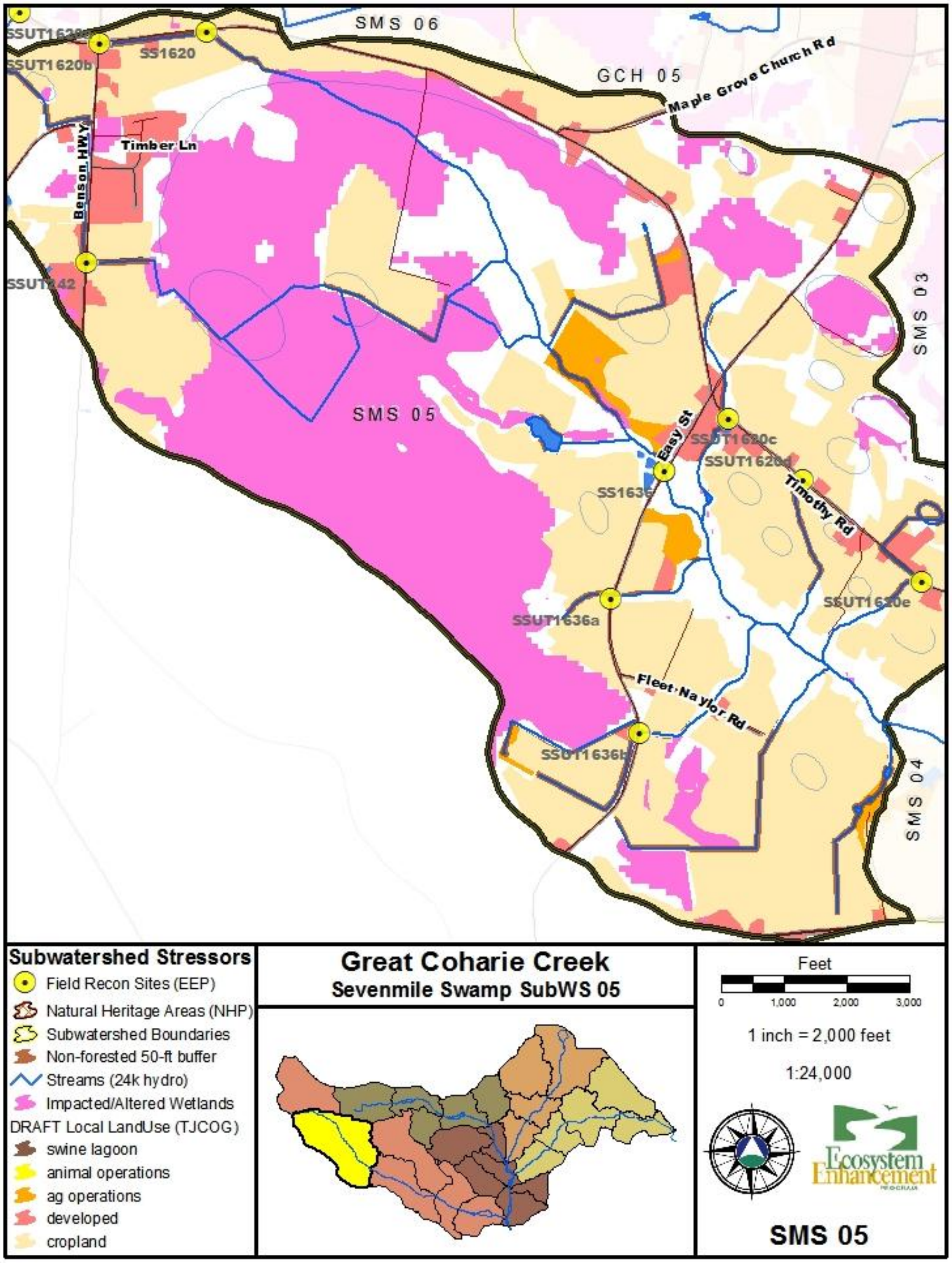
Seven Mile Swamp 04: Assets. This subwatershed contains the main stem of Seven Mile Swamp and 4 tributaries.



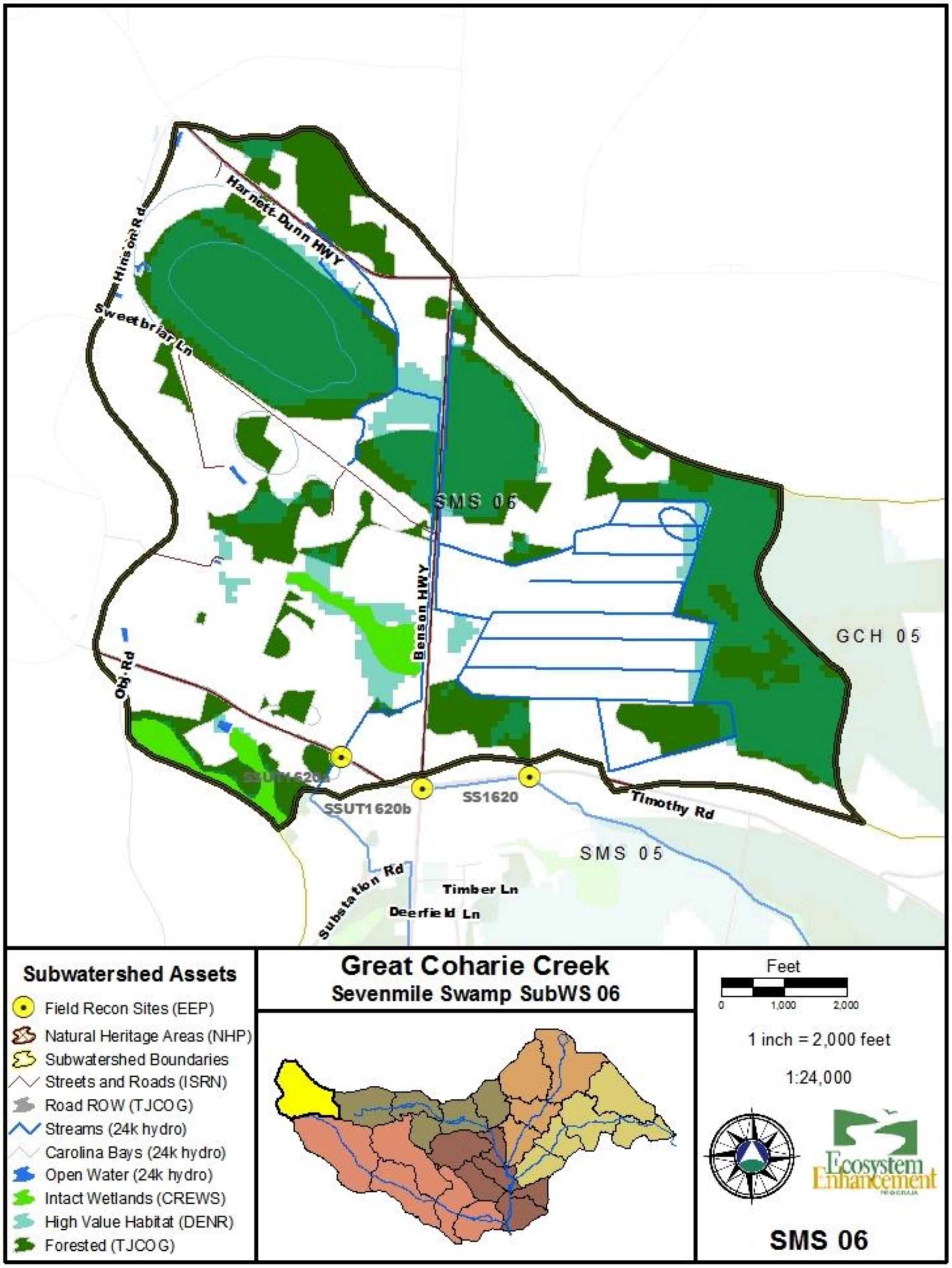
Seven Mile Swamp 04: Stressors. There are indications from the aerial photos and the low flow conditions of the stream that there are well established beaver dams in this subwatershed. The main stem of the stream is well buffered but the headwaters of the 4 tributaries have been ditched and are not buffered.



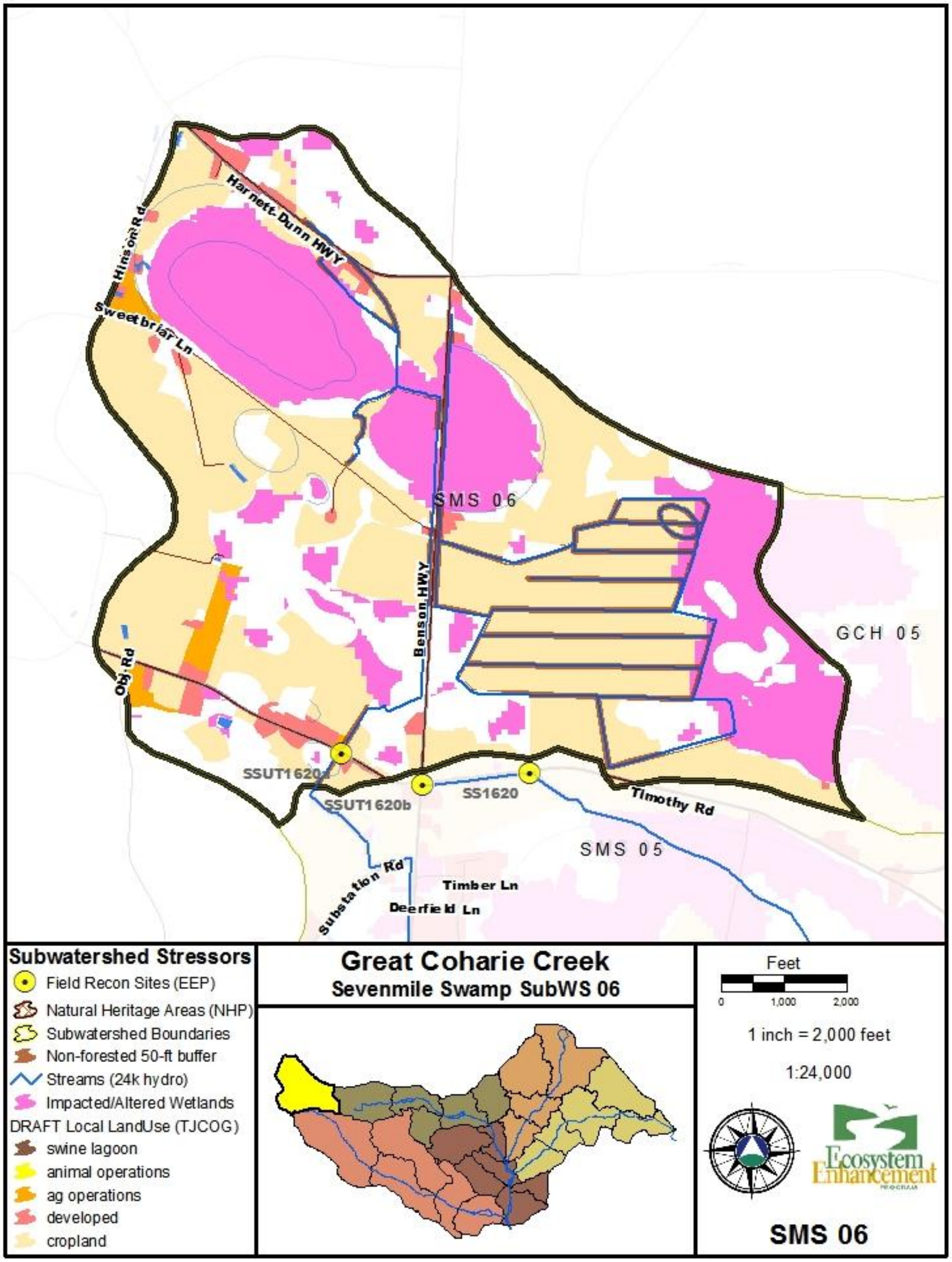
Seven Mile Swamp 05: Assets. This is the largest subwatershed in the planning area. It is 5 square miles, making up 9% of the planning area. It contains the headwaters of Seven Mile Swamp, 10 tributaries and a complex system of drainage ditches.



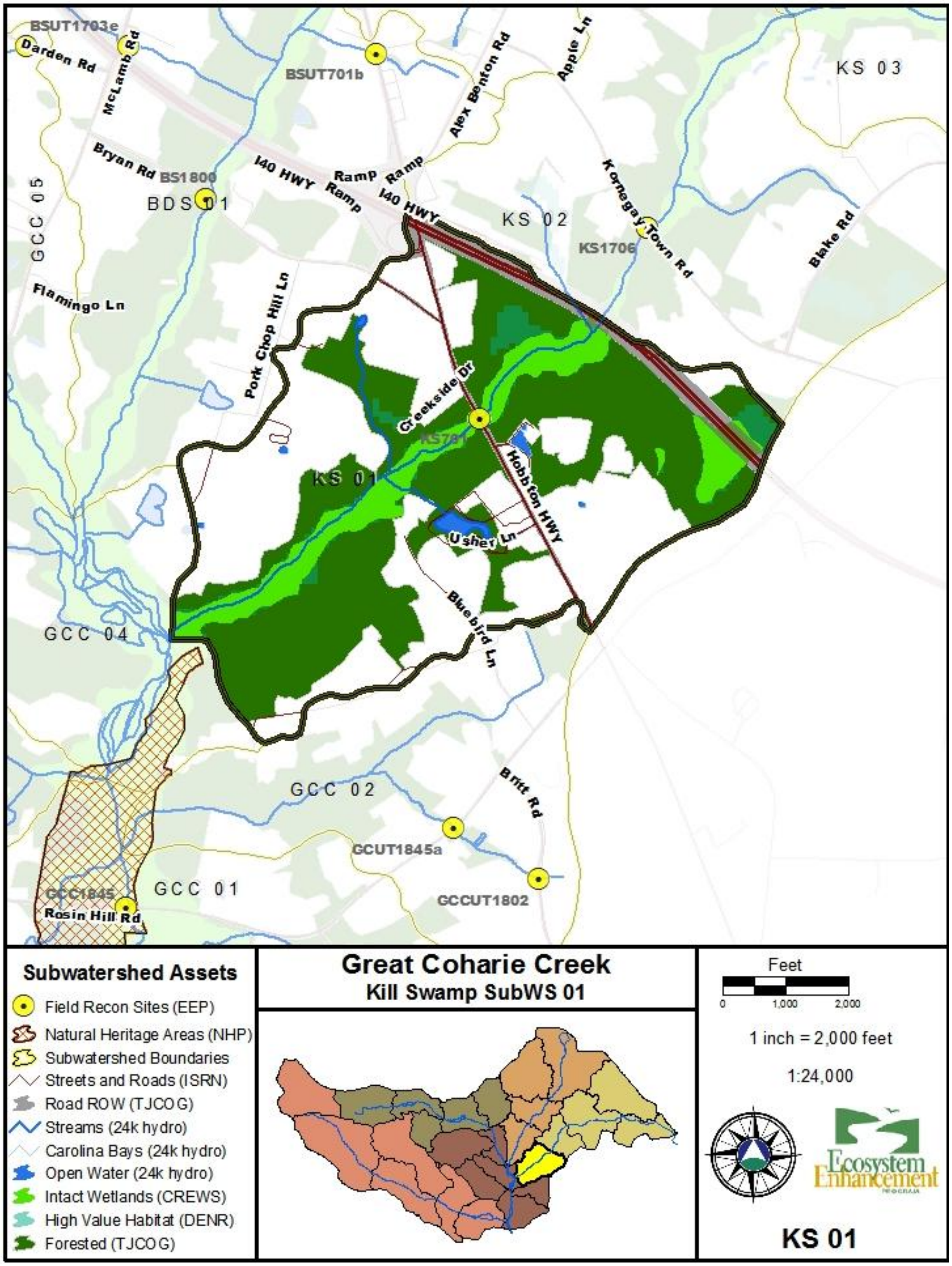
Seven Mile Swamp 05: Stressors. Roughly 25% of the subwatershed appears to have been a Carolina Bay that was identified as high value habitat. Small portions are under conservation easements by Fish and Wildlife while the rest is in managed timber or cropland. Fifty percent of the streams are not buffered. Fifty-seven percent of the subwatershed has hydric A soils.



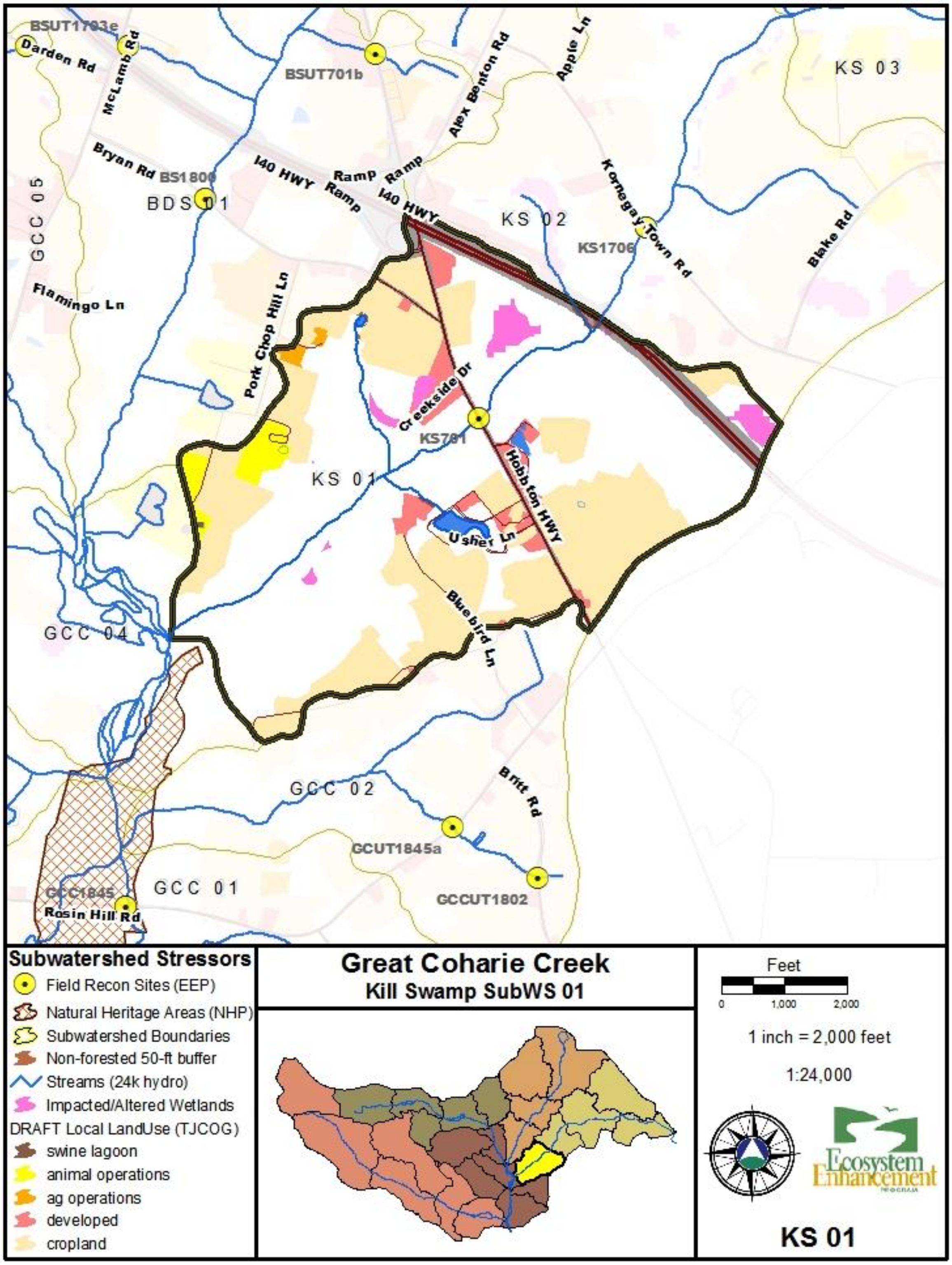
Seven Mile Swamp 06: Assets. The headwaters of Seven Mile Swamp begin in a small patch of forest at Hwy 242. The remainder of the subwatershed is a complex set of drainage ditches that has connected the hydrology to Seven Mile Swamp via ditches that connect in Seven Mile Swamp 05. None of this subwatershed is in the 100 year flood plain.



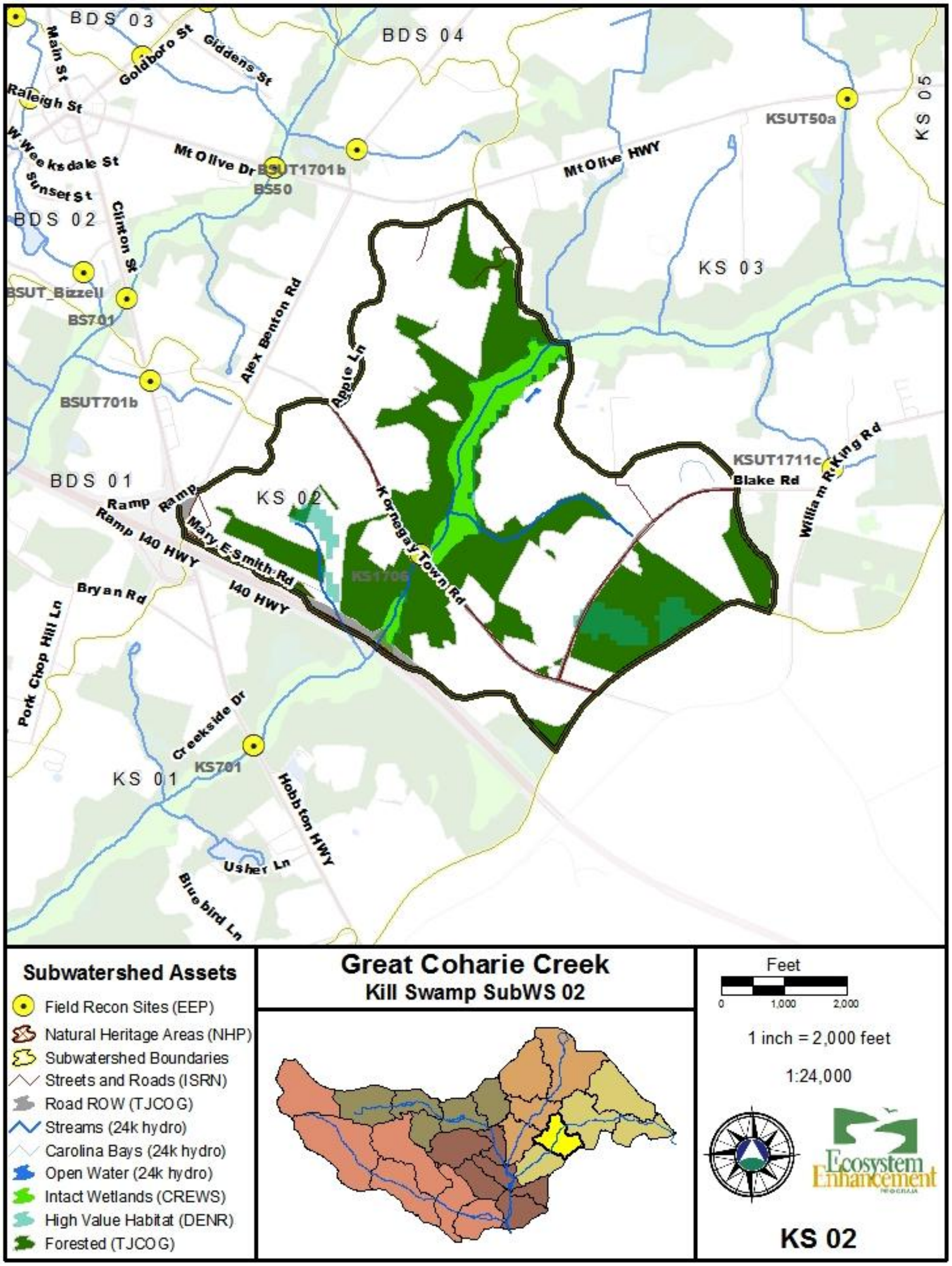
Seven Mile Swamp 06: Stressors. Sixty-six percent of the soils are hydric A. Approximately 30% of the watershed has been identified as high value wetland habitat and half of those have been altered. The uniform series of ditches appear to be bringing water onto the land.



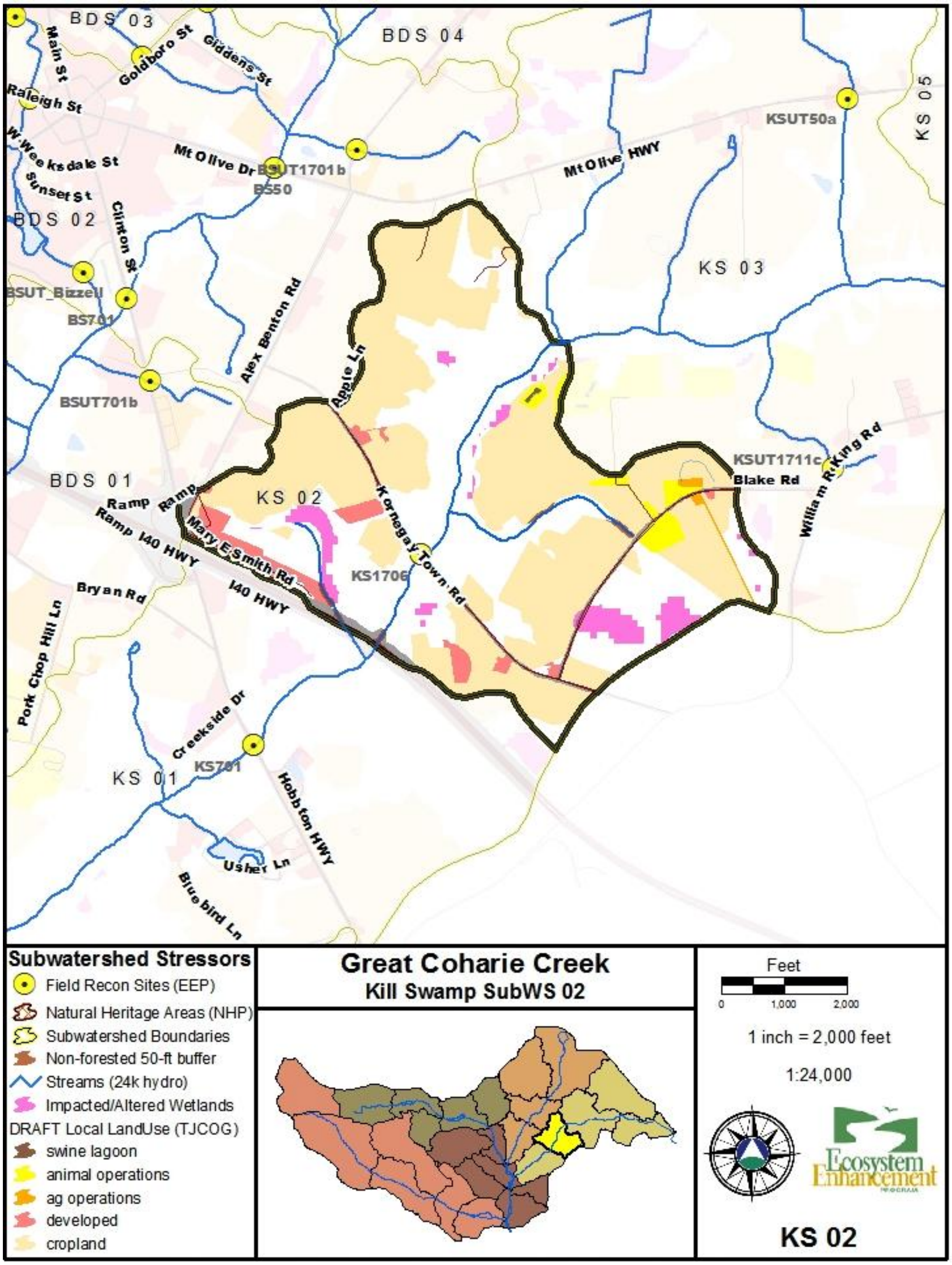
Kill Swamp 01: Assets. This subwatershed contains the bottom of Kill Swamp just before it drains into Great Coharie Creek. Fifty percent of this watershed is forested. More than 90% of the buffer is unimpacted. Efforts should continue to preserve these forested areas.



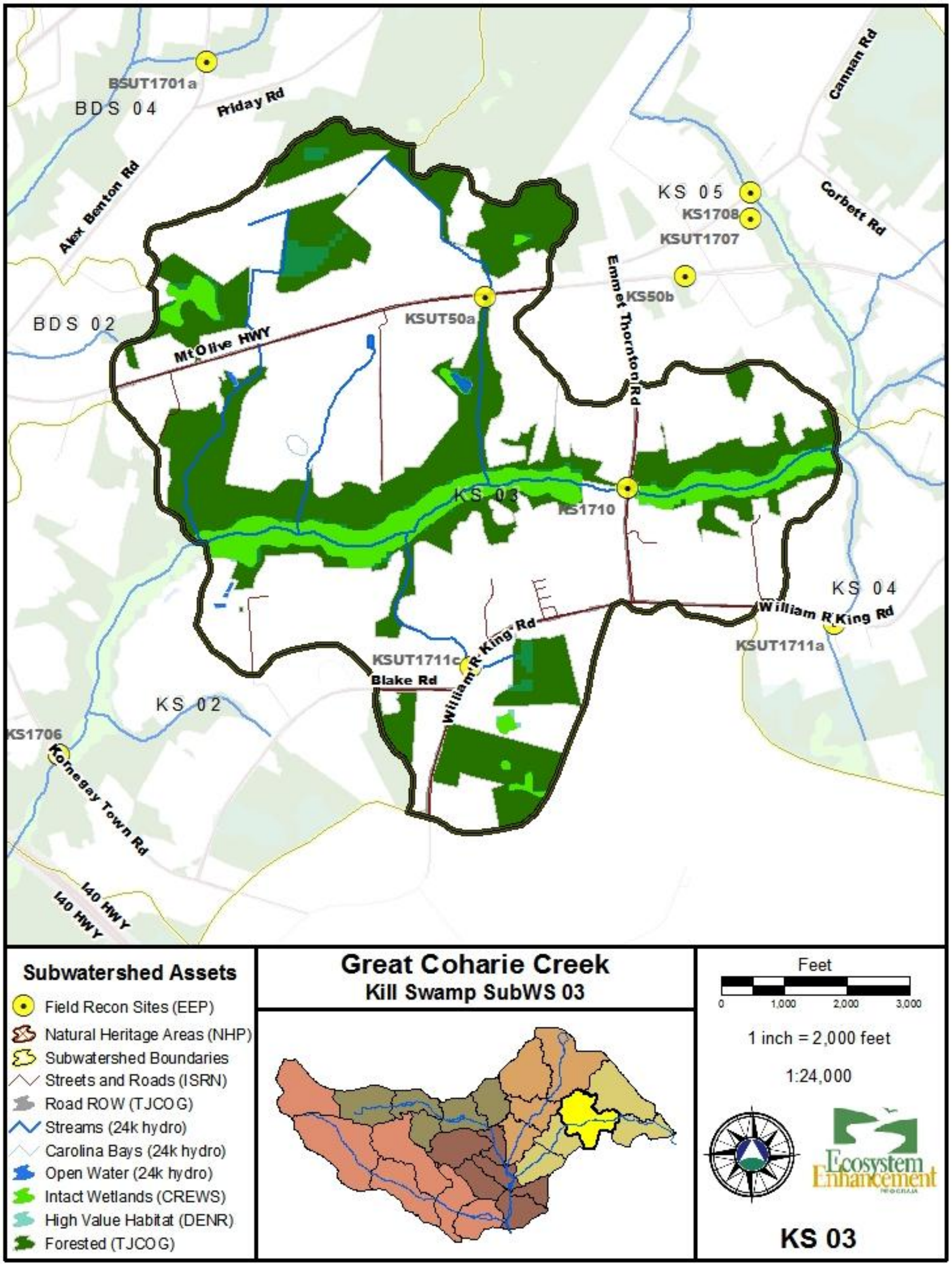
Kill Swamp 01: Stressors. The primary land use in this subwatershed is cropland. There are two small tributaries that are not as well buffered and are fed by headwater farm ponds.



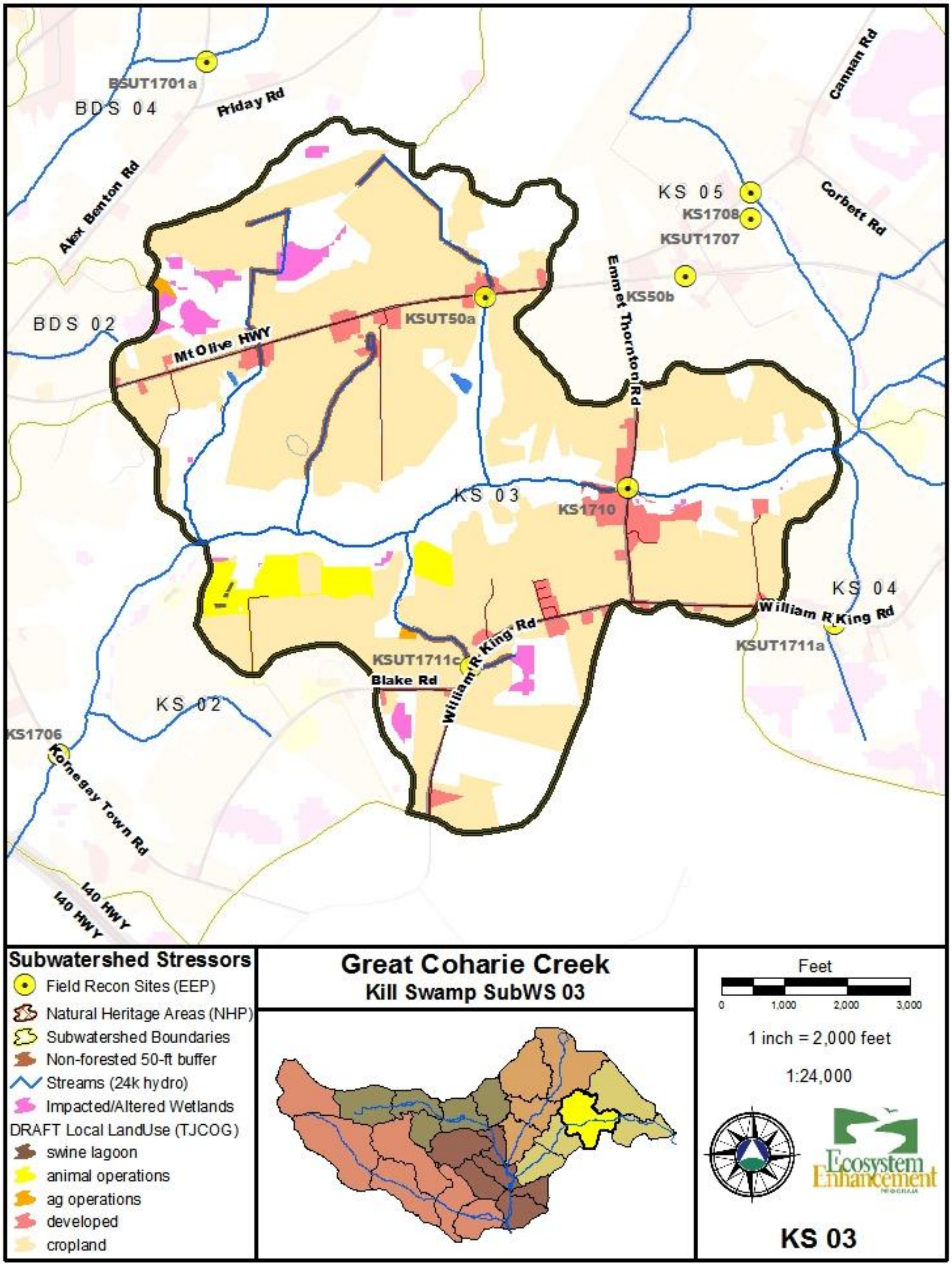
Kill Swamp 02: Assets. This subwatershed contains the main channel of Kill Swamp and two tributaries. The primary land use is cropland with 36% of the land being forested. The main stem of Kill Swamp is buffered. This may be due to the fact that 19% of the land area in this subwatershed is in the 100 year floodplain.



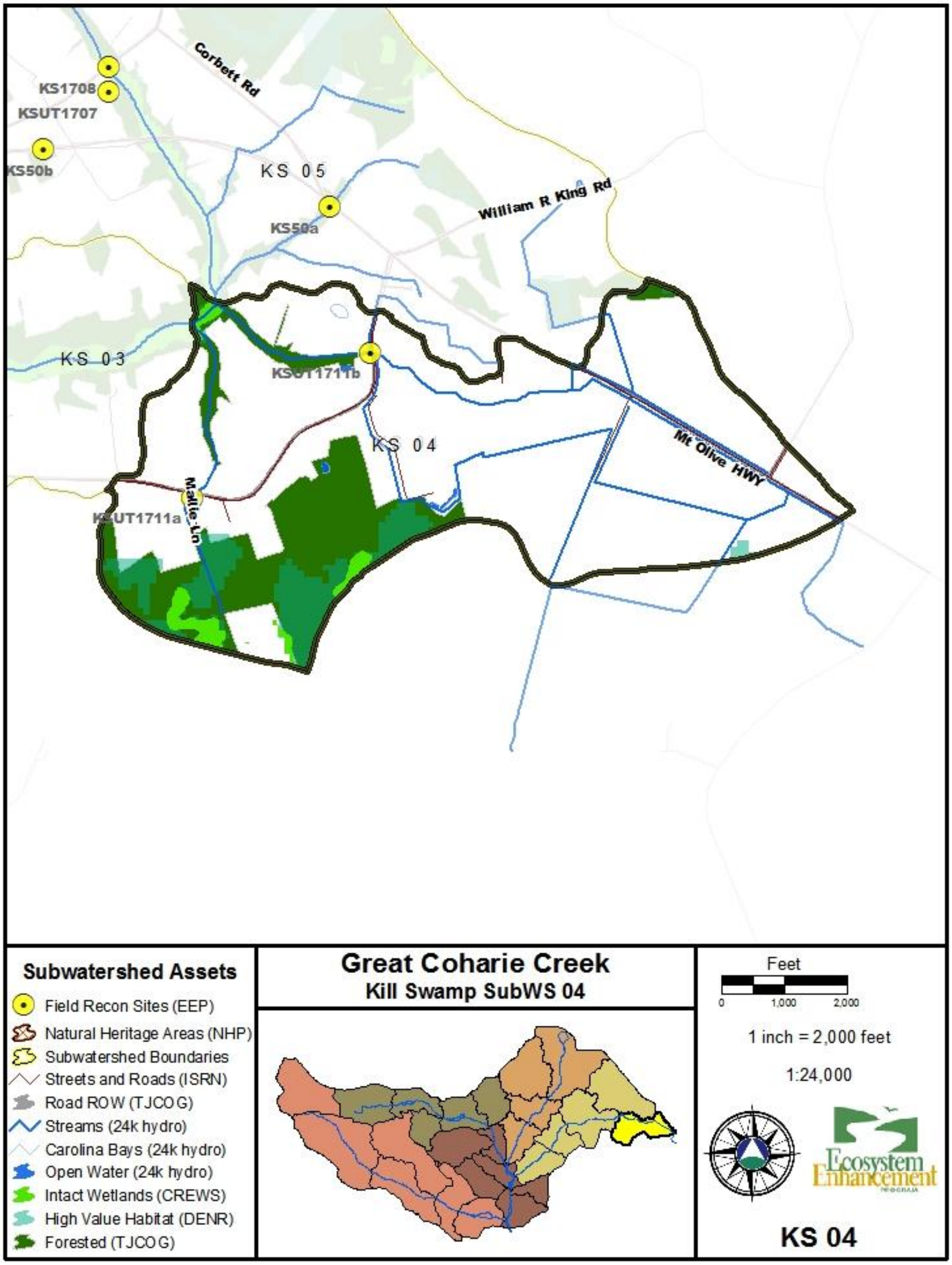
Kill Swamp 02: Stressors. One of the tributaries is not buffered on one side and the other appears to have been timbered in recent years. Focus on buffering the two tributaries is recommended.



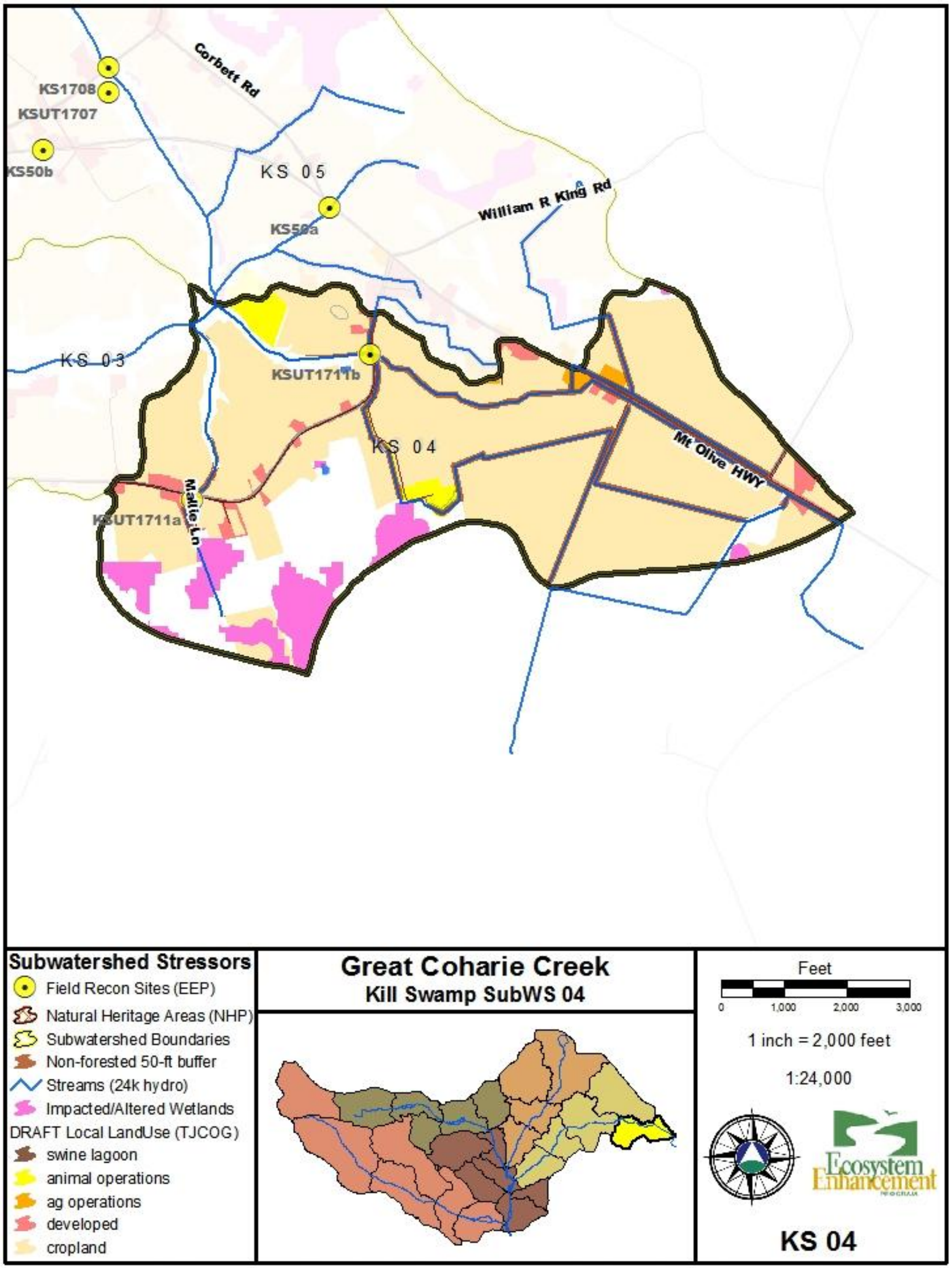
Kill Swamp 03: Assets. This subwatershed contains the main stem of Kill swamp along with 4 tributaries. The land use is typical to the planning area. A portion of the main stem of Kill Swamp, near Emmet Thornton Road, is impacted by pasture and ponds. Two of the tributaries are connected to field ditches in the headwaters and are somewhat buffered.



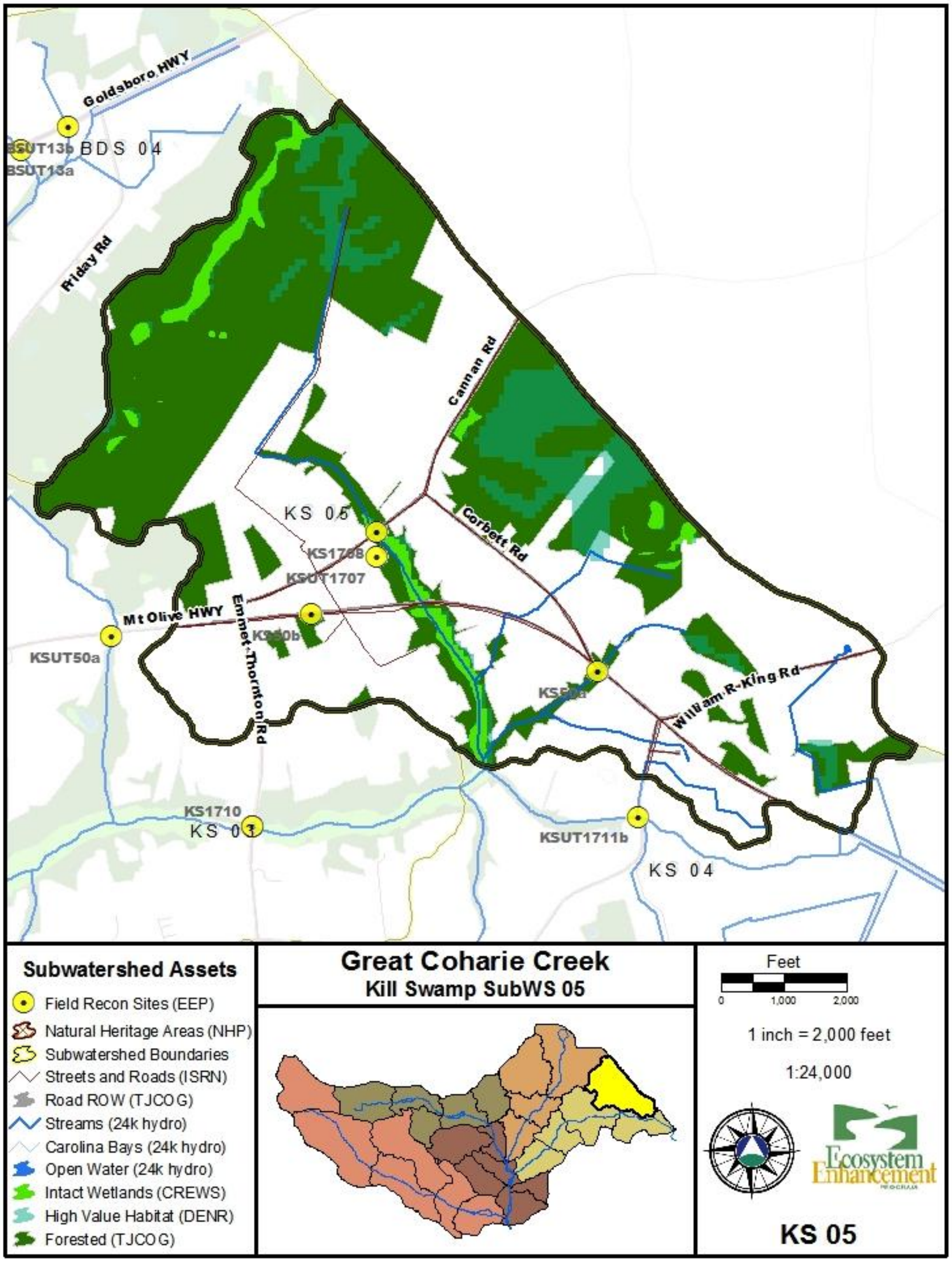
Kill Swamp 03: Stressors. Two tributaries are not buffered and run through agricultural fields. A beaver dam was sighted near Emmet Thornton Road. The stream substrate is silt and detritus and there is a filamentous algae.



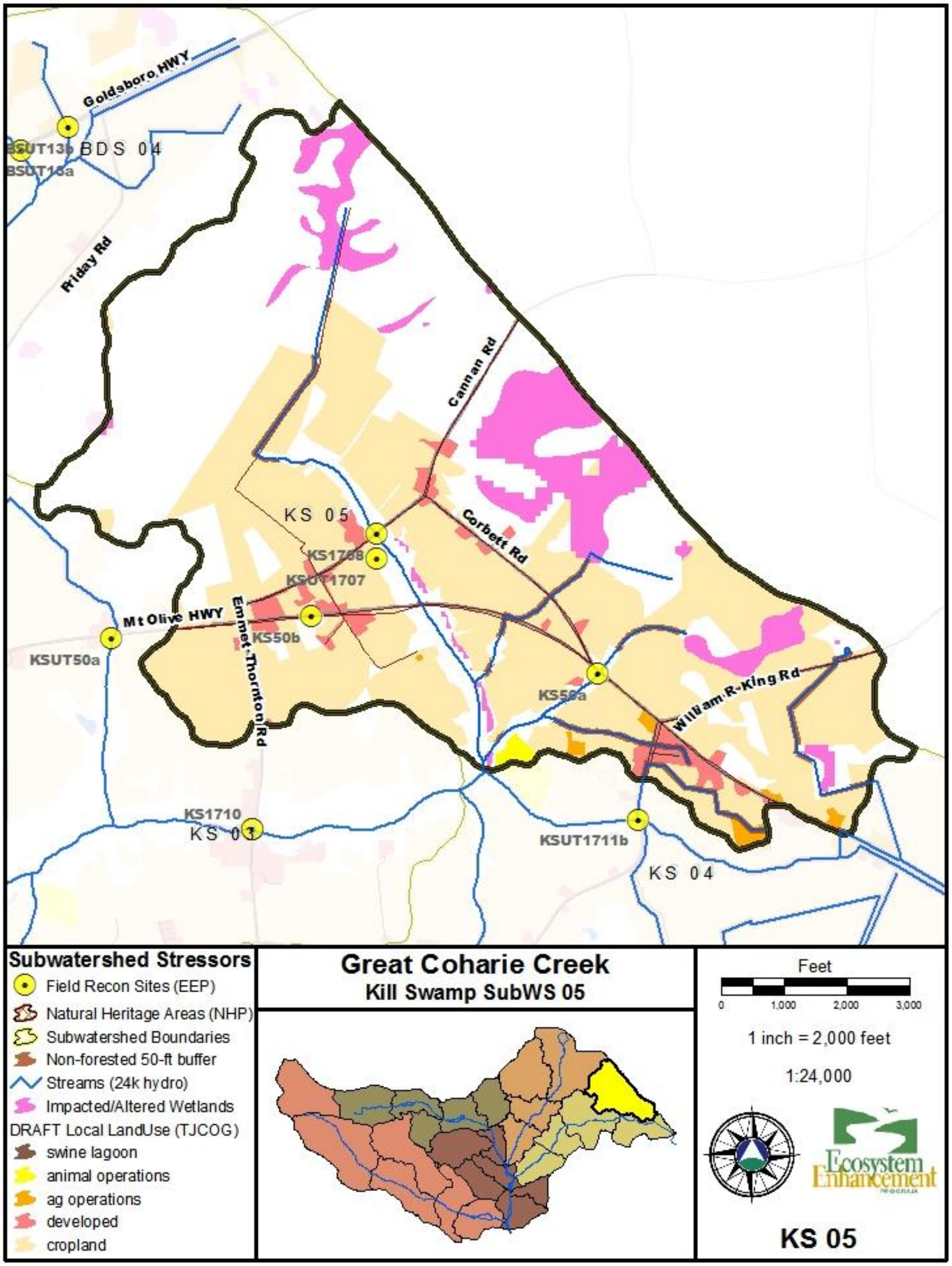
Kill Swamp 04: Assets. This is the headwaters of Kill Swamp including 3 tributaries and a series of drainage ditches. Only 18% of the streams are buffered. Except for a forested area in the southwest portion of the subwatershed, the land use is cropland, homes and other agricultural operations.



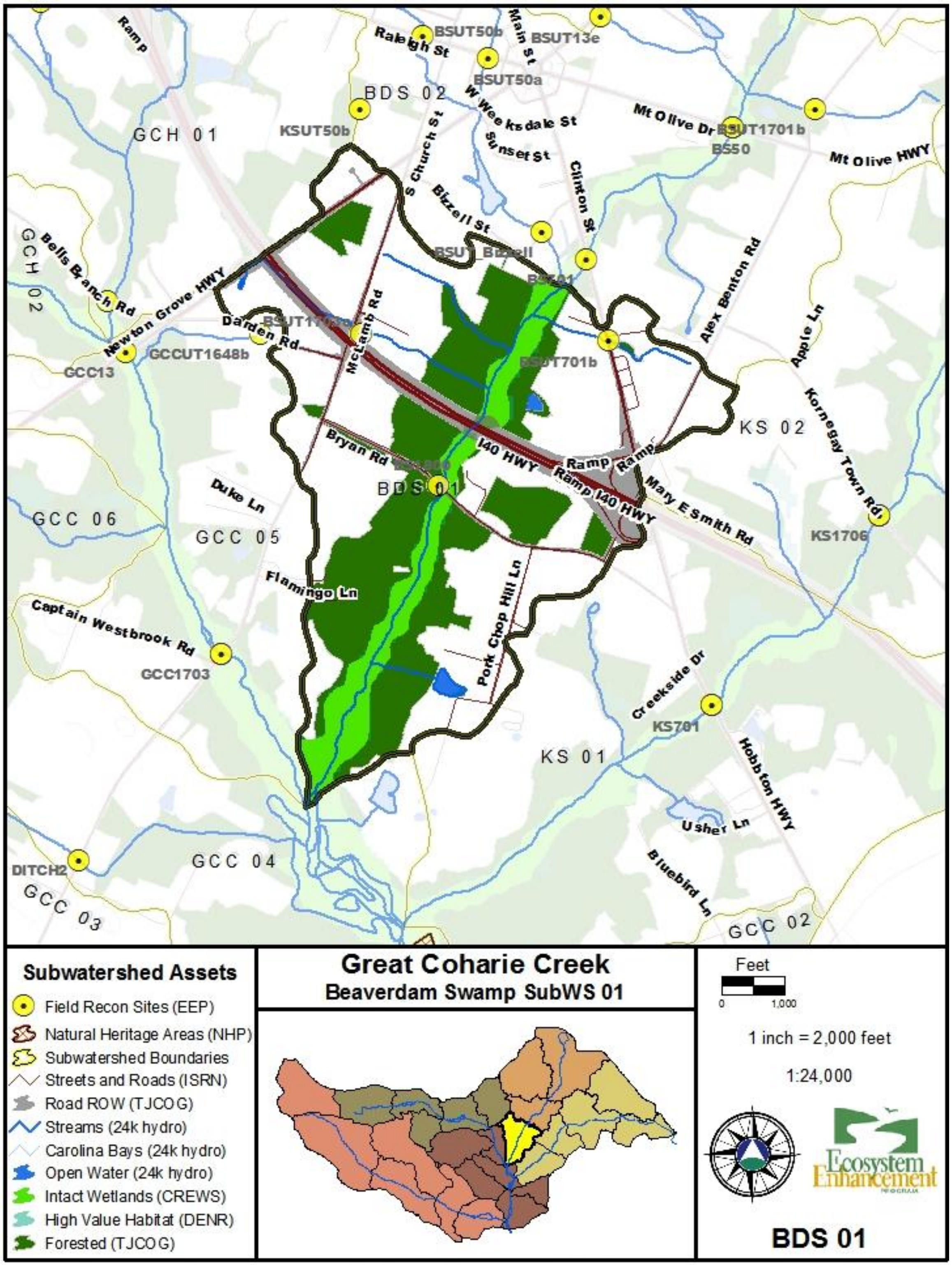
Kill Swamp 04: Stressors. There are a significant number of ditches on the east side of the subwatershed that drain cropland and feed into Kill Swamp. Meter readings in the stream that receives the ditches showed very high conductance. More study needs to be done to determine the pollutant type. Stream restoration and BMPs are highly recommended in this watershed.



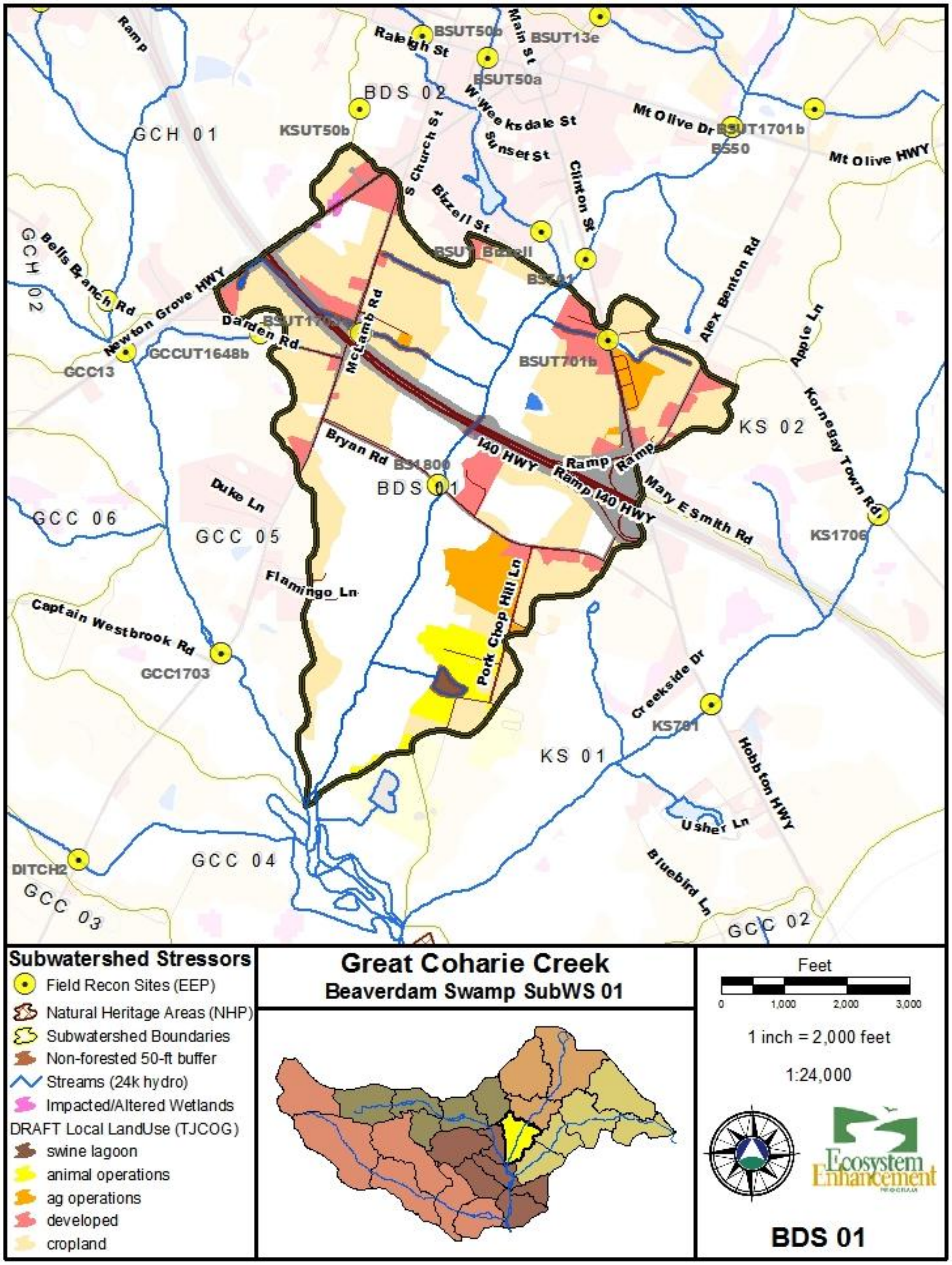
Kill Swamp 05: Assets. This subwatershed contains a series of tributaries and ditches that feed the headwaters of Kill Swamp. In some cases the hydrology between this subwatershed and Kill Swamp 04 are unclear due to the ditch system.



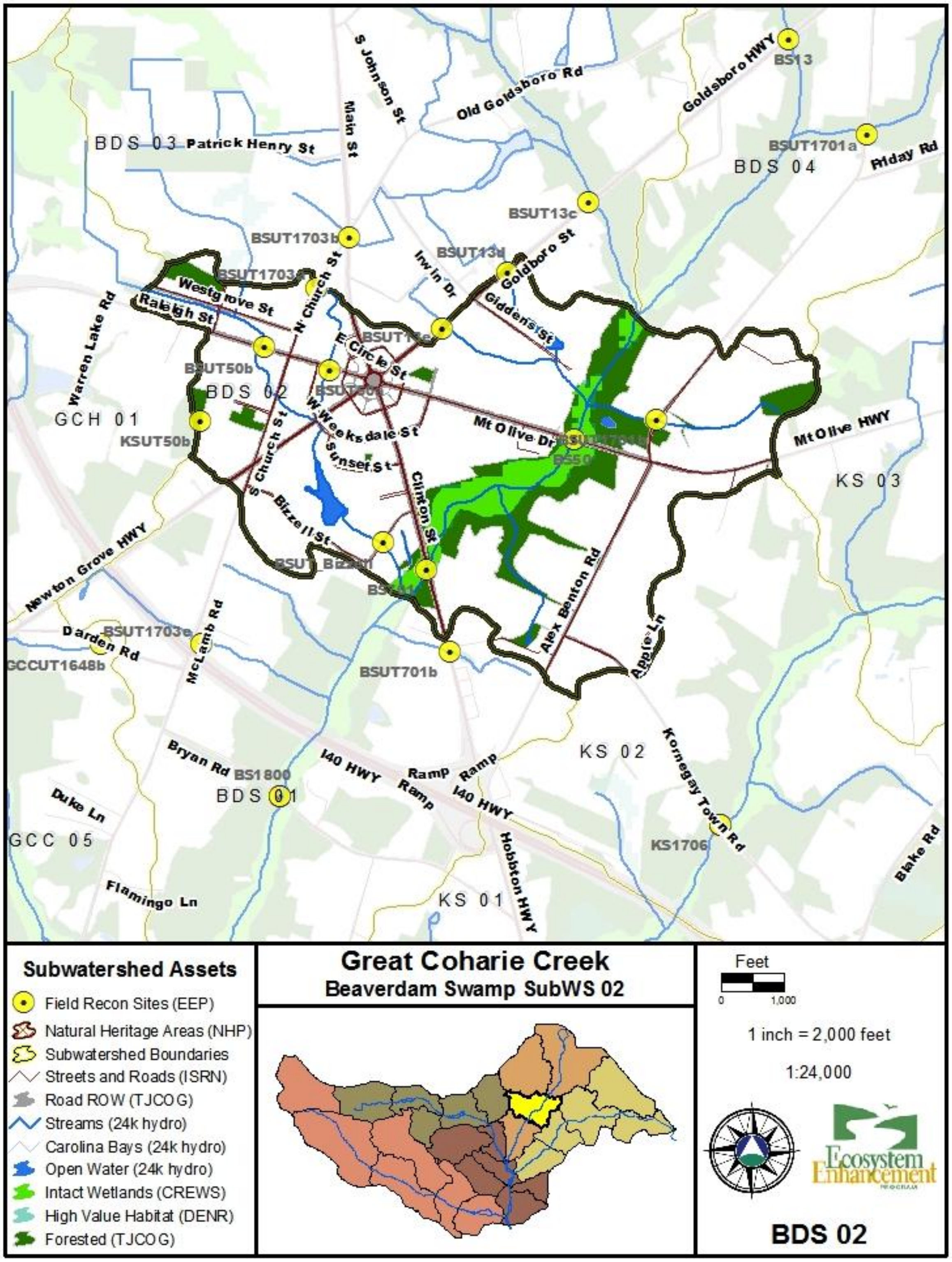
Kill Swamp 05: Stressors. Almost half the watershed is forested but most of that is not hydrologically connected to Kill Swamp except through ditches. Half of the mapped streams are not buffered. There is a potential for stream, wetland restoration and BMPs in this watershed.



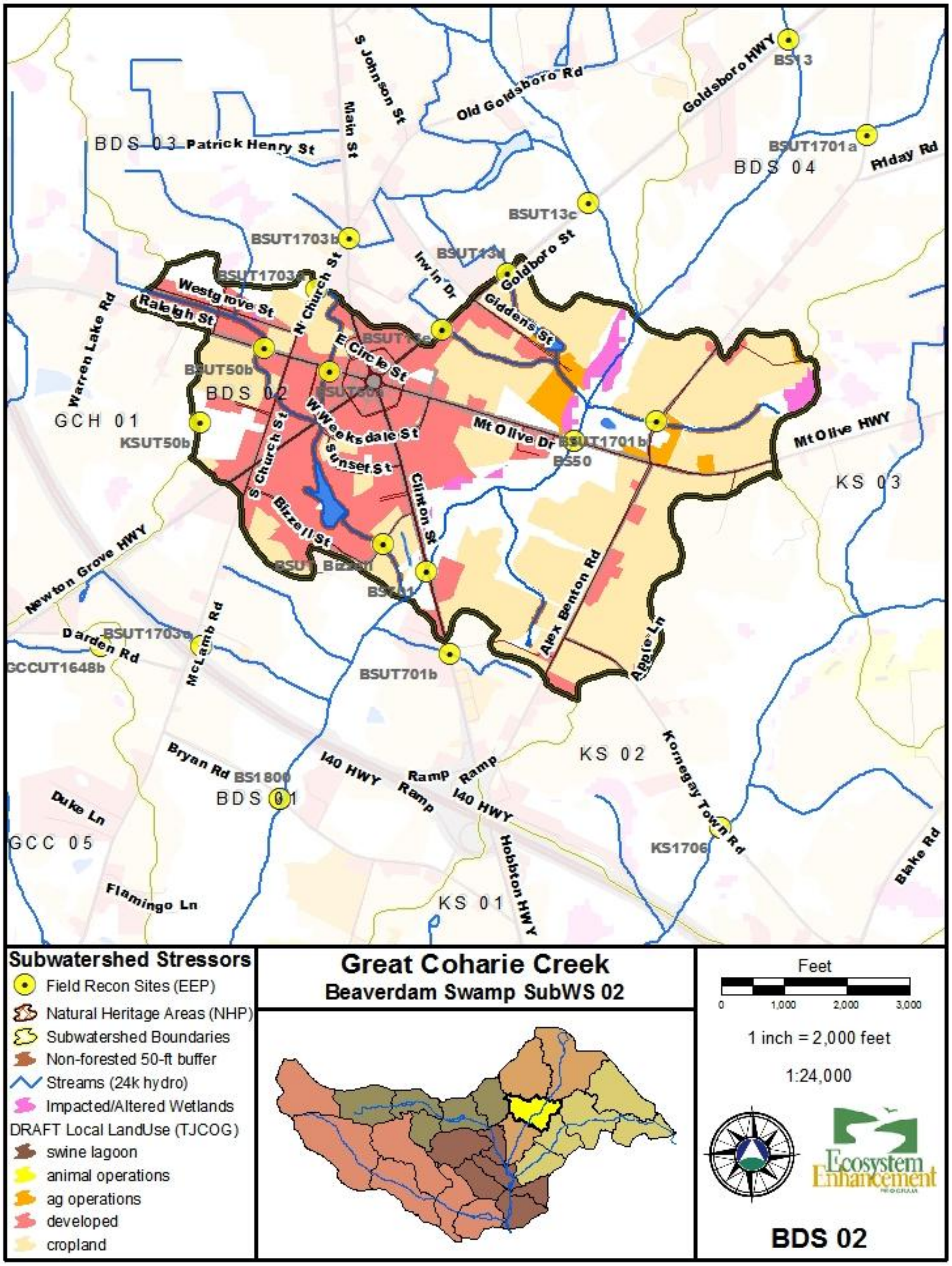
Beaverdam Swamp 01: Assets. This is a highly impacted area that drains to Great Coharie Creek 04. It contains the main stem of Beaverdam Swamp and 4 tributaries. I-40 and an interchange are in this watershed and part of the watershed is in the Town of Newton Grove.



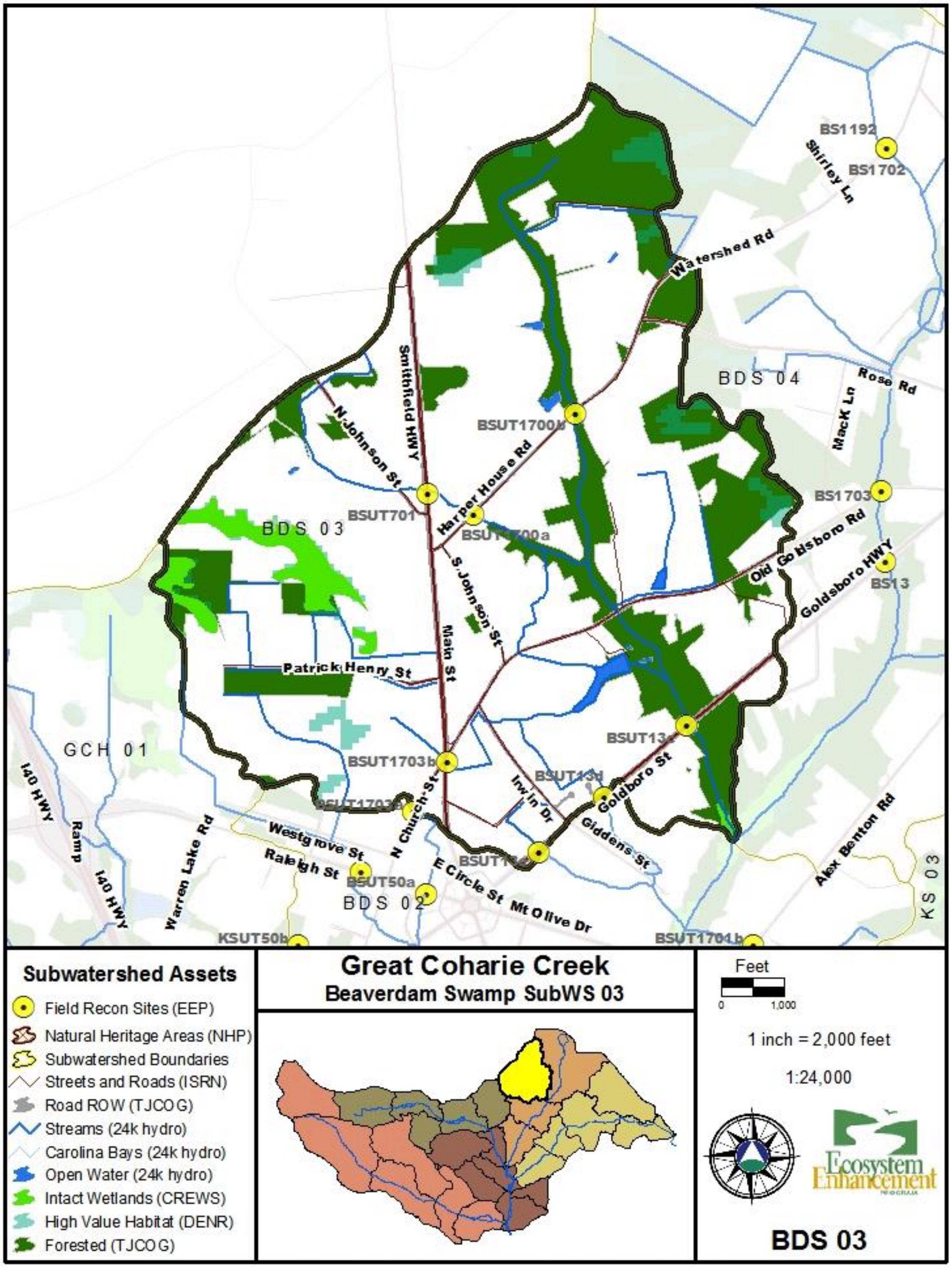
Beaverdam Swamp 01: Stressors. The headwater of one of the tributaries is covered by I-40. Between development and the roads, this watershed has a significant amount of impervious surface. Beaverdam Swamp is well buffered but the tributaries are not. The headwater of one tributary appears to be a hog lagoon.



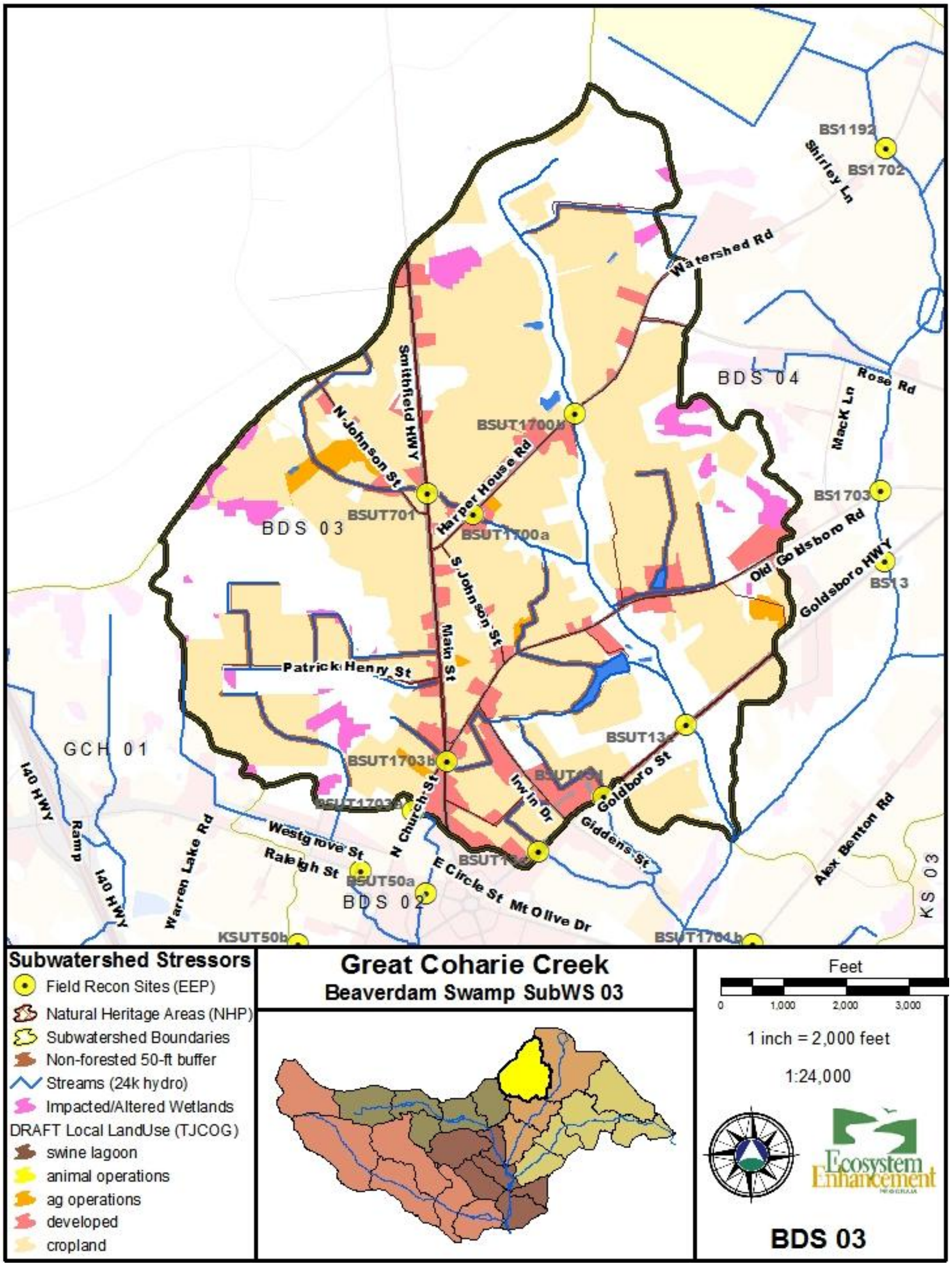
Beaverdam Swamp 02: Assets. This area contains the center of Newton Grove, the main stem of Beaverdam Swamp and 4 tributaries. Sixty-five percent of the streams are not buffered and 24% have development within 100 feet of the stream. This is by far the most developed subwatershed in terms of impervious surface and stormwater BMPs should be considered.



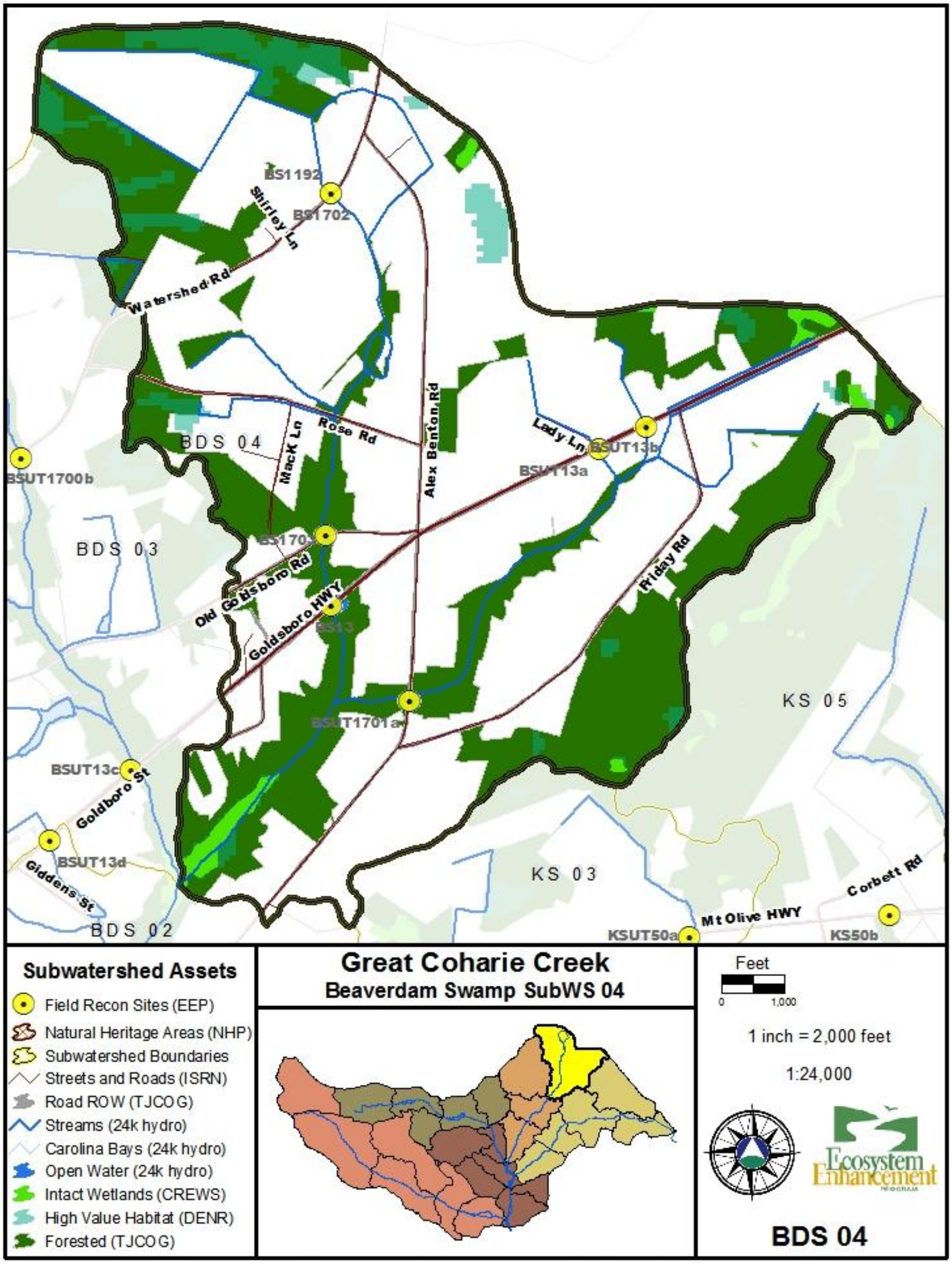
Beaverdam Swamp 02: Stressors. It has been observed that a stream draining a pond north of Bizzell Street is inputting sediment and nutrients into Beaverdam Swamp. This pond is fed by two tributaries so the exact source is unknown at this time. Beaverdam Swamp near 701 has a well defined channel but a wide swamp floodplain. The substrate is sand, silt and detritus.



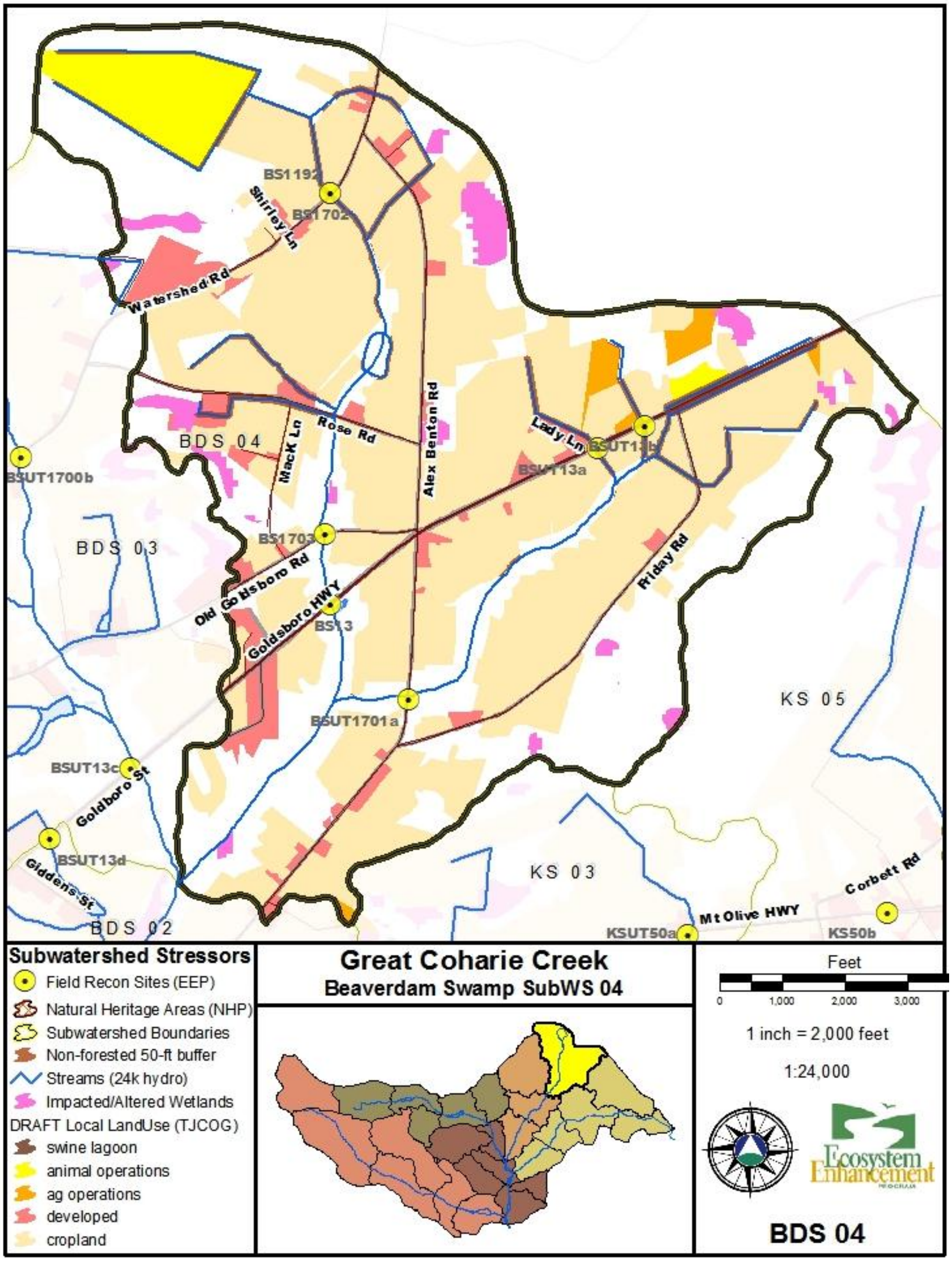
Beaverdam Swamp 03: Assets. This subwatershed contains portions of Newton Grove but is primarily cropland. The land area drains a large tributary to Beaverdam Swamp but also contains several ditch systems that drain into Beaverdam Swamp 02.



Beaverdam Swamp 03: Stressors. There are several headwater stream restoration opportunities and BMP opportunities to limit the amount of pollutants that may be carried from the ditches to Beaverdam Swamp.



Beaverdam Swamp 04: Assets. This subwatershed contains the headwaters of Beaverdam Swamp. The main stem is pretty well buffered but contains little to no buffer at the headwaters.



Beaverdam Swamp 04: Stressors. There is potential for stream buffering in the headwaters and wetland restoration opportunity. The primary land is cropland. The aerials reveal open water in several locations along the main stem of the stream indicating beaver dam ponding. In the northern corner of the watershed there is a ditch system around a swine operation that ties into the stream.

Subwatershed Prioritization

Preliminary subwatershed prioritization takes place to help guide assessment and field efforts in the next phase of the plan. Subwatershed prioritization, described below, was based on existing data and field surveys.

Preservation and habitat considerations: Subwatersheds GCC01, GCC04 and KS01 (Figure 16) have high quality habitat along the main stem of those streams that should be evaluated for possible continuation of the Significant Natural Heritage Area designation. BDS01 from below I-40 to the where Beaverdam Swamp enters Great Coharie Creek is an area of recreational interest for the stakeholders. The quality of this riparian habitat should be assessed. Two subwatersheds, SMS05 and KS05 both have significant wetland habitat that should be assessed for preservation or restoration.

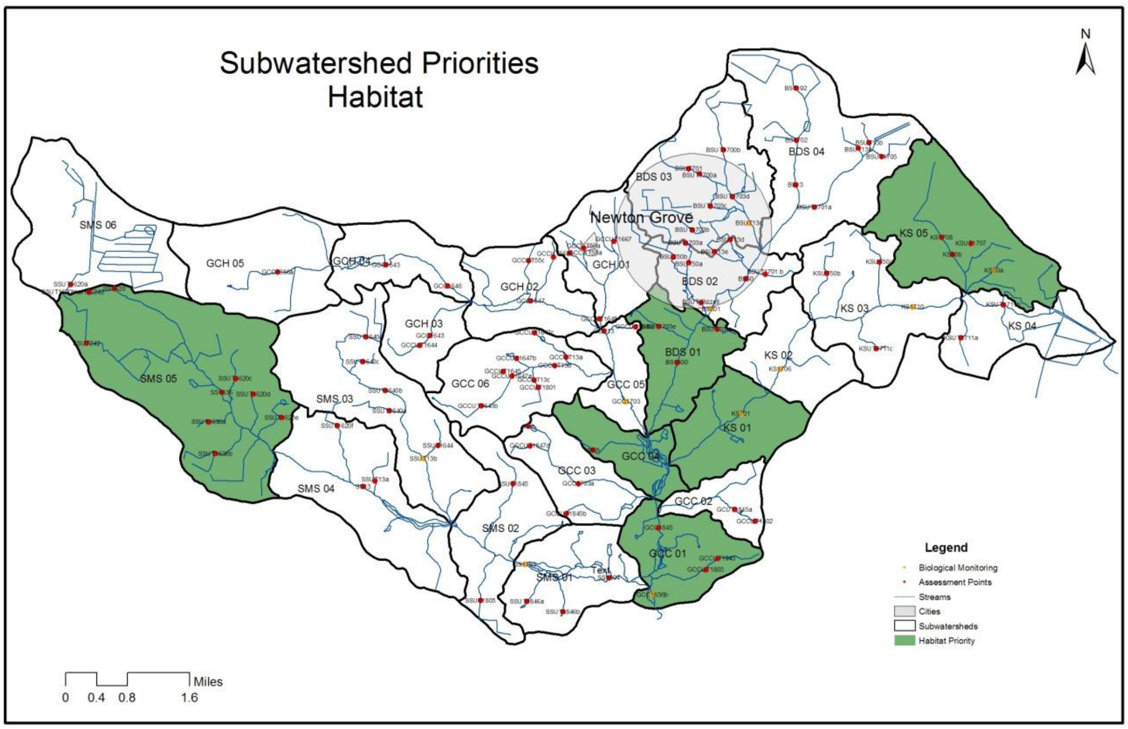


Figure 16. Priority areas selected for habitat assessment.

Stream restoration: Based on evaluations of aerial photography, 1-foot contour data and the current stream hydrology data, subwatersheds GCC03, GCC06, GCH02, SMS03, SMS04, SMS05, KS03, KS04, KS05, BDS02, BDS03, BDS04 (Figure 17) appear to have a good amount of opportunity for stream restoration or stream buffer planting. In the next phase, field evaluations should be made and water quality, habitat and hydrology data should be taken to determine the impacts of non-buffered and dredged streams to the watershed system.

Wetland restoration: As noted in the wetland section of this report, a large portion of the watershed is either intact or altered wetlands. Therefore, to focus our resources on the most high quality wetlands, the NC CREWS and high value habitat data (One NC Naturally Conservation Tool) displayed in the subwatershed maps was used to ascertain the subwatersheds where wetland preservation or restoration should focus. These subwatersheds are GCC03, GCC06, GCH01, GCH02, GCH05, SMS03, SMS05, SMS06, KS05, BDS04 (Figure 18).

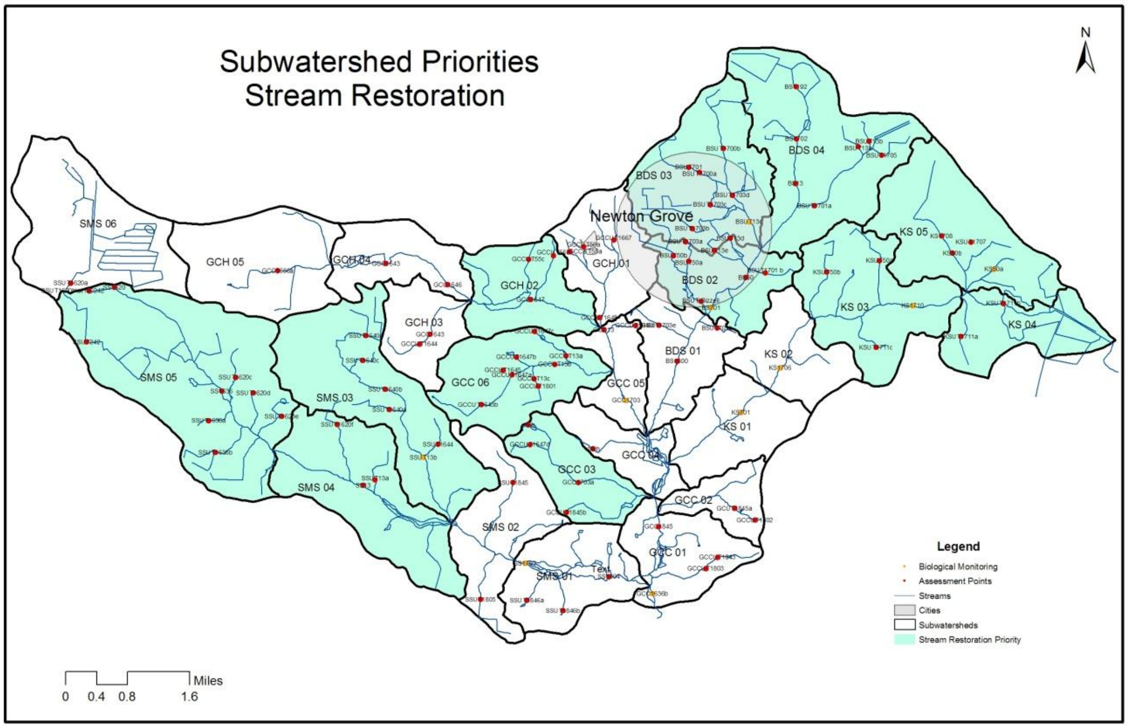


Figure 17. Priority areas identified for significant stream and buffer restoration opportunities.

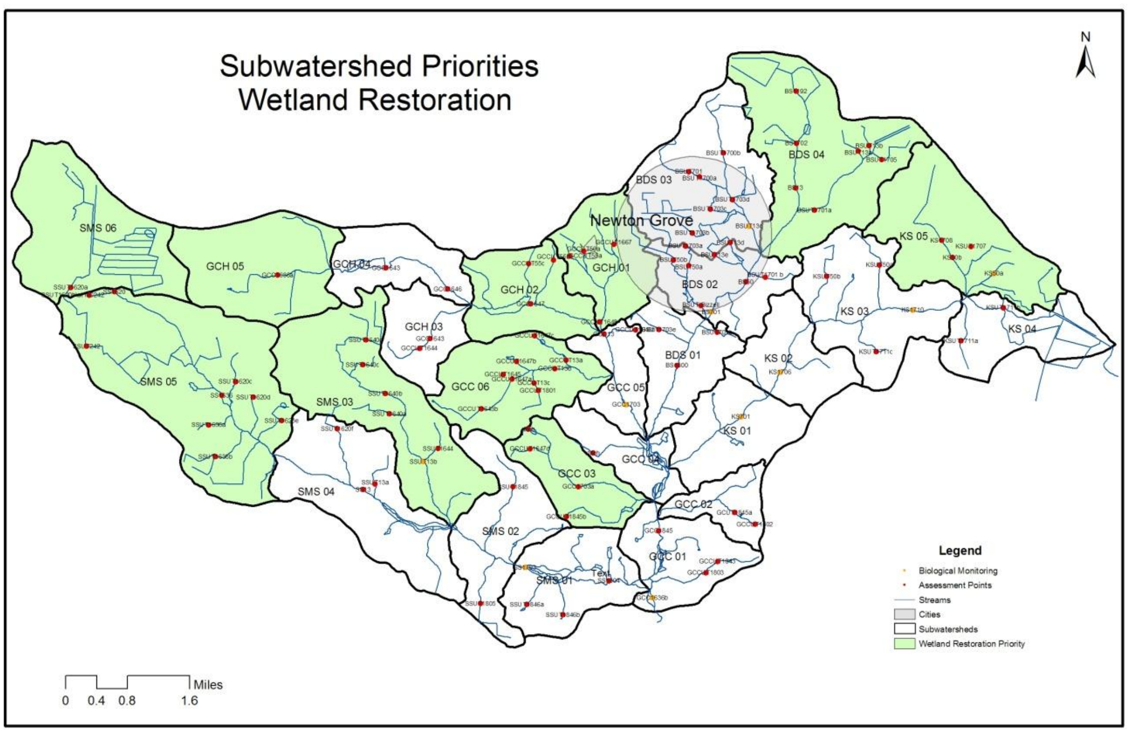


Figure 18. Priority areas where high quality wetlands should be assessed for protection or restoration.

BMP: Best Management Practices are structural or non-structural practices that help reduce pollutants, such as sediment, nutrients, fertilizers and fecal coliform from moving into the streams. It is expected that agricultural BMPs will be specified by NRCS and Sampson County Soil and Water as they work with each landowner and stormwater BMPs in areas with higher impervious surface will be developed in partnership with DOT and the Town of Newton Grove. In the next phase of the plan GCC04, GCH01, GCC06, SMS02 on ditches, SMS03, SMS04, SMS05, SMS06 ditches, KS02, KS03, KS04, KS05, BDS01, BDS02, BDS03 and BDS04 (Figure 19) should be assessed for BMP placement.

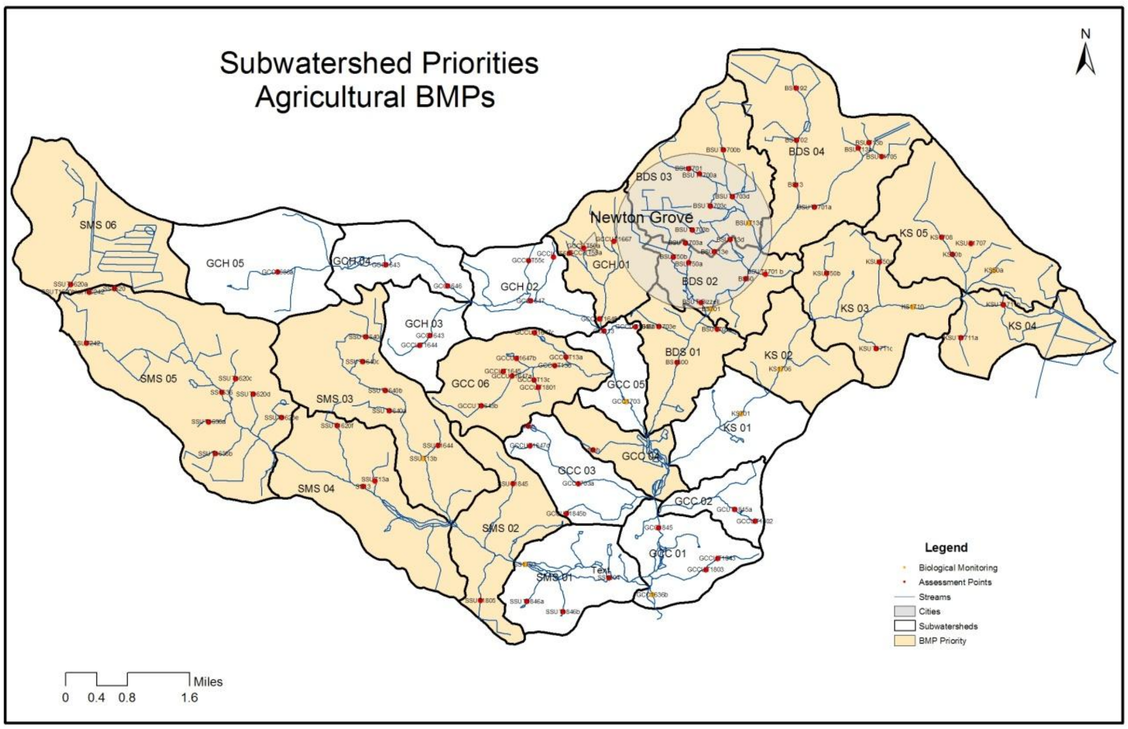


Figure 19. Priority areas for agricultural and stormwater BMPs.

Five subwatersheds did not receive prioritization because relative to the other subwatersheds, there was not enough evidence in the existing data to describe these subwatersheds as needing special focus. This is based on existing data and can change when additional data is assessed.

Riparian Zone Conditions

Using the land use data developed by TJCOG, an analysis was conducted to determine the land use within 50 feet of the stream in order to determine where "disturbed" buffer may occur in the watershed. The land use categories were grouped into buffered if the land use was forest, wetland, scrub or open water and categorized as not buffered if the land use was agriculture operations, cropland, animal operations, swine lagoon or developed. This is with the assumption that the land uses described above required the removal of vegetated buffer. The total amount of unbuffered stream in the whole planning area is 49% or 700 acres. This is based on the current hydrology layer which at this time also includes ditches. The data will be refined during the next phase of the plan.

Preliminary Identification of Restoration Opportunities

The map (Figure 20) shows the possible restoration opportunities based on current GIS data. This data looked at impacted wetlands and impacted stream buffer. The method for determining impacted buffer is described in the section above. Impacted wetland data comes from NC CREWS. Additional methodology can be found in Appendix A. Based on this data, 3,000 acres of wetlands have been impacted with half of this now being in pine plantation.

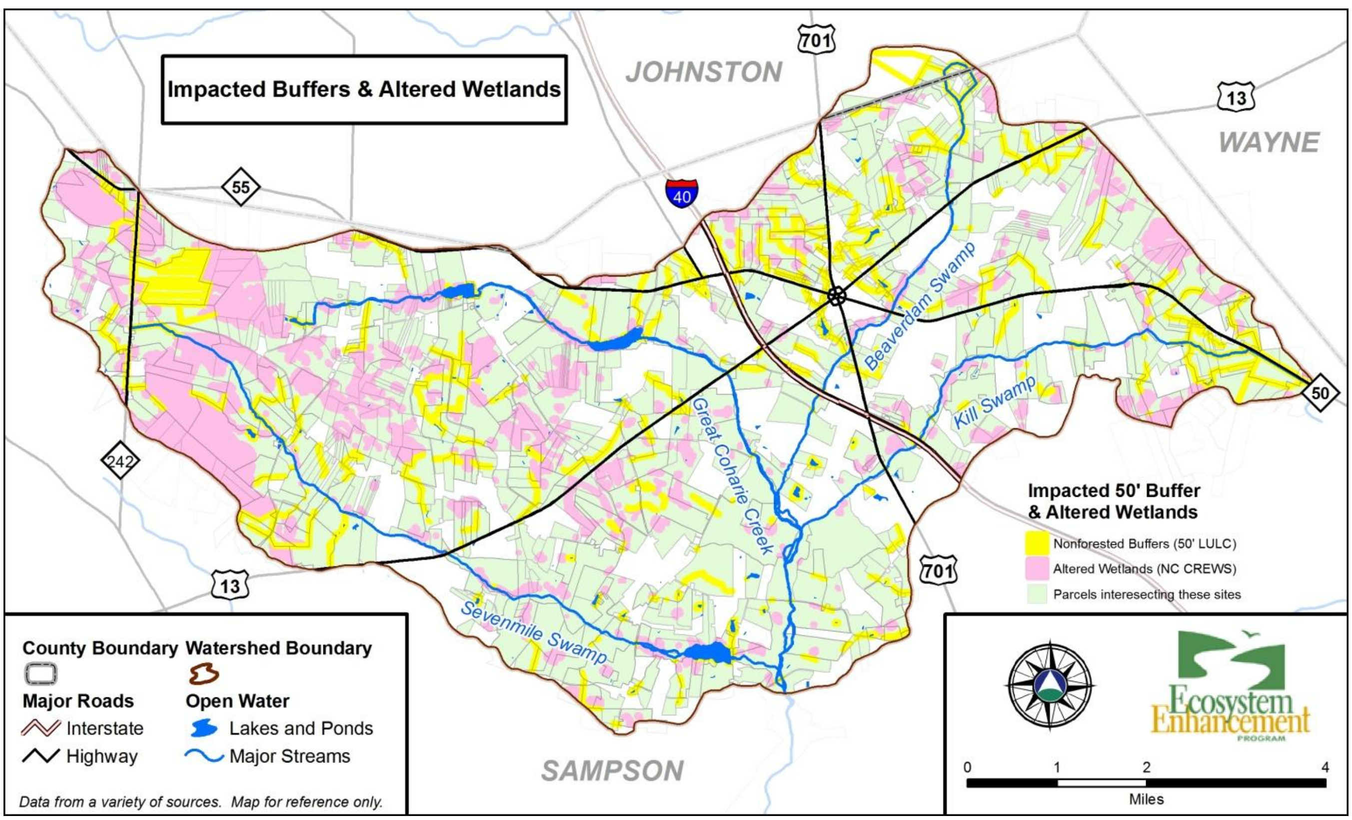


Figure 20. Map of potential wetland and stream restoration opportunities including parcels that intersect with the restoration area.

CONCLUSIONS

Potential Sources and Stressors

Below is a summary table of potential sources and stressors in the watershed. It is often difficult to clearly define a source and a stressor. Some stressors are causes of other stressors. In this table, Source is defined as an activity that causes one or more stressors. The ***Stressors put stress on the aquatic systems to lessen its ability to function. Functions assessed are hydrology, habitat and water quality. Ideally, stressors can be reduced by altering the activities listed under Sources.***

Table 17. Potential sources of and stressors in the watershed

	SOURCES										
	Ditches	Impervious surface	Land development	Roads	Wastewater Treatment Plant	Modified stream channels	Impoundments (beaver mill or road culvert)	Animal waste land application	Crop production	Atmospheric deposition	Livestock in Streams
STRESSORS											
Biochemical Oxygen Demand	x				x			x	x	x	x
Loss of riparian buffer			x	x		x			x		x
Invasive aquatic vegetation							x	x	x		x
Loss of in-stream habitat		x	x			x	x				x
Erosion / sedimentation	x	x	x	x		x	x		x		x
Loss of floodplain connection			x			x					
Restricted aquatic species movement				x		x	x				
Flow alterations	x	x	x	x		x	x				
Elevated inorganic nitrogen and total phosphorus	x				x	x		x	x	x	x
Elevated pathogen load	x					x		x			x
Low DO	x				x	x	x	x	x		
Loss of high value forest and wetlands	x		x	x		x	x		x		
Mercury										x	

<u>Sources</u>

Below are descriptions of all the potential sources of pollutants or stressors in this watershed. At this point, an exhaustive list has been developed to illustrate the multiple potential for impacts. The next phase of the planning process, the assessment phase, will attempt to determine the specific sources and their locations.

Ditches here are differentiated from modified stream channels in that they are water conveyances that are man-made. The topography shows no natural valley. Ditches are used to drain wetlands or to capture stormwater runoff from roadways. Ditches move water and pollutants quickly to natural water bodies.

Impervious surface is usually an artificial structure that cannot be penetrated by water such as roads, roof tops and parking lots. Compacted soil is also highly impervious. Impervious surfaces do not allow water to soak in, causing it to run off. It is often a major source of stressors in watersheds as the water runoff carries a number of pollutants and moves more quickly and in greater quantities to water bodies than if the water soaked into the soils. The largest percentage of impervious surface is found in Newton Grove and along the I-40 corridor and scattered parcels throughout the watershed.

Land development includes clearing and impacting forests, wetlands and streams and building artificial structures in their place. Impervious surface and roads are a subset of this. Impacts of these sources may be riparian disturbance and stream channel modification. When looking at land use by parcel, this watershed has less than 5% development, not including 3% road cover. Land development is concentrated in Newton Grove and in scattered parcels throughout the watershed.

Roads cover 3% of the watershed. Though roads are a subset of impervious surface and development, roads are sources of specific stressors – restricted aquatic movement and flow alteration – that appear to be problems in this watershed. I-40 is a source of stormwater pollutants.

Wastewater Treatment Plants as well as other permitted dischargers are potential sources of pollutants. Newton Grove's treatment plant is monitored and has a well-documented record of the water quality near the plant.

Modified stream channels are streams that have been altered. In this watershed, most of the headwater streams have been ditched and cleared of vegetation. This activity leads to multiple stressors including loss of habitat, erosion and quick transport of pollutants.

Impoundments are created in this watershed by road crossings, mill dams and beaver dams. There are four mill dams in the watershed. These impoundments appear to have stable ponds. The combination of beaver activity near road crossings appears to be causing flow alterations resulting in sediment build-up and restriction to aquatic species movement. Flooding and tree die off may also be resulting. In these impounded areas, invasive aquatic vegetation has come in.

Animal waste land application is a potential source of nutrients in the water. In this watershed swine and poultry waste are applied to the land. As with any other fertilizer, excessive amounts can find its way to local water bodies.

Cropland Production probably has the most effect on water quality, hydrology and habitat in this planning area because it is the most abundant land use. The greatest effect is in the clearing of buffers and dredging of streams. The positive side to this is that the impacts can be reversed by buffering streams from the land activities and reestablishing the stream habitats.

Atmospheric Deposition - When mercury is released into the atmospheric environment, either from natural or human-made sources, it can eventually deposit into surface waters, where bacteria convert the metal into the organic form, called methylmercury. This form of the metal is assimilated by larger organisms when they consume the bacteria, and mercury begins its journey up the food chain. Great Coharie Creek is listed for mercury based on fish tissue testing. This is not an issue that can be resolved locally but should be recognized as a local health concern when consuming fish or mammals that consume fish. In addition, nitrogen and phosphorus may enter the system through atmospheric deposition.

Livestock in Streams causes destruction to riparian and in-stream habitat and soil erosion. Livestock waste inputs increase the levels of bacteria and nutrients. This is one source that can be easily eliminated through fencing and alternative water sources.

Stressors

Based on initial data evaluation and field work, the Planning Team identified the following as potential stressors to the aquatic system. In the assessment phase of the plan, the Planning Team will collect additional data in order to determine if the following are stressors and what their sources might be.

Biochemical Oxygen Demand (BOD) is a measure of the quantity of oxygen used by microorganisms (aerobic bacteria) in the oxidation of organic matter. Nitrogen and phosphorus inputs stimulate microorganism growth which increases BOD and results in lower dissolved oxygen.

Loss of riparian buffer removes the ability for vegetation to filter pollutants before reaching the stream, reduces shading in the stream, reduces the amount of woody debris and root masses used for in-stream habitat and reduces terrestrial habitat. Removal of riparian buffer could also be listed as a source.

Invasive aquatic vegetation may have a substantial impact on water quality in streams. Dense growths of aquatic vegetation may contribute to wide diurnal fluctuations in dissolved oxygen and pH, which may be detrimental to fish and aquatic invertebrate populations. Additionally, aquatic vegetation may have a significant impact on the dynamics of nutrients and suspended sediments in flowing systems. Aquatic plants (particularly submersed species) trap sediments and serve as sinks for nutrients during the growing season. They also may function as a biological "pump" during the growing season and actively mobilize nutrients from the sediments (e.g. phosphorus) into the water column by leakage through the leaves. Plant species which do not overwinter in a green, vegetative state also become senescent during the latter part of the growing season and begin to leak nutrients from their tissues into the water column. These plants will decompose completely during the late fall and winter months and release nutrients from decaying tissues into the water column. Decaying organic matter may impact aquatic species habitat.

Loss of in-stream habitat is caused by the alteration of stream channels through dredging and removal of woody debris and vegetation and by impoundments that slow the water down, trap sediment and alter the vegetative composition of the stream.

Erosion / sedimentation is a natural process that is often exacerbated by bare soil. Erosion takes place on the land and along stream banks. The in-stream substrate in this watershed should range from sand to gravel. Fine particles, such as silt, can impair biological habitat and there are indications that this is the case. Much sediment is trapped behind beaver and manmade impoundments in this watershed, allowing it to settle**.** This is good for the water quality downstream but has local effects that are undesirable.

Loss of floodplain connection occurs when a stream channel is made deeper either dredging or through erosion. When a stream is not able to access its floodplain, water is moved more quickly downstream, carrying excess sediment and pollutants. When a stream does access its floodplain, water energy dissipates, and sediment and pollutants are filtered out by the vegetation on the floodplain.

Restricted aquatic species movement may be an issue related to the impoundments. Lower in the Great Coharie, several fish species of concern have been identified. Since it is difficult to conduct fish studies in these swamp conditions, the level of fish species movement through the watershed is unknown.

Flow alterations in this watershed are caused by impoundments, road crossings, beaver dams, and aquatic vegetation in the main stems and ditching in the headwaters.

Elevated inorganic nitrogen and total phosphorus have been found to be a concern in swamp stream in this region. Nitrogen and phosphorus input stimulate microbial growth and increase the biochemical oxygen demand (BOD). High BOD, in turn, results in lowered dissolved oxygen concentrations (i.e. microbial respiration is consuming the oxygen).

Elevated pathogen load is a potential stressor in this watershed. Common sources of elevated pathogen load include leaking septic systems, malfunctioning waste water treatment plants, animal operations or wildlife.

Low dissolved oxygen is common in swamp streams. However, various triggers such as high BOD or excessive aquatic vegetation can have an effect on the natural range of DO in the system.

Loss of high value forest and wetlands impacts terrestrial and aquatic habitat and reduces the ability of the landscape to contain and filter stormwater. Removal of high value forest and wetlands can also be considered a source of hydrologic alterations.

Mercury in North Carolina is thought to come from aerial deposition of emissions from coal-fired power plants. This pollutant is out of the realm of what can be addressed in a local watershed effort but it should be noted that Great Coharie Creek is on the impaired stream list for mercury. Human health concerns arise when fish and wildlife from these ecosystems are consumed by humans.

RECOMMENDATIONS FOR FUTURE ASSESSMENT

The next steps in the planning effort are to determine what additional information is needed to answer the questions that have come from the preliminary assessment of the watershed. This will include collecting more data that will help the Planning Team and Local Advisory Team understand the water quality, hydrology and habitat problems as well as the assets that should be a focus of protection. Below is a discussion of data gaps that should be filled and how the assessment should be approached based on current understanding of the watershed and its land use.

Data Gaps

There are four major sources of data in a watershed planning effort. The first is water quality data that includes chemical, physical and biological data that is often collected by NCDWQ, universities and other research efforts. Very little data of this type had been collected prior to this watershed planning effort. To date, some basic parameters have been collected by our team at 38 sites and nutrient and fecal coliform data has been collected at six sites. Macroinvertebrate studies have taken place at 9 sites. More would typically be preferred but the lack of flow and wadable streams reduced the number of desired monitoring sites. In addition, fish and mussel data would be very informative but the conditions of the streams are not conducive to fish and mussel surveys. The lack of historical biological data is clearly a result of the stream characteristics that do not allow the use of typical assessment methods. In the next phase, water quality analysis should be focused in subwatersheds where restoration or BMPs may have a positive effect on water quality and at end points in subwatersheds where pollutant sources may be isolated.

The second source of data is GIS data that includes spatial data and tabular data associated with specific spatial points. Fortunately, there is a significant amount of GIS data for this area and most of our preliminary findings are based on GIS data. The primary data gaps were addressed in the first phase of this plan and discussed in this report. In the next phase what is necessary is a refinement of certain data sets. This includes field verifying the land use dataset; refining the hydrology dataset to add streams and remove manmade ditches; developing a more accurate impacted wetland dataset; developing an accurate impacted stream layer using the field verified land use and updated hydrology data and mapping established beaver impoundments.

The third type of data are field surveys, during which staff observes land use, water quality, habitat and hydrology at every road crossing in the watershed and other access points, where available. This allows for a better perspective when assessing GIS and other data in the office. Field surveys have up to this point been done from road crossings but additional access is needed, especially to assess impediments to flow and areas where restoration, preservation or BMPs may help improve the watershed. GIS data and input from local stakeholders will be helpful in narrowing in on potential stressors.

The fourth type of data consists of information provided by local stakeholders. This information is invaluable in understanding the interconnectedness between the aquatic resources and the people who live in the watershed. Continued outreach and work with willing stakeholders is imperative to the success of this work.

Objectives for Watershed Assessment

Since there is little data for this watershed, there is much to be learned. However, with limited resources, the assessment must have guiding principles. In this case they are the watershed goals developed by the Planning Team and the Local Advisory Team (Table 18). Assessment objectives focus on water quality, habitat and hydrology. Additional items of interest will be addressed in the final report as areas of focus for future studies.

Table 18. Assessment Objectives that will guide next phase assessment plans

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 main stem 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.

Assessment Approach for Water Quality Objectives

WQ1. Assess water quality in the subwatersheds where stream and buffer restoration and BMPs may be most effective.
Responsible Partner: DWQ-WAT
Approach: Priority subwatersheds for restoration and BMP placement have been identified on page 90 of this report. WAT will conduct in-field assessments as described in WQ2 below, with a specific focus on the subwatersheds where restoration and BMPs are most likely to take place.

WQ2. Assess water quality at end points of subwatersheds, or where accessible, to isolate pollutant sources.
Responsible Partner: DWQ-WAT
Approach: WAT will conduct water quality monitoring (nutrients, fecal coliform, and field parameters) to characterize water quality at the exit points of the five major subwatersheds. WAT will also conduct in-field assessments of nutrients and ambient physical conditions using a combination of field meter readings (pH, conductance, dissolved oxygen, temperature), field chemistry measurements (NH_3-N, NO_3-N, and phosphate-P using Hach color comparators), and laboratory analyses (collected when the results from the field test kits suggest elevated nutrient conditions). These measurements will be conducted at road crossings. The data collected will be used to bracket potential problem areas and suggest stressors that may be contributing to the degradation of water quality and which may require further investigation.

WQ3. Identify key sources and stressors in areas where biological monitoring has indicated limited biological communities.
Responsible Partner: DWQ-WAT
Approach: WAT will conduct water quality monitoring (nutrients, fecal coliform, and field parameters) at all benthos sites for 3 to 4 months. This activity will evaluate field parameters and nutrient conditions existing within the subwatersheds that may be acting as stressors on benthic invertebrates and other aquatic life and facilitate the interpretation of the benthic macroinvertebrate assessments in light of ambient water chemistry. WAT personnel will collect all samples, and the DWQ chemistry laboratory will conduct the analyses. Data will be reviewed after this short-term monitoring is completed, and a decision will be made jointly with EEP personnel and the technical team whether or not to continue monitoring activities at any of these locations and/or to add additional sites and whether or not to add or delete laboratory chemistry parameters.

WQ4. Enhance our understanding of how pollutants are processed from the headwaters to the main stem of Great Coharie Creek.
Responsible Partner: EEP, TJCOG, DWQ-WAT, Friends of Sampson County Waterways
Approach: Assessment of pollutant transport in this system is difficult due to the swamp conditions, including the wide floodplain, low flow and natural sediment substrate. There are indications that pollutants are moving into the system in the headwaters and are

settling out behind beaver dams, manmade impoundments and natural low-flow areas. The intent here is to try and capture data to support these assumptions. Due to the difficult nature of accessing the whole system, a combination of field water quality data, visual assessments, GIS data and modeling will be used.

Assessment will be done using WAT data as described above, combined with a GIS aerial interpretation and field verification of beaver dams, manmade impoundments and natural low-flow locations. Data will be interpreted above and below these impoundments, dams and low flow areas to identify any indication of change. Boat access will most likely be needed for field verification of aerial interpretation, using assistance from Friends of Sampson County Waterways. Flow will be modeled using HEC-RAS or simpler Manning's equation based estimate. Cross sections and velocity will be collected by EEP staff at the lowest point on Great Coharie to assist in providing accurate flow data.

Assessment Approach for 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.
Responsible Partner: EEP, TJCOG, DWQ-WAT, Friends of Sampson County Waterways
Approach: DWQ-BAU conducted habitat assessments when conducting biological sampling in February, 2010 using the *DWQ Coastal Plain Habitat Assessment Form*. In-stream habitat for coastal plain streams includes sticks, logs, macrophytes, undercut banks/root mats and leaf packs. Substrate, pool variety and channel modifications are considered in-stream. This form will be used by DWQ-WAT during their water quality assessments described in WQ2 above. EEP will use this form or the *ECU Coastal Plain Stream Assessment Protocol* in additional sites identified for potential enhancement, restoration or protection. Reaches identified as deficient will be assessed to determine if sources of stress can be defined. Good quality habitat will be documented for future reference.

HB2. Better characterize riparian habitat quality, identify the most common riparian habitat deficiencies and their causes and locate areas of best riparian habitat quality.
Responsible Partner: EEP, TJCOG, DWQ-WAT, NRCS/SWCD
Approach: Riparian habitat will be characterized in 3 ways: 1) DWQ-WAT will assess riparian area at sites where water quality is assessed. The DWQ *Coastal Plain Habitat Assessment Form* is limited in riparian assessment parameters so a modified *ECU Coastal Plain Stream Assessment Protocol* is preferred; 2) TJCOG will improve upon the impacted buffer data already developed and map protection priority areas which EEP staff – with input from NRCS/SWCD staff - will field assess using a modified *ECU Coastal Plain Stream Assessment Protocol* (developed by TJCOG) and; 3) EEP staff will conduct a bird survey looking at diversity and target species prevalence. High quality riparian habitat and impacted riparian areas will be mapped for the final management plan.

HB3. Identify invasive aquatic species and better understand their impact on habitat, water quality and flow.
Responsible Partner: DWQ-WAT
Approach*:* DWQ-WAT will identify the dominant species of non-native, invasive plants (e.g. alligatorweed, Asian spiderwort, and creeping water primrose) as well as aggressive native species (e.g. cattails, bladderwort, and proliferating spikerush) present in the streams and the shallow impoundments that may be impacting downstream water quality and provide a qualitative evaluation of the vegetation densities and coverage. Correlations with water quality and habitat data will be examined.

HB4. Locate existing high value forest and wetlands and identify areas where these resources may be restored.
Responsible Partner: TJCOG, EEP
Approach: TJCOG will improve upon data developed for phase I. EEP will then field verify the restoration potential and document this using field forms and protocols yet to be determined by the Planning Team. Data from ***HB2***, riparian habitat, will be incorporated into this objective.

HB5. Identify where in-stream impacts occur due to excessive sediment inputs and investigate sediment sources of those impacts.
Responsible Partner*:* DWQ-WAT, EEP, NRCS/SWCD
Approach: Sediment has been singled out here for additional discussion due to the complexity of assessing sediment load and because this is a stressor that can be addressed through BMPs and enhancement/restoration. Various methods of scale can be used to assess sediment load and sources including monitoring, modeling (from simple land use and soil erodibility calculations to a simulation model that tracks sediment through the system) and visual interpretation.

The recommended approach is to use data collected in the ***WQ*** objectives and ***HB1*** discussed above to indentify where in-stream impacts occur. Best method for source identification for the purposes of pre-restoration data collection is visual field assessments conducted at sites identified via GIS and aerial interpretation and with input from NRCS/SWCD. Field assessment will document erosion features and surficial scour/erosion or mass wasting/caving. EEP will also document soil loss in headwater stream reaches using the *Streambank Erosion Worksheet* which was created for the Community Conservation Assistance Program by Tom Hill, NC Division of Soil and Water Conservation (Hill, n.d.).

Assessment Approach for Hydrology Objectives

HD1. Field verify and correct hydrology GIS data and determine stream classification for streams with restoration potential.
Responsible Partner*:* TJCOG, EEP, DWQ-WAT
Approach: TJCOG will use field verification information collected by EEP and WAT to improve the hydrology dataset, including adding natural streams that are not currently represented and removing manmade ditches. EEP staff will determine stream

classification for streams with restoration potential using the DWQ stream classification form.

HD2. Identify extent of channel modification and impacts to floodplain areas.
Responsible Partner*:* TJCOG and EEP
Approach: Channel modifications will be assessed using GIS and field work described in ***HD1***. Entrenchment ratio will also be calculated for potential stream restoration reaches.

HD3. Assess flow patterns and identify sources of flow alteration.
Responsible Partner*:* EEP, TJCOG, DWQ-WAT
Approach: This objective relates to ***WQ4*** in that an understanding of flow patterns is important to understand the movement of pollutants through the system. Flow will be modeled using HEC-RAS or simpler Manning's equation based estimate. Cross sections and velocity will be collected by EEP staff at the lowest point on Great Coharie to assist in providing accurate flow data. Flow alterations will be identified via GIS and field work as described in ***WQ4*** and ***HD2***.

Assessment Approach for Social Objectives

SL1. Enhance our understanding of how the community values and interacts with the aquatic resources.
Responsible Partner*:* EEP, Cooperative Extension
Approach: The local stakeholders have provided much insight into this issue but there are many community members who have not had input into the process. The recommended approach is for EEP to work with Cooperative Extension to develop a draft survey and to distribute to landowners within the watershed. The Local Advisory Team will then review and provide final input into the survey questions and outreach method. Surveys will be assessed and incorporated into the final management plan.

SL2. Identify community's restoration goals and develop strategies to reach those goals.
Responsible Partner*:* EEP, Cooperative Extension
Approach: A critical element of a watershed plan is outlining how management strategies are going to be implemented. Implementation of a watershed plan is most successful when there is technical assistance, funding and long-term local commitment. Several agencies, represented on the stakeholder and technical teams, are capable of providing technical assistance. Funding comes in a variety of forms and can be more easily obtained when a plan is in place. However, most management strategies will have to take place on private property or in conjunction with a public entity. Therefore, it is important to shape the management strategies to suit the goals of the community so that the plan is more likely to be implemented to its fullest extent. The approach will be integrated into the survey described in SL1.

Local Priorities

Local Priorities have been documented throughout this report based on input from the Local Advisory Team. The purpose here is to highlight these priorities again so that they continue to be at the forefront of the Planning Team's plans for Phase II assessment. The statements below are based on local input. Part of the Phase II assessment will be to collect data that confirms these observations or provides new data that helps address these concerns.

1. Beaver are a concern countywide due to their ability to back up flow in these already slow moving streams and cause flooding.
2. Sediment is being trapped behind road crossings and beaver impoundments and filling in the channels, causing low flow and an increased transition from stream to wetland.
3. Aquatic plants are causing a number of problems including impeding flow and obstructing recreation.
4. Reduced flow, in general, is a concern and has many observed causes including beaver dams, aquatic vegetation and log jams in the road culverts.
5. Nutrients and BOD were not an apparent and observable issue but data provided to the Local Advisory Team increased their concern of excessive nutrients and the resulting Biological Oxygen Demand in the streams.

OUTREACH

Between September, 2009 and January, 2010, three newspaper articles were published about the plan and a public meeting was held January 2010 in conjunction with the Newton Grove town board meeting. An information sheet was developed for stakeholders and field staff to hand out. Below is a summary of additional outreach expected through September 2011.

- Two public meetings to present findings
- Surveys mailed to residence in watershed
- Letters to landowners requesting permission to conduct field measurements
- Six Local Advisory Team meetings
- Three press releases or articles

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APPENDIX A GIS DATA PROCESS STEPS

Subwatershed Delineation Process Steps

- The first step was to combine three 14-digit HUCs into the Local Watershed Planning area.

- Then small subwatersheds were digitized on-screen as polygons in ArcGIS 9.3 from the USGS 7.5 minute DRG. This resulted in 36 draft subwatersheds.

- Based on size and location, the subwatersheds were combined into 26 draft subwatersheds.

- The boundaries were compared to modeled catchments from the NHD-plus data layer. There were 47 modeled catchments and the boundaries were refined based on the results.

- The boundaries of the 26 subwatersheds were re-digitized on-screen as polylines in ArcGIS 9.3 from 1-foot contours derived from LIDAR data from the NC Floodplain Mapping Program.

- The boundaries were compared to the 12-digit Watershed Boundary Dataset. The subwatershed boundaries were refined based on the WBD.

- The polylines were converted to polygons and populated with size and name attributes.

Land Use / Land Cover Process Steps

The local land use layer was created in a multi-step process. Using the USDA Common Land Unit as the base, a new layer was created and categorized using modified Anderson Level I classes based on visual interpretation of 2008 high-resolution aerials. Additional line work and modification was done as needed to properly classify the local watershed planning area. The steps are further described below.

There were a range of possible baseline layers for creating local land use. For instance, existing land uses layers exist for North Carolina in the GAP layer and MRLC layer. However, we wanted to leverage the 2008 high-resolution aerials and virtually all available land use or land cover data is based upon satellite imagery. Upon inspection, the boundaries of the USDA Common Land Unit dataset seemed to match quite well down to the field scale. The forest boundaries, landowner and field edges were digitized with remarkable accuracy based upon our initial inspection.

Using the CLU layer, we created a new land use layer and determined the land use classes to use:

- forest
- scrub
- water
- hydro - other
- agriculture operations
- animal operations
- cropland
- road
- developed
- lagoon

Forest was determined through visual inspection of the aerial photographs. Likewise, scrub was used where overgrown woody vegetation or cutover areas were visible;

Roadways were added as the void space in the county parcel layer. The void represents the public road right-of-ways. There were spatially joined to the land use layer.

Using DWQ's hydrology polygon layer, water features were added the land use layer. The features were manually divided into water, lagoon or hydro-other. The hydro-other category was used for hydrology features that appeared vegetated. Hydro-other was used as a surrogate for wetlands in the land use layer. Lagoon polygons were identified from a point shape file of waste lagoons and confirmed through visual aerial photo inspection.

Cropland was initially classified for the polygons with their centroid in the Agricultural Lands layer (downloaded from NCOneMap), but reviewed and updated manually into cropland, agriculture operations and animal operations. When agricultural and processing buildings were visible in the photos, the land use was classified as agriculture operations. Where animal pens and/or waste lagoons were visible in the photos, the polygons were classified as animal operations.

Using the remaining unclassified parcels, a manual interpretation was done, splitting polygons where necessary and populating the land use attributes. Similarly, as a finer inspection was conducted, the automated land uses were giving a quick review for major errors.

Note that this data has not been field verified yet and there may be several errors in classification.

Preliminary Restoration Opportunity Layers

To create the altered wetlands layer, the NC CREWS layers was used as the basis and the following drained, impacted and cutover feature classes were selected:

11 Managed Pineland
17 Headwater Swamp
22 Drained Freshwater Marsh
29 Drained Hardwood Flat
30 Drained Pine Flat
37 Drained Headwater Swamp
40 Human Impacted
46 Cleared Bottomland Hardwood
47 Cleared Depressional/Riverine Swamp Forest
49 Cleared Hardwood Flat
50 Cleared Pine Flat
57 Cleared Headwater Swamp
66 Cutover Bottomland Hardwood
67 Cutover Depressional/Riverine Swamp Forest
69 Cutover Hardwood Flat
70 Cutover Pine Flat
77 Cutover Headwater Swamp

Once a new layer of altered wetlands was created, a second version was created by dissolving the polygons so adjacent features were merged into a single polygon.

In order to identify potential stream sites, we decided to use the buffer condition as an indicator of potential stream impacts. The first step was to create a layer of land use within the 50-foot buffer. The local land use created for this project was used and clipped to the 50-foot buffer. Then the following land uses were selected as indicators of impacted buffers: cropland, developed, agriculture operations, animal operations, swine lagoons and roads. Once a new layer of non-forest buffer was created, a second version was created by dissolving the polygons so adjacent features were merged into a single polygon. It should be noted that the buffer layer includes all streams and ditches but does not include Carolina Bays.

These layers were created through a desktop analysis process and sites identified may not be appropriate for restoration or enhancement. These sites have not been field verified and further investigation is needed to determine what, if any, restoration potential exists. The GIS data seem to indicate that these areas have a higher likelihood of being degraded sites.

Asset Maps

Intact wetlands data was based on the NC CREWS data layer. The flowing feature classes were selected as the intact wetlands:

2	Freshwater Marsh
6	Bottomland Hardwood
7	Depressional/Riverine Swamp Forest
9	Hardwood Flat
10	Pine Flat

The second layer created for the asset maps was a layer of high-value habitat based on the Biodiversity/Wildlife Habitat Assessment (BWHA) layer created as part of DENR Conservation Planning Tools. This layer is an index layer based on several factors that prioritize aquatic and terrestrial habitat by landscape function and connectivity. The index layer is broken into legend classes to indicate similar habitat value. The highest two classes (6 and 7) were selected for the high value habitat layer as seen in the diagram below.

Lowest	Resource Rarity and Distinctiveness	Highest
Lowest	Resource Function	Highest

	Moderate								Maximum	
Measures	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Rarity/ Distinctiveness			Priority Watersheds T & E Tribs	Free Standing EO - Mod	Free Standing EO - High	SNHA County	Stream Buffer T & E	SNHA Regional		SNHA National and State
Function	LHI Guild (1)	CREWS-Beneficial			NWI	CREWS - Substantial	CREWS Exceptional	HQW (select)	ORW (select)	LHI Guild (10)
	All Streams				Shellfish Closed	Submerged Aquatic Vegetation	DWQ Bioclass Good	Fish Nursery Areas	DWQ Bioclass Excellent	
						Important Bird Areas	Hard Bottom	Oyster Sanctuaries	Native Trout Waters	
								Shellfish open		
								Anadromous Fish Spawning		

Great Coharie Creek Compiled Natural Resource Information

Rare species:
Historical Pine Barrens tree frog (SR) to NE
Loggerhead shrike (SC)

Several US Fish and Wildlife Service conservation easements along the upper Great Coharie Creek

In the Mill Creek TNC Conservation Area (can be found in the NC Wildlife Action Plan)

Great Coharie Creek is on DWQ's 303d list

Great Coharie Creek Swamp – Locally significant natural area just downstream – managed by NHP (info in Sampson Co Inventory) – see description below

Landscape Habitat Indicator Guilds (see descriptions below):
Core Area: Cape Fear, Black and South River Floodplains - Guild: Forested Floodplains and Non-riverine Wet Flats (EO Rank: A – 5 to 6 guild members present)
Core Area: Cape Fear, Black and South Rivers and Tributaries – Guild: Dry-Hydric Hardwood and Mixed Forests (EO Rank: A – 5 to 6 guild members present)

Conservation Planning Tool
Biodiversity and Wildlife Habitat: 7
Water Services: 10
Forest: High value forested areas (and threatened areas)
Ag Land: High value agriculture areas (and threatened areas)

Dry-Hydric Hardwood and Mixed Forests
State Rank
S5 – the combination of habitats used by this guild is fairly common throughout the state; several large examples occur within the Southern Coastal Plain and seem relatively secure
Habitat Description
Closed canopy forests consisting of either pure hardwoods or a mixture of hardwoods and conifers; pure stands of pines or other conifers are excluded. Similar to Dry-Wet Hardwood and Mixed Forest Guild but also includes regularly flooded riverine swamps. Mature examples, which are the focus here, typically include a stratified structure, although the density of shrubs and herbs varies with the specific community type. Hardwood leaf litter, fallen logs, and standing snags are typically plentiful.
PLANT COMMUNITIES
Includes all of the communities listed for the General Forested Floodplain and Wet Flats guild plus the types of upland hardwoods included in the Dry-Wet Hardwood and Mixed Forests guild.
NHP Natural Community Types
Fully Used Habitats
Basic Mesic Forest
Blackwater Bottomland Hardwoods

Brownwater Bottomland Hardwoods
Brownwater Levee Forest
Coastal Plain Small Stream Swamp
Maritime Deciduous Forest
Mesic Mixed Hardwood Forest
Nonriverine Wet Hardwood Forest
Nonriverine Swamp Forest
Piedmont/Coastal Plain Heath Bluff
Dry Oak–Hickory Forest (Coastal Plain Subtype)
Dry-Mesic Oak-Hickory Forest (Coastal Plain Subtype)
Dry-Mesic Basic Oak–Hickory Forest (Coastal Plain Subtype)
Coastal Fringe Evergreen Forest
Maritime Evergreen Forest (Mid-Atlantic Subtype)
Cypress--Gum Swamp
Maritime Swamp Forest
Small Depression Swamp
Tidal Swamp

Partially Used Habitats

Coastal Plain Semipermanent Impoundment
Natural Lake Shoreline Swamp
Oxbow Lake

VEGETATION COVER MAP UNITS

GAP Map Units

Fully Used Habitats

15. Seepage and Streamhead Swamps
17. Maritime Forests and Hammocks
30. Cypress-Gum Floodplain Forests
49. Coastal Plain Oak Bottomland Forest
50. Coastal Plain Mixed Bottomland Forests
63. Coastal Plain Mesic Hardwood Forests
75. Tidal Swamp Forest
78. Pond-Cypress - Gum Swamps, Savannas and Lakeshores
126. Interdune Wooded Depression Swamp
138. Coastal Plain Dry to Dry-Mesic Oak Forests
158. Coastal Plain Nonriverine Wet Flat Forests

Partially Used Habitats

380. Coastal Plain Fresh Water Emergent

Indicator Species

Species in this guild must be at least somewhat tolerant of both dry and flooded conditions during the breeding period. For bird species, frequent use of swamp habitats is based on Lynch et al. (1994).

Birds

Coccyzus americanus
Picoides villosus
Vireo flavifrons
Vireo olivaceus
Sitta carolinensis
Dendroica dominica

EO RANK SPECIFICATIONS

A – five to six guild members are present
B – three to four guild members are present
C – two guild members are present
D – one guild member is present

Core Habitat Areas

EO SPECIFICATIONS

Separation Distances:

(based on the Cuckoos and Anis, Woodpeckers, and Passerines EO Specs Groups)

Suitable Habitat = 5 km

• all types of forest are likely to be suitable for dispersal, including swamps and dry upland hardwoods

Unsuitable Habitat = 5 km

• wide tracts of non-forested habitats or large bodies of water

Minimum Habitat Units:

C-level occurrences were recorded in the headwaters of Millers Creek (Millers Creek Terrace) along Mill Creek at Pridgen Flats-Dismal Bay, and on an un-named tributary of Island Creek at Sidbury Road Savanna. In all three cases, the floodplain forest was 150 m wide or less. B-level occurrences were also recorded at the Fountain Tract and Little Alligator Swamp where only small blocks of non-riverine swamp forest exist imbedded in other types of peatland communities or pine plantations. While this suggests that at least a few species in this guild – particularly red-eyed vireo, yellow-throated vireo, and yellow-billed cuckoo – can exist in relatively small areas, only blocks of habitat meeting the default minimum requirements were mapped.

IDENTIFIED CORE HABITAT AREAS

Cape Fear, Black, and South River Floodplains

Guild Members: *Coccyzus americanus, Dendroica dominica, Picoides villosus, Sitta carolinensis, Vireo flavifrons, Vireo olivaceus*

• Black River (Sampson County): *Coccyzus americanus, Dendroica dominica, Picoides villosus, Sitta carolinensis, Vireo flavifrons, Vireo olivaceus*

• Great Coharrie Creek: *Coccyzus americanus, Dendroica dominica, Picoides villosus, Sitta carolinensis, Vireo flavifrons, Vireo olivaceus*

• Little Coharrie Creek: *Coccyzus americanus, Vireo flavifrons, Vireo olivaceus*

Occurrence References: NCMNS, 1997; Hall, 1998; LeBlond and Grant, 2000; LeBlond et al., 2001; LeBlond and Grant, 2005; LeBlond and Grant, 2006; NHP, 2006

Occurrence Rank: A

Size: 46187 ha. (114130 acres)

Forested Floodplains and Non-riverine Wet Flats

State Rank

S5 – Good quality habitat occurs throughout the state. Although less subject to logging than upland forests, large areas that have been clear-cut or converted to pine plantations can be found in most floodplains, including large tracts of swamp land that have left only open water behind.

Habitat Description

Includes the entire spectrum of forest communities associated with floodplains, from permanently flooded swamps to never-flooded, mesic stands growing on the floodplain slopes. Also includes similar wet to mesic communities growing on inter-basin flats, natural lake shorelines, or a few other mesic situations (e.g., Deciduous Maritime Forests). However, stands of mesic hardwoods located well away from floodplains and not adjoining stands of wet forest are excluded.

Composition varies widely, with no single plant species being especially characteristic. Hardwood trees are important in all types, although cypress may be dominant in some examples. Substrates range from mineral to mucky to peat. Although there is some intergradation of these habitats with woodlands or shrublands associated with deep deposits of peat, those types differ in their more open structure and lack of hardwood tree species. Pure stands of Atlantic white cedar are also excluded although they have a closed canopy structure. The status of bay forests – which consist of closed canopy stands dominated by evergreen hardwoods (particularly *Gordonia*) – is unclear with regard to supporting members of this guild.

PLANT COMMUNITIES

Communities supporting this guild combine those for the Cypress-Gum Swamp and Wet-Mesic Hardwoods Guilds. Bay forests are provisionally included, particularly since they are difficult to distinguish in the GAP Cover Map from other types of non-riverine hardwoods. Small inclusions of open water or pines – presumably loblollies, which are native to these habitats – are allowed, but larger impoundments lacking trees or large pine plantations are excluded.

Indicator Species

Due to the wide range of communities included as habitat for this guild, indicator species are associated more with structural features than plant species composition. All guild members are vertebrates that occur primarily in wet to mesic forested habitats and that are at least tolerant of regular flooding and in some cases actually require permanent standing water (e.g., anhingas, wood ducks, southeastern myotis).

Certain species of moths that feed on maples could belong to this guild, since their host plants occur in virtually all the habitats included for this guild. Currently, however, we do not have enough samples from upland stands of red maple in the Coastal Plain to distinguish species that are truly restricted to wet-mesic conditions from those that are more generalized in their habitat requirements.

Herps

Pseudacris brimleyi

Birds

Anhinga anhinga

Aix sponsa

Buteo lineatus

Strix varia

Empidonax virescens

Parula americana

Setophaga ruticilla

Protonotaria citrea

Mammals

Corynorhinus rafinesquii macrotis

Myotis austroriparius

EO RANK SPECIFICATIONS

A – nine to eleven guild members are present

B – six to eight guild members are present

C – three to five guild members are present

D – two guild members are present

Cape Fear, Black, and South River Floodplains

Guild Members: *Aix sponsa, Anhinga anhinga, Buteo lineatus, Corynorhinus rafinesquii macrotis, Empidonax virescens, Parula americana, Protonotaria citrea, Pseudacris brimleyi, Setophaga ruticilla, Strix varia*

• Great Coharrie Creek: *Buteo lineatus*, *Empidonax virescens*, *Parula americana, Protonotaria citrea, Strix varia*
• Little Coharrie Creek: *Aix sponsa, Buteo lineatus, Empidonax virescens, Parula americana, Protonotaria citrea, Setophaga ruticilla, Strix varia*
• South River (Sampson County): *Aix sponsa*, *Buteo lineatus, Empidonax virescens, Parula americana*, *Protonotaria citrea*, *Strix varia*
Occurrence References: NCMNS, 1997; LeBlond and Grant, 2000; LeBlond et al., 2001; LeBlond and Grant, 2005; LeBlond and Grant, 2006; NHP, 2006
Occurrence Rank: A
Size: 37500 ha. (92665 acres)

GREAT COHARIE CREEK SWAMP
Significant Natural Heritage Area
Site significance: State **Size:** 3,944 acres (405 primary acres, 3,539 secondary acres)
Quadrangles: Bearskin, Bonnetsville, Clinton North, Clinton South, Newton Grove South, Timothy
Ownership: State of North Carolina, private
SIGNIFICANT FEATURES: Great Coharie Creek Swamp natural area supports two populations of the Significantly Rare bluff oak (*Quercus austrina*). This oak is currently known from only five populations in the state, and both populations at this site are ranked as State Significant. The site also contains extensive areas of the Cypress–Gum Swamp natural community.
LANDSCAPE RELATIONSHIPS: This site is located in north central Sampson County along the Great Coharie Creek floodplain from the confluence with Kill Swamp downstream (south) to highway NC 24. It is isolated by distance and habitat alteration from other natural areas, with much of the intervening area converted to farm land. The natural area itself is an important 16-mile-long floodplain corridor that benefits several animal groups. Within the natural area, the primary boundary includes habitat in good natural condition and/or with other exceptional biological values, while the secondary boundary includes areas of lesser natural value, but which buffer primary habitat and/or have good restoration potential.
SITE DESCRIPTION: Great Coharie Creek Swamp natural area includes the active channels and floodplain of Great Coharie Creek along a 16-mile stretch northwest of Clinton. The creek is divided into several braided channels throughout much of the site, especially in the central and southern portions. Although some of the forested habitat has been recently cleared, much remains in fair to good condition and supports an extensive occurrence of the Cypress–Gum Swamp Blackwater Subtype natural community. Swamp tupelo (*Nyssa biflora*) is the most frequent canopy dominant, with baldcypress (*Taxodium distichum*) more prominent southward, and sweet gum (*Liquidambar styraciflua*) an important component in several areas. Other important canopy species include swamp red maple (*Acer rubrum* var. *trilobum*) and laurel oak (*Quercus laurifolia*), with Carolina ash (*Fraxinus caroliniana*) an important component of the understory. In some areas, exotic plants like privet (*Ligustrum sinense*) and chinaberry (*Melia azedarach*) have become abundant. Great Coharie Creek Swamp serves as one of the largest and most important landscape corridors in Sampson County. The floodplain habitat is used by many neotropical migrant and breeding birds, while the aquatic habitat in the active stream channels supports many species of waterbirds, fishes, and reptiles.
MANAGEMENT AND PROTECTION: Almost of the this natural area is contained within the Great Coharie Creek floodplain and requires little or no active management where canopies are mature or naturally regenerating. Most of the site is public land owned by the State of North

Carolina and managed by the Ecosystem Enhancement Program, but small areas are privately owned without protection status.

NATURAL COMMUNITIES: Cypress–Gum Swamp Blackwater Subtype.

RARE PLANTS: bluff oak (*Quercus austrina*).

RARE ANIMALS: Watch List: Swainson’s warbler (*Limnothlypis swainsonii*).

REFERENCES:

LeGrand, H.E., Jr. 2002. Site survey report: Great Coharie Creek Swamp (IP Coharie tract). N.C. Natural Heritage Program, Office of Conservation and Community Affairs, DENR, Raleigh, N.C.

Summary of Existing Data
Great Coharie Creek Local Watershed Plan Area

Prepared by NC Division of Water Quality
Watershed Assessment Team
April 30, 2009

Introduction

The upper portion of the Great Coharie Creek watershed was selected by the Ecosystem Enhancement Program (EEP) for development of a Local Watershed Plan (LWP). The LWP area (Figure 1) is approximately 53 sq. miles and located primarily in northern Sampson County, with a very small portion of the northeastern headwaters in Johnston County in the Rolling Coastal Plain ecoregion (Griffith, 2002). The entire watershed is located in hydrologic unit (HU) 03030006 and includes three cataloging units (CU): -090010, -090015, and -090020. It is also located in NC Division of Water Quality (DWQ) subbasin Cape Fear 19 (03-06-19). There are only four named streams (Great Coharie Cr., Beaverdam Sw., Kill Sw., and Sevenmile Sw.) though there are a large number of unnamed tributaries and what appear to be Carolina Bays.

Land use (Figure 2 and Appendix 1, adapted from the National Land Cover Database 2001) in the watershed is predominantly agriculture (50% by area) and forested (30%). The few developed areas (8% of total area) that are present are centered in the community of Newton Grove in the northeastern portion of the watershed.

Named streams and their corresponding NC stream index numbers are shown in Table 1. All waters in the LWP area carry the stream classification C Sw, which protects them for C class uses (including aquatic life, secondary recreation, and fish consumption) but acknowledges their natural swamp characteristics (the “Sw” secondary classification). Swamp streams often show poor flow and low dissolved oxygen levels, particularly in the summer months, as part of their natural condition.

Great Coharie Creek was listed in the 2006 NC 303(d) list as impaired for fish consumption based on a Fish Advisory for mercury in fish tissue (NC DWQ 2006b). Though this impairment was broadly applied by DWQ to all waters east of I-85 based on fish consumption advice issued by the NC Department of Health and Human Services (DHHS), fish tissue samples have been collected and analyzed for metals (including mercury) in the Great Coharie downstream at US 701 that showed exceedences of state and federal criteria for mercury concentrations.

Table 1: Named waterbodies and NC stream index numbers

Waterbody name	Description	DWQ Stream Index number
Great Coharie Creek (Blackmans Pond)	From source to Black River	18-68-1
Beaverdam Swamp	From source to Great Coharie Creek	18-68-1-1
Kill Swamp	From source to Great Coharie Creek	18-68-1-2
Sevenmile Swamp	From source to Great Coharie Creek	18-68-1-3

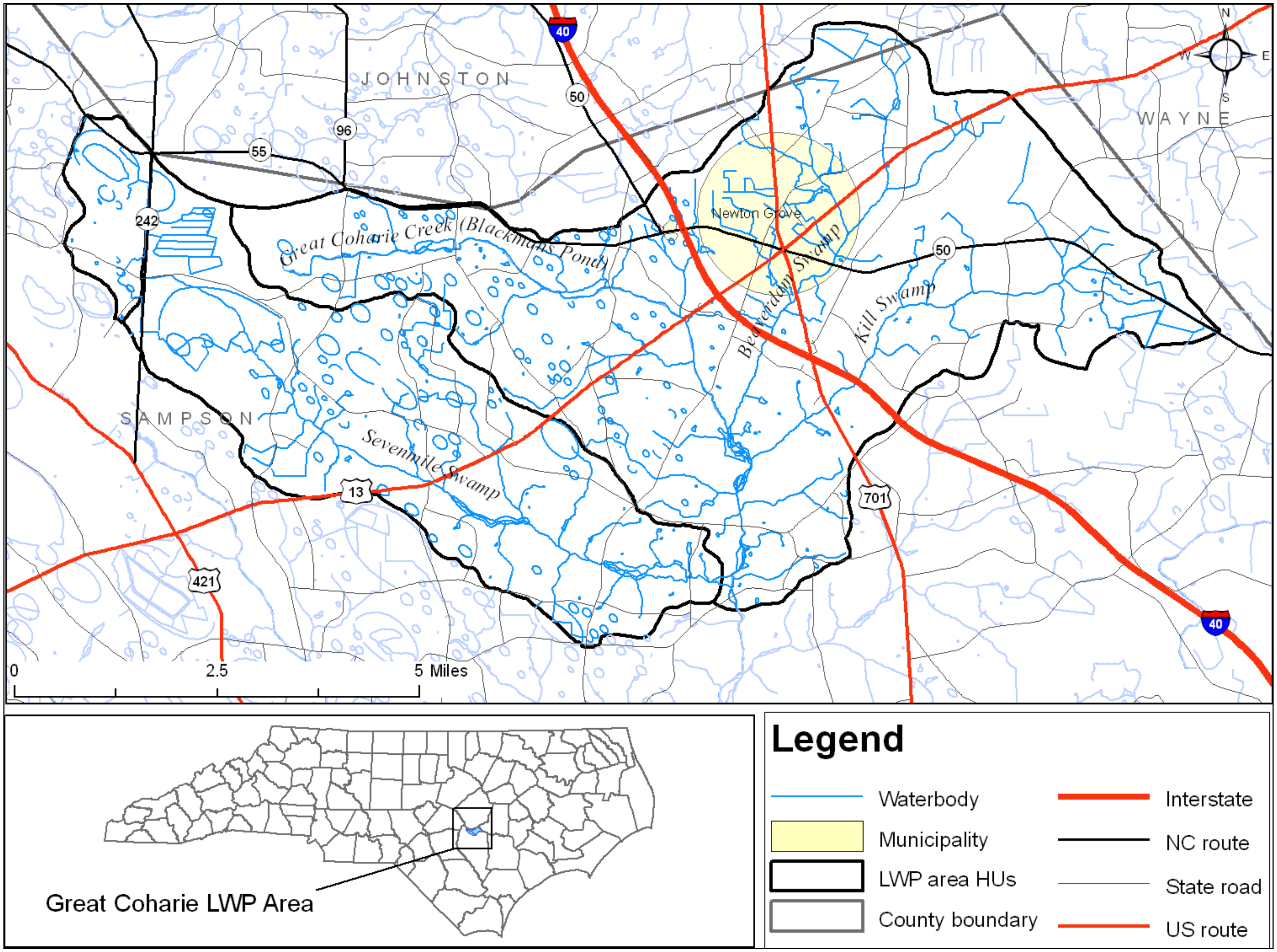

Figure 1: Overview of the Great Coharie Local Watershed Plan (LWP) Area

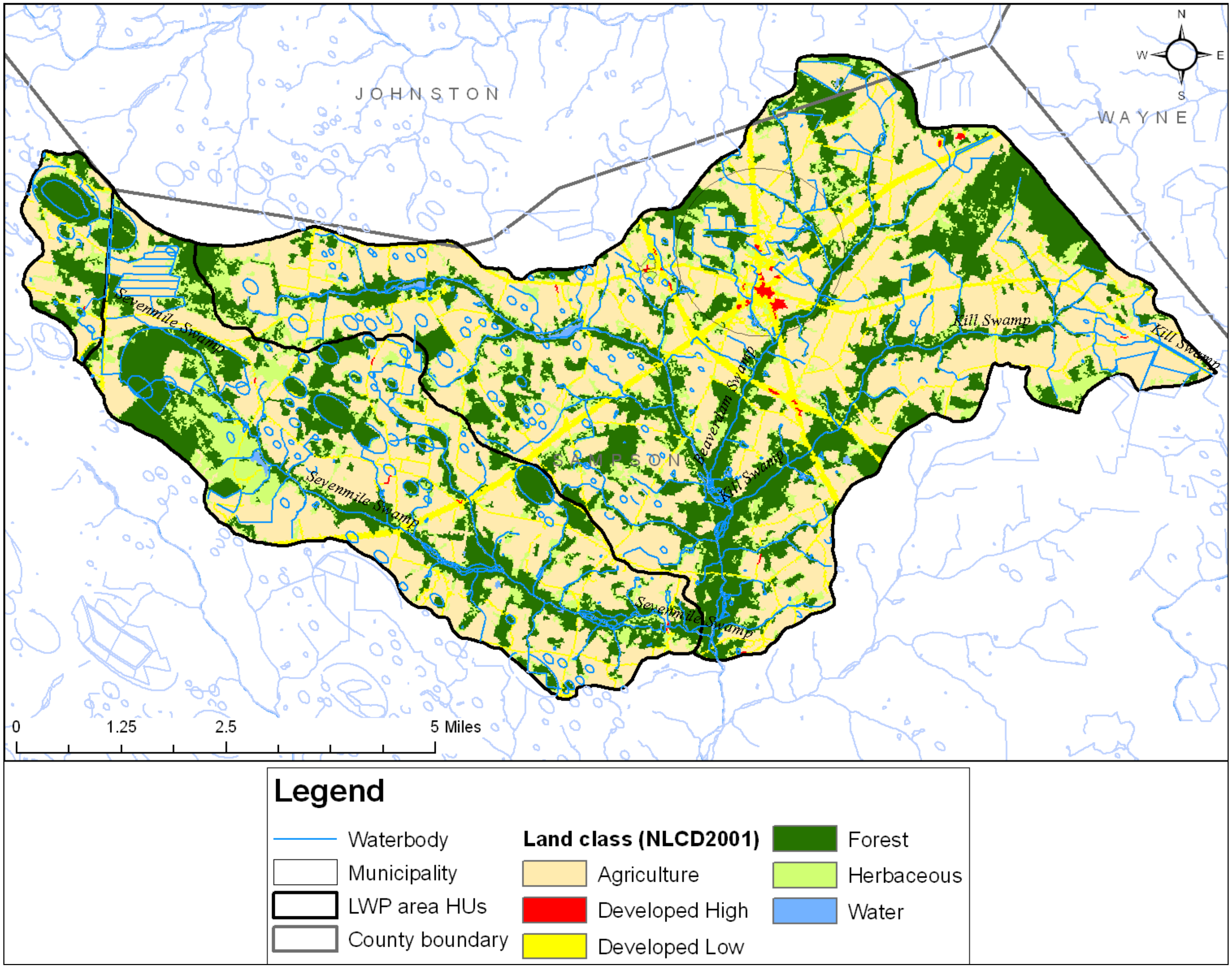

Figure 2: Aggregate land classes in the Great Coharie LWP area (adapted from NLCD2001)

Existing data

Very little water quality data has been collected in this watershed. The data that have been identified and are discussed in this document include:

- Chemical parameters collected at one location by DWQ from 1973-1979;
- Fish tissue data collected by DWQ downstream of the watershed in 2000;
- Descriptions of types of data available from four groundwater monitoring wells maintained by USGS;
- Location and description of known potential contaminant sources, such as NPDES permitted facilities, permitted animal operations, and permitted petroleum underground storage tanks (UST);
- Summary of violations and other known issues of point source dischargers.

Chemical, physical, and bacteriological data

Chemistry data have been collected at five locations in the LWP area by DWQ and the US Geological Survey (USGS). Locations are depicted in Figure 3 and described in Table 2.

Data collections by DWQ occurred at one location (station B8560000, Great Coharie Cr. at SR 1636 near Timothy) during the period of 1973-1979. Distributions of results for parameters of interest are shown in Appendix 2. The results are notable in that they appear to indicate fairly good water quality, particularly as compared with other data collected in the state during that time period.

USGS records indicate that there have been four groundwater monitoring wells located in the LWP area. Three of these had 1-2 sets of associated chemistry data, though results date back to the 1950's. The remaining well (SA-125) had a single set of chemistry results from 1999. No other data appear to be available from these wells.

Table 2: Historic monitoring locations in the Great Coharie LWP area

Agency	Site #	Description	Type	Latitude (dec deg)	Longitude (dec deg)
DWQ	B8560000	Great Coharie Cr. at SR 1636 near Timothy	Stream	35.244	-78.45
USGS	0351454078214501	SA-006 Wm & Mary Motel	GW well	35.2485	-78.3622
USGS	0351545078202501	SA-008 Catholic Ch	GW well	35.2627	-78.3400
USGS	0351344078190301	SA-009 I King	GW well	35.2291	-78.3172
USGS	0351204078231601	SA-125 GW Nitrate Site 36	GW well	35.2011	-78.3878

Biological community and habitat assessment data

No records of any benthic macroinvertebrate, fish community, habitat assessment, or toxicological monitoring were found for the LWP area.

USGS stream gages

There are no USGS stream gages located in the LWP area. The closest active gage is located on the Black River (to which the Great Coharie is a tributary) near Tomahawk (USGS station 02106500). It has been active since 1951.

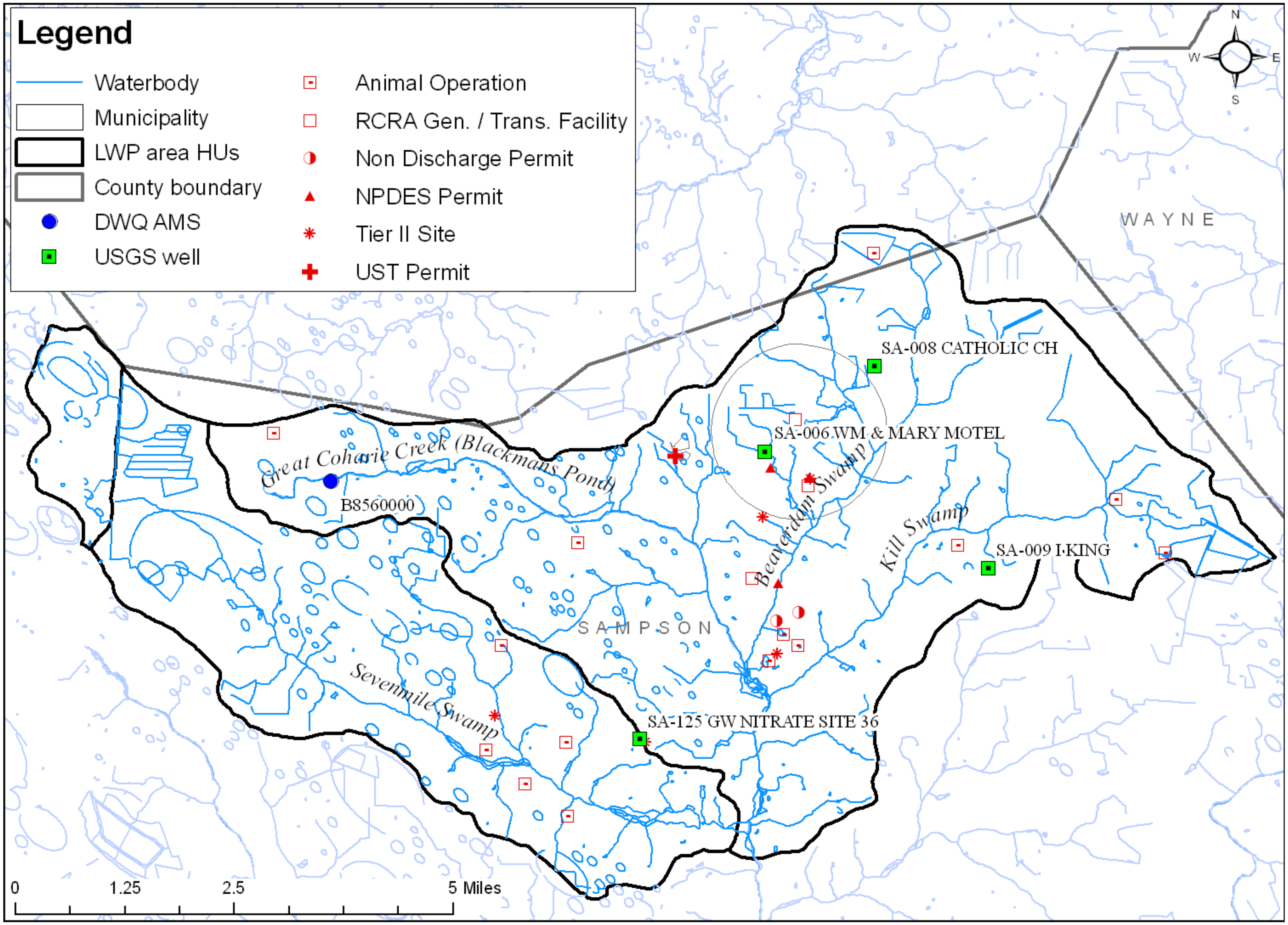

Figure 3: Monitoring locations and potential contaminant sites in the Great Coharie LWP area

Fish tissue data

Fish tissue samples were collected downstream of the LWP area in the Great Coharie Cr. at NC 701 in June 2000. Samples were analyzed for mercury, arsenic, total chromium, copper, nickel, lead, and zinc. Only mercury exceeded any state (NC) or national (FDA) criteria. NC has a criterion of 0.4 ppm for total mercury and the FDA has an action limit of 1.0 ppm. Mercury results are shown in Table 3. Thirteen of seventeen samples (76%) exceeded the NC criteria of 0.4 ppm and 5 of 17 samples (29%) exceeded the FDA criteria of 1.0 ppm. In discussions with BAU biologists, they indicated that it is generally believed that the source for the great majority of mercury found in fish tissue in NC is from aerial deposition of emissions from coal-fired power plants.

Table 3: Results of mercury analyses of fish tissue collected from Great Coharie at NC 701 in June 2000

Species	Common name	Length (cm)	Weight (g)	Sample type	Hg [1] (mg/kg)
Amia calva	Bowfin	51.5	1582	F	**<u>1.5</u>**
		49.2	1234	F	**<u>1.5</u>**
		42.5	788	F	**0.63**
		38	515	F	**0.56**
Esox niger	Chain pickerel	28.5	163	FC2	**0.5**
Lepomis auritus	Redbreast sunfish	18.1	149.5	FC2	0.38
		15.7	90	FC2	0.28
Lepomis macrochirus	Bluegill	14.1	63.5	FC2	0.3
Micropterus salmoides	Largemouth bass	42	1227	F	**<u>1.7</u>**
		42	1227	F	**<u>1.8</u>**
		34.8	670	F	**0.97**
		37.8	351	F	**0.69**
Minytrema melanops	Spotted sucker	36.8	1221	F	**0.71**
		37.2	656	F	0.34
		39.5	841	F	**0.55**
Perca flavescens	Yellow perch	25.2	197	F	**<u>1.2</u>**
		23.8	152	F	**0.52**

[1] Results in **bold** exceed the NC criteria for Hg of 0.4 ppm. Results in **<u>bold/underline</u>** also exceeded the FDA action level for Hg of 1.0 ppm.

Potential contaminant sources

Potential contaminant sources were identified using a GIS layer of regulated facilities and activities compiled by the NC Division of Environmental Health (Source Water Assessment and Protection [SWAP] program). There were 28 features listed as “Potential Contaminant Sources” (Figure 3), which consisted primarily of animal operations and NPDES permitted facilities.

Animal Operations

There are fourteen permitted animal operations (all swine) in the LWP area. Current permit numbers and latitudes/longitudes were obtained from the DWQ Basinwide Information Management System (BIMS) and are shown in Table 4. It is suspected that due to their size and number, these animal operations may have some water quality impacts in the LWP area due to runoff from the feedlots themselves, from overland and atmospheric transport of pollutants from land application of waste, and from atmospheric transport of pollutants such as ammonia from lagoons as well as feedlots.

Table 4: Permitted animal operations in the Great Coharie LWP area

Permit number	Facility Name	Latitude (dec. deg.)	Longitude (dec. deg.)
AWS820013	Warren Swine Farms	35.232930	-78.323372
AWS820049	Rosin Hill Farms, Inc.	35.200558	-78.402786
AWS820067	Pork Chop Hill Finishing	35.218236	-78.358683
AWS820094	Pork Chop Hill	35.213975	-78.361652
AWS820125	Circle L	35.233688	-78.400047
AWS820177	Thomas Gene Edwards Farm	35.240255	-78.291430
AWS820229	P&J Farms	35.231363	-78.281555
AWS820271	TDM #5	35.199416	-78.418822
AWS820284	G&R Farms	35.216722	-78.415733
AWS820305	Ronald Wooten Farm	35.252088	-78.461472
AWS820488	Pork Chop Hill Finishing #6	35.216466	-78.355758
AWS820610	JH Farm	35.188350	-78.402519
AWS820699	TDM 30 (Best Bros.)	35.193813	-78.410988
AWS510128	TDM Farm 29 (W.T. Herring 100 ac. Site)	35.281400	-78.340000

NPDES permitted facilities

The only individual NPDES permit in the LWP area is the Newton Grove WWTP (permit NC0072877). It is a minor (<1MGD permitted flow) municipal treatment plant that handles primarily domestic (90%) and a small amount of industrial (10%) wastewater. The WWTP discharges to Beaverdam Swamp. Chemical parameters required for self-monitoring of their effluent are fairly standard (biological oxygen demand [BOD], chlorine, fecal coliform, dissolved oxygen [DO], flow, ammonia, total nitrogen, pH, total phosphorus, total suspended solids [TSS], and temperature). Fecal coliform, DO, and temperature monitoring is also required in Beaverdam Creek upstream and downstream of the outfall.

A review of the WWTP's recent history (1/2004-12/2008) showed a number of violations of permit limits for BOD, fecal coliform, DO, ammonia nitrogen, TSS, and pH (Appendix 3). The monthly and weekly average BOD was the limit most commonly violated, though almost half of them (six of fourteen) were from a single six-week period in early 2007. Only two BOD limit violations were reported in 2008. The other parameters' limits were violated much less frequently, generally only 1-4 times within the last five years. DWQ has initiated seven enforcement actions (e.g., Notices of Violation) against the WWTP in the last five years.

Two other facilities are covered under NPDES stormwater general permits: Hog Slat, Inc. (NCG030310) and S&W Ready Mix Concrete (NCG140028). These would not be anticipated to have a large impact on water quality in the LWP area.

Table 5: Individual and general NPDES permitted facilities in the Great Coharie LWP area

Permit number	Facility Name	Latitude (decimal degrees)	Longitude (decimal degrees)
NC0072877	Newton Grove WWTP	35.225000	-78.358890
NCG030310	Hog Slat Inc- Newton Grove Site	35.244167	-78.353333
NCG140028	S&W Ready Mix Concrete	35.245833	-78.361111

Other Potential Contaminant Sources

The other "potential contaminant sources" shown on the DEH GIS layer include four RCRA (Resource Conservation and Recovery Act) general/transportation facilities, two non-discharge permits, five Tier II facilities, and one permitted petroleum underground storage tank (UST).

Watershed reconnaissance

In February 2009, WAT staff spent a day visiting sixteen stream sites at road crossings throughout the watershed. Land use appeared to be largely agriculture, with particularly large tracts of cotton in the northwest portion of the LWP area, and much of the agricultural area was receiving active land application of wastewater. As for animal operations, there were some cows and horses in pasture, but the majoritywere hog farms, which seemed to be more concentrated in the lower part of the watershed. The developed area around Newton Grove was fairly small. Agricultural ditches were extremely common, though it is not known if the majority of these may have been channelized streams or drained wetlands.

The streams themselves appeared to be typical swamp streams, generally characterized by poor flow with some tannin. Impoundments were common. Some were the result of manmade dams but beaver activity appeared to be particularly high in this area. The few stream reaches where good flow was noted were below millponds. In much of the watershed, riparian wetlands were present, and the streams were flooding them. It may be that as higher winter water levels fall at least some of the streams may develop more flow and more distinct channels, but most sites were not wadeable at the time of reconnaissance. If poor flow and lack of wadeable areas are present year-round, they will preclude using standard DWQ methods for water quality sampling, or will limit the sampling to only certain times of the year (likely spring and fall).

Filamentous algae and macrophytes were abundant at many sites, indicating nutrient enrichment. This was particularly noted in Beaverdam Cr. above the WWTP outfall. None of the field parameters suggested obvious water quality concerns. DO and pH seemed in line with what is to be expected in swamp streams in the winter, with averages for DO concentration of 10.4 mg/L (range 7.8-11.9 mg/L), DO saturation of 79% (range 59-99%), and pH of 5.9 SU (range 5.5-6.4SU). Specific conductance averaged 105 uS/cm at 25°C (perhaps slightly elevated over what might be expected) but showed a slightly wider range (73-133 uS/cm at 25°C) than other parameters. Conductance appeared to be slightly higher in the eastern portion of the watershed (Beaverdam and Kill Swamps), but with no obvious cause seen.

Summary of main findings

Due to the paucity of existing data in the watershed, few findings can be stated for the LWP area. Recent reconnaissance confirmed that many of the streams are low energy, tannic, swamp streams. Many of the reaches visited had good contact with their riparian wetlands. Many sites showed signs of nutrient enrichment, such as heavy filamentous algal growth. Beaver activity was high, and some fairly large and extensive dams were present at some sites.

Land use was strongly predominated by agriculture, including a large amount of acreage that appears to be used for land application of treated wastewater, such as lagoon effluent. There are very large tracts in the northwest portion of the watershed that are in cotton cultivation, which is a crop that traditionally has been more dependent on herbicides/defoliants and pesticides.

The only data that suggested a specific water quality concern in the LWP area were from fish tissue samples collected in the Great Coharie several miles downstream. The great majority of samples exceeded NC criteria for concentrations of mercury. However, the source of the mercury is likely from coal-fired power plants well outside of the LWP area.

Data gaps and monitoring needs

Possible issues affecting water quality that were identified in this LWP area include:

- Extensive agricultural land use, including animal operations and row crops;
- Instream indicators of nutrient enrichment;
- Possible slight elevation of specific conductance in the eastern half of the LWP area;
- A point source discharger with a history of permit limit violations;
- A small area of development around the town of Newton Grove;
- High levels of mercury in fish tissue downstream;
- Extensive historic ditching of wetlands;
- A number of manmade dams;
- Extensive beaver activity.

As virtually no data have been collected in the past in the LWP area, there are extremely significant gaps to be addressed to address these issues. However, these gaps will likely be difficult to fill, as many of the streams may be borderline or wholly inappropriate for many of DWQ's traditional monitoring methods. This is a particular issue for biological communities, such as benthic macroinvertebrates and fish. Fish community methods are not applicable to streams south of Lillington in the Cape Fear River basin, which excludes this LWP area. Benthic macroinvertebrate SOPs include swamp stream methodology and criteria, but streams must be wadeable and must have visible flow, as taxa found in non-flowing waters cannot be used to differentiate between water quality or habitat issues and conditions attributable to naturally poor flow and low dissolved oxygen levels. However, an attempt should be made collect benthos samples where possible on the major named tributaries to screen for possible stressors. It may be particularly useful to compare the eastern (Beaverdam Swamp and Kill Swamp) and western (Sevenmile Swamp and upper Great Coharie Cr.) portions of the watershed, as specific conductances may be slightly elevated in the eastern portion.

Chemical sampling would be helpful, particularly to address concerns over nutrient enrichment, increased fecal coliform levels, and sedimentation due to the heavy agricultural uses in the LWP area. Lack of flow may limit the available sites for this, or at least limit the time of year that it is possible. DWQ lake monitoring methods may be useful in some areas (such as Blackman's Pond), though WAT lacks the resources and equipment (e.g., boats) to perform these. Stormflow sampling will likely not be beneficial in this watershed due to the large number of wetlands, which generally mediate the hydrology somewhat, preventing "flashy" hydrology and therefore storm samples are often not appreciable different from baseflow.

A survey of wetland condition may be useful, as wetlands are fairly prevalent in the watershed and the quantity and quality of wetlands can have direct impacts on instream water quality and hydrology. A cursory review of aerial photos suggests that many of the historic wetlands in the area have been ditched and are now in active agricultural use, and a better understanding of the extent of this wetland loss may also be useful to the LWP process.

The developed area around Newton Grove is fairly small. Further reconnaissance should be done in the area to determine if data collections would be worthwhile to assess the extent of "urban" impacts. These could be focused on hydrology (i.e., to determine relative flashiness) or instream measures of physical condition, such as habitat assessments, BEHI, stage/discharge, pebble counts, etc., though, again, natural swamp stream characteristics will limit the applicability of some of these methods.

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Appendix 1: Land Use by Category

The following table summarizes percent contribution of each land classification in the Great Coharie Creek Local Watershed Plan area. These data were calculated from the National Land Cover Database (NLCD) 2001. The definitions for the NLCD land classes are available from the Multi-Resolution Characteristics Consortium (MRLC) website at http://www.mrlc.gov/nlcd_definitions.php. The aggregate categories shown were developed in conjunction with EEP planning staff during previous projects and are what are shown in Figure 2 of the main document text.

Aggregate land class	% of LWP area	NLCD land class	% of LWP area
Agriculture	49.7%	Cultivated Crops	49.2%
		Hay/Pasture	0.5%
Developed High	0.2%	Developed, High Intensity	0.0%
		Developed, Medium Intensity	0.2%
Developed Low	7.5%	Developed, Low Intensity	1.5%
		Developed, Open Space	6.1%
Forest	30.3%	Deciduous Forest	3.9%
		Emergent Herbaceous Wetlands	0.5%
		Evergreen Forest	9.0%
		Mixed Forest	5.6%
		Woody Wetlands	11.3%
Herbaceous	12.0%	Barren Land	0.6%
		Herbaceous	7.0%
		Shrub/Scrub	4.3%
Water	0.3%	Open Water	0.3%

Appendix 2: Summary of chemical data collected by DWQ

The table below provides a summary of analytical data collected by DWQ at site B8560000, Great Coharie Creek at SR 1636 near Timothy between December 1973 and March 1979. The total number of results, number and percent of results that were reported as less than the reporting limit (non-detect), and percentiles for each STORET method code and parameter name are shown, though percentiles are omitted for parameters where all results were non-detects.

			Non-detects		Percentiles						
Method code	Parameter name	# results	#	%	Min	10th	25th	50th	75th	90th	Max
10	Water temperature (°C)	55	0	0	4	6.6	11.0	15	21	24.52	30
45	Precipitation previous 24 hrs. (in.)	42	1	2	0	0	0.0	0	0	0.235	0.8
60	Stream flow (cfs)	4	0	0	0	0	2.5	11	13.5	14	14
61	Stream flow - inst-(cfs)	2	0	0	0	0	0.0	1	2	2	2
65	Stream stage (feet)	24	0	0	3.72	4.23	5.0	5.57	5.83	6.11	6.52
78	Secchi Transparency (m)	2	0	0	0.33	0.33	0.3	0.415	0.5	0.5	0.5
95	Conductivity lab (umho/cm @25ºC)	51	0	0	20	30	40.0	50	60	60	70
300	Dissolved oxygen (mg/L)	55	0	0	1.8	3.8	6.0	7.6	8.9	10.2	12.8
301	Dissolved oxygen saturation (%)	47	0	0	6.3	37	53.0	72	86.5	95.2	158
310	BOD 5 day (mg/L)	54	1	2	0.1	0.4	0.7	1	1.4	2.1	3.7
335	COD low level (mg/L)	1	1	100	-	-	-	-	-	-	-
340	COD high level (mg/L)	51	13	25	10	16	20.0	25	30	34.8	68
400	pH (SU)	48	0	0	4.5	4.9	5.3	5.7	6	6.8	7
410	Alkalinity total as CaCO3 (mg/L)	48	0	0	0	1.9	3.3	6	11.7	18.2	500
415	Alkalinity phenolphthalein (mg/L)	12	0	0	0	0	0.0	0	0	0	0
435	Acidity total as CaCO3 (mg/L)	19	0	0	10	13	15.0	24	30	31	50
436	Acidity mineral (mg/L)	2	0	0	0	0	0.0	0	0	0	0
610	Ammonia nitrogen (mg/L)	19	11	58	0.05	0.05	0.1	0.05	0.09	0.17	0.35
625	Total Kjeldahl nitrogen TKN as N (mg/L)	20	0	0	0.05	0.2	0.2	0.3	0.5	0.6	0.8
630	Nitrate/nitrite NO2 + NO3 as nitrogen (mg/L)	20	0	0	0.13	0.14	0.2	0.53	0.73	1.1	1.3
660	Orthopo4 po4 mg/l	1	1	100	-	-	-	-	-	-	-
665	Phosphorus total as P (mg/L)	20	9	45	0.05	0.05	0.1	0.05	0.09	0.18	0.25
927	Magnesium Mg total (mg/L)	1	1	100	-	-	-	-	-	-	-
1000	Arsenic as - diss ug/l	1	1	100	-	-	-	-	-	-	-

Method code	Parameter name	# results	Non-detects		Percentiles						
			#	%	Min	10th	25th	50th	75th	90th	Max
1002	Arsenic As total (ug/L)	14	11	79	10	10	10.0	10	15	40	50
1025	Cadmium Cd dissolved (ug/L)	1	1	100	-	-	-	-	-	-	-
1027	Cadmium Cd total (ug/L)	15	14	93	28	41.2	50.0	50	50	50	50
1034	Chromium Cr total (ug/L)	16	16	100	-	-	-	-	-	-	-
1036	Cobalt co - susp ug/l	1	1	100	-	-	-	-	-	-	-
1037	Cobalt Co total (ug/L)	15	15	100	-	-	-	-	-	-	-
1040	Copper cu - diss ug/l	1	1	100	-	-	-	-	-	-	-
1042	Copper Cu total (ug/L)	15	15	100	-	-	-	-	-	-	-
1045	Iron Fe total (ug/L)	16	0	0	100	107	237.5	405	800	2630	4800
1051	Lead Pb total (ug/L)	15	14	93	100	100	100.0	100	100	140	200
1055	Manganese Mn (ug/L)	14	13	93	50	50	50.0	50	50	70	90
1056	Mangnesemn - diss ug/l	1	0	0	100	100	100.0	100	100	100	100
1067	Nickel Ni total (ug/L)	3	3	100	-	-	-	-	-	-	-
1090	Zinc zn - diss ug/l	1	1	100	-	-	-	-	-	-	-
1092	Zinc Zn total (ug/L)	15	15	100	-	-	-	-	-	-	-
1099	Antimonytis-wet mg/kg	1	1	100	-	-	-	-	-	-	-
31504	Tot colimfim les /100ml	5	0	0	30	30	205	1200	1400	1600	1600
31616	Fecal coliform MF method (colonies/100mL)	55	8	15	10	10	20	70	270	760	1900
70305	Salinitycnductvy g/l	11	0	0	0	0	0.0	0	0	0	0
70507	Phosphorus in total orthophosphate as P (mg/L)	2	2	100	-	-	-	-	-	-	-
71900	Mercury Hg total (ug/L)	16	14	88	0.5	0.5	0.5	0.5	0.5	1.08	2.2
72034	Instant spillway cfs	5	0	0	0	0	0.0	2	3	3	3
82079	Turbidity lab (NTU)	12	0	0	2	2	3.0	4	8.8	11.7	12

Appendix 3: Newton Grove WWTP Permit Limit Violations

A report of all permit limit violations for the Newton Grove WWTP (permit NC0072877) for the period of January 1, 2004- March 12, 2009 was extracted from the DWQ Basinwide Information Management System. Results are shown below.

Parameter	Violation date	Sampling frequency	Units	Limit	Calculated value	Violation Type	Violation Action
BOD, 5-Day (20 Deg. C)	10/30/04	Weekly	mg/l	7.5	9.3	Weekly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	02/12/05	Weekly	mg/l	15.	15.2	Weekly Ave. Exceeded	Proceed to NOV
BOD, 5-Day (20 Deg. C)	04/02/05	Weekly	mg/l	7.5	9.4	Weekly Ave. Exceeded	No Action, BIMS Calc. Error
BOD, 5-Day (20 Deg. C)	02/18/06	Weekly	mg/l	15.	23.6	Weekly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	02/25/06	Weekly	mg/l	15.	29.4	Weekly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	02/28/06	Weekly	mg/l	10.	16.75	Monthly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	09/23/06	Weekly	mg/l	7.5	7.6	Weekly Ave. Exceeded	Proceed to NOV
BOD, 5-Day (20 Deg. C)	04/21/07	Weekly	mg/l	7.5	8.3	Weekly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	04/28/07	Weekly	mg/l	7.5	9.7	Weekly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	04/30/07	Weekly	mg/l	5.	7.	Monthly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	05/12/07	Weekly	mg/l	7.5	11.2	Weekly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	05/31/07	Weekly	mg/l	5.	5.85	Monthly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	06/09/07	Weekly	mg/l	7.5	8.	Weekly Ave. Exceeded	Proceed to NOV
BOD, 5-Day (20 Deg. C)	01/26/08	Weekly	mg/l	15.	20.4	Weekly Ave. Exceeded	Proceed to Enforcement Case
BOD, 5-Day (20 Deg. C)	01/31/08	Weekly	mg/l	10.	10.42	Monthly Ave. Exceeded	Proceed to Enforcement Case
Coliform, Fecal MF, M-FC Broth,44.5C	01/05/08	Weekly	#/100ml	400.	5,400.	Weekly Geomean	Proceed to Enforcement

						Exceeded	Case
DO, Oxygen, Dissolved	03/10/04	Weekly	mg/l	5.	4.8	Daily Min. Not Reached	No Action, BPJ
Nitrogen, Ammonia Total (as N)	12/31/04	Weekly	mg/l	4.	4.94	Monthly Ave. Exceeded	Proceed to Enforcement Case
Nitrogen, Ammonia Total (as N)	01/31/05	Weekly	mg/l	4.	4.1	Monthly Ave. Exceeded	Proceed to NOV
Nitrogen, Ammonia Total (as N)	04/12/08	Weekly	mg/l	6.	9.66	Weekly Ave. Exceeded	Proceed to Enforcement Case
Nitrogen, Ammonia Total (as N)	04/30/08	Weekly	mg/l	2.	3.57	Monthly Ave. Exceeded	Proceed to Enforcement Case
Solids, Total Suspended	02/18/06	Weekly	mg/l	45.	55.	Weekly Ave. Exceeded	Proceed to Enforcement Case
Solids, Total Suspended	02/25/06	Weekly	mg/l	45.	48.	Weekly Ave. Exceeded	Proceed to Enforcement Case
pH	02/16/06	Weekly	su	6.	5.82	Daily Min. Not Reached	Proceed to Enforcement Case