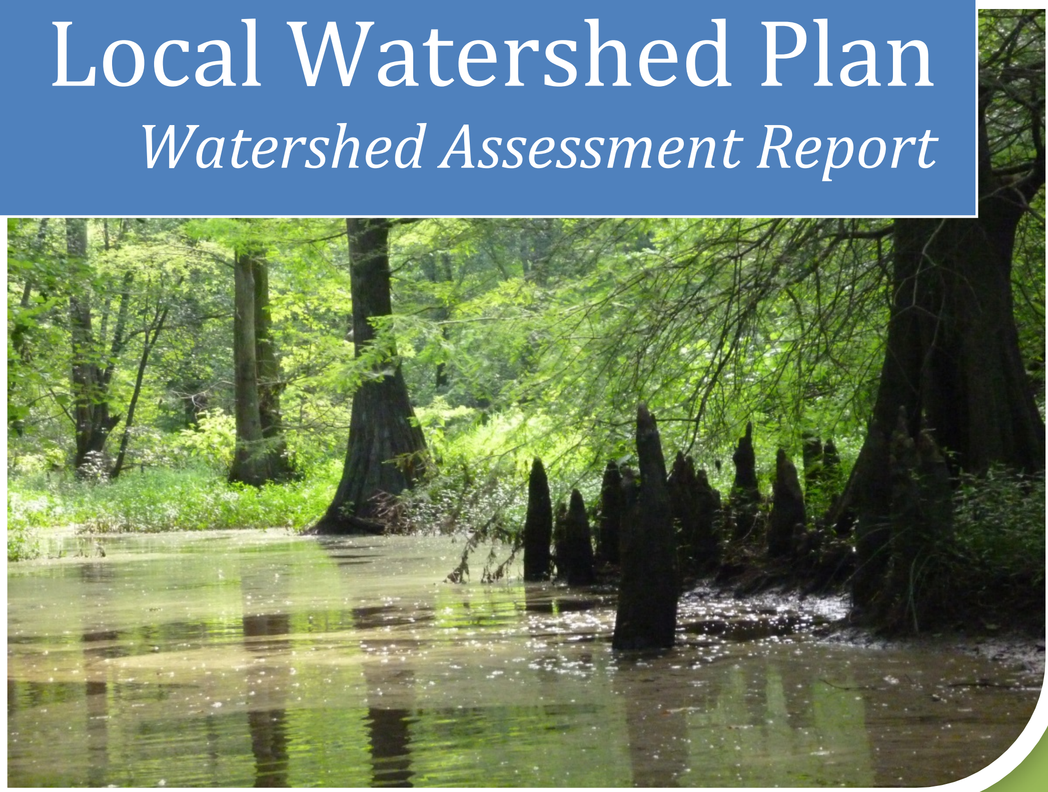
October 2014

FINAL

Great Coharie Creek Local Watershed Plan

Watershed Assessment Report



Prepared For: NC Ecosystem Enhancement Program

Prepared By: Triangle J Council of Governments

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Executive Summary

This document summarizes the activities and results of Phase II of the process to develop a Local Watershed Plan (LWP) for the headwaters of the Great Coharie Creek area, a 53 square mile watershed in northern Sampson County in North Carolina, including the Town of Newton Grove (see Figure 1). This report was prepared by Triangle J Council of Governments (TJCOG), and the project was conducted in partnership with the NC Ecosystem Enhancement Program (EEP) and the NC DENR Division of Water Resources (DWR), following EEP's phased Local Watershed Planning Process. EEP's LWP process includes a Phase I – Preliminary Watershed Characterization, Phase II – Detailed Watershed Assessment, and Phase III – Watershed Management Plan and Project Atlas. The ultimate purpose of EEP local watershed planning is to identify a suite of potential management actions to protect ecological assets and address problems to improve watershed functions. EEP uses LWPs to guide its stream, wetland and buffer mitigation efforts, and involves local stakeholders so the LWP can be used locally to improve watershed conditions. This planning study is being developed with the help of a Local Advisory Team (LAT) that includes representatives from local government, conservation and recreation organizations, and local resource agencies. A list of the LAT Members can be found in Appendix A.

Phase I of the Great Coharie Creek Local Watershed Planning (LWP) process focused on characterizing the watersheds, and concluded in 2010. Phase II of the NCEEP Great Coharie Creek LWP process, focused on watershed assessment, began in July 2010. The purpose of Phase II of the LWP was to determine the functional integrity of streams and other aquatic systems in the watershed; identify the key stressors and their sources impacting water quality, habitat, and hydrology; and identify problem areas and key assets in the watershed.

The success of this LWP is rooted in the active interest and continuing participation of a variety of stakeholders. The stakeholder process was designed to involve community stakeholders into a Local Advisory Team (LAT), consisting of several dozen active stakeholders in this watershed that broadly represent several interests and was the primary engagement group over the course of LWP Phases I-III. Through the course of the project, from 2009-2014, the GCC LAT met 13 times plus had two field trips and two dinner meetings in Newton Grove.

Developing Great Coharie Creek LWP Assessment Goals & Assessment Objectives was one of the first key tasks taken on by the LAT in Phase I. The Assessment Objectives helped steer the data collection and assessment conducted in Phase II. The Goals the LAT developed for the LWP include:

- 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 the 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; and,
- Ensure the goals of the planning effort align with the conservation and economic goals of the community.

A few key assessment objectives include:

- **Water Quality Objectives – WQ4**. Enhance our understanding of how pollutants are processed from the headwaters to the main stem of Great Coharie Creek;
- **Habitat Objectives – HB3**. Identify invasive aquatic species and better understand their impact on habitat, water quality and flow;
- **Hydrology Objectives – HD1**. Correct hydrology GIS data and determine stream classifications; and,
- **Social Objectives – SL1**. Understand how the community values and interacts with the aquatic resources.

During the development of Phase II of this LWP many partners collaborated to collect and analyze various types of data throughout this watershed. Partners include DWR Watershed Assessment Team, NC DWR Biological Assessment Unit, and the NC Ecosystem Enhancement Program. The data that was collected includes but is not limited to habitat and benthic macroinvertebrate assessments, physical and chemical water quality data, stream and wetland assessments and desktop analysis.

Water quality monitoring data reveal that nutrient enrichment and low dissolved oxygen are the two most important water quality problems, although low dissolved oxygen seems to be a normal, natural condition for a blackwater swamp stream. Water quality data and conditions for aquatic life within Great Coharie Creek were similar to those observed in nearby Cape Fear basin coastal plain swamp streams (both agriculturally impacted and Colly Creek, which was used as a reference for comparing water quality results).

Surface runoff from agricultural and developed lands is quickly drained and transported to mainstem streams through a vast, interconnected network of ditch and waterways, which may account for nutrient issues observed in the watersheds. In the mainstem streams, water moves slowly and inundates the floodplain. Water quality monitoring indicated that nutrient and sediment loads were highest in low-order channels (streams, ditches and waterways) and decreased (i.e., improved) through the mainstem streams. Water quality at the outlet of the study area was better than in the headwaters.

To summarize the water quality functions in the watershed, agricultural and developed areas with ditches void of riparian vegetation are sources of nutrients and sediment that enter ditches, waterways and streams. The slow moving mainstem streams with wide, inundated floodplains retain and process nutrients, cleaning the water as it moves through the watershed. The vast network of streams, waterways and ditches has a profound influence on the hydrology and water quality of the system. The high density of ditches means that precipitation and accompanying sediment and pollutants are rapidly transported from the uplands through the ditches and waterways to the streams. However, the low slope of the ditches and streams, coupled with the numerous flow obstructions and dense aquatic vegetation serves to slow the water and decrease the velocity and stream energy in the mainstem channels.

Based on these findings, efforts to restore and protect the Great Coharie Creek local watershed should focus on two primary areas:

- **Reduce runoff and erosion** and by slowing water, nutrients and sediment at their source in the fields. This could be accomplished through agricultural BMPs, installing vegetated buffers along ditches and waterways, and allowing ditches to become naturalized with plants and wider flood-prone widths; and,

- **Protect the riparian floodplains**. These seasonally flooded mainstem riparian zones are the most important watershed assets of the Great Coharie Creek study area and provide tremendous ecological functions. They help sustain the rich natural heritage in the Great Coharie Creek and the Black River.

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SECTION 1. Introduction

This *Watershed Assessment Report* (WAR) presents the methods and results of the Great Coharie Creek watershed assessment conducted for the North Carolina Department of Environment and Natural Resources (NC DENR) Ecosystem Enhancement Program (EEP). This document summarizes the activities and results of Phase II of the process to develop a Local Watershed Plan (LWP) for the headwaters of the Great Coharie Creek area, a 53 square mile watershed in northern Sampson County including the Town of Newton Grove (Figure 1). This assessment was conducted by Triangle J Council of Governments (TJCOG) in cooperation with the EEP and the NC DENR Division of Water Resources (DWR) (formerly the Division of Water Quality). This planning study is being developed with the help of a Local Advisory Team (LAT) that includes representatives from local government, conservation and recreation organizations, and local resource agencies. A list of the LAT Members can be found in Appendix A.

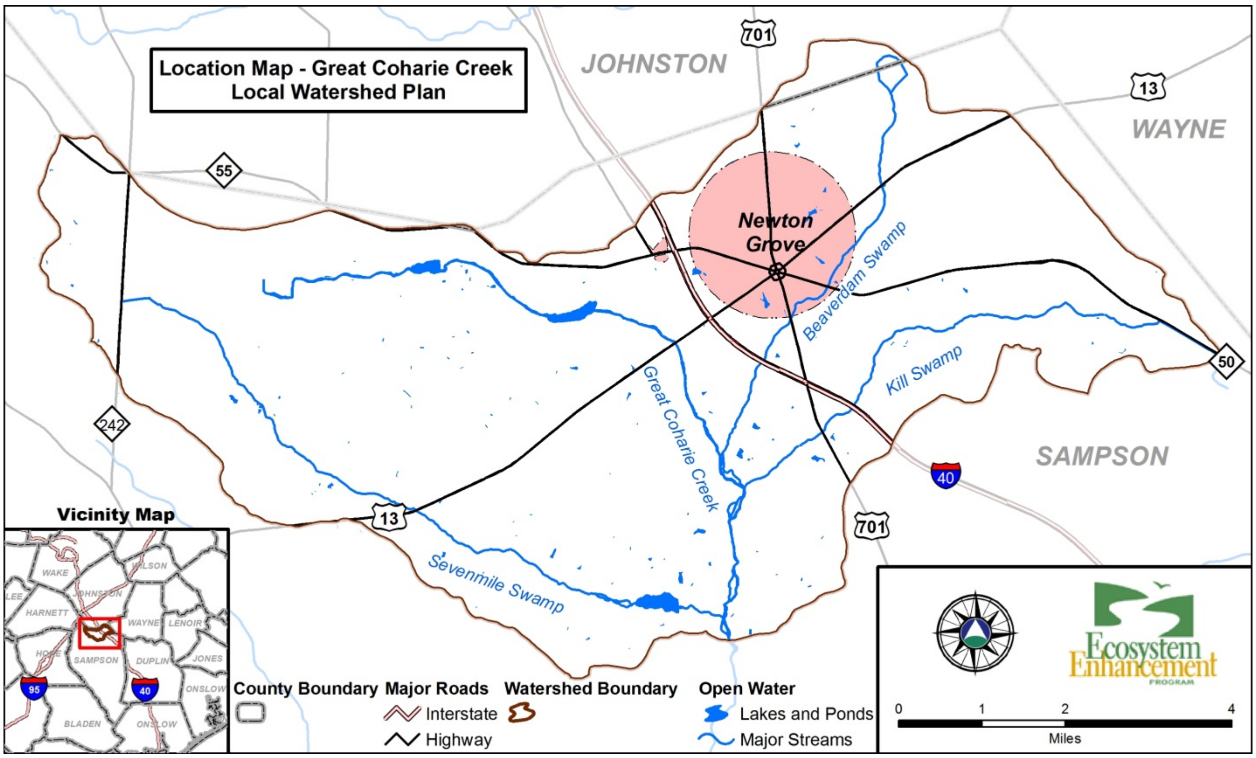

Figure 1. Great Coharie Creek local watershed planning area location map.

1.1. LWP Process and Background

EEP develops LWPs in a phased approach that includes a Phase I – Preliminary Watershed Characterization, Phase II – Detailed Watershed Assessment, and Phase III – Watershed Management Plan and Project Atlas. The ultimate purpose of EEP local watershed planning is to identify a suite of potential management actions to protect ecological assets and address problems to improve watershed functions. EEP uses LWPs to guide its stream, wetland and buffer mitigation efforts, and involves local stakeholders so the LWP can be used locally to improve watershed conditions.

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

1.2. Summary of Phase I Findings and Recommendations

The Phase I report: *Great Coharie Creek Preliminary Findings Report* (EEP, 2010) included a preliminary characterization of the watershed planning area and the following summary of planning and local objectives for watershed assessments.

Table 1. Great Coharie Creek local watershed planning objectives from Phase I.

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 the downstream end of subwatersheds, or where accessible, to isolate pollutant sources.
WQ3. Identify key sources and stressors in areas where biological monitoring has indicated impacted 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.

1.2.1. Subwatersheds and Catchments

One key outcome from Phase I was the delineation of subwatersheds and catchments. The Great Coharie Creek LWP study area was divided into five subwatersheds for each of the named streams (Sevenmile Swamp *[SMS]*, Kill Swamp *[KS]*, Beaverdam Swamp *[BDS]*, and Great Coharie, which is split into Great Coharie Headwaters *[GCH]* for the upper reaches and Great Coharie Creek *[GCC]* that includes the outlet of the LWP study area. Catchments and subwatershed are shown in Figure 2**.**

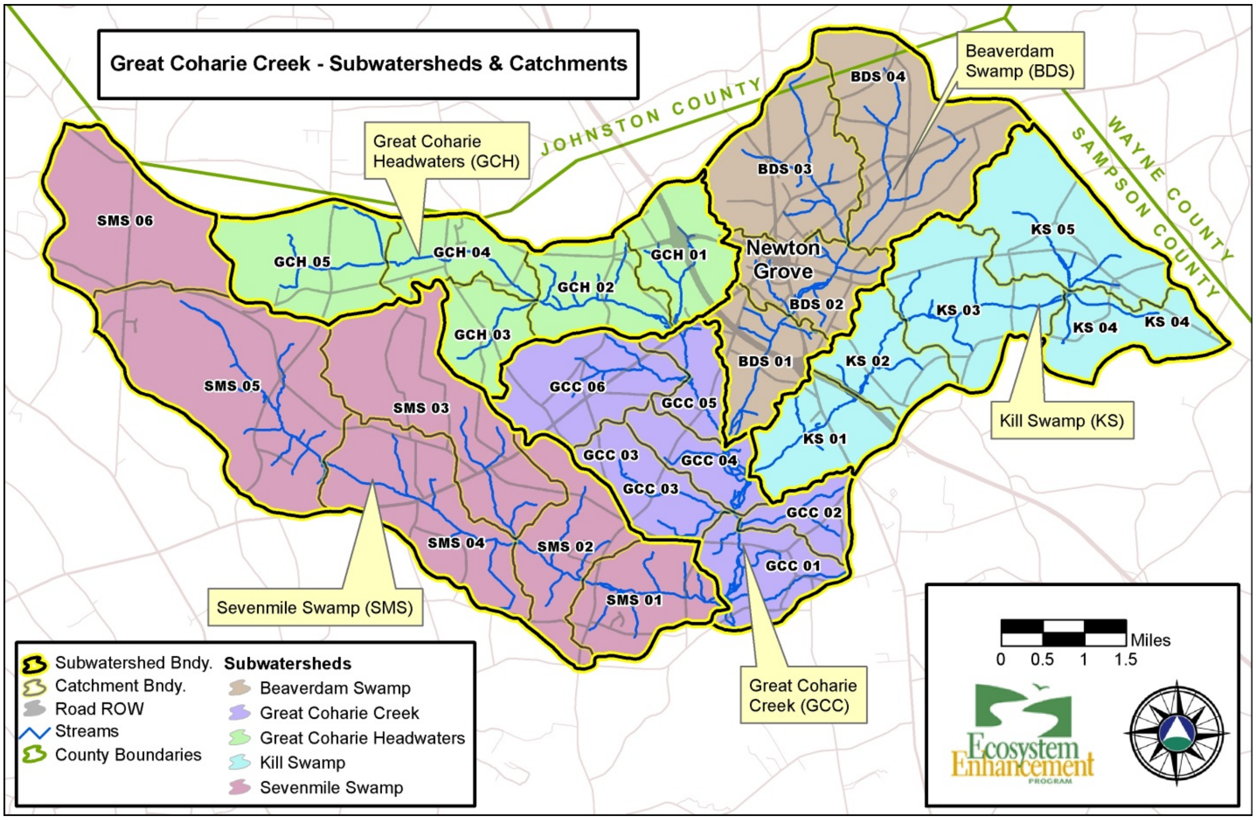

Figure 2. Great Coharie Creek subwatersheds and catchments.

1.3. Goals and Objectives of Phase II Watershed Assessment

In the second phase of the project, the data collection efforts of the DWR-WAT and TJCOG's Stream Reach Assessments were driven by the objectives listed above, particularly the objectives under the headings of Water Quality, Habitat, and Hydrology.

The major goals of Phase II were to:

1. Determine the functional integrity of streams and other aquatic systems in the watershed;
2. Identify the key stressors and their sources and problem areas that are impacting water quality, habitat and hydrology; and,
3. Identify key ecological assets in the watershed.

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SECTION 2. Methods

This section describes the methods used to assess the watershed conditions. These included:

- 2.1 GIS Data – GIS analysis of detailed land use, surface hydrology and wetlands;
- 2.2 Wetland Data – Desktop and field assessment of wetland conditions;
- 2.3 Biological Data – Field assessment of benthic macroinvertebrates and habitat conditions;
- 2.4 Water Column Data – Monitoring and assessment of water quality; and,
- 2.5 Habitat and Channel Data – Field assessment of stream channel conditions and riparian buffers.

2.1. GIS Data

GIS data includes spatial and tabular data associated with specific locations. In Phase I, GIS data were compiled and analyzed to provide preliminary watershed characterizations. During Phase I, a detailed field-scale land use layer was developed and subsequently refined in Phase II through limited field verification. Phase II addressed GIS data gaps identified in Phase I, including surface hydrology and wetlands. Surface hydrology in this context includes the full network of streams, ditches, waterways, lakes, ponds, and other impoundments. The GIS summary below is divided into subsections for land use; streams, waterways and ditches; and swine lagoons, open water, and impoundments. Wetland is discussed separately in Section 2.2.

2.1.1. Land Use

A detailed land use GIS data layer was developed from aerial photographs in Phase I; however, some classification uncertainties existed between animal operations and agricultural operations land use types. The uncertain areas were flagged on field maps, and TJCOG staff made land use observations and notes while traveling around the watershed during the stream assessment work (see Section 2.5.2). The land use categories were then corrected based on the field-verified land use type.

Also, building footprints were acquired from the NC Floodplain Mapping Program. Buildings were added to the GCC land use layer as a new land use category.

2.1.2. Streams, Waterways and Ditches

The process for developing detailed hydrology layers for streams, waterways and ditches began with the statewide USGS 24K surface hydrology dataset that was developed from USGS 1:24,000 USGS topographic maps. The process included:

- separating Carolina bays, open water, swine lagoons, streams and ditches into separate layers;
- correcting the spatial location of streams from aerial photographs;
- creating a layer of potential waterways based on topography; and,
- digitizing ditches from aerial photographs.

2.1.2.1. Streams

The USGS 24K stream layer included a number of different types of features, including streams, ditches, Carolina bays, artificial flow paths, impoundments, and wetlands. Open water features were removed from the polyline layer. More about the open water polygon layer is described in Section 2.1.3.

Using topography as a guide, features were differentiated by streams or ditches. A feature was classified as a ditch if no stream valley was indicated on the topography. Features within a stream valley were classified as streams. Features classified as ditches were then put into a separate layer of ditches. The features on the stream layer were then spatially corrected based on their visible location on 2010 high-resolution aerial photographs. Finally, flow paths through impoundments were added or verified to ensure a connected stream network.

2.1.2.2. Potential Waterways

Following a procedure developed by researchers at EEP and East Carolina University as part of the Coastal Plain Stream and Riparian Zone Assessment protocol (ECU 2005), TJCOG created a layer of additional small ephemeral and intermittent surface water features and chose the term “potential waterways” to describe them. Potential waterways were digitized using USGS 7.5’ topographic quads where two or more contour lines curved at 90 degrees or sharper (see Figure 2). In the Great Coharie Creek (GCC) study area, these small waterway features exist exclusively in the transition zones between the flat uplands and the wide mainstem floodplains. These transition areas have the steepest slopes in the watershed and are transected with numerous natural valleys in which these potential waterways exist.

The potential waterway features that were digitized from USGS topo maps were then examined on high-resolution aerial photographs. Where a channel was visible on the aerial photos, the potential waterway was spatially aligned, or if the aerial photo clearly showed the lack of a channel, the feature was removed.

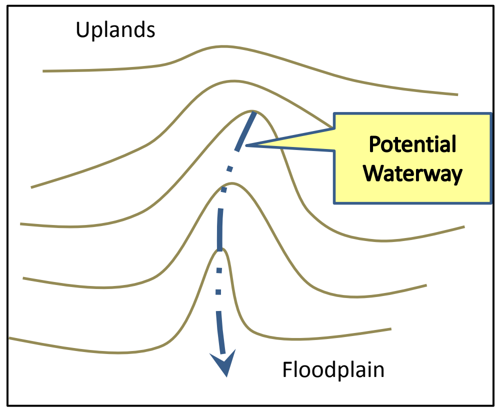

Figure 3. Diagram of potential waterway where two or more contours bend at an acute angle.

2.1.2.3. Ditches

Beginning with the features from the original USGS 24K layer that were classified as ditches (because of the lack of a defined stream valley), these features were spatially corrected based on 2010 aerial photos. Additional ditches were identified and digitized from aerials at an average scale of 1:2,000. The GCC watershed area had a tremendous amount of ditches along roadways, in developed areas, and within and along the edges of fields. Based on aerial photographs and field observations, nearly every field has ditches along its edges, but in places where a ditch was not visible on the aerial because of tree cover, it may have been excluded, so this layer is a conservative estimate of ditches.

2.1.3. Swine Lagoons, Open Water, and Seasonally Flooded

The process for developing swine lagoons, open water, and seasonally flooded datasets began with the statewide USGS 24K polygon surface hydrology layer and a point location data set of swine lagoons. The process included:

- identifying and correcting swine lagoons;
- correcting the spatial location of open water features from aerial photographs and adding new open water features;

- creating a layer of seasonally flooded areas; and,
- merging the data into the detailed land use layer.

2.1.3.1. Swine Lagoons

The process of creating swine lagoon polygons began with a statewide layer of hydrography polygons and a point layer of swine lagoons. For each point feature in the swine lagoon layer, the aerial photographs and hydrography layer was examined. If a polygon layer was in the hydrography layer, it was coded as a swine lagoon. Then the aerial photograph was used to verify the presence of and location of the lagoon. Boundaries were corrected based on aerial photographs. The features were also inspected on the aerial photographs to confirm whether they were waste lagoons. In many cases waste lagoons appeared red or brown in aerials, whereas farm ponds appeared blue or almost black. The presence of livestock buildings were also used to corroborate waste lagoons.

Once polygons were created, verified and spatially corrected to align with the point features, other areas with land use classified as animal operation were inspected on aerial photographs for other lagoons that may not have been on the initial point layer. Once all the features were added to a swine lagoon layer, these polygons were merged into the detailed land use layer.

2.1.3.2. Open Water

A layer of open water including ponds and lakes was created from a statewide layer of hydrography polygons. This layer was adjusted by correcting spatial locations based on 2010 aerial photographs. Additional manmade open water impoundments and farm ponds were digitized from visual inspection of aerial photographs. Once all the open water polygons were checked and corrected, the open water features were merged into the detailed land use layer.

2.1.3.3. Seasonally Flooded

The initial goal was to create a layer of beaver impoundments. Several beaver dams and impoundments were visible on aerial photographs, but dense riparian vegetation also made visual inspection from aerial photographs difficult along many waterways. A ground-level investigation provided insights into the magnitude and pervasive nature of impoundments along the mainstem streams, which led to a change in the approach for mapping impoundments.

After inspecting aerial photographs, it became clear that much of the mainstem channel conditions were obstructed by dense riparian vegetation. To see what conditions were like on the ground, two TJCOG staff spent a day paddling Great Coharie Creek with members of Friends of Sampson County Waterways. The trip covered approximately two miles of Great Coharie Creek, from McLamb Road to Rosin Hill Road. GPS was used to track the path and waypoints were collected at various features along the way. Over the two-mile stretch, 30 flow obstructions were identified. These included two active beaver dams, two abandoned beaver dams and many fallen trees. It became apparent that the entire mainstem channel in this section exists as an inundated channel with many flow obstructions and multiple flow paths. The low slope of the channel means that even a small fallen tree can become a flow obstruction backing up water. Based on aerial photos, this section of the stream is typical of the mainstem channels, which was also corroborated from observations at other road crossings in the watershed.

Armed with the knowledge that the entire mainstem channel exists as an interconnected network of multi-thread swamp channels created by multiple flow obstructions, the objective for the creation of this data layer was modified. Rather than delineate discrete beaver impoundments, TJCOG focused on determining spatial extent of the seasonally inundated areas along the mainstem streams. The areas contain many obstructions from natural causes (as distinct from open water, which are manmade impoundments).

Using the aerial photographs overlaid with contour data and the 100-year floodplain, the boundaries of impounded areas were digitized from the aerials where visible and inferred from contours and floodplain boundaries where they were obstructed with forest cover. In some places with forest cover, there was a visible change in vegetation at the margins of the impounded areas, which was used as another clue in delineating the boundaries of impounded areas. Because the extent of the impounded area is somewhat variable from season to season and depends on rainfall and runoff as well as groundwater inflows, the name for this data layer was changed to seasonally flooded. Once the features were delineated and checked against aerial photos, the data were merged into the detailed land use layer.

2.2. Wetland Data

The LWP study area has a tremendous amount of wetlands. It was noted in the Great Coharie Creek Preliminary Finding Report (EEP 2010) that 95% of the soils in the study area are hydric soils. Hydric soils are one factor in determining the presence of jurisdictional wetlands, and the dominance of hydric soils indicates that much of the watershed study area is capable of supporting wetlands.

Given this information, it was determined that wetlands would not be a land use class in the detailed land use layer, but rather a separate data layer that can be used as an overlay to land use. TJCOG evaluated several datasets and determined NC CREWS to have the most utility.

2.2.1. NCCREWS GIS Analysis

The NC CREWS data set contains three separate data layers. The CREWS layer contains values for the wetland evaluation and significance analysis conducted as part of the NC CREWS process. A “wets” layer is also part of the NC CREWS data, and it contains information about wetland types as estimated by the NC CREWS analysis. There is also a “rest” layer that contains information about wetland restoration potential.

During the GCC project, TJCOG experimented with different ways to apply and evaluate the NC CREWS data. A novel approach was developed to identify areas that contain potentially intact wetlands, wetlands with enhancement potential, and former wetland areas potentially suitable for wetland restoration. The wets data layer contains polygons expected to be jurisdictional wetlands, including those that are intact and impacted. The rest layer includes areas where wetland enhancement or restoration are possible.

By combining or overlapping the two layers in GIS, three distinct types of polygons were created.

- polygons that were only in the original wets layer;
- polygons that were in both the original wets and rest layers; and,
- polygons that were only in the original rest layer.

If a polygon was only in the original wets layer (i.e., not in the rest layer), it was considered an existing wetland with no restoration potential, and was classified as a *potentially intact wetland.* If a polygon was in both the wets and rest layer, it was considered an existing wetland with restoration potential, and was classified as a *potentially degraded wetland.* If a polygon was only in the rest layer (i.e., not in the wets layer), it was considered not to be an existing wetland, but had wetland restoration potential. It was therefore classified as a potential former wetland.

This wetland analysis approach with the NC CREWS data has not been conducted previously to our knowledge, but it could provide utility beyond the study area to provide a quick screening approach for identifying potential wetland preservation, enhancement and restoration opportunities where the NC CREWS data is available.

2.2.2. DWR Wetlands Assessment

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

2.2.2.1. Site Selection

EEP and TJCOG selected a subset of sites within subwatersheds identified as priorities for wetland restoration in the *Great Coharie Creek Preliminary Findings Report* (EEP, 2010). TJCOG utilized the NC CREWS data to identify potential wetland enhancement opportunities for further evaluation. Based on the distribution of wetland types in the subwatersheds, the predominant wetland types were mapped as pine flats, hardwood flats and managed pineland, together comprising 91% of the wetlands by acreage in the priority subwatersheds. The analysis then identified the largest (greater than 20 ac) contiguous wetlands within each of these main types including both drained and un-drained (drained being the primary modification for these types of wetlands). In addition to identifying 77 sites appropriate for enhancement, 87 wet hardwood/pine flats and 88 wet swamps were identified to serve as potential reference sites.

TJCOG culled this list to a more manageable set of 36 potential sites, which were prioritized based on the number of owners/parcels, site location (e.g., proximity to roads, location on the parcel, etc.), wetland size, and the degree of wetness based upon aerial photography analysis. The prioritized list included eight sites listed as high priority. EEP chose 9 total sites; 6 sites expected to have enhancement or restoration potential and 3 sites expected to serve as reference sites for the field assessment.

2.2.2.2. Wetland Field Assessments

Functional assessments were conducted on these nine wetland sites by DWR, TJCOG and EEP staff using the NCWAM assessment methodology. The field staff were all trained in NCWAM, but had varying levels of experience with NCWAM. Staff assessed wetlands along the outer 30-50 feet of the area and in multiple locations to capture any differences in wetland type or function.

DWR produced a report, “Evaluation of Wetland Function in Selected Wetlands in the Great Coharie Creek Watershed: Technical Memorandum” (2013a) that describes the wetland assessment and results.

2.3. Biological Data

The Biological Assessment Unit (BAU) of DWR conducted benthic macroinvertebrate studies at several mainstem locations in the study area in February and March 2010. The purpose of their study was to 1) identify impacted stream segments that may require immediate attention; and 2) provide baseline data to help assess the biological response to future management strategies. The BAU report, “Results of Macroinvertebrate Assessment in the Upper GCC Watershed Conducted in February and March 2010” (2010) presents the process and results of benthic sampling.

Benthic samples were collected using swamp methods according to the July 2006 version of DWR Standard Operating Procedures for Benthic Macroinvertebrates. A qualitative scoring system for coastal streams was used to evaluate habitat and classify sampling locations as Natural, moderately stressed ("Moderate Stress"), or severely stressed ("Severe Stress"). Temperature, dissolved oxygen, pH, and specific conductance were also measured.

2.4. Water Column Data

DWR-WAT conducted water quality monitoring and assessments at numerous locations in the watershed (see Figure 4). The purpose of the water quality sampling effort was 1) to characterize water quality at benthos sites and exit points of the four major subwatersheds, 2) to locate sources of stream degradation and nutrient enrichment, and 3) to identify possible water quality stressors on aquatic life (DWR-WAT, 2013b).

During the routine monitoring phase, field parameters were measured and samples were collected for lab analysis at 12 stations on a monthly basis from July 2010 to June 2011. Field parameters included dissolved oxygen, specific conductance, water temperature, and pH. Lab analysis included fecal coliform bacteria, ammonia as N, nitrite+nitrate as N, Total Kjeldahl as N, total phosphorous, total suspended solids, and turbidity.

Data must be compared against water quality standards or watershed reference conditions. Water quality standards do not exist for swamp streams, and it was difficult to identify a suitable reference watershed with adequate data for comparison. Nearby Colly Creek was determined to be an adequate reference, because it had a similar level of impoundedness and was also a blackwater system. Data were also collected in nearby Colly Creek to help characterize swamp stream reference conditions for comparison with the extensively modified Great Coharie LWP. Data from Colly Creek sampling provide a point of comparison from a less impacted watershed. See Appendix D for more information about the impoundedness assessment conducted for Colly Creek and GCC.

Follow up water quality assessments involved measuring physical parameters and collecting water column samples at 73 locations (on generally smaller tributaries than the monitoring stations) from December 2010 to June 2011 to help target sources and identify water quality hot spots. All data were collected during base flow conditions (more than 48 hours since the last measurable rain event). The LWP area experienced varying degrees of drought during the assessment period (abnormally dry to moderate to severe drought). Therefore, flow was relatively low at all assessment sites, but flow measurements did follow a normal seasonal trend normal (higher in winter and spring, lower in summer and fall).

Since these sites were not gaged, two methods were used to characterize flow conditions. WAT used discharge from a USGS gage located downstream on the Black River near Tomahawk as a reference for general flow conditions within the region. Also, when each sample was taken at a given station, WAT staff made a visual estimate of relative flow using a four-point scale.

Data were collected in 2013 at five previous monitoring stations in the LWP area and at nearby agriculturally impacted and reference swamp streams. Examination of BOD and nutrients in other nearby agriculturally impacted streams and the reference stream suggests that low dissolved oxygen in the Great Coharie Creek LWP area is largely a natural phenomenon resulting from extremely low flow and impounding, possibly exacerbated somewhat by dense growths of aquatic vegetation (DWR-WAT 2013b).

DWR produced three reports on the water quality monitoring activities, and more detailed information on each of these studies can be found within the reports listed below.

- "Summary of Water Quality Monitoring Results for the Great Coharie Creek LWP Area: Technical Memorandum." Report dated March 29, 2012. This report briefly summarizes the findings of water quality monitoring at twelve sites within the Great Coharie Creek LWP area (2012a).
- "Results of Water Quality Assessments in the Great Coharie Creek LWP Area: Technical Memorandum." Report dated June, 2012. This report summarizes findings of water quality follow up assessments to locate potential sources of water quality degradation and nutrient enrichment across the LWP area (2012b).
- "Water Quality Integrated Analysis Report for the Great Coharie Creek Local Watershed Plan: Final Report." Report dated November 2013. This report provides a discussion and interpretation of the significant findings of water quality investigations conducted within the Great Coharie Creek LWP area (2013b).

2.5. Habitat and Channel Data

Habitat and channel conditions were investigated by DWR and TJCOG during the course of this project. DWR conducted an aquatic vegetation study and collected data on habitat conditions during water quality monitoring and assessment. TJCOG conducted stream assessments that evaluated channel and riparian zone conditions.

2.5.1. DWR Vegetation Surveys

DWR-WAT conducted visual surveys of aquatic vegetation in the Great Coharie Creek LWP area at 73 locations in the spring and summer of 2011. Objectives of the survey were: 1) to assess dominant weedy vegetation within the Great Coharie Creek LWP area, 2) relate the potential impacts of dense growths of vegetation on water quality, and 3) provide stakeholders with information to leverage funding for management activities. In addition, the surveys provided additional information to examine the relationships between benthic macroinvertebrate populations and presence of vegetation. A description of the visual survey methods and results is included in the DWR report, "Distribution of Vegetation in the Great Coharie Creek Local Watershed Planning Area: Final Report" (2012c). A summary of the results are provided in the results section of this report below.

2.5.2. TJCOG Stream Reach Field Assessments

TJCOG conducted stream channel field assessments in June 2012 at areas that were likely to be impacted/degraded. The overall purpose of the Stream Reach Field Assessments was to 1) assess stream sites that seem to indicate, via desktop analysis, potential for restoration or enhancement projects to improve hydrology, habitat, and/or water quality functions and 2) to document baseline conditions at these sites to help evaluate functional uplift provided by future restoration or enhancement projects or watershed management activities. As such, sites were selected for field assessment that appeared to be impacted in some way.

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SECTION 3. Results

The following section provides a summary of the results of the watershed assessment along with information about the stressors and sources in the watershed, problem areas, assets and the functional assessment.

3.1. Results

This section summarizes the results of the field assessments and GIS analysis.

3.1.1. Field Assessments

This section summarizes the results of the field assessments including biological data, water column data, habitat and channel data, and wetland assessment data. Field assessment sites are shown on Figure 4.

3.1.1.1. Biological Data – Benthic Macroinvertebrates

Prior to the LWP assessment, no benthic data existed for the LWP watershed area. DWR-BAU conducted benthic monitoring at nine mainstem locations in 2010, including at least one site on each of the named tributaries. Sites were selected based on flow and wadeability. Seven sites were swamp-like in character; only two were stream-like.

Benthic sample results were reported in terms of Total Taxa Richness, EPT Richness, and NC Biotic Index (NCBI) values. EPT Richness is the number of insect order *Ephemeroptera* (mayfly), *Plecoptera* (stonefly), and *Trichopera* (caddisfly) taxa and is important because these insect orders are more environmentally sensitive so their presence indicates higher quality water. Eight sites were rated as Moderate Stress and one site, the downstream-most site near the outlet of the watershed area, was rated as Natural.

DWR-BAU classified the nine sites as shown in Table 2.

Table 2. Great Coharie Creek bioclassification results.

Subwatershed	Site No.	Results
Sevenmile Swamp	US 13	Moderate Stress
Sevenmile Swamp	SR 1703	Moderate Stress
Kill Swamp	NC 50/55	*Not Rated (Moderate Stress)
Kill Swamp	SR 1710	Moderate Stress
Kill Swamp	SR 1706	Moderate Stress
Kill Swamp	US 701	Moderate Stress
Beaverdam Swamp	Bizzell St./Newton Grove	Moderate Stress
Great Coharie Creek	SR 1703	Moderate Stress
Great Coharie Creek	SR 1636	Natural

There was, however, a large degree of variation within the Moderate bioclassification, and six of the nine sites scored within one point of “severely stressed”. The one site that rated Natural, SR 1636, the downstream most site in the watershed , also had the largest substrates (most sites had only sand). The site with the worst NCBI value was KS 1710, which was adjacent to an active pasture.

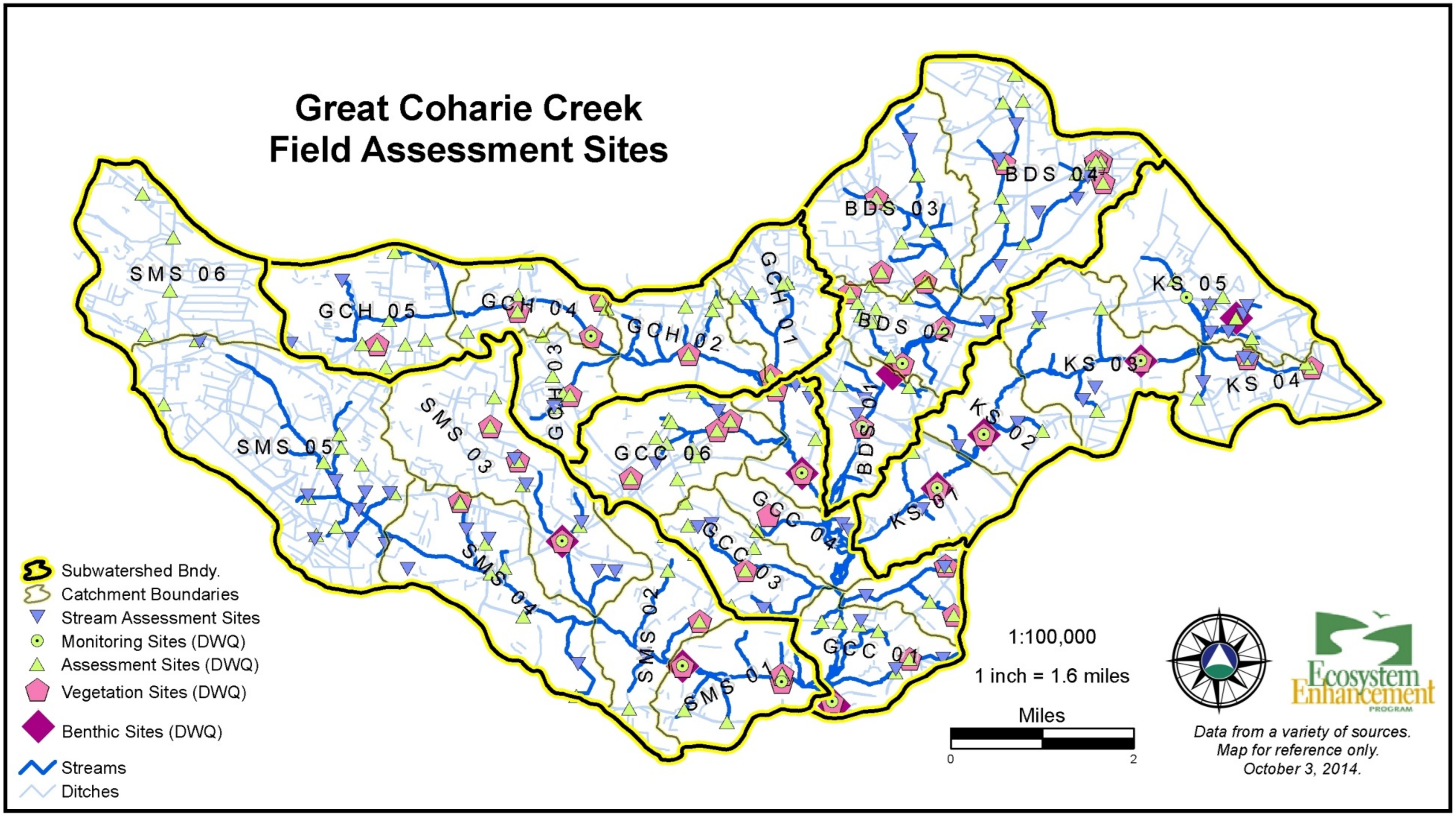

Figure 4. Great Coharie Creek field assessment site map.

According to the DWR-BAU report (2010), because of a lack of correlation between biotic indicators and water chemistry, local conditions (e.g., habitat or channel morphology) may be affecting the benthic community more than water-borne stressors. DWR-BAU staff found no indications of specific water-borne stressors that may be impacting the benthic community at the nine sites. Habitat and channel morphology were determined to be a larger influence than water quality in the structure of the communities at each site.

3.1.1.2. Water Column Data – DWR Water Quality Sampling

Water quality data, along with channel and habitat data can help us understand aquatic resource stressors in the LWP area. The following section summarizes the results of water quality sampling, including regular monitoring, follow up assessments, and reference study. Field assessment locations are shown in Figure 4.

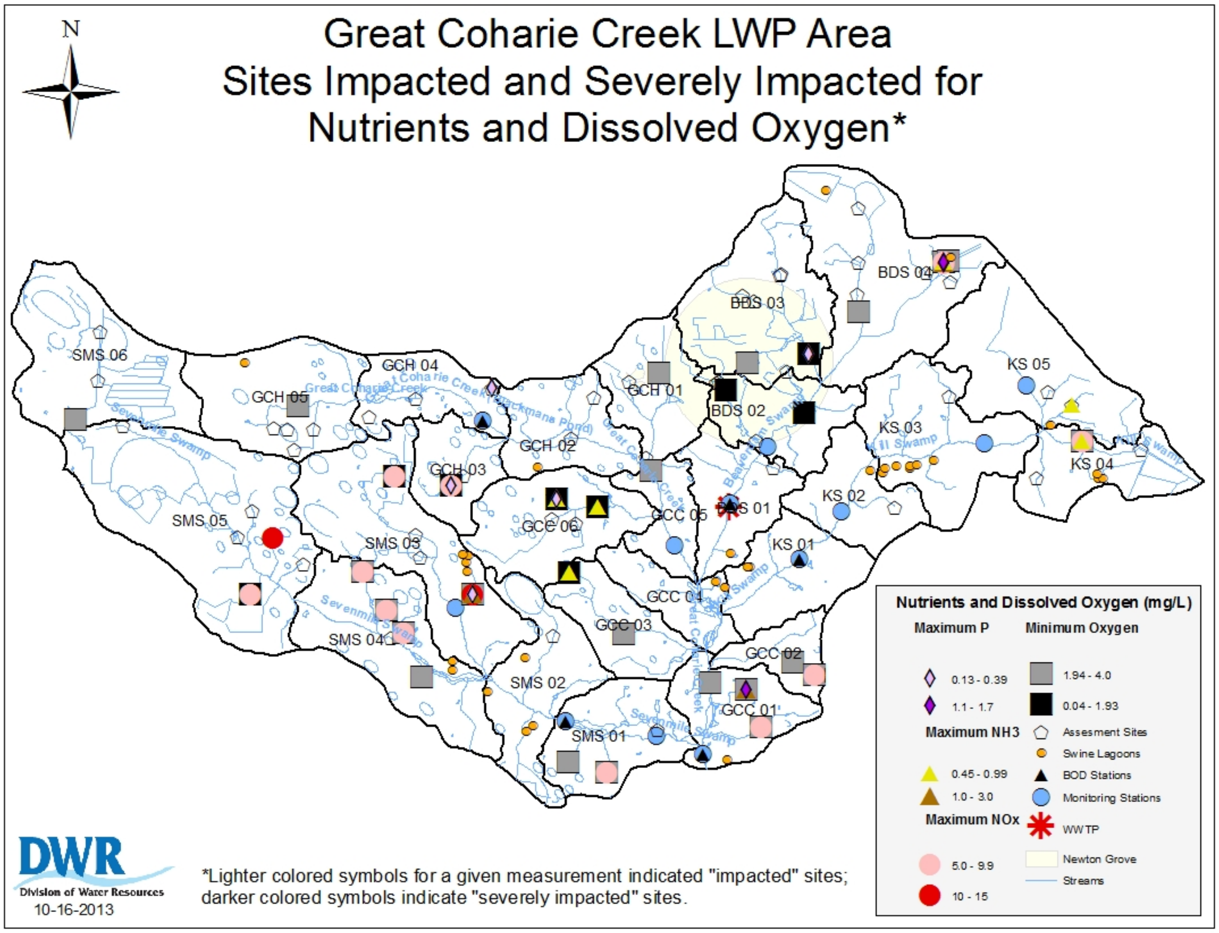

Figure 5. Water quality monitoring stations impacted for nutrients or dissolved oxygen. Excerpted from the DWR-WAT Integrated Report (2013b).

Water quality monitoring data reveal that nutrient enrichment and low dissolved oxygen are the two most important water quality problems, although low dissolved oxygen seems to be a normal, natural condition for a blackwater swamp stream. Water quality data and conditions for aquatic life within Great Coharie Creek were similar to those observed in nearby Cape Fear basin coastal plain swamp streams (both agriculturally impacted and the reference). Benthic communities within the LWP area, although lacking in numbers or variety of species, are in similar condition as those in other swamp streams in the lower Cape Fear basin (DWR-WAT 2013b).

Low flow appears to have a significant impact on dissolved oxygen. Low dissolved oxygen occurred across the LWP area, particularly during the warm months, and appears to be related to a combination of natural swamp conditions, beaver dams, and potentially anthropogenic impacts (dams, road blockages, and nutrient enrichment). Flow was impacted by a combination of low rainfall within the Great Coharie Creek region and the presence of swamp conditions, including artificial impoundments and an abundance of beaver dams. Low flow and impounding also created conditions conducive to excessive growth of filamentous algae and weedy invasive and native vegetation, which further exacerbated flow and dissolved oxygen problems. Low flow, swamp conditions, and impounding do have beneficial effects including the retention and processing of nutrients that otherwise would have been passed downstream and possibly by retaining fecal coliform bacteria. The presence of beaver impoundments and a broad swamp floodplain generally reduce the flashiness of streams following significant rainfall by forcing runoff waters laterally into the adjacent wetlands, reducing the likelihood of downstream flooding following all but extremely heavy rainfall.

Conditions in the smaller tributaries (with smaller drainage areas) were different than those in the larger streams for many parameters (lower pH and higher concentrations of dissolved oxygen, fecal coliforms, ammonia nitrogen, TKN, and NOx) due likely to less impounding and closer proximity to pastures, agricultural fields, and animal operations (DWR-WAT 2013b).

Nutrient input may change spatially from year to year due to changes in fertilizer regimes resulting from crop rotations and/or land use changes, such as conversion of a pasture to field crops. Subsurface drainage from agricultural fields and groundwater in highly pervious soils may be a source of nutrient enrichment, particularly NOx.

Ammonia nitrogen was elevated in the Kill Swamp and upper Sevenmile Swamp watersheds and appears to be the result of agricultural operations, particularly animal operations. Elevated total Kjeldahl nitrogen (TKN) corresponded with high ammonia nitrogen concentrations at the same sites. This reflects both the high ammonia nitrogen and considerable bound (organic) nitrogen. This most likely reflected agricultural fertilizer applications.

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

Fecal coliform bacteria do not constitute a widespread water quality issue in the LWP area. There are a few localized hotspots which may benefit from implementation of simple BMPs, such as fencing out of cattle (DWR-WAT 2013b).

Data collected in 2013 at selected monitoring stations in the LWP area and at nearby agriculturally impacted and reference swamp streams did not show any strong relationships between low dissolved oxygen and either BOD or nutrients. Examination of BOD and nutrients in other nearby agriculturally impacted streams and the reference stream suggests that low dissolved oxygen in the Great Coharie

Creek LWP area is largely a natural phenomenon resulting from extremely low flow and impounding, possibly exacerbated somewhat by dense growths of aquatic vegetation (DWR-WAT 2013b).

3.1.1.3. Habitat and Channel Data

This section provides a summary of the DWR-WAT aquatic vegetation study and TJCOG stream assessments.

3.1.1.3.1. DWR-WAT Aquatic Vegetation Study

DWR-WAT conducted visual surveys of aquatic vegetation in the Great Coharie Creek LWP area at 43 locations. DWR-WAT developed a qualitative form for this survey that used a scale of 1 (least) to 4 (most) to visually measure relative abundance of common species.

Table 3. Weedy native vascular plants and miscellaneous wetland grasses found within the Great Coharie Creek LWP area, February 2009 through August 2011. (Excerpted from Table 1 in DWR-WAT, 2012c)

Common Name	Scientific Name	Frequency (N of 43 sites)	Percent of 43 sites
Smartweed	*Polygonum hydropiperoides*	20	47
Cattails	*Typha* spp.	17	39
Bladderwort	*Utricularia* spp.	12	27
Grasses, unidentified	Poaceae	10	23
Proliferating spikerush	*Eleocharis baldwinii*	6	14
Watermeal	*Wolffia* spp.	2	5
Duckweed	*Spirodela* or *Lemna* spp.	1	2

Table 4. Invasive exotic aquatic and wetland plants found within the Great Coharie Creek LWP area, February 2009 through August 2011. (Excerpted from Table 2 in DWR-WAT, 2012c).

Common Name	Scientific Name	Frequency (N of 43 sites)	Percent of 43 sites
Asian spiderwort	*Murdannia keisak*	20	45
Alligatorweed	*Alternanthera philoxeroides*	9	20
Creeping waterprimrose	*Ludwigia hexapetala*	6	14
Parrotfeather	*Myriophyllum aquaticum*	3	7

DWR-WAT found that both native and invasive aquatic plants are prone to problematic overabundance in the GCC watershed, particularly in shallow channels and open, swampy areas. This overabundant vegetation can cause and exacerbate flooding, reduce light penetration in the water column, harbor disease vectors (e.g., mosquitoes), crowd out more desirable vegetation, hinder recreational uses, and consume dissolved oxygen as it dies and decays (DWR-WAT, 2012c).

Filamentous algae were found at more than half of the sites, usually as dense growths on other vegetation or as floating mats in open areas. Native wetland grasses occurred at 23% of the sites and were occasionally very dense, particularly in shallow channels that had standing water or saturated soils. The large, open, stream-wetland complexes (swamps) with limited flow contained the greatest variety of plants, whereas streams with more frequent and consistent flow tended to have fewer plants.

A group of fourteen sites were selected as potential locations which might benefit from some vegetation management to help restore flow and improve habitat conditions for stream benthic macroinvertebrate populations. Vegetation management may also potentially open areas of stream for other uses, such as fishing and canoeing. Once vegetation management is begun, however, ongoing maintenance control will be needed in subsequent years or, possibly, again within the same growing season. Undesirable effects of management operations (e.g., oxygen depletion due to decaying vegetation and downstream movement of plant fragments which may establish elsewhere) must be considered. The recommended vegetation management sites are included in the *Great Coharie Creek Watershed Management Plan* (TJCOG 2014). The impacts of downstream impounding by beaver dams also may overshadow any effects of vegetation management on stream flow.

Three non-native invasive species (Asian spiderwort (*Murdannia keisak*), alligatorweed (*Alternanthera philoxeroides*), and creeping waterprimrose (*Ludwigia hexapetala*)) and a native species of smartweed (*Polygonum hydropiperoides*) were common to very abundant at many sites. All four of these plants have a similar appearance when growing in dense stands and are easily misidentified. This probably has led to an assumption among local residents that most of their weed problems are alligatorweed when, in fact, most of the dense infestations actually are Asian spiderwort and smartweed. Local residents and city and county officials will need to assess the extent of the infestations further up and downstream prior to making any decisions on the feasibility of vegetation management at selected sites. This will impact management decisions, particularly the cost of successful management.

3.1.1.3.2. TJCOG Stream Reach Field Assessment

As noted in Section 2, TJCOG stream assessment field work was focused on visiting small reaches with impacted buffers. In many cases, these small reaches have been channelized and straightened to increase drainage from agricultural areas.

In general, the most prevalent stressors evident at the stream assessment sites were absent or inadequate buffers, sedimentation, agricultural runoff, livestock access, and lack of woody debris. Some reaches exhibited channel or bank instability, but, in many cases, somewhat stable channels had re-established at the bottom of the agricultural ditches. Given the gentle slopes and low stream energy in these headwater systems, TJCOG also observed aggradation in most channels with sediment from adjacent agricultural field slowly filling in previously deepened channels. TJCOG field teams did encounter aquatic fauna (e.g., frogs, turtles, crayfish), even in some highly impacted sites. In many of the larger reaches, signs of beaver were evident.

Table 5 and Table 6 below present select metrics from the stream assessment data collected by TJCOG during site visits. Findings are normalized to percentage of occurrences in each specified subwatershed.

Table 5. Bank stability and shading metric by subwatershed. Colors indicate condition from worst (red) to best (dark green).

	Entire Great Coharie LWP Area	Sevenmile Swamp	GCC Head-waters	Beaver-dam Swamp	Kill Swamp	GCC Mainstem
	N=51	N=14	N=8	N=6	N=13	N=10
Bank stability						
Unstable	6%	7%	0%	0%	8%	10%
Moderately unstable	27%	36%	38%	0%	15%	40%
Moderately stable	45%	43%	63%	67%	31%	40%
Stable	22%	14%	0%	33%	46%	10%
Shading						
Unshaded	37%	50%	50%	17%	23%	40%
Moderately unshaded	25%	29%	13%	33%	23%	30%
Moderately shaded	29%	21%	25%	33%	46%	20%
Mostly shaded	8%	0%	13%	17%	8%	10%

Table 6. Stream and Riparian Condition (SRC) scores [ECU Rural Low Order Riparian Assessment Protocol Scoring System (ECU 2005)]

	Entire Great Coharie LWP Area	Seven-mile Swamp	GCC Head-waters	Beaver-dam Swamp	Kill Swamp	GCC Main-stem
Number of sites assessed (total) in the specified watershed	n=51	n=14	n=8	n=6	n=13	n=10
SRC 1: Instream woody structure						
Relatively unaltered	2%	0%	0%	0%	8%	0%
Somewhat altered	14%	21%	13%	17%	8%	10%
Altered	22%	29%	25%	33%	8%	20%
Severely altered	63%	50%	63%	50%	77%	70%
SRC 2: Sediment regime						
Relatively unaltered	0%	0%	0%	0%	0%	0%
Somewhat altered	55%	71%	25%	33%	62%	60%
Altered	29%	7%	50%	50%	23%	40%
Severely altered	16%	21%	25%	17%	15%	0%
SRC 3: Channel-riparian zone connection						
Relatively unaltered	10%	14%	13%	0%	15%	0%
Somewhat altered	22%	14%	38%	33%	8%	30%
Altered	31%	50%	0%	33%	31%	30%
Severely altered	37%	21%	50%	33%	46%	40%
SRC 4: Pollution affecting the stream						
Relatively unaltered	4%	7%	13%	0%	0%	0%
Somewhat altered	14%	14%	13%	17%	23%	0%
Altered	76%	71%	63%	83%	69%	100%
Severely altered	6%	7%	13%	0%	8%	0%
SRC 5: Factors affecting the riparian zone						
Relatively unaltered	8%	7%	38%	0%	0%	0%
Somewhat altered	14%	0%	13%	0%	23%	30%
Altered	14%	7%	13%	33%	15%	10%
Severely altered	65%	86%	38%	67%	62%	60%
SRC 6: Habitat quality of riparian zone						
Relatively unaltered	0%	0%	0%	0%	0%	0%
Somewhat altered	8%	0%	38%	0%	8%	0%
Altered	24%	7%	25%	33%	31%	30%
Severely altered	69%	93%	38%	67%	62%	70%

3.1.1.4. Wetland Assessments

DWR, EEP and TJCOG conducted field assessments at nine wetland sites (see Table 7), spanning five different wetland types (pocosin, pine flat, hardwood flat, bottomland hardwood forest and nonriverine swamp forest). Three of these sites (Wetland IDs 8, 15, and 17) were expected to be potentially intact wetlands, and six (Wetland IDs 1, 3, 5, 7, 10, and 13) were expected to be potentially degraded wetland sites.

The field crews used the NCWAM assessment protocol (2010), and rated five sites as high, two medium, and two low for overall function (DWR-WAT 2013a). The sites expected to be potentially intact wetlands (Wetland IDs 8, 15, and 17) actually were rated as low (n=2) or medium (n=1), whereas the sites expected to be potentially degraded wetlands were rated as medium (n=1) or high (n=5). Factors affecting the lower functional rating for the potentially intact sites included:

- confined animal operations within 2 miles of the wetland;
- wetlands not acting as buffers for tributaries or other open water;
- small amount of forested wetland;
- extensive beaver impoundments within the assessment area; and/or,
- lacking one or more structural components from the herbaceous layer to the canopy, as well as mature trees, downed wood and snags.

Table 7. Wetland assessment sites and results. Excerpted from the DWR-WAT Wetland Technical Memorandum (2013a).

Wetland ID	NCWAM wetland type	Area (acres)	Wetland Sub-function Rating			Wetland Overall Rating
			Hydrology	Water Quality	Habitat	
1	pocosin	173	high	high	med	high
3	pine flat	30	high	high	low	high
5	pocosin	286	high	med	high	high
7	hardwood flat	57	high	high	med	high
8*	hardwood flat/pine flat	21	high	low	low	low
10	pine flat	22	high	high	med	high
13	pine flat	70	med	med	low	med
15*^	bottomland hardwood forest	1763	high	low	low	low
17*	nonriverine swamp forest	20	med	low	med	med

*Selected as potential preservation sites, ^riverine Wetland

The sites predicted from GIS analysis of the NCCREWS data to be potentially degraded wetlands (Wetland IDs 1, 3, 5, 7, 10, and 13) were actually rated in the field as either medium or high for overall wetland function using the NCWAM methodology. Hydrology functions were rated as high for all these wetland sites except one, and the water quality function was rated as high for all but two sites. However, several individual functions (especially water quality and habitat) were rated was medium or low (see Table 7). Factors affecting these individual functions included:

- moderate ground disturbance and the lack of deep depressions for ponding water;

- presence of animal feeding operations, agricultural lands and recent clear cutting adjacent to and surrounding the wetland; and/or,
- lacking one or more structural components from the herbaceous layer to the canopy, as well as mature trees, downed wood and snags.

3.1.2. GIS Data Analysis

During this phase of the project, new GIS data was developed for detailed land use, surface hydrology and wetlands as described in Section 2.1 and 2.2. The results of the GIS data analysis are shown below in Table 8 through Table 10.

3.1.2.1. Land Use

Detailed land use data was developed and refined for the entire GCC watershed area. The following land use classes are included in the GIS dataset:

- Open Water – lakes and ponds;
- Seasonally Flooded – periodically inundated floodplains along the mainstem channels;
- Forest – forested land cover;
- Scrub – recently disturbed scrub/shrub areas and recently cutover areas;
- Cropland – agricultural lands under row crop cultivation;
- Animal Operations – confined animal operations as well as active pasture lands;
- Ag Operations – commercial agricultural processing areas;
- Lagoons – swine waste lagoons;
- Developed – residential and commercial development including lawns, driveways and parking lots;
- Roads – public roadways including right-of-ways; and,
- Buildings – footprints of residential, commercial and agricultural buildings.

Land use distribution for each of the 26 catchments in the LWP area is shown below and summarized by the major subwatersheds. The data is shown as a percentage of the catchment or subwatershed area. The cells in the table are shaded according to the percentage of each land use class on a scale of 0% - 100% with colors corresponding to Figure 6, subwatershed maps in Section 3.6, and catchment maps in Appendix E.

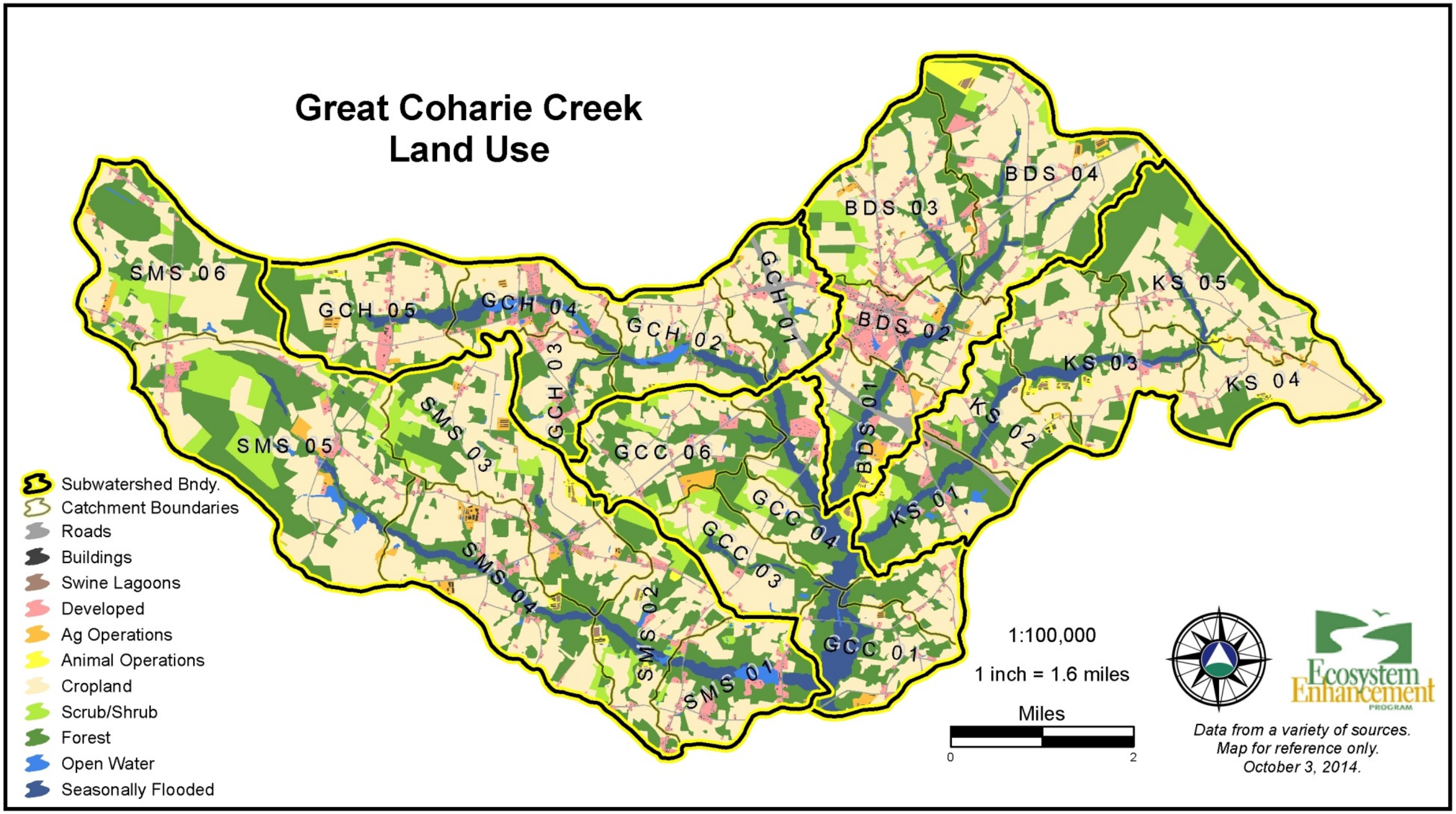

Figure 6. Great Coharie Creek land use map.

Table 8. Land use as a percent of subwatershed or catchment area. Data is shown by catchment (e.g., SMS 01) and summarized by subwatershed (GCC – Great Coharie Creek, SMS – Sevenmile Swamp, KS – Kill Swamp, BDS – Beaverdam Swamp, and GCH – Great Coharie Headwaters). Colors correspond to land use colors on maps in Section 3.6 and in Catchment maps in the appendix (e.g., green for forest, blue for open water, etc.). Color intensity/shading is used to visually show higher percentages as darker colors and lower percentages as lighter colors. Catchments are shown individually (e.g., SMS 01 percentages sum across the row to 100% of the size shown in the first column.) Subwatershed total (e.g., SMS TOTAL) land use percentages are shown below the catchments and sum across the row to the total subwatershed size shown in the first column.

Name	Size (mi2)	open water	seasonally flooded	forest	scrub	cropland	animal operations	ag operations	lagoon	developed	road	building
SMS 01	1.8	4%	10%	32%	2%	40%	0%	0%	0%	9%	2%	0%
SMS 02	2.0	1%	4%	32%	10%	42%	2%	0%	1%	5%	2%	1%
SMS 03	3.5	0%	1%	29%	7%	54%	1%	1%	0%	3%	2%	0%
SMS 04	2.8	0%	7%	24%	1%	57%	0%	2%	0%	4%	3%	1%
SMS 05	5.0	1%	2%	31%	15%	43%	0%	2%	0%	4%	2%	0%
SMS 06	3.0	1%	0%	39%	8%	46%	0%	1%	0%	3%	1%	0%
SMS TOTAL	**18.1**	**1%**	**3%**	**31%**	**8%**	**48%**	**1%**	**1%**	**0%**	**4%**	**2%**	**0%**
GCC 01	1.5	0%	23%	31%	0%	37%	0%	2%	0%	2%	3%	1%
GCC 02	0.8	0%	2%	32%	0%	59%	0%	0%	0%	4%	2%	0%
GCC 03	1.3	1%	4%	19%	12%	58%	0%	1%	0%	3%	2%	0%
GCC 04	1.0	0%	21%	34%	8%	32%	3%	0%	1%	0%	1%	0%
GCC 05	0.9	0%	17%	28%	5%	36%	0%	0%	0%	10%	4%	0%
GCC 06	2.1	0%	1%	35%	5%	49%	0%	3%	0%	3%	4%	0%
GCC TOTAL	**7.7**	**0%**	**11%**	**30%**	**5%**	**45%**	**1%**	**1%**	**0%**	**3%**	**3%**	**0%**
KS 01	1.6	2%	10%	41%	5%	31%	2%	0%	0%	3%	6%	0%
KS 02	1.4	0%	6%	30%	4%	50%	1%	1%	0%	3%	3%	1%
KS 03	2.6	0%	6%	27%	0%	58%	2%	0%	0%	3%	2%	0%
KS 04	1.5	0%	1%	21%	1%	71%	2%	1%	0%	2%	2%	0%
KS 05	2.9	0%	1%	42%	5%	46%	0%	0%	0%	2%	2%	0%
KS TOTAL	**10.0**	**0%**	**5%**	**33%**	**3%**	**51%**	**1%**	**0%**	**0%**	**3%**	**3%**	**0%**
BDS 01	1.5	0%	12%	24%	3%	35%	3%	4%	0%	7%	11%	0%
BDS 02	1.5	1%	7%	9%	3%	45%	0%	2%	0%	23%	8%	2%
BDS 03	2.8	0%	2%	22%	10%	55%	0%	1%	0%	6%	4%	1%
BDS 04	3.7	0%	3%	29%	4%	51%	4%	1%	0%	4%	3%	0%
BDS TOTAL	**9.6**	**0%**	**5%**	**23%**	**5%**	**49%**	**2%**	**2%**	**0%**	**8%**	**5%**	**1%**

Table 8 (continued). Land use as a percent of subwatershed or catchment area.

Name	Size (mi2)	open water	seasonally flooded	forest	scrub	cropland	animal operations	ag operations	lagoon	developed	road	building
GCH 01	1.6	1%	1%	23%	6%	52%	0%	0%	0%	5%	11%	0%
GCH 02	1.6	3%	6%	24%	1%	59%	0%	0%	0%	4%	2%	0%
GCH 03	1.1	0%	3%	35%	1%	51%	0%	1%	0%	6%	2%	0%
GCH 04	1.4	5%	9%	21%	0%	47%	0%	1%	0%	12%	4%	1%
GCH 05	2.4	0%	4%	30%	1%	53%	0%	1%	0%	7%	2%	1%
GCH TOTAL	**8.1**	**2%**	**5%**	**27%**	**2%**	**53%**	**0%**	**1%**	**0%**	**7%**	**4%**	**1%**
LWP TOTAL	**53.4**	**1%**	**5%**	**29%**	**5%**	**49%**	**1%**	**1%**	**0%**	**5%**	**3%**	**0%**

3.1.2.2. Streams, Waterways and Ditches

Stream, potential waterway and ditch data layers were developed for the GCC planning area as described in Section II. Together, these features comprise a network of surface channels that transport water from upland areas to the mouth of the GCC watershed. The drainage network of ditches is very extensive and virtually every stream is extended with a network of interconnected ditches. Artificial drainage has been created along roadways, along field edges and throughout agricultural and developed lands. Data on streams, waterways and ditches is shown below for each catchment and summarized by major subwatershed. Data has been normalized to allow comparison of different sized catchments.

Stream density ranged from 0 miles of streams per square mile of watershed in Sevenmile Swamp 06 (the upstream most catchment in Sevenmile swamp had no streams or natural valleys) to 4.8 miles of stream per square mile of watershed in Great Coharie Creek 04 (the mainstem catchment that includes the confluence of Great Coharie Creek with Beaverdam Swamp and Kill Swamp).

Waterway density ranged from 0 miles of waterways per square mile of watershed in Sevenmile Swamp 06 (this catchment is nearly flat and contains no valleys) to 4.3 miles of waterway per square mile of watershed in Great Coharie Creek 05 (a small mainstem catchment that includes a wide floodplain at its center with a comparatively steep transition area from surrounding uplands).

Ditch density ranged from 2.4 ditches per square mile of watershed in Great Coharie Creek 04 to 11.0 miles of ditches per square mile of watershed in Sevenmile Swamp 05 (an upper catchment in Sevenmile swamp with extensive agricultural lands and large areas of managed pine lands, some of which have been recently harvested and include many miles of ditches).

For the LWP area as a whole, when the entire network of channels is considered, there are over 545 miles of stream, waterways and ditches in the 54 square mile area. This equates to over 10 miles of channel per every square mile of watershed, nearly 1 million linear feet of streams and waterways and nearly 2 million linear feet of ditches within this LWP planning area. Refer to Figure 7 and Table 9 on the next page(s).

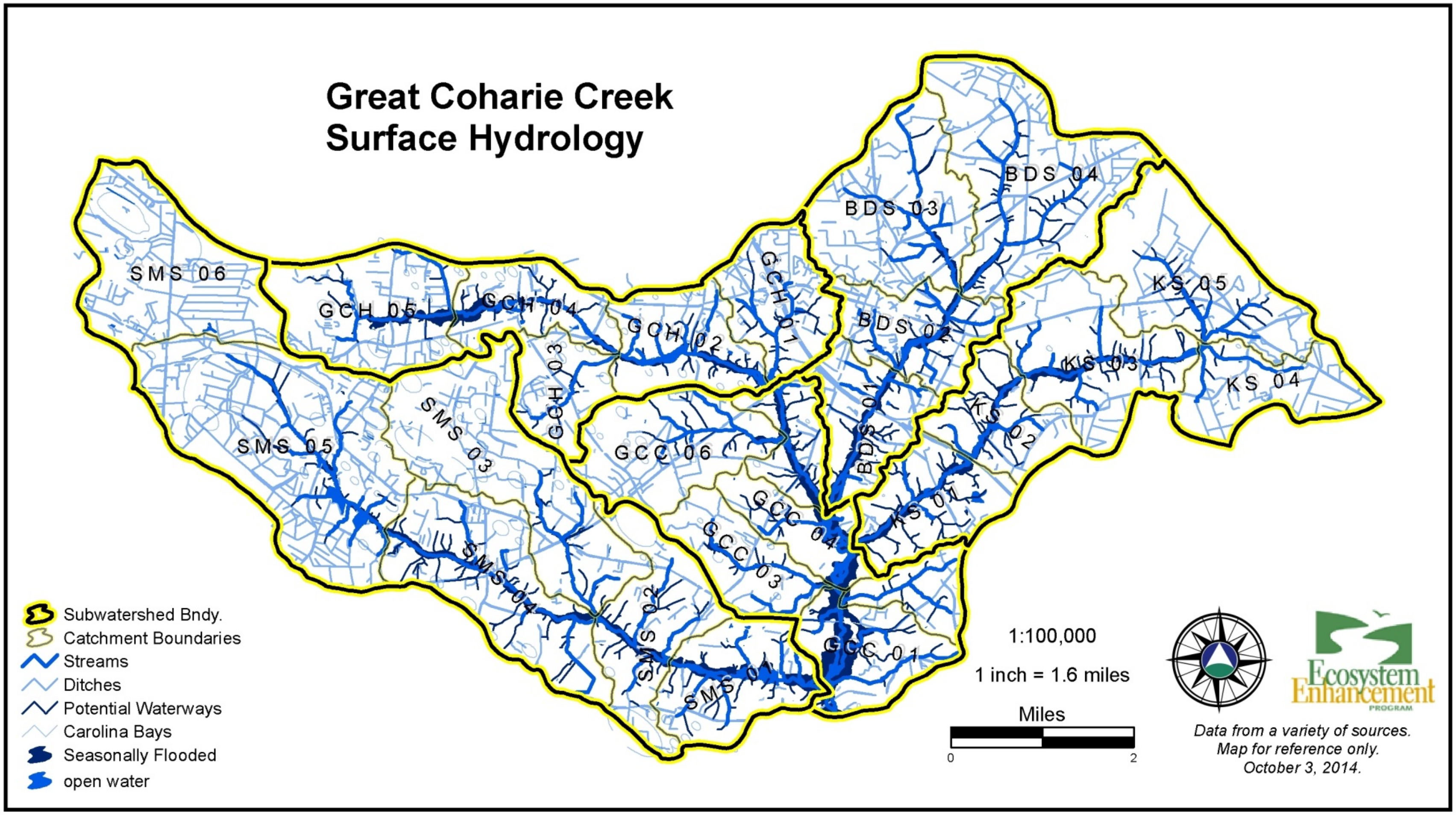

Figure 7. Great Coharie Creek surface hydrology features map (streams, ditches, waterways, Carolina bays, open water, and seasonally flooded).

Table 9. Stream, ditch and waterway length and density by subwatershed. Data is shown by catchment (e.g., SMS 01) and summarized by subwatershed (GCC – Great Coharie Creek, SMS – Sevenmile Swamp, KS – Kill Swamp, BDS – Beaverdam Swamp, and GCH – Great Coharie Headwaters). Color intensity/shading (blue for streams and waterways; red for ditches) is used to visually indicate higher density with darker colors. The darkest color is the highest density across the 26 catchments. For streams, potential waterways and ditches total length is shown in miles. To allow areas of different size to be compared, the length was divided by the catchment size to yield a comparable density as miles of channel per square mile of catchment area.

Name	Size (mi2)	Streams (mi)	Stream Density (mi/mi2)	Waterways (mi)	Waterway Density (mi/mi2)	Ditches (mi)	Ditch Density (mi/mi2)
SMS 01	1.8	5.2	2.9	4.5	2.5	5.5	3.0
SMS 02	2.0	3.4	1.7	4.1	2.0	8.5	4.3
SMS 03	3.5	3.0	0.9	2.3	0.7	22.9	6.6
SMS 04	2.8	5.3	1.9	8.1	2.9	15.2	5.3
SMS 05	5.0	6.8	1.4	3.0	0.6	55.6	11.0
SMS 06	3.0	0.0	0.0	0.0	0.0	30.1	10.1
SMS TOTAL	**18.1**	**23.8**	**1.3**	**22.0**	**1.2**	**137.9**	**7.6**
GCC 01	1.5	5.9	3.9	2.8	1.8	5.7	3.7
GCC 02	0.8	2.3	2.9	1.2	1.6	3.6	4.6
GCC 03	1.3	2.9	2.2	1.1	0.8	7.1	5.3
GCC 04	1.0	4.9	4.8	1.8	1.8	2.4	2.4
GCC 05	0.9	2.4	2.7	3.8	4.3	5.4	6.0
GCC 06	2.1	3.1	1.4	3.1	1.5	13.8	6.5
GCC TOTAL	**7.7**	**21.5**	**2.8**	**13.9**	**1.8**	**38.0**	**4.9**
KS 01	1.6	3.0	1.8	6.0	3.7	5.9	3.6
KS 02	1.4	3.1	2.2	5.2	3.7	4.2	3.0
KS 03	2.6	4.6	1.8	5.4	2.1	11.8	4.6
KS 04	1.5	2.2	1.4	0.4	0.3	13.1	8.5
KS 05	2.9	3.2	1.1	3.5	1.2	19.1	6.7
SMS TOTAL	**10.0**	**16.0**	**1.6**	**20.5**	**2.1**	**54.1**	**5.4**
BDS 01	1.5	4.2	2.8	3.7	2.4	12.2	8.1
BDS 02	1.5	5.0	3.3	3.5	2.3	13.0	8.6
BDS 03	2.8	4.9	1.7	1.4	0.5	22.6	8.0
BDS 04	3.7	4.5	1.2	5.2	1.4	31.2	8.4
BDS TOTAL	**9.6**	**18.7**	**2.0**	**13.8**	**1.4**	**79.0**	**8.3**

Table 9 (continued). Stream, ditch and waterway length and density by subwatershed.

Name	Size (mi2)	Streams (mi)	Stream Density (mi/mi2)	Waterways (mi)	Waterway Density (mi/mi2)	Ditches (mi)	Ditch Density (mi/mi2)
GCH 01	1.6	2.6	1.7	3.2	2.1	15.4	9.9
GCH 02	1.6	4.6	2.8	3.5	2.1	7.3	4.5
GCH 03	1.1	1.4	1.3	1.2	1.1	7.3	6.6
GCH 04	1.4	2.2	1.6	3.4	2.5	9.1	6.7
GCH 05	2.4	3.1	1.3	3.3	1.4	17.4	7.2
GCH TOTAL	**8.1**	**14.0**	**1.7**	**14.7**	**1.8**	**56.6**	**7.0**
LWP TOTAL	**53.4**	**94**	**1.8**	**85**	**1.6**	**366**	**6.9**

3.1.2.1. Wetlands

Potentially intact, potentially degraded and potential former wetlands were delineated in the GCC planning area using the NC CREWS data layers as described in Section II. The number of acres and the percentage of the subwatershed area for each of these types of wetlands are shown in Table 10 below.

Potentially intact wetlands ranged from 1% (Great Coharie Creek 06, Beaverdam Swamp 04, and Great Coharie Headwaters 01, 03 and 05) to 24% in Great Coharie Creek 01. Potentially degraded wetlands ranged from 0% in Great Coharie Creek 02 to 31% in Sevenmile Swamp 05. Potential former wetlands ranged from 2% in Great Coharie Creek 05 to 26% in Kill Swamp 04. Taken together, potentially intact and degraded wetlands (i.e., existing wetlands) make up almost 15% of the planning area, and within the catchments, ranged from 2% in Great Coharie Creek 02 to 34% in Sevenmile Swamp 05. For the watershed planning area in total, 24% of the area was classified as potentially intact, degraded or former wetlands. Refer to Figure 8 and Table 10 on next page(s).

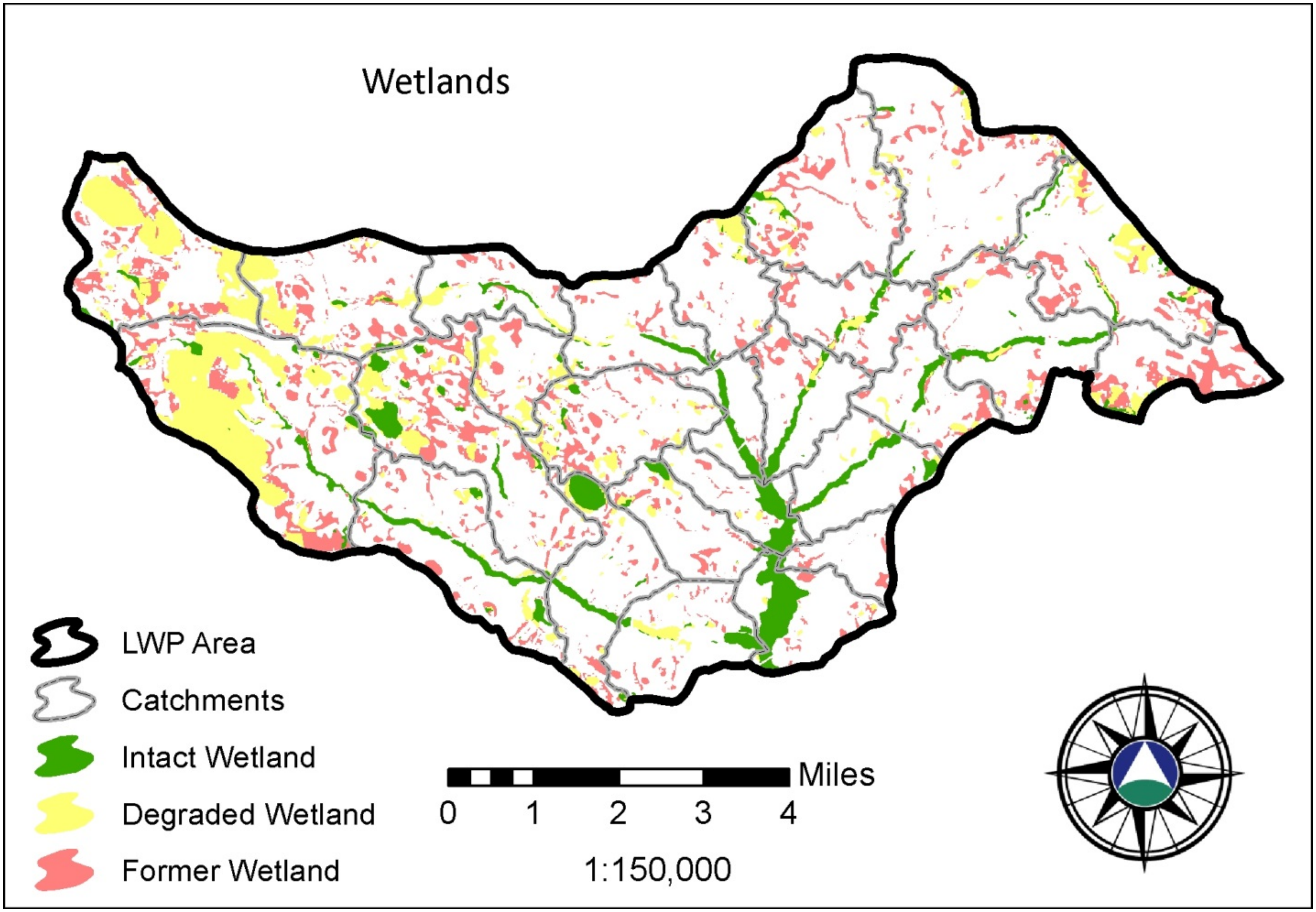

Figure 8. Great Coharie Creek wetlands. NCCREWS GIS data was used to identify potentially intact wetlands, potentially degraded wetlands and potential former wetlands.

Table 10. Great Coharie Creek wetlands by subwatershed and expected condition. Data is shown by catchment (e.g., SMS 01) and summarized by subwatershed (GCC – Great Coharie Creek, SMS – Sevenmile Swamp, KS – Kill Swamp, BDS – Beaverdam Swamp, and GCH – Great Coharie Headwaters). Wetlands are shown by size in acres and percent of the catchment or subwatershed area. Color intensity/shading is used to visually indicate higher density with darker colors. The darkest color is the highest density across the 26 catchments.

Name	Size (ac)	Intact Wetland (ac)	Intact Wetland (% of catchment)	Degraded Wetland (ac)	Degraded Wetland (% of catchment)	Former Wetland (ac)	Former Wetland (% of catchment)
SMS 01	1,161	63	5%	55	5%	51	4%
SMS 02	1,277	139	11%	60	5%	90	7%
SMS 03	2,212	155	7%	209	9%	367	17%
SMS 04	1,822	141	8%	58	3%	139	8%
SMS 05	3,228	109	3%	993	31%	444	14%
SMS 06	1,915	30	2%	535	28%	271	14%
SMS TOTAL	**11,615**	**637**	**5%**	**1,910**	**16%**	**1,361**	**12%**
GCC 01	980	240	24%	11	1%	44	4%
GCC 02	503	10	2%		0%	45	9%
GCC 03	851	33	4%	31	4%	79	9%
GCC 04	648	134	21%	12	2%	24	4%
GCC 05	576	86	15%	4	1%	14	2%
GCC 06	1,361	20	1%	109	8%	178	13%
GCC TOTAL	**4,919**	**524**	**11%**	**167**	**3%**	**385**	**8%**
KS 01	1,037	102	10%	23	2%	32	3%
KS 02	888	44	5%	31	4%	86	10%
KS 03	1,634	98	6%	41	3%	128	8%
KS 04	990	23	2%	67	7%	258	26%
KS 05	1,827	54	3%	151	8%	210	11%
KS TOTAL	**6,375**	**322**	**5%**	**314**	**5%**	**715**	**11%**
BDS 01	960	75	8%	15	2%	68	7%
BDS 02	970	41	4%	27	3%	93	10%
BDS 03	1,808	37	2%	62	3%	221	12%
BDS 04	2,375	29	1%	57	2%	160	7%
BDS TOTAL	**6,113**	**182**	**3%**	**161**	**3%**	**542**	**9%**

Table 10 (continued). Great Coharie Creek wetlands by subwatershed and expected condition.

Name	Size (ac)	Intact Wetland (ac)	Intact Wetland (% of catchment)	Degraded Wetland (ac)	Degraded Wetland (% of catchment)	Former Wetland (ac)	Former Wetland (% of catchment)
GCH 01	1,000	13	1%	78	8%	71	7%
GCH 02	1,044	43	4%	31	3%	67	6%
GCH 03	709	4	1%	112	16%	77	11%
GCH 04	873	33	4%	51	6%	46	5%
GCH 05	1,547	18	1%	246	16%	183	12%
GCH TOTAL	**5,172**	**112**	**2%**	**519**	**10%**	**443**	**9%**
LWP TOTAL	**34,176**	**1,775**	**5%**	**3,070**	**9%**	**3,447**	**10%**

3.2. *Stressors and Sources*

This section summarizes the stressors and sources within the Great Coharie Creek LWP study area. A detailed description of these stressors is provided in the *Preliminary Findings Report* (EEP 2010). The primary stressors in the study area are elevated nutrients and low dissolved oxygen. Other important stressors include increases in invasive aquatic vegetation, erosion and sedimentation, flow alterations, and loss of wetlands, riparian buffers, and high value forests. Table 11 through Table 13 present stressors with sources, functions, and impacts.

Table 11. Great Coharie Creek stressors and sources.

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

Table 12. Great Coharie Creek stressors and functions.

STRESSORS	Water Quality	Hydrology	Habitat
Biochemical oxygen demand	X		X
Loss of riparian buffer	X	X	X
Invasive aquatic vegetation	X	X	X
Loss of in-stream habitat		X	X
Erosion / sedimentation	X	X	X
Loss of floodplain connection	X	X	X
Restricted aquatic species movement			X
Flow alterations	X	X	X
Elevated inorganic nitrogen and total phosphorus	X		X
Elevated pathogen load	X		X
Low DO	X		X
Loss of high value forest and wetlands	X	X	X
Mercury	X		X

Table 13. Great Coharie Creek stressors, sources and impacts.

Stressors	Primary Sources	Impacts
Loss of riparian buffer	Removal of riparian vegetation; land use development	Stream bank erosion; increase in water temperature; lack of shading; loss of in-stream woody debris and leaf matter; reduced pollutant processing; increased overland sedimentation; higher overland flow velocities
Invasive aquatic vegetation	Native and exotic plant matter transported by flow and animals	Loss of habitat; restricted stream flows; poor aesthetics; reduced stream access
Loss of in-stream habitat	Channel modifications and dredging; sedimentation	Habitat degradation
Erosion / sedimentation	Overland runoff from agriculture and spoil areas; stream bank erosion; livestock access to streams; channel modification; riparian disturbance	Habitat degradation; increased turbidity; increased nutrient loads
Loss of floodplain connection	Channel modification and dredging	Increased stream flow velocity; loss of habitat; reduction in pollutant processing; reduced flood attenuation
Restricted aquatic species movement	Stream blockages; invasive aquatic plants; impoundments (beaver and man-made); elevated road culverts; exposed utility crossings	Reduced habitat range

Table 13 (continued). Great Coharie Creek stressors, sources and impacts.

Stressors	Primary Sources	Impacts
Flow alterations	Channel modification and dredging; impoundments (beaver and man-made); overland runoff; subsurface drainage; stormwater runoff; ditches	Reduced flood attenuation; increased flooding risk; pathway for pollutant transport and delivery;
Elevated inorganic nitrogen and total phosphorus	Livestock access to streams; agricultural runoff and subsurface flows; failing septic systems; improperly managed livestock operations or swine lagoons; wind-blown fertilizer	Nutrient enrichment, which can lead to excessive algae growth, especially when coupled with warm, slow moving water
Elevated pathogen loads	Livestock access to streams; failing septic systems; improperly managed livestock operations or swine lagoons	Risk to human health
Low DO	Stream blockages; excessive algae growth; invasive aquatic plants; impoundments (beaver and man-made)	Habitat degradation
Loss of high value forest and wetlands	Sedimentation from agriculture, spoil areas, and stream bank erosion; livestock access to riparian zone; channel modification and dredging; riparian disturbance and removal of riparian vegetation; land use development; ditching and draining wetlands for agricultural production; impoundments (beaver and man-made)	Habitat loss and degradation; Reduced flood attenuation; increased flooding risk; reduced pollutant processing; increased stream flow velocity
Mercury	Atmospheric deposition	Increased toxicity in fish and other aquatic organisms leading to human health risk

3.3. Problem Areas

Based on field data and desktop analysis, problem areas were identified across the watershed. This subsection summarizes the problem areas by hydrology, water quality, habitat and overall functions. The field work, GIS analysis, and functional assessment provided some insights into specific catchments and subwatershed problem areas, but provided the most insight into the specific problem areas within each catchment. Therefore, the following subsection is organized by functions and provides information about the problem areas within the catchments across the study area. Section 3.3.4 identifies targeted problem area catchments.

3.3.1. Hydrology Problem Areas

For hydrology functions and conditions, surface runoff from agricultural and developed lands is quickly drained and transported to mainstem streams through a large, interconnected network of ditch and waterways. In the mainstem streams, water moves slowly and inundates the floodplain. The problem areas for hydrology are areas that generate high runoff volumes and the network of ditches and waterways that transport it, especially those that are deep, devoid of vegetation, and with steeper slopes. These low-order channels collect surface runoff, intercept groundwater, and move it quickly to mainstem streams.

3.3.2. Water Quality Problem Areas

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

3.3.3. Habitat Problem Areas

From a habitat perspective, the entire study area has naturally low dissolved oxygen, especially in the slow moving, seasonally inundated mainstem swamps. Also, the low velocity and frequent flow obstructions in the mainstem streams means that much of the sediment that enters from the ditches and waterways, is deposited in the mainstem channel or on the floodplain. This keeps sediment from downstream reaches, but allows fine sediments to settle and increase the embeddedness of channel substrate, degrading habitat for aquatic macroinvertebrates and fish. Also, invasive species, both native and non-native, are extensive in the study area. Aquatic plants choke the stream channels in places, especially where flooding has created open water and direct sunlight. Additionally, invasive species are prevalent along the riparian areas within the study area, especially where there is a narrow buffer.

3.3.4. Overall Functional Problem Areas

The functional assessment identified three catchments where hydrology, water quality and habitat functions are the lowest, where stressors are high and problem areas are extensive. These catchments are Kill Swamp 04 (KS04), Beaverdam Swamp 02 (BDS 02) and Great Coharie Headwaters 01 (GCH 01). Beaverdam 02 includes virtually all of the Town of Newton Grove. Great Coharie Headwaters 01 is bisected by Interstate 40 and the interchange with NC 50/55. See Table 20 for the functional assessment results by catchment and Section 3.6 for subwatershed conditions.

3.4. *Functional Assessment*

This subsection summarizes the functional assessment for Great Coharie Creek. It includes a summary of the approach used to assess functions, the functional rating tables, criteria and rationale used for scoring, and the results of the functional assessment.

3.4.1. Functional Approach

The functional assessment considered hydrology, water quality and habitat conditions within the LWP area. This task involved developing and applying a functional approach suitable for use in the beaver-complex conditions in the Great Coharie Creek study area. In developing an appropriate functional evaluation approach, TJCOG staff reviewed functional approaches used in previous LWP efforts and EEP guidance documents, compiling a suite of functional metrics, potential approaches, and data requirements.

Potential functional approaches were grouped into 6 broad categories that included:

- A *weighted formula approach* where the function of the subwatershed was the sum of the weighted functions of water quality, hydrology and habitat. Weighting would be done with input from the LAT. This approach can be visualized with the formula:
    - Overall Function = (WQ Function x Weight $_{WQ}$) + (Hydro Function x Weight $_{Hydro}$) + (Habitat Function x Weight $_{Habitat}$);
- A *quantitative approach* which follows a similar approach of summing individual functions but without the weighting factors:
    - Overall Function = WQ Function + Hydro Function + Habitat Function;
- A *qualitative approach* that typically lists individual components of functions with either ratings or presence/absence determinations;
- An approach based on the *functional pyramid* with hierarchical functions building upon one another from hydrology, hydraulics, geomorphology, physio-chemical, and biological (Harman, et. al. 2012);
- An approach based on one or more *specific indicators* like those listed in the EEP Local Watershed Planning manual (2012), which provided several potential indicators and measures to consider when evaluating functions; and,
- A *rating-based approach* using a combination of qualitative data and manual spatial analysis based on a described set of observed and expected conditions under high, medium and low functions for several parameters within hydrology, water quality and habitat functions.

The pros and cons of each approach were considered along with a review of available data. Through internal discussions and conversations with EEP and the DWR, and upon considering the unique conditions of the watershed, the rating-based approach was determined to be the most suitable and allowed for consideration of the location, proximity and connectedness of land uses and a dense network of ditches, waterways, streams, and seasonally-flooded channels. For this approach, TJCOG staff developed a multi-parameter descriptive rating table for each function and for high, medium and low functional conditions. This rating table will be useful beyond this project area and should help facilitate rapid preliminary functional determinations of coastal plain systems in the future. The rating tables are shown below, followed by a description of the reasoning for the ratings.

3.4.2. Functional Rating Tables

Table 14. Functional rating analysis: land use indicators of watershed function. Colors indicate quality, from good (green) to bad (red).

Land Cover/Use	Indicators of HIGH FUNCTIONING	Indicators of AT-RISK FUNCTIONING	Indicators of LOW FUNCTIONING
➢ Core interior forest ➢ Habitat diversity ➢ Imperviousness ➢ Intensity ➢ Landscape patterns ➢ Fragmentation ➢ Buffers ➢ LU proximity to channels ➢ BMPs ➢ Buffer function ➢ Buffer land cover ➢ Connectedness	✓ Large, contiguous tracts of protected mature forests ✓ A diversity of healthy upland, riparian and aquatic habitats ✓ Forest and natural land uses dominate the catchment ✓ Forest and low-impervious land uses dominate the catchment ✓ High-intensity land uses are concentrated in small pockets interspersed with large area of natural open space ✓ Lower-intensity land uses buffer higher-intensity lands and filter surface runoff ✓ High-intensity land uses are disconnected from surface channels ✓ Runoff is treated with BMPs ✓ Streams and waterways are buffered by a diversity of natural land uses ✓ Streams and waterways are buffered by forests ✓ Important habitats are connected with natural corridors	- Few large, contiguous tracts of mature forests - Degraded and/or limited diversity of upland, riparian and aquatic habitats - Natural land uses do not dominate the catchment - Low-impervious land uses do not dominate the catchment - Higher-intensity land uses are situated across more of the landscape - High-intensity land uses exist adjacent to natural areas - High-intensity land uses are in closer proximity to surface channels - Runoff is not consistently treated or managed with BMPs - Some buffers are bypassed with concentrated flows - Stream networks with narrow vegetated or bisected buffers - Important habitats are not well connected with corridors	× Few contiguous tracts of forests × Few and degraded upland, riparian and aquatic habitats × High-intensity land uses dominate the catchment × Highly impervious land uses dominate the catchment × Few open spaces or natural areas exist × Lower-intensity land uses surrounded by higher-intensity lands × High-intensity land uses are connected to surface channels × Runoff from impervious surfaces is connected to surface channels without BMPs × Buffers are by-passed with concentrated flows × Stream networks not buffered by vegetation × Habitats are not connected

Table 15. Functional rating analysis: surface water indicators of watershed function. Colors indicate quality, from good (green) to bad (red).

Surface Waters	Indicators of HIGH FUNCTIONING	Indicators of AT-RISK FUNCTIONING	Indicators of LOW FUNCTIONING
➢ Baseflows ➢ Channel forming flows ➢ Hydrograph ➢ Ditch density ➢ Drainage patterns ➢ Upstream-downstream connectivity ➢ Channel connectivity ➢ Impoundedness ➢ Flooding ➢ Organic inputs ➢ Primary Production ➢ Sediment and Erosion ➢ Stream Energy/ Power ➢ Water Temperature ➢ Dissolved Oxygen ➢ Nutrients ➢ Pathogens ➢ Toxins	✓ Adequate baseflow ✓ Channel forming flows occur roughly annual to bi-annually (bankfull flows once per year to two years) ✓ Natural hydrograph with moderated high flows that slowly decline over time ✓ Natural water cycle with high levels of evapotranspiration and subsurface flow and groundwater infiltration, and little runoff ✓ Runoff is primarily sheet flow with fewer drainage waterways ✓ Drainage is controlled and allowed to infiltrate ✓ Drainage is controlled on or near its source and allowed to infiltrate ✓ Few manmade ditches ✓ Watershed is able to attenuate floodwaters ✓ Watershed is able to slow and treat floodwaters ✓ Free of barriers that limit migration and movement of aquatic organisms ✓ Adequate structure and protection during high flows	- Declining baseflows - More frequent (annually to semi-annual) channel forming flows (bankfull flows one or more times per year) - Somewhat "flashy" hydrographs with steepening rising limbs, somewhat higher peak flows, and likely higher volumes and steeper declines - Drainage provides rapid runoff and movement of water to the stream network - Ephemeral waterways drain connected upgradient areas - There is a network of somewhat connected ditches and/or waterways - More frequent or higher magnitude flooding - Some impoundments or flow obstructions provide limited treatment - Less contact time and more catastrophic flooding - Some barriers that limit migration and movement of aquatic organisms -	× Lower baseflows × Frequent (semi-annual) channel forming flows (bankfull flows more than once per year) × "Flashy" hydrographs with steeper rising limbs, higher peak flows, higher volumes and steeper declines × Drainage provides rapid runoff and movement of water to the stream network × Ephemeral waterways largely replaced with a network of connected stormwater pipes from upgradient impervious areas × There is a dense network of connected ditches and waterways × More frequent and higher magnitude flooding × Few flow obstructions × Less contact time and more catastrophic flooding × Extensive barriers that limit migration and movement of aquatic organisms × Lack of protection during high flows × Homogenous channel substrate embedded with fine silt and clays

Table 15 (continued). Functional rating analysis: surface water indicators of watershed function.

Surface Waters	**Indicators of HIGH FUNCTIONING**	**Indicators of AT-RISK FUNCTIONING**	**Indicators of LOW FUNCTIONING**
(Continued)	✓ Diverse channel substrate supporting macrophytes and nesting ✓ Diversity of surface water habitats including open water, shallow marsh, seasonally flooded wetlands, and flowing water ✓ Forested headwaters providing organic and woody inputs ✓ Channels are able to transport sediment in dynamic equilibrium with low turbidity ✓ Clean, low nutrient, non-toxic, cold baseflows ✓ Stream temperature is moderated and oxygen levels support healthy aquatic communities ✓ Nutrient inputs are processed and chemical cycles are balanced ✓ Nutrients support balanced primary production ✓ Free of harmful pathogens or toxic or persistent pollutants	- Limited protection during high flows - Homogenous channel substrate limits macrophytes and nesting - Limited diversity of surface water habitats including open water, shallow marsh, seasonally flooded wetlands, and flowing water - Degraded headwaters provide limited organic and woody inputs - Some destabilizing erosion, down cutting or rapid aggradation - Channels are not able to transport sediment in equilibrium and there is higher turbidity - Polluted baseflows - Stream temperature is unmoderated and oxygen levels do not support fully healthy aquatic communities - Nutrient inputs are not fully processed and chemical cycles are unbalanced - Nutrients support excessive primary production - Some toxic or persistent pollutants or harmful pathogens	× No diversity of surface water habitat types × High-intensity land uses dominate the headwaters eliminating organic and woody inputs × Destabilizing erosion, down cutting or rapid aggradation × Channels are not able to transport sediment and there is high turbidity × Stream temperature is extreme and oxygen levels do not support aquatic communities × Nutrients cause excessive primary production × Excessive nutrient inputs are causing unbalanced chemical cycling and eutrophication × Toxic and persistent pollutants and harmful pathogens × Many toxic or persistent pollutants

Table 16. Functional rating analysis: wetland indicators of watershed function. Colors indicate quality, from good (green) to bad (red).

Wetlands/ Floodplain	Indicators of HIGH FUNCTIONING	Indicators of AT-RISK FUNCTIONING	Indicators of LOW FUNCTIONING
➢ Wetland presence and status ➢ Wetland distribution ➢ Floodplain connectivity	✓ Many diverse, intact wetlands exist, and few degraded or former wetlands exist in the catchment ✓ Wetlands exist in headwaters, Carolina bays, riparian corridors and around open water ✓ Mainstem channels have wide, undeveloped floodplains ✓ Mainstem channels have active, seasonally flooded, forested floodplains	- A mix of potentially intact, degraded and former wetlands exist - Reduced wetland diversity - Mainstem channels are more confined with narrower floodplains. - Mainstem channels are more entrenched and less connected to their floodplains	× Few intact, degraded, or former wetlands × Limited wetland diversity × Mainstem channels are armored and constricted × Mainstem channels are disconnected from their floodplains

3.4.3. Functional Rating Rationale

The following section provides a summary of the land use, surface water and wetland factors used in the functional assessment and the rationale for their use to rate the hydrology, water quality and habitat functions.

3.4.3.1. Land Use

Land use plays an important role in the watershed functions of hydrology, water quality and habitat. In the functional assessment, different aspects of land use were considered for each function. Land use imperviousness was a factor in the hydrology function. Land use impacts were considered for the water quality function, and land use fragmentation and patterns were considered for the habitat function. The functional considerations of each land use category are described below.

Hydrology (Imperviousness)

The hydrology function is about how water moves through the watershed. That process begins with land use and the conversion of rainfall to runoff. To evaluate the potential of different land uses to generate runoff, land uses were grouped into three impervious categories. An assessment of imperviousness categories was used as a surrogate for a direct measurement of impervious area. In GCC, all connections were presumed to be surface connections (i.e., streams, waterways and ditches), so the proximity to channels and intervening land uses (e.g. forested riparian buffer) help determine the potential hydrologic affects.

Water Quality (Land Use Impact Intensity)

To evaluate the potential of different land uses to generate pollutants and water quality stressors, land uses were grouped into three categories based on their intensity. An assessment of land use intensity was used as an indication of the potential source of higher pollutant concentrations including sediment, nutrients, and pathogens. With such a high density of surface water connections in the GCC headwaters, including streams, waterways and ditches, the proximity to channels and intervening land use (e.g. forested riparian buffer) help determine the potential water quality effects.

Habitat (Land Use Fragmentation)

To evaluate the potential of different land uses to provide habitat, land uses were grouped into three categories. An assessment of land use was used as a general indication of the potential to provide terrestrial and aquatic habitat. Land use configuration and connectivity are also important factors considered in the functional rating.

While there were some minor differences between imperviousness and intensity categories as described in Section 3.4.1, but the land use descriptions below highlight the impact of each land use category on watershed functions.

3.4.3.1.1. High Function – Low Imperviousness, Low Intensity land uses: forest, seasonally flooded, and open water

- **Forest** includes woody vegetation that includes a mix of tree species and community types, including managed pine lands. Forest lands have natural low runoff rates. Forests do not typically contribute high non-point source pollutant loads, but they can be a source of sediment and nutrients from atmospheric deposition or wind-blown fertilizers, especially if ditched or poorly managed. Larger, more contiguous forests with core interior habitat provide higher habitat function, although forested corridors connecting larger tracts are also important factors.

- **Seasonally Flooded** includes areas characterized by swamps and periodically inundated floodplains along the main stems of the named streams. These areas are active floodplains that shrink and grow as the water level rises and falls. Functionally, these areas are the most valuable areas in the local watershed area for hydrology, water quality and habitat. They store and slowly release floodwaters, moderating high flows. They are many flow obstructions along these channels including road and utility crossings, fallen trees, active and historic beaver dams and manmade impoundments. Biological denitrification occurs in the periodically saturated root zones of woody vegetation converting nitrate in the water column to harmless nitrogen gas. Aquatic and riparian plants in the seasonally flooded areas also remove nutrients through uptake. These areas also provide diverse aquatic, riparian and terrestrial habitat. There provide core interior habitat and natural corridors.

- **Open Water** includes ponds and impounded channels. From a hydrologic perspective, rainfall on open water is immediately delivered, but from a water quality perspective, open water is slow-moving and a functional asset because sediment and attached pollutants settle out of the water column. In addition, aquatic organisms and plants take up and process nutrients. From a habitat perspective, these areas (especially when surrounded by forest or seasonally flooded areas) can provide important functions.

3.4.3.1.2. At-Risk Function – Moderate Imperviousness, Moderate Intensity land uses: cropland and scrub

- **Scrub** is composed primarily of recently harvested lands that appear cutover and disturbed in various stages of regeneration. Young woody vegetation can have higher evapotranspiration rates than mature forests and high surface storage capacity, so runoff would be expected to be low. Scrub lands can be a source of sediment. Scrub lands can provide marginal habitat for some species and provide better habitat than some other higher intensity land uses.

- **Swine Lagoon** includes the surface area of swine waste ponds. While these areas are designed to be hydrologically disconnected from the surface hydrology (stream, waterways, or ditches); they are concentrated sources of nutrients and pathogens, so the risk for contamination is higher. The closer the lagoon is to streams, waterways or ditches, the higher the risk of contamination. These areas negatively impact habitat.

- **Cropland** includes agricultural fields and access roads. The imperviousness of cropland is spatially variable based on compaction from farm equipment and temporally variable by the growing season and planting cycles. There may be under drains (soil tiles) increasing the runoff from some of the croplands in the local watershed. Cropland can be a source of sediment and nutrients. Croplands can provide areas for foraging and edge habitat.

3.4.3.1.3. Low Function – High Imperviousness, High Intensity Land Use: buildings, roads, ag operations, developed, swine lagoons and animal operations

- **Buildings** are physical footprints, so they are 100% impervious, and associated with high-intensity development. Roof tops can be a source of heavy metals from roof shingles and thermal pollution from dark impervious surfaces. There areas and surrounding development do not provide much habitat function.

- **Roads** include the entire road right of way (where no property parcel exists) and as such are a mix of the road surface and the roadside area. Virtually every road has a ditch along at least one side, and as such, roads quickly drain to ditches, waterways and streams. Roads can be a source of heavy metals, oils, other toxic substances as well as thermal pollution. Additionally, roadside rights of way can be a source of nutrients and sediment. Right-of-ways can provide edge habitat, but do not generally provide much habitat function.

- **Agricultural Operations** are commercial agriculture processing, transfer and distribution areas. Functionally, these areas are likely to be nearly 100% impervious. These areas act similar to roads, except that they can be even more likely to be a source of heavy metals, oils, fertilizer, herbicides and/or pesticides from heavy vehicle use and the storage and transfer of agricultural chemicals. These areas can also be sources of sediment from hard packed dirt and gravel surfaces. These areas do not provide much habitat value.

- **Developed** lands include home sites, neighborhoods and large portions of the Town of Newton Grove. This land use category is typically assigned for the entire parcel; so, on an overall basis, imperviousness will vary with development density, lot size, open space and managed vegetation. Developed land increases the variety and amount of pollutants generated on the site and the development process disturbs land, increasing sediment loading. Developed lands can be sources of heavy metals, oils, other toxic substances from motor vehicles, fertilizers and pesticides from lawns and managed vegetation, pathogens from pet waste and failing septic systems and thermal pollution from paved surfaces. Developed lands can provide some edge habitat and areas for foraging, but do not generally provide much habitat value.

- **Animal Operations** includes pasture lands as well as confined animal areas. Imperviousness is high in areas with much animal traffic, but lower on pasture lands. Animal operation areas can be sources of high nutrient and pathogen loads. Pasture lands can provide some edge habitat and areas for foraging, but do not generally provide much habitat value.

3.4.3.2. Surface Hydrology

Surface hydrology includes an assessment of the density of streams, potential waterways and ditches. Together they represent the network of channels that move water and sediment from upgradient areas through the stream channels to the mouth of the local watershed. To evaluate catchments of different sizes, lengths were normalized by the catchment area to yield a density.

3.4.3.2.1. High Function – Streams

Streams are channels that are expected to qualify as jurisdictional waters of the State including perennial and intermittent channels that exist within a natural valley. It is difficult to put a strict valuation on stream density because while higher stream density could indicate higher sinuosity and therefore slower flow, it could also indicate more channels which could increase flow if they are tributaries or decrease flow if they are threaded channels. So, stream density is reported as a characteristic, and was evaluated spatially as part of the functional assessment but not scored directly in hydrologic function assessment.

3.4.3.2.2. At-Risk Function – Waterways

Waterways were digitized as flow paths where at least two USGS contour lines bent at a 90-degree or sharper angle to represent natural valleys that would be expected to carry concentrated flow during runoff events. Many of these features are expected to be ephemeral channels, but visual inspection of aerial imagery indicates that some of these channels may carry perennial or intermittent flow. Waterways exist in the local watershed primarily along the edges of floodplains in the transition to flat uplands. These “transition” zones contain the steepest slopes in the watershed. A higher density primarily means the catchment has more transitions zones and/or more waterway channel length. In an upland catchment with few waterways, water is flowing across the surface or in ditches, whereas in a catchment with many waterways, runoff may be getting to the mainstem more quickly, so the floodplain connection becomes critical to determine the hydrologic impact of many waterways. So, waterway density is reported as a characteristic, and was evaluated spatially as part of the functional assessment but not scored directly in hydrologic function assessment.

3.4.3.2.3. Low Function – Ditches

Ditches include roadside, stormwater and agricultural channels digitized from aerial imagery as well as portions of the statewide hydrology layer that were determined to be manmade based on the lack of a natural valley. Manmade ditches exist in this watershed and increase the drainage of otherwise poorly drained soils. Most of the watershed contains hydric soil and increased drainage may be required for agricultural and forestry-related activities. Most roadways in the watershed have one or two parallel roadside ditches connected to channels at each low point. Most ditches connect to another ditch into an interconnected network of ditches with multiple outlets to waterways and streams. A higher density of ditches indicates more ditches which by design increased the magnitude and volume of water and delivers it more quickly. So, higher ditch density is indicative of low hydrologic function.

3.4.3.3. Wetlands

Hydrology

Wetland evaluation included an assessment of potentially intact, degraded and former wetlands in each catchment. Wetlands in this watershed were classified into these categories using the NC CREWS wetlands and restoration layers. Wetlands impact hydrologic function because they can store water and release and infiltrate it slowly. More wetlands are better for hydrology function, so to normalize different-sized catchments, TJCOG examined the percent of the catchment area containing intact, degraded and former wetlands.

Water Quality

Wetlands including those in seasonally impounded riparian areas are extremely beneficial to water quality. Wetlands serve as natural filters and serve to improve water quality through plant uptake, increasing infiltration, adsorption, and denitrification. The greater the number and quality of wetlands within a catchment, the higher the water quality function they provide.

Habitat

Wetlands including those in seasonally impounded riparian areas are the most important habitat areas in the landscape. Wetlands provide nesting, rearing, foraging locations for a variety of terrestrial and aquatic species. Wetlands provide foraging areas and are used by the majority of animals at some point in their life cycle. The greater the number and quality of wetlands within a catchment, the higher the habitat function they provide.

3.4.3.3.1. High Function – Potentially Intact Wetlands

Potentially Intact Wetlands are wetlands that were not indicated to have restoration need. They are an estimate of intact jurisdictional wetlands, but are only a modeling result and should not be considered a factual representation of jurisdictional wetlands, which can only be determined by a licensed wetland professional. The highest hydrology, water quality and habitat functions exist in intact wetlands with natural land cover in headwaters and along surface channels and impoundments. More potentially intact wetlands indicate higher hydrology, water quality and habitat function.

3.4.3.3.2. At-Risk Function – Potentially Degraded Wetlands

Potentially Degraded Wetlands are wetlands where restoration need was indicated. They are a modeling estimate of jurisdictional wetlands with enhancement potential. From a hydrology perspective, these areas still provide hydrologic moderation, best when naturally vegetated and in headwaters or along surface channels and impoundments. Potentially degraded wetlands can still provide substantial water quality and habitat functions in headwaters, along surface channels, around impoundments, and in upland flats. Potentially degraded wetlands indicate a positive, while not ideal, functional benefit to hydrology, water quality, and habitat.

3.4.3.3.3. Low Function – Potential Former Wetlands

Potential Former Wetlands are not expected to qualify as current jurisdictional wetlands. However, they are a modeling estimate of former wetlands with restoration potential. From a hydrology perspective, these areas still provide a small improvement to hydrologic function and are naturally poorly drained. Function is best when naturally vegetated and in headwaters, along surface channels and surrounding impoundments. Potential former wetlands can still provide some benefit to water quality and hydrology functions in headwaters, along surface channels around impoundments and in upland flats. Potential former wetlands indicate a positive, while not ideal, benefit to hydrology, water quality, and habitat functions.

3.4.4. Functional Metrics

3.4.4.1. Hydrology

The imperviousness data for catchments, subwatersheds and buffers is provided in Table 17 below. The buffer for this assessment included 50 feet on either side of streams and waterways and 25 feet on either side of ditches.

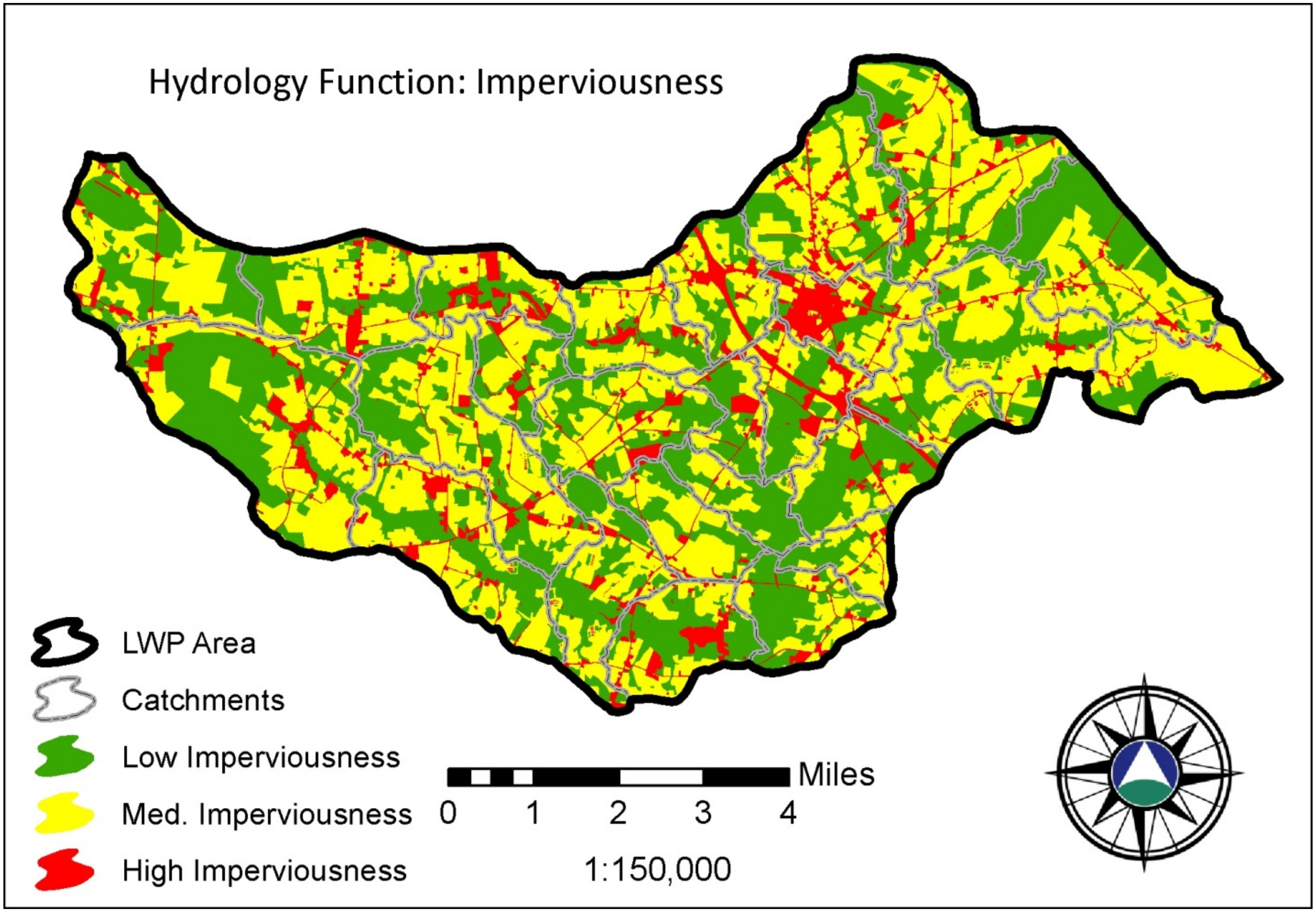

Figure 9. Land use imperviousness map. Colors indicate hydrology function form best (green) to worst (red). Catchments boundaries are shown in gray.

Table 17. Great Coharie Creek land use impervious categories for catchments and buffers. Data is shown by catchment (e.g., SMS 01) and summarized by subwatershed (GCC – Great Coharie Creek, SMS – Sevenmile Swamp, KS – Kill Swamp, BDS – Beaverdam Swamp, and GCH – Great Coharie Headwaters). Shown as percentage of catchment or subwatershed total. Buffer include streams (50'), ditches (25') and waterways (25'). Colors by hydrology function from best (green) to worst (red). Shading by magnitude of all 26 catchments, with the highest being the darkest and the lowest being the lightest.

Name	Catchment (H) Low Imperviousness	Catchment (M) Moderate Imperviousness	Catchment (L) High Imperviousness	25'-50' Buffer (H) Low Imperviousness	25'-50' Buffer (M) Moderate Imperviousness	25'-50' Buffer (L) High Imperviousness
SMS 01	44%	40%	16%	59%	12%	29%
SMS 02	47%	44%	9%	54%	20%	25%
SMS 03	37%	56%	7%	36%	37%	28%
SMS 04	32%	58%	10%	44%	27%	29%
SMS 05	48%	43%	9%	47%	28%	25%
SMS 06	47%	46%	6%	37%	43%	20%
SMS TOTAL	**43%**	**48%**	**9%**	**45%**	**29%**	**26%**
GCC 01	55%	37%	8%	66%	16%	19%
GCC 02	34%	59%	7%	50%	28%	23%
GCC 03	35%	58%	7%	52%	26%	22%
GCC 04	63%	35%	1%	82%	13%	6%
GCC 05	50%	36%	15%	56%	10%	34%
GCC 06	41%	49%	10%	37%	27%	36%
GCC TOTAL	**46%**	**46%**	**8%**	**56%**	**20%**	**24%**
KS 01	56%	32%	12%	60%	13%	26%
KS 02	41%	52%	8%	53%	25%	22%
KS 03	34%	60%	6%	50%	30%	20%
KS 04	23%	72%	5%	27%	56%	17%
KS 05	49%	46%	5%	34%	39%	27%
KS TOTAL	**41%**	**52%**	**7%**	**44%**	**33%**	**23%**
BDS 01	40%	39%	22%	39%	17%	43%
BDS 02	19%	45%	36%	29%	23%	48%
BDS 03	34%	55%	11%	31%	33%	36%
BDS 04	36%	55%	9%	34%	35%	31%
BDS TOTAL	**33%**	**51%**	**16%**	**33%**	**29%**	**38%**

Table 17 (continued). Great Coharie Creek land use impervious categories for catchments and buffers.

Name	Catchment (H) Low Imperviousness	Catchment (M) Moderate Imperviousness	Catchment (L) High Imperviousness	25'-50' Buffer (H) Low Imperviousness	25'-50' Buffer (M) Moderate Imperviousness	25'-50' Buffer (L) High Imperviousness
GCH 01	30%	52%	18%	34%	29%	37%
GCH 02	31%	59%	10%	40%	29%	30%
GCH 03	39%	51%	10%	35%	32%	33%
GCH 04	31%	47%	23%	31%	20%	48%
GCH 05	36%	53%	11%	42%	32%	27%
GCH TOTAL	**33%**	**53%**	**14%**	**37%**	**29%**	**34%**
LWP TOTAL	**40%**	**50%**	**11%**	**43%**	**28%**	**29%**

3.4.4.2. Water Quality

Water quality functions were assessed using field data and land use impact. Field data, including water quality monitoring and stream reach assessments, were not universally available for every catchment since access was a limitation for water quality data and stream reach assessments were targeted to impacted reaches. Nonetheless, water quality monitoring and stream reach assessments were invaluable to inform the functional processes in the watershed and were used to extrapolate conditions to catchments without sufficient field data.

Water quality data provided some insights into conditions within different subwatersheds and catchments, but was most useful to differentiate conditions in small streams, waterways and ditches from the conditions of the mainstem swamp streams. Additionally, stream reach assessment results were used to calibrate conditions observed in GIS to those in the field. This information was factored into the functional rating tables and was a primary factor in conducting the functional assessment. Water quality data and stream reach assessments were used generally to develop the rating table and provide understanding about field conditions and was used more directly to inform the functional assessment results in the catchments where field data was available.

The land use impact data was also used for catchments, subwatersheds and buffers and is provided in Table 18 below. The buffer for this assessment included 50 feet on either side of streams and waterways and 25 feet on either side of ditches.

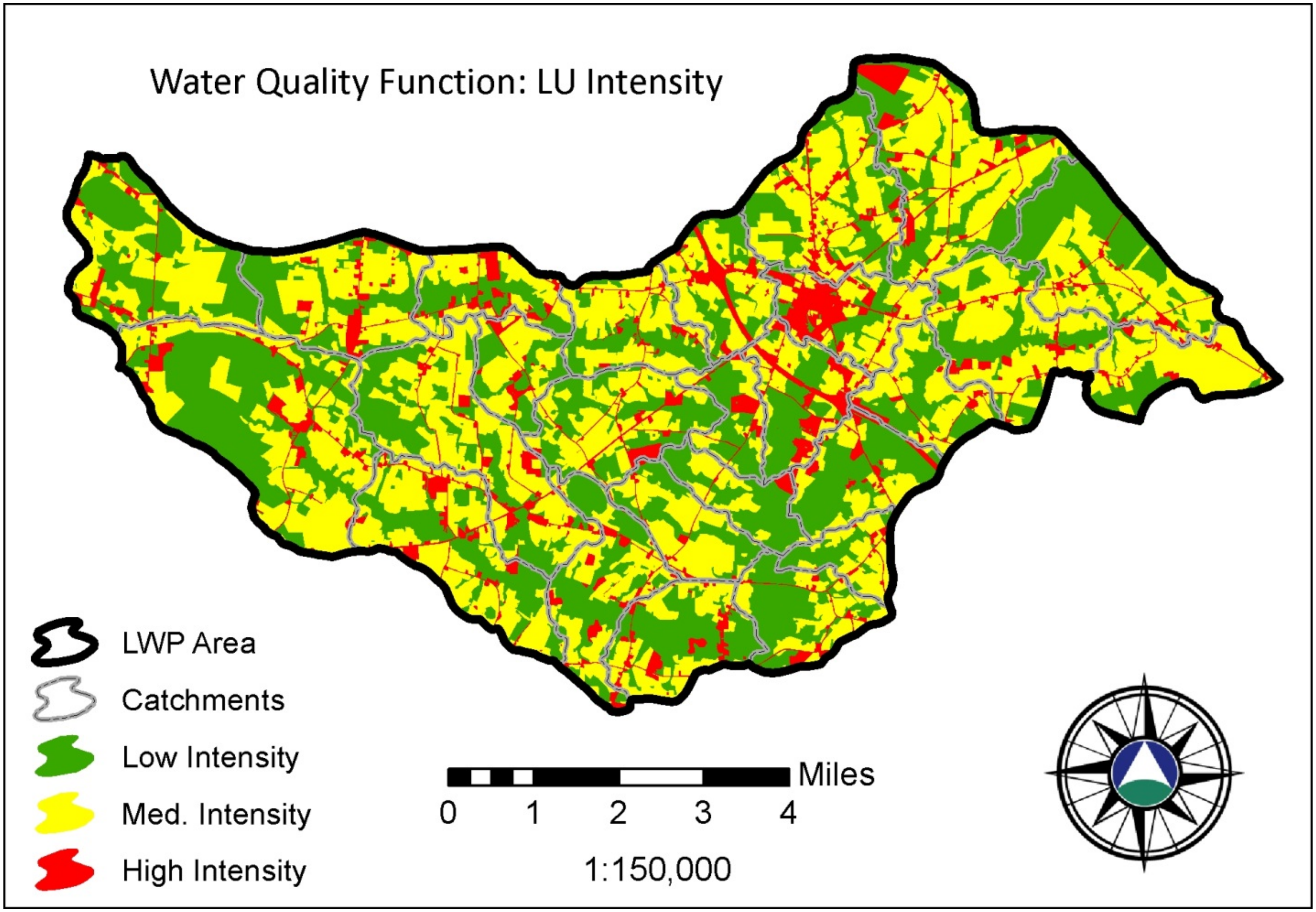

Figure 10. Land use intensity map. Colors indicate water quality function form best (green) to worst (red). Catchments boundaries are shown in gray.

Table 18. Great Coharie Creek land use impact categories for catchments and buffers. Data is shown by catchment (e.g., SMS 01) and summarized by subwatershed (GCC – Great Coharie Creek, SMS – Sevenmile Swamp, KS – Kill Swamp, BDS – Beaverdam Swamp, and GCH – Great Coharie Headwaters). Shown as percentage of catchment or subwatershed total. Buffer include streams (50'), ditches (25') and waterways (25'). Colors by water quality function from best (green) to worst (red). Shading by magnitude of all 26 catchments, with the highest being the darkest and the lowest being the lightest.

Name	Catchment			25'-50' Buffer		
	(H) Low Impact	(M) Moderate Impact	(L) High Impact	(H) Low Impact	(M) Moderate Impact	(L) High Impact
SMS 01	46%	42%	12%	66%	13%	21%
SMS 02	37%	52%	11%	57%	20%	22%
SMS 03	30%	61%	9%	32%	38%	30%
SMS 04	31%	59%	11%	45%	27%	28%
SMS 05	34%	58%	8%	36%	43%	21%
SMS 06	40%	55%	6%	29%	51%	20%
SMS TOTAL	**35%**	**56%**	**9%**	**41%**	**36%**	**24%**
GCC 01	55%	37%	8%	67%	16%	17%
GCC 02	34%	59%	7%	50%	28%	22%
GCC 03	23%	71%	6%	48%	34%	18%
GCC 04	55%	40%	5%	75%	17%	8%
GCC 05	45%	41%	14%	52%	14%	33%
GCC 06	36%	53%	10%	37%	28%	35%
GCC TOTAL	**41%**	**50%**	**9%**	**54%**	**23%**	**23%**
KS 01	52%	36%	12%	61%	16%	23%
KS 02	37%	54%	9%	51%	26%	23%
KS 03	34%	58%	8%	50%	29%	21%
KS 04	22%	72%	6%	26%	54%	20%
KS 05	44%	51%	5%	30%	43%	27%
KS TOTAL	**38%**	**54%**	**8%**	**43%**	**34%**	**23%**
BDS 01	36%	38%	25%	39%	16%	45%
BDS 02	17%	48%	35%	29%	26%	45%
BDS 03	24%	65%	11%	26%	39%	35%
BDS 04	32%	55%	13%	31%	35%	34%
BDS TOTAL	**28%**	**54%**	**18%**	**31%**	**31%**	**39%**

Table 18 (continued). Great Coharie Creek land use impact categories for catchments and buffers.

Name	Catchment (H) Low Impact	Catchment (M) Moderate Impact	Catchment (L) High Impact	25'-50' Buffer (H) Low Impact	25'-50' Buffer (M) Moderate Impact	25'-50' Buffer (L) High Impact
GCH 01	25%	58%	17%	29%	35%	36%
GCH 02	33%	59%	7%	49%	30%	22%
GCH 03	38%	52%	10%	37%	34%	29%
GCH 04	35%	47%	18%	42%	20%	38%
GCH 05	35%	54%	11%	40%	33%	27%
GCH TOTAL	**33%**	**55%**	**13%**	**39%**	**31%**	**30%**
LWP TOTAL	**35%**	**54%**	**11%**	**41%**	**32%**	**28%**

3.4.4.3. Habitat

The land use habitat data for catchments and subwatersheds is provided in Table 19 below. The table provides data for the catchment or subwatershed areas as well as the buffer. The buffer for this assessment included 300 feet on either side of streams.

Table 19. Great Coharie Creek land use [habitat] impact categories for catchments and buffers. Data is shown by catchment (e.g., SMS 01) and summarized by subwatershed (GCC – Great Coharie Creek, SMS – Sevenmile Swamp, KS – Kill Swamp, BDS – Beaverdam Swamp, and GCH – Great Coharie Headwaters). Shown as percentage of catchment or subwatershed total. Buffer include only streams, but a wider, 300' buffer. Colors by habitat function from best (green) to worst (red). Shading by magnitude of all 26 catchments, with the highest being the darkest and the lowest being the lightest.

Name	Catchment			300' Buffer		
	(H) Low Impact	(M) Moderate Impact	(L) High Impact	(H) Low Impact	(M) Moderate Impact	(L) High Impact
SMS 01	46%	42%	12%	76%	15%	8%
SMS 02	37%	52%	11%	71%	20%	10%
SMS 03	30%	61%	9%	68%	22%	10%
SMS 04	31%	59%	11%	69%	22%	9%
SMS 05	34%	58%	8%	54%	35%	12%
SMS 06	40%	55%	6%	0%	0%	0%
SMS TOTAL	**35%**	**56%**	**9%**	**66%**	**24%**	**10%**
GCC 01	55%	37%	8%	74%	20%	6%
GCC 02	34%	59%	7%	63%	30%	7%
GCC 03	23%	71%	6%	63%	34%	3%
GCC 04	55%	40%	5%	83%	15%	2%
GCC 05	45%	41%	14%	85%	11%	4%
GCC 06	36%	53%	10%	56%	30%	14%
GCC TOTAL	**41%**	**50%**	**9%**	**71%**	**23%**	**6%**
KS 01	52%	36%	12%	86%	9%	5%
KS 02	37%	54%	9%	68%	25%	8%
KS 03	34%	58%	8%	72%	21%	8%
KS 04	22%	72%	6%	20%	71%	9%
KS 05	44%	51%	5%	40%	50%	10%
KS TOTAL	**38%**	**54%**	**8%**	**60%**	**32%**	**8%**
BDS 01	36%	38%	25%	67%	20%	14%
BDS 02	17%	48%	35%	39%	34%	27%
BDS 03	24%	65%	11%	41%	46%	13%
BDS 04	32%	55%	13%	56%	38%	6%
BDS TOTAL	**28%**	**54%**	**18%**	**50%**	**36%**	**14%**

Table 19 (continued). Great Coharie Creek land use [habitat] impact categories for catchments and buffers.

Name	Catchment (H) Low Impact	Catchment (M) Moderate Impact	Catchment (L) High Impact	300' Buffer (H) Low Impact	300' Buffer (M) Moderate Impact	300' Buffer (L) High Impact
GCH 01	25%	58%	17%	49%	29%	22%
GCH 02	33%	59%	7%	60%	36%	5%
GCH 03	38%	52%	10%	68%	21%	10%
GCH 04	35%	47%	18%	93%	1%	5%
GCH 05	35%	54%	11%	61%	26%	13%
GCH TOTAL	**33%**	**55%**	**13%**	**65%**	**25%**	**10%**
LWP TOTAL	**35%**	**54%**	**11%**	**63%**	**28%**	**10%**

3.4.5. Functional Results

This section provides a summary of the results of the functional assessment for hydrology, water quality, and habitat in the Great Coharie Creek LWP area. Table 20, below, shows the rating for each function and an overall average function.

Table 20. Great Coharie Creek watershed functional assessment results by catchment. Data is averaged by catchment (e.g., SMS 01) and subwatershed (GCC – Great Coharie Creek, SMS – Sevenmile Swamp, KS – Kill Swamp, BDS – Beaverdam Swamp, and GCH – Great Coharie Headwaters). Color indicates function, from best (green) to worst(red). Function was assessed with a 5 point scale (1 [worst], 3[at-risk], or 5 [best]) with at-risk- (2) and at-risk+(4) to further refine the middle rating.

Catchment	Hydrology Function	WQ Function	Habitat Function	AVERAGE Function
GCC 01	5	5	5	**5**
GCC 02	3	3	4	**3**
GCC 03	3	3	4	**3**
GCC 04	5	5	5	**5**
GCC 05	5	5	5	**5**
GCC 06	3	4	4	**4**
GCC AVERAGE	**4**	**4**	**5**	**4**
GCH 01	2	1	1	**1**
GCH 02	4	4	4	**4**
GCH 03	3	3	4	**3**
GCH 04	3	3	4	**3**
GCH 05	3	3	4	**3**
GCH AVERAGE	**3**	**3**	**3**	**3**
SMS 01	5	5	5	**5**
SMS 02	5	4	4	**4**
SMS 03	3	3	4	**3**
SMS 04	3	3	4	**3**
SMS 05	2	3	5	**3**
SMS 06	4	3	4	**4**
SMS AVERAGE	**4**	**4**	**4**	**4**
KS 01	5	5	5	**5**
KS 02	3	3	3	**3**
KS 03	3	1	2	**2**
KS 04	1	1	1	**1**
KS 05	3	3	4	**3**
KS AVERAGE	**3**	**3**	**3**	**3**

Level of Function indicated by a 5-point scale

5	4	3	2	1
High	At-Risk (+)	At-Risk	At-Risk (-)	Low

Table 20 (continued). **Great Coharie Creek watershed functional assessment results by catchment.**

BDS 01	5	5	5	**5**
BDS 02	1	1	1	**1**
BDS 03	3	2	2	**2**
BDS 04	3	3	2	**3**
BDS AVERAGE	**3**	**3**	**3**	**3**

Level of Function indicated by a 5-point scale

5	4	3	2	1
High	At-Risk (+)	At-Risk	At-Risk (-)	Low

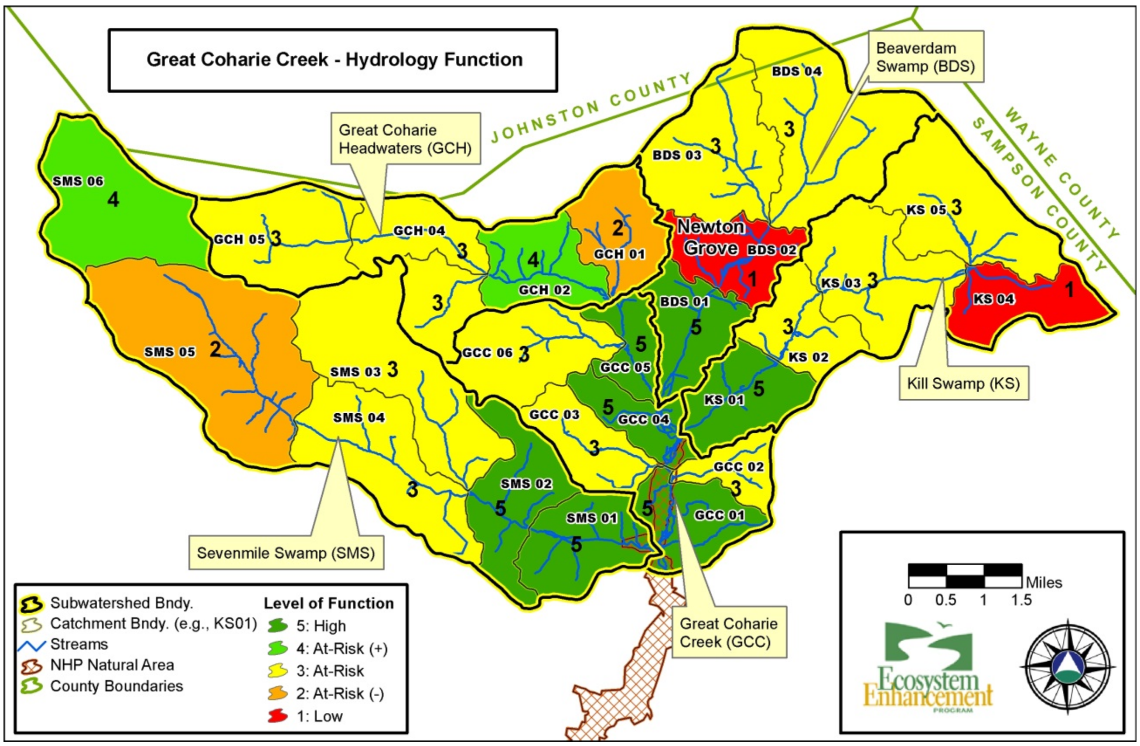

Figure 11. Hydrology functional assessment results map. Color indicates function, from best (green) to worst(red). Function was assessed with a 3 point scale (1 [worst], 3[at-risk], or 5 [best]) with at-risk- (2) and at-risk+(4) to further refine the middle rating.

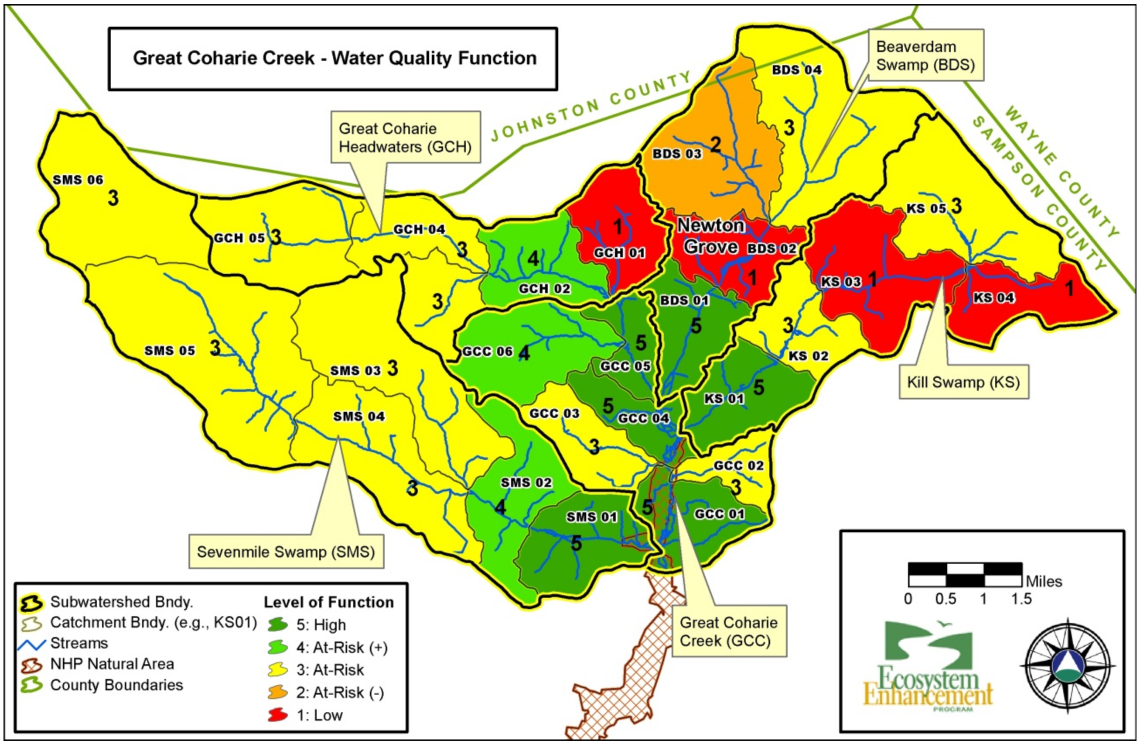

Figure 12. Water quality functional assessment results map. Color indicates function, from best (green) to worst(red). Function was assessed with a 3 point scale (1 [worst], 3[at-risk], or 5 [best]) with at-risk-(2) and at-risk+(4) to further refine the middle rating.

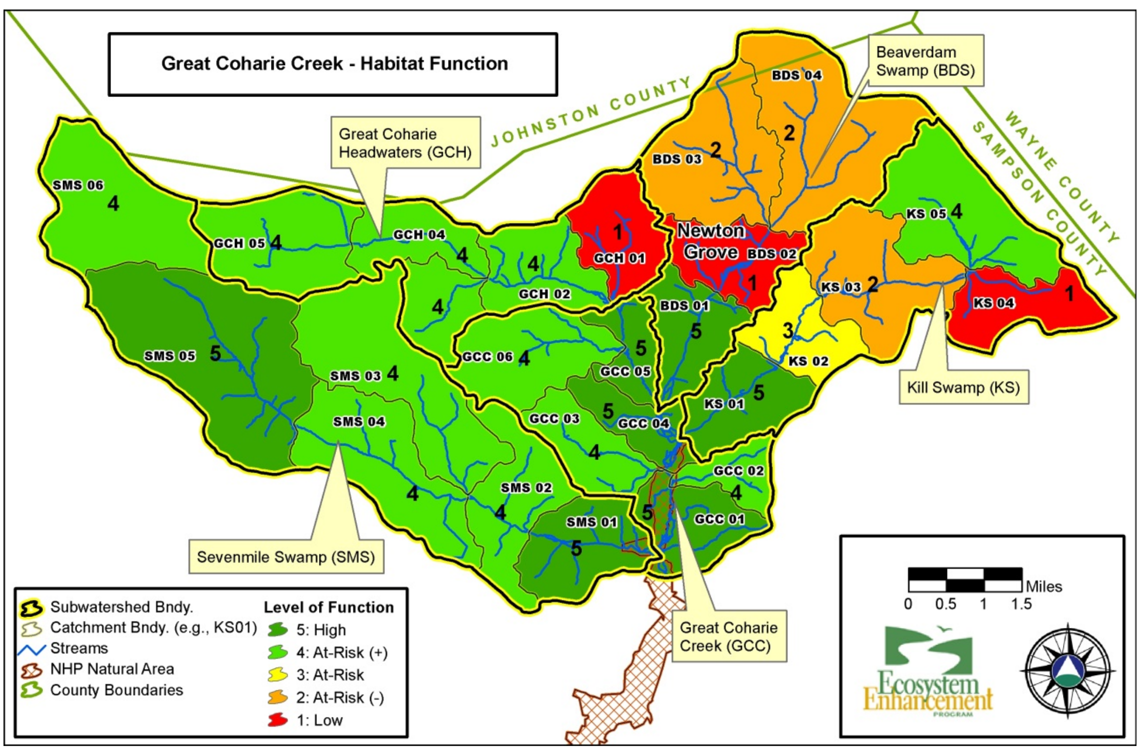

Figure 13. Habitat functional assessment results map. Color indicates function, from best (green) to worst(red). Function was assessed with a 3 point scale (1 [worst], 3[at-risk], or 5 [best]) with at-risk- (2) and at-risk+(4) to further refine the middle rating.

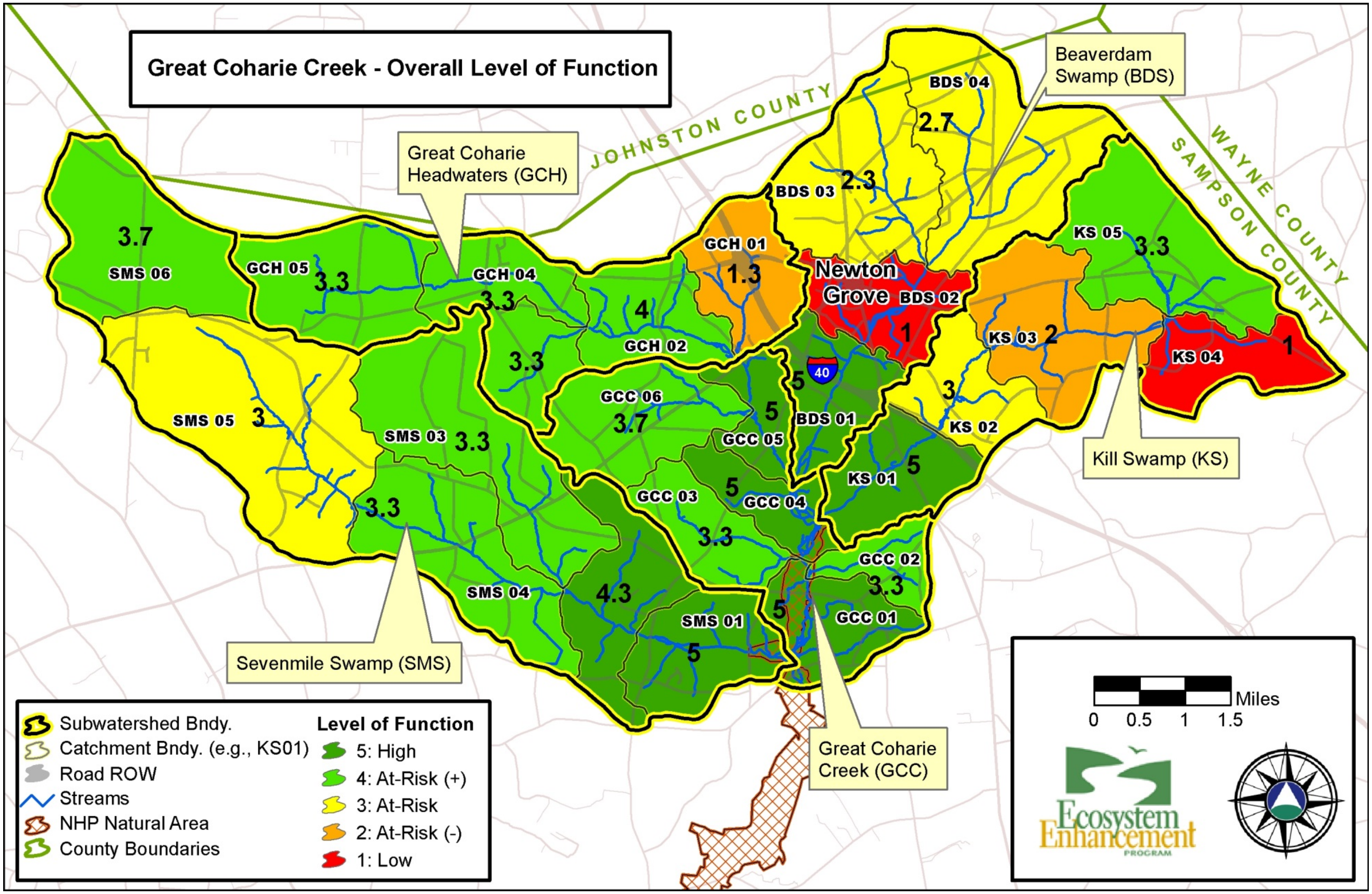

Figure 14. Overall functional assessment results map. Color indicates function, from best (green) to worst(red). Function was assessed with a 3 point scale (1 [worst], 3[at-risk], or 5 [best]) with at-risk- (2) and at-risk+(4) to further refine the middle rating.

3.4.1. Overall Conditions

The Great Coharie Creek local watershed planning area is characterized by nearly flat uplands that transition steeply into wide floodplains. The uplands contain extensively ditched agricultural and managed pine lands. The transition areas are primarily forested and transected with small channels and waterways. The floodplain exists as an inundated complex of beaver dams and other man-made and natural impoundments.

3.4.1.1. Hydrology

Hydrology is discussed first because it is the foundation of watershed function. In this context, hydrology is the movement of water from uplands through the ditches and waterways and streams to the mouth of the watershed planning area. Hydrology influences and drives the other watershed functions. In the Great Coharie Creek LWP area, water moves rapidly from uplands into ditches and waterways, but then moves slowly through the streams because of the gentle longitudinal slope and frequent flow obstructions. Most of the ditches in the watershed have little to no riparian vegetation to slow overland runoff. Additionally, many ditches are deep channels that intersect the ground water table increasing the flows to ditches.

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

3.4.1.2. Water Quality

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

Nutrients enter the ditches and waterways through overland runoff, subsurface flows and through airborne means when fertilizer is spread during windy conditions. Drainage tiles, which serve to increase drainage under agricultural fields, can greatly increase the export of nitrogen from agricultural fields to ditches and into waterways and streams. The lack of riparian vegetation on ditches exacerbates the problem by not providing any filtering function to overland runoff and increasing the likelihood of bank erosion. Additionally, deeply incised ditches intercept groundwater and concentrate flows. The lack of riparian vegetation to provide shading, increases sunlight, and results in increases in water temperature and algal growth.

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

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

3.4.1.3. Habitat

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

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

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

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

3.5. Ecological Assets

Based on field data and desktop analysis, ecological assets were identified across the watershed. This subsection summarizes the assets by hydrology, water quality, habitat and overall functions. The field work, GIS analysis, and functional assessment provided some insights into specific catchments and subwatershed asset areas, but provided the most insight into the specific assets within each catchment. Therefore, the following subsection is organized by functions and provides information about the ecological assets within the catchments across the study area. Section 3.3.4 identifies targeted catchments with important assets.

3.5.1. Hydrology Assets

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

3.5.2. Water Quality Assets

For water quality functions and conditions, water quality monitoring indicated that nutrient and sediment loads decreased (i.e., improved) through the mainstem streams, demonstrating the nutrient processing and uptake in the mainstem channels. Water quality at the outlet of the study area was better than in the headwaters, largely because the mainstem channels are cleaning and filtering the water. A primary ecological process likely to occur under the conditions in the Great Coharie is bacterial denitrification within the saturated root zone of woody riparian plants. The seasonally inundated, wooded riparian zones along the mainstem channels are the most important water quality assets in the Great Coharie Creek headwaters study area.

3.5.3. Habitat Assets

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

3.5.4. Overall Functional Assets

The functional assessment identified six catchments where hydrology, water quality and habitat functions were rated the highest, where stressors were fewer and ecological assets were intact. These catchments were Sevenmile Swamp 01 (SMS 01); Great Coharie Creek 01, 04 and 05 (GCC 01, GCC 04, and GCC 05); Kill Swamp 01 (KS01), and Beaverdam Swamp 01 (BDS 01). These catchments include the mainstem channels and outlets of all four named streams. These areas have predominantly intact, forested, seasonally inundated riparian corridors. See Table 20 for the functional assessment results by catchment and Section 3.6 for subwatershed conditions.

3.6. *Subwatershed Conditions*

The following subsection provides a discussion of conditions and functions within the 5 main subwatersheds and 26 catchments. Information from several sections of this report has been consolidated to provide subwatershed- and catchment-specific context. Additionally, this subsection provides a discussion how the conditions within each catchment and subwatershed affect the hydrology, water quality, and habitat functions.

3.6.1. Sevenmile Swamp

The Sevenmile Swamp subwatershed contains six catchments. Four catchments are mainstem catchments (SMS-01, SMS-02, SMS-04, and SMS-05). One catchment is a tributary catchment (SMS-03), and one catchment in the headwaters of Sevenmile Swamp (SMS-06) doesn’t actually have any stream channels, but is connected to the mainstem through an extensive network of ditches. Table 21 includes conditions and metrics for Sevenmile Swamp and Figure 15 provides a map of the subwatershed. Detailed maps of the individual catchments are provided in Appendix E.

Table 21. Sevenmile Swamp conditions and metrics. Shading indicates magnitude with higher percentages shown with darker colors. Shading is based on all 26 catchments, with darkest being highest among all catchments. For land use, colors indicate land use category to match maps shown in Section 3.

Sevenmile Swamp (SMS)	SMS 01	SMS 02	SMS 03	SMS 04	SMS 05	SMS 06	SMS TOTAL	
Size (mi2)	1.8	2.0	3.5	2.8	5.0	3.0	**18.1**	**Size**
Size (ac)	1,161	1,277	2,212	1,822	3,228	1,915	**11,615**	
Open Water	4%	1%	0%	0%	1%	1%	**1%**	**Land Use**
Seasonally Flooded	10%	4%	1%	7%	2%	0%	**3%**	
Forest	32%	32%	29%	24%	31%	39%	**31%**	
Scrub	2%	10%	7%	1%	15%	8%	**8%**	
Cropland	40%	42%	54%	57%	43%	46%	**48%**	
Animal Operations	0%	2%	1%	0%	0%	0%	**1%**	
Ag Operations	0%	0%	1%	2%	2%	1%	**1%**	
Lagoon	0%	1%	0%	0%	0%	0%	**0%**	
Developed	9%	5%	3%	4%	4%	3%	**4%**	
Road	2%	2%	2%	3%	2%	1%	**2%**	
Building	0%	1%	0%	1%	0%	0%	**0%**	
(H) Low Impact	46%	37%	30%	31%	34%	40%	**35%**	**Catch-ment**
(M) Moderate Impact	42%	52%	61%	59%	58%	55%	**56%**	
(L) High Impact	12%	11%	9%	11%	8%	6%	**9%**	
(H) Low Impact	66%	57%	32%	45%	36%	29%	**41%**	**25-50' buffer**
(M) Moderate Impact	13%	20%	38%	27%	43%	51%	**36%**	
(L) High Impact	21%	22%	30%	28%	21%	20%	**24%**	
(H) Low Impact	76%	71%	68%	69%	54%	0%	**66%**	**300' buffer**
(M) Moderate Impact	15%	20%	22%	22%	35%	0%	**24%**	
(L) High Impact	8%	10%	10%	9%	12%	0%	**10%**	
Streams (mi)	5.2	3.4	3	5.3	6.8	0	**23.8**	**Surface Hydrology**
Waterways (mi)	4.5	4.1	2.3	8.1	3	0	**22**	
Ditches (mi)	5.5	8.5	22.9	15.2	55.6	30.1	**137.9**	
Stream Density (mi/mi2)	2.9	1.7	0.9	1.9	1.4	0	**1.3**	
Waterway Density (mi/mi2)	2.5	2	0.7	2.9	0.6	0	**1.2**	
Ditch Density (mi/mi2)	3	4.3	6.6	5.3	11	10.1	**7.6**	
Intact Wetland (ac)	63	139	155	141	109	30	**637**	**Wetlands**
Degraded Wetland (ac)	55	60	209	58	993	535	**1,910**	
Former Wetland (ac)	51	90	367	139	444	271	**1,361**	
Intact Wetland (% of catchment)	5%	11%	7%	8%	3%	2%	**5%**	
Degraded Wetland (% of catchment)	5%	5%	9%	3%	31%	28%	**16%**	
Former Wetland (% of catchment)	4%	7%	17%	8%	14%	14%	**12%**	

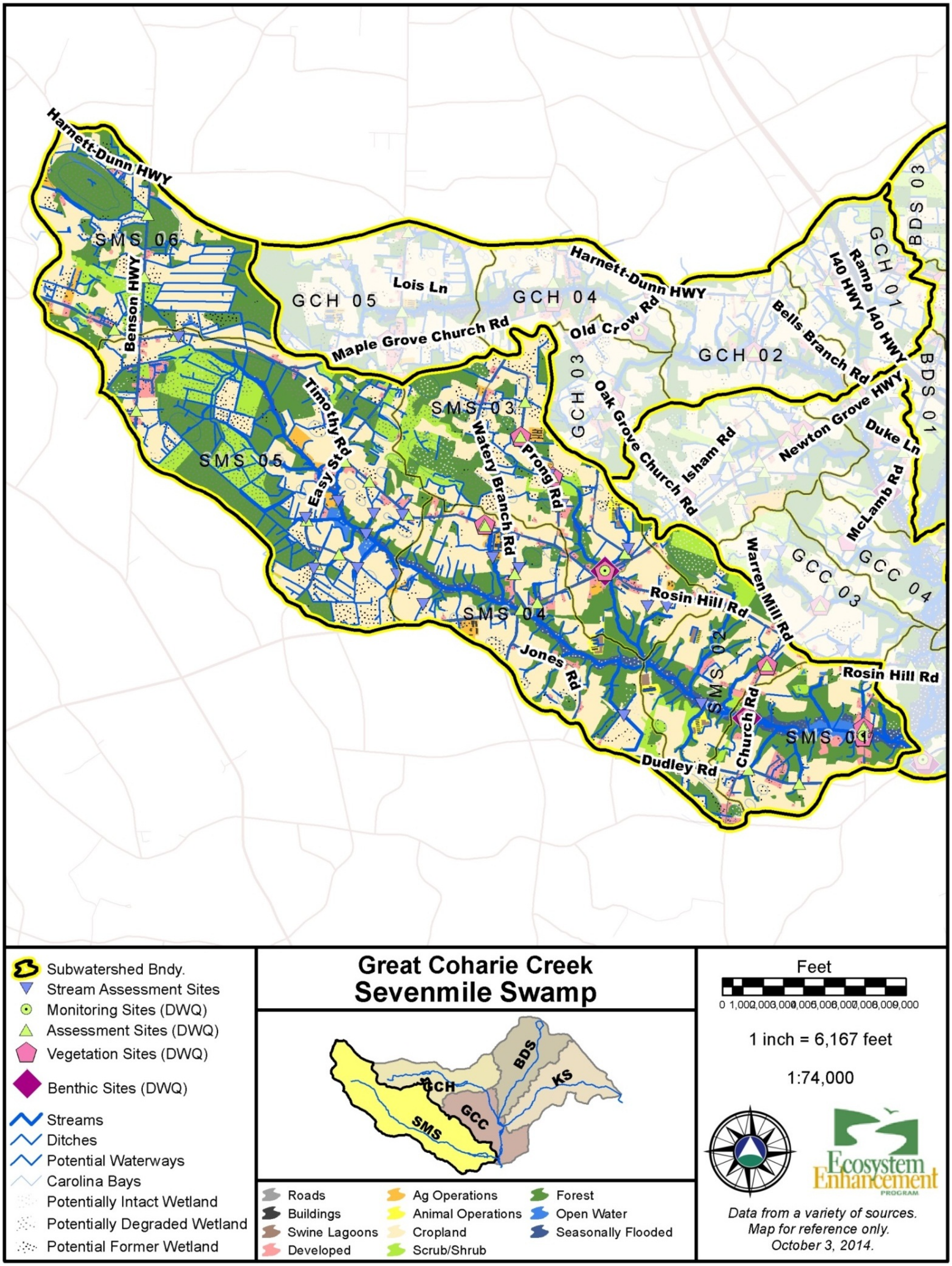

Figure 15. Sevenmile Swamp subwatershed conditions map. Colors indicate land use category as per the legend and land use tables in Section 3. Patterns are used to show wetlands with white dots being potentially intact wetlands. Detailed maps of each catchment are included in Appendix E.

The SMS-01 catchment is the downstream most catchment in Sevenmile Swamp. The mouth of Sevenmile flows into Great Coharie Creek just upstream of Roanoke Rd, near the outlet for the planning area. This 1.8 square mile catchment contains a very wide forested riparian corridor with a wide, inundated, seasonally flooded area along the mainstem of SMS. There is a large mill pond, (House's Mill Pond) centrally located in the catchment, upstream of Houses Mill Rd. There are several tributaries that flow into SMS and are well buffered for most of their length. This catchment was rated as high function for hydrology, water quality and habitat. The wide, inundated mainstem and mill pond help to sustain and improve the hydrology and water quality functions, while the wide wetlands and forested riparian corridor provided important habitat.

SMS-02 is a mainstem catchment upstream of SMS-01. This 2.0 square mile catchment has a fairly wide forested riparian buffer and is inundated as a wide swamp through this catchment. Several tributaries and many ditches and waterways drain to the mainstem of SMS in this catchment. There is a large, partially forested, partially cutover Carolina Bay in the northern portion of the catchment near the intersection of Newton Grove Highway and Oak Grove Church Rd. This catchment was rated as high function for hydrology and at-risk + function for water quality and habitat. The inundated mainstem channel provides excellent hydrology function, and numerous wetlands and the mainstem corridor provide water quality function. Animal operations with drainage ditches and large swine waste lagoons near the riparian corridor are potential water quality concerns.

SMS-03 is a large tributary catchment to the north of the mainstem of SMS. This 3.5 square mile catchment has a central tributary stream with a narrow forested riparian corridor. There are several seasonally flooded areas along its length and many ditches that drain the northern portion of the catchment. Over one third of the catchment is current or former wetlands including numerous drained and forested or partially cutover Carolina bays. This catchment was rated as at-risk for hydrology and water quality and at-risk + for habitat. The large tracts of forest and scrub in the northern portion of the catchment and the forested riparian corridor along the central tributary contribute to the habitat function.

SMS-04 is a mainstem catchment upstream of SMS-02 just upstream of the outlet of SMS-03. This 2.8 square mile catchment contains a long section of the mainstem of Sevenmile Swamp within a fairly wide, inundated, seasonally flood riparian corridor. Many relatively short ditches and waterways enter the mainstem channel along this reach. There are a number of drained Carolina bays in this catchment. This catchment was rated as at-risk for hydrology and water quality and at-risk + for habitat. The wide forested riparian corridor provides important habitat, but the cropland and ag operations area are rapidly drained via a network of ditches. An area of animal operations and large swing lagoons near the mainstem channel toward the downstream end of the catchment are a potential water quality concern.

SMS-05 is a large mainstem catchment upstream of SMS-04. This is the largest catchment in the LWP area and contains the mainstem of Sevenmile Swamp, several large tributaries and a vast network of interconnected ditches. This catchment has the densest network of ditches of any other catchment with 11 miles of ditch for every square mile in the catchment, over 55 miles of ditches total. The mainstem channel has a fairly narrow forested riparian corridor in its downstream half, with a narrow inundated floodplain. There are two large open water impoundments adjacent to the stream within the riparian corridor. The upstream half of the catchment contains large tracts of forest and recently harvested timber stands. These areas are extensively drained. In the upstream half of the catchment, the mainstem and a large tributary have areas of seasonally flooded swamp channel. This catchment was rated as at-risk - for hydrology function, at-risk for water quality function, and high for habitat function. Nearly half the catchment contains existing or former wetlands and the network of ditches rapidly moves water to the streams, decreasing the hydrology function. The open water impoundments and the inundated floodplains provide some water quality function and the large tracks of forest along with the forested riparian buffer provide important habitat. These forest tracks provide some of the largest core interior forest in the LWP area.

SMS-06 is an unusual, nearly level upland catchment upgradient of SMS-05. This 3.0 square mile catchment has no stream channels, but contains a vast network of interconnected ditches that drain into SMS-05. Large croplands dominate the landscape interspersed with fairly large forested areas, including a very large Carolina bay near the highest part of the LWP area. The catchment was rated as at-risk + for hydrology and habitat and at-risk for water quality. The nearly level terrain slows drainage and the large forested areas provide important core interior habitat. There are no seasonally flooded areas and the extensive ditch network is largely unbuffered so nutrients are able to enter the ditches.

3.6.2. Great Coharie Creek

The Great Coharie Creek subwatershed contains six catchments. Three of the catchments (GCC-01, GCC-04 and GCC-05) at mainstem catchments and the other three (GCC-02, GCC-03 and GCC-06) are tributary catchments. Table 22 includes conditions and metrics for the Great Coharie Creek subwatershed and Figure 16 provides a map of the subwatershed. Detailed maps of the individual catchments are provided in Appendix E.

Table 22. Great Coharie Creek conditions and metrics. Shading indicates magnitude with higher percentages shown with darker colors. Shading is based on all 26 catchments, with darkest being highest among all catchments. For land use, colors indicate land use category to match maps shown in Section 3.

Great Coharie Creek (GCC)	GCC 01	GCC 02	GCC 03	GCC 04	GCC 05	GCC 06	GCC TOTAL	
Size (mi2)	1.5	0.8	1.3	1	0.9	2.1	**7.7**	**Size**
Size (ac)	980	503	851	648	576	1,361	**4,919**	
Open Water	0%	0%	1%	0%	0%	0%	**0%**	**Land Use**
Seasonally Flooded	23%	2%	4%	21%	17%	1%	**11%**	
Forest	31%	32%	19%	34%	28%	35%	**30%**	
Scrub	0%	0%	12%	8%	5%	5%	**5%**	
Cropland	37%	59%	58%	32%	36%	49%	**45%**	
Animal Operations	0%	0%	0%	3%	0%	0%	**1%**	
Ag Operations	2%	0%	1%	0%	0%	3%	**1%**	
Lagoon	0%	0%	0%	1%	0%	0%	**0%**	
Developed	2%	4%	3%	0%	10%	3%	**3%**	
Road	3%	2%	2%	1%	4%	4%	**3%**	
Building	1%	0%	0%	0%	0%	0%	**0%**	
(H) Low Impact	55%	34%	23%	55%	45%	36%	**41%**	**Catch-ment**
(M) Moderate Impact	37%	59%	71%	40%	41%	53%	**50%**	
(L) High Impact	8%	7%	6%	5%	14%	10%	**9%**	
(H) Low Impact	67%	50%	48%	75%	52%	37%	**54%**	**25-50' buffer**
(M) Moderate Impact	16%	28%	34%	17%	14%	28%	**23%**	
(L) High Impact	17%	22%	18%	8%	33%	35%	**23%**	
(H) Low Impact	74%	63%	63%	83%	85%	56%	**71%**	**300' buffer**
(M) Moderate Impact	20%	30%	34%	15%	11%	30%	**23%**	
(L) High Impact	6%	7%	3%	2%	4%	14%	**6%**	
Streams (mi)	5.9	2.3	2.9	4.9	2.4	3.1	**21.5**	**Surface Hydrology**
Waterways (mi)	2.8	1.2	1.1	1.8	3.8	3.1	**13.9**	
Ditches (mi)	5.7	3.6	7.1	2.4	5.4	13.8	**38**	
Stream Density (mi/mi2)	3.9	2.9	2.2	4.8	2.7	1.4	**2.8**	
Waterway Density (mi/mi2)	1.8	1.6	0.8	1.8	4.3	1.5	**1.8**	
Ditch Density (mi/mi2)	3.7	4.6	5.3	2.4	6	6.5	**4.9**	
Intact Wetland (ac)	240	10	33	134	86	20	**524**	**Wetlands**
Degraded Wetland (ac)	11		31	12	4	109	**167**	
Former Wetland (ac)	44	45	79	24	14	178	**385**	
Intact Wetland (% of catchment)	24%	2%	4%	21%	15%	1%	**11%**	
Degraded Wetland (% of catchment)	1%	0%	4%	2%	1%	8%	**3%**	
Former Wetland (% of catchment)	4%	9%	9%	4%	2%	13%	**8%**	

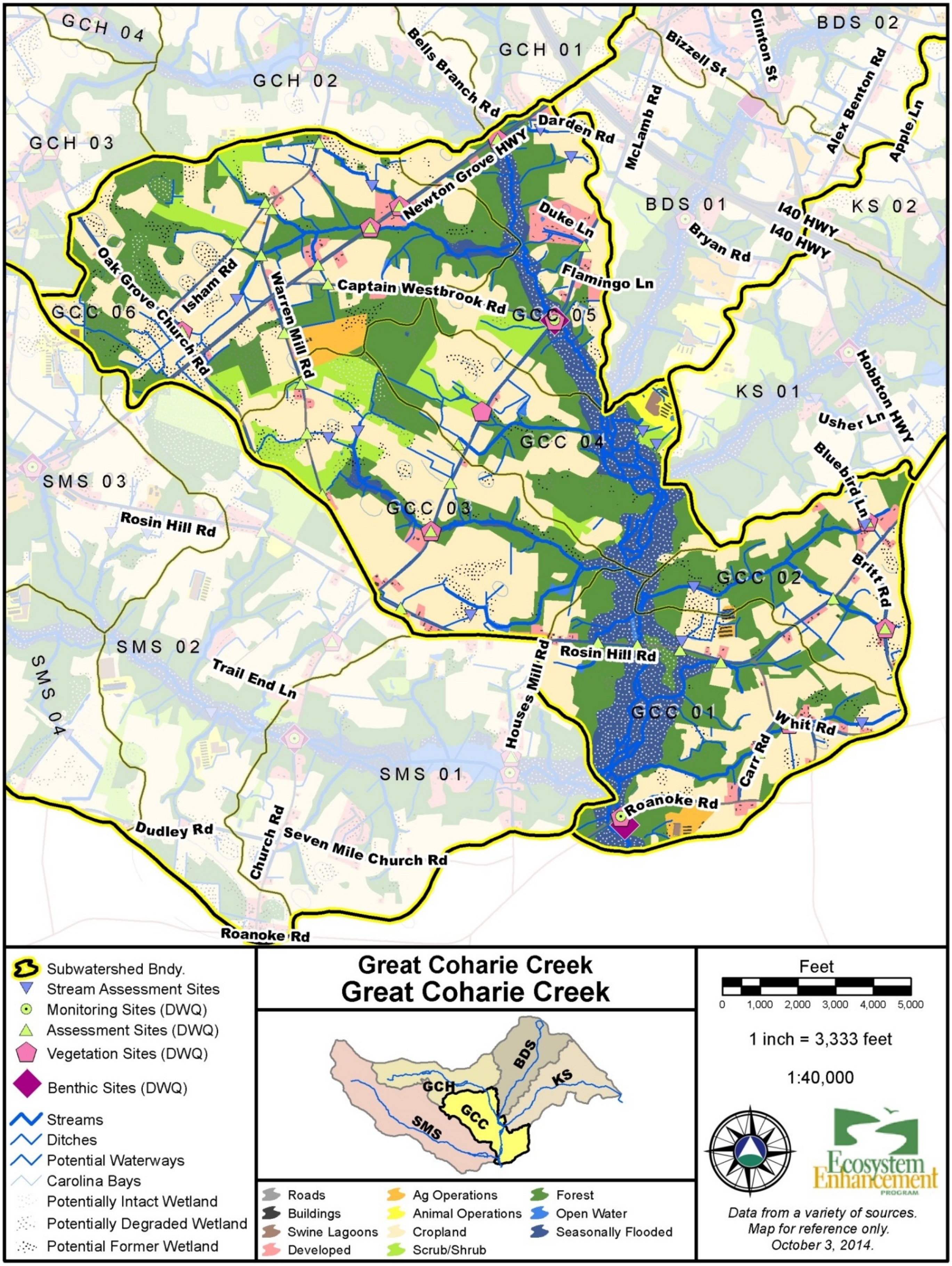

Figure 16. Great Coharie Creek subwatershed conditions map. Colors indicate land use category as per the legend and land use tables in Section 3. Patterns are used to show wetlands with white dots being potentially intact wetlands. Detailed maps of each catchment are included in Appendix E.

GCC-01 contains the mouth of the watershed planning area. This catchment was one of only six catchments in the study area that was rated with the highest level of function for hydrology, water quality and habitat. This 1.5 square mile catchment contains the mainstem of GCC within a wide, forested and seasonally flooded riparian zone. The channel is braided with multiple threads.

GCC-02 is a small tributary watershed that lies to the east of Great Coharie Creek. The confluence of this 0.8 square mile catchment is upstream of Rosin Hill Road. This catchment was rated as at-risk (moderate) function for hydrology and water quality and at-risk + for habitat. The tributary has a forested buffer for much of its length, but the channel is deeply incised with limited access to a floodplain.

GCC-03 is a tributary catchment that lies to the west of Great Coharie Creek. The confluence of this 1.3 square mile catchment is just upstream of the outlet of the GCC-02 catchment. This catchment was rated as at-risk (moderate) function for hydrology and water quality and at-risk + for habitat. The tributary has a forested riparian buffer along much of its length, with impounded, seasonally flooded areas cover more than 50% of its length.

GCC-04 is a mainstem catchment immediately downstream of the confluence of Great Coharie Creek and Beaverdam Swamp. It also includes the confluence with Kill Swamp. This catchment includes a tributary to the west of GCC. This 1.0 square mile catchment was rated as high level of function for hydrology, water quality and habitat. The mainstem channel is braided with multiple threads and exists within a wide, forested, inundated riparian zone with many flow obstructions. The tributary has a forested buffer for most of its length and flows into GCC toward the upstream end of this reach.

GCC-05 is a 0.9 square mile mainstem catchment upstream of the confluence with Beaverdam Swamp and downstream of the crossing with Newton Grove Highway. The mainstem channel exists within a seasonally flooded riparian zone that provides an important habitat corridor. This catchment was rated as high level of function for hydrology, water quality and habitat. All ditches and waterways flow to the mainstem channel and seasonally flooded riparian area.

GCC-06 is a tributary catchment to the west of GCC. The 2.1 square mile catchment contains a central tributary and several smaller side tributaries. The main tributary has a forested buffer for most of its length, but the side channels have little to no riparian buffer. All of the channels are extended with extensive ditch networks impacting the hydrology and water quality functions. This catchment was rated at-risk for hydrology function and at-risk + for water quality and habitat. Large patches of forest improve the habitat function and an inundated, seasonally flooded main tributary channel help improve water quality function.

3.6.3. Kill Swamp

The Kill Swamp subwatershed contains five catchments. Four are mainstem catchments (KS-01, KS-02, KS-03, and KS-05), and one catchment (KS-04) is a tributary catchment. Table 23 includes conditions and metrics for Kill Swamp and Figure 17 provides a map of the subwatershed. Detailed maps of the individual catchments are provided in Appendix E.

Table 23. Kill Swamp conditions and metrics. Shading indicates magnitude with higher percentages shown with darker colors. Shading is based on all 26 catchments, with darkest being highest among all catchments. For land use, colors indicate land use category to match maps shown in Section 3.

Kill Swamp (KS)	KS 01	KS 02	KS 03	KS 04	KS 05	KS TOTAL	
Size (mi2)	1.6	1.4	2.6	1.5	2.9	**10**	**Size**
Size (ac)	1,037	888	1,634	990	1,827	**6,375**	
Open Water	2%	0%	0%	0%	0%	**0%**	**Land Use**
Seasonally Flooded	10%	6%	6%	1%	1%	**5%**	
Forest	41%	30%	27%	21%	42%	**33%**	
Scrub	5%	4%	0%	1%	5%	**3%**	
Cropland	31%	50%	58%	71%	46%	**51%**	
Animal Operations	2%	1%	2%	2%	0%	**1%**	
Ag Operations	0%	1%	0%	1%	0%	**0%**	
Lagoon	0%	0%	0%	0%	0%	**0%**	
Developed	3%	3%	3%	2%	2%	**3%**	
Road	6%	3%	2%	2%	2%	**3%**	
Building	0%	1%	0%	0%	0%	**0%**	
(H) Low Impact	52%	37%	34%	22%	44%	**38%**	**Catch-ment**
(M) Moderate Impact	36%	54%	58%	72%	51%	**54%**	
(L) High Impact	12%	9%	8%	6%	5%	**8%**	
(H) Low Impact	61%	51%	50%	26%	30%	**43%**	**25-50’ buffer**
(M) Moderate Impact	16%	26%	29%	54%	43%	**34%**	
(L) High Impact	23%	23%	21%	20%	27%	**23%**	
(H) Low Impact	86%	68%	72%	20%	40%	**60%**	**300’ buffer**
(M) Moderate Impact	9%	25%	21%	71%	50%	**32%**	
(L) High Impact	5%	8%	8%	9%	10%	**8%**	
Streams (mi)	3	3.1	4.6	2.2	3.2	**16**	**Surface Hydrology**
Waterways (mi)	6	5.2	5.4	0.4	3.5	**20.5**	
Ditches (mi)	5.9	4.2	11.8	13.1	19.1	**54.1**	
Stream Density (mi/mi2)	1.8	2.2	1.8	1.4	1.1	**1.6**	
Waterway Density (mi/mi2)	3.7	3.7	2.1	0.3	1.2	**2.1**	
Ditch Density (mi/mi2)	3.6	3	4.6	8.5	6.7	**5.4**	
Intact Wetland (ac)	102	44	98	23	54	**322**	**Wetlands**
Degraded Wetland (ac)	23	31	41	67	151	**314**	
Former Wetland (ac)	32	86	128	258	210	**715**	
Intact Wetland (% of catchment)	10%	5%	6%	2%	3%	**5%**	
Degraded Wetland (% of catchment)	2%	4%	3%	7%	8%	**5%**	
Former Wetland (% of catchment)	3%	10%	8%	26%	11%	**11%**	

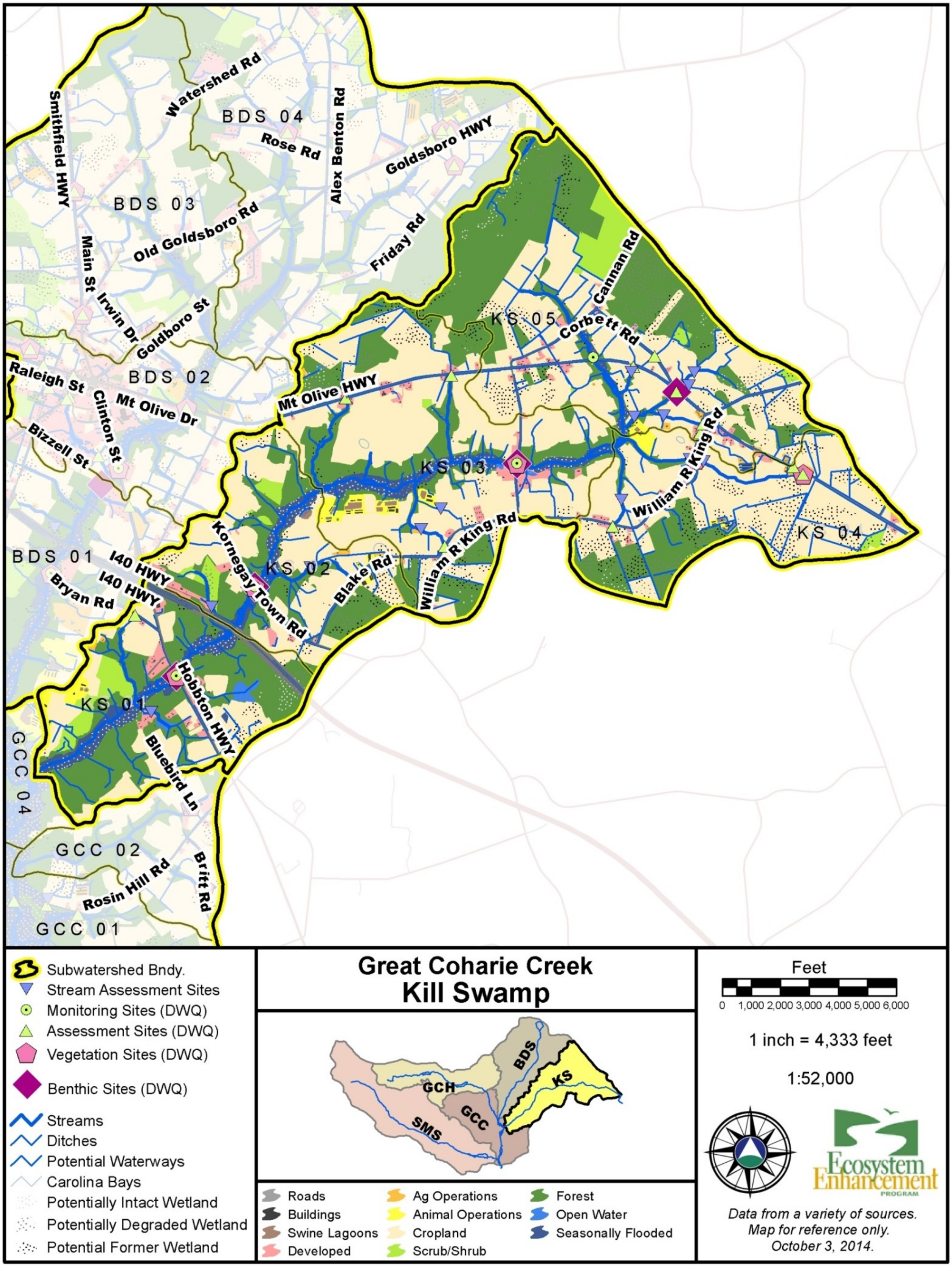

Figure 17. Kill Swamp subwatershed conditions map. Colors indicate land use category as per the legend and land use tables in Section 3. Patterns are used to show wetlands with white dots being potentially intact wetlands. Detailed maps of each catchment are included in Appendix E.

KS-01 is a mainstem catchment that includes the mouth of Kill Swamp at its downstream end and is transected by Interstate 40 at its upstream end. The mainstem channel is inundated for its entire length in this catchment and contains a wide forested riparian corridor. Within this 1.6 square mile catchment, several relatively small tributaries, ditches and waterways drain into the swamp along its length. This catchment was rated as high function for hydrology, water quality and habitat. The forested, flooded mainstem channel provides high function, and large contiguous forest lands provide additional habitat function. Many of the side channels and ditches are forested for their entire length.

KS-02 is a mainstem catchment upstream of I-40 and KS-01. This 1.4 square mile catchment has an inundated mainstem channel through its length. A fairly wide forested buffer exists along the mainstem and a large tributary to the south of the mainstem. Large areas of cropland exist in the catchment and encroach on the riparian corridor in a few locations. This catchment was rated as at-risk for hydrology, water quality and habitat functions. A network of unbuffered ditches drain cropland and animal operations, but the mainstem swamp helps to provide hydrology, water quality and habitat function.

KS-03 is a mainstem catchment upstream of KS-02. This 2.6 square mile catchment contains the mainstem of Kill Swamp within an inundated, seasonally flooded corridor through its entire length. There are two fairly large tributaries and one smaller one on the north side of the mainstem that are forested through nearly their entire length. To the south of the mainstem, several ditches and waterways drain cropland and animal operations. Numerous swine lagoons exist near the riparian corridor and pose a potential water quality concern. This catchment was rated as at-risk for hydrology function, low for water quality function and at-risk - for habitat function. The inundated mainstem channel provides some hydrology moderation, but the ditches detract from the hydrology function. The lack of buffers on the ditches to the south of the mainstem and the close proximity of the swine lagoon hinder water quality functions. The floodplain has encroachment from animal operations and cropland in several location as well as development near Emmet Thornton Rd that impact the habitat function.

KS-04 is a tributary catchment near the upstream end of Kill Swamp. The outlet of this catchment joins with the outlet of KS-05 and flows into KS-03. This 1.5 square mile catchment is severely impacted with extensive agriculture and a network of ditches. Very few of the channels have any vegetated buffer; only the downstream most portion of the tributaries have a narrow forested buffer. Over a quarter of this catchment includes potential former wetlands, now drained and used for cropland. There is one area of contiguous forest in the southeast portion of the catchment, but this area is not connected to a riparian corridor or other forested areas. This catchment was rated as low for hydrology, water quality and habitat function. The extensive unbuffered ditch network rapidly transports water, nutrients and sediment to Kill Swamp.

KS-05 is the upstream most catchment in Kill Swamp. This 2.9 square mile watershed contains the inundated mainstem of Kill Swamp, which exists within a narrow forested corridor. There are extensive lateral ditches that drain surrounding croplands. This catchment was rated as at-risk for hydrology and water quality functions and at-risk + for habitat functions. The inundated swamp provides some hydrology and water quality function, and large, contiguous forests in the catchment provide important core interior habitat.

3.6.4. Beaverdam Swamp

The Beaverdam Swamp subwatershed contains four catchments. Three of the catchments (BDS-01, BDS-02 and BDS-04) are mainstem catchments and the other catchment (BDS-03) is a tributary catchment. This subwatershed contains the Town of Newton Grove and a portion of Interstate 40. Table 24 includes conditions and metrics for Beaverdam Swamp and Figure 18 provides a map of the subwatershed. Detailed maps of the individual catchments are provided in Appendix E.

Table 24. Beaverdam Swamp conditions and metrics. Shading indicates magnitude with higher percentages shown with darker colors. Shading is based on all 26 catchments, with darkest being highest among all catchments. For land use, colors indicate land use category to match maps shown in Section 3.

Beaverdam Swamp (BDS)	BDS 01	BDS 02	BDS 03	BDS 04	**BDS TOTAL**	
Size (mi2)	1.5	1.5	2.8	3.7	**9.6**	**Size**
Size (ac)	960	970	1,808	2,375	**6,113**	
Open Water	0%	1%	0%	0%	**0%**	**Land Use**
Seasonally Flooded	12%	7%	2%	3%	**5%**	
Forest	24%	9%	22%	29%	**23%**	
Scrub	3%	3%	10%	4%	**5%**	
Cropland	35%	45%	55%	51%	**49%**	
Animal Operations	3%	0%	0%	4%	**2%**	
Ag Operations	4%	2%	1%	1%	**2%**	
Lagoon	0%	0%	0%	0%	**0%**	
Developed	7%	23%	6%	4%	**8%**	
Road	11%	8%	4%	3%	**5%**	
Building	0%	2%	1%	0%	**1%**	
(H) Low Impact	36%	17%	24%	32%	**28%**	**Catch-ment**
(M) Moderate Impact	38%	48%	65%	55%	**54%**	
(L) High Impact	25%	35%	11%	13%	**18%**	
(H) Low Impact	39%	29%	26%	31%	**31%**	**25-50' buffer**
(M) Moderate Impact	16%	26%	39%	35%	**31%**	
(L) High Impact	45%	45%	35%	34%	**39%**	
(H) Low Impact	67%	39%	41%	56%	**50%**	**300' buffer**
(M) Moderate Impact	20%	34%	46%	38%	**36%**	
(L) High Impact	14%	27%	13%	6%	**14%**	
Streams (mi)	4.2	5	4.9	4.5	**18.7**	**Surface Hydrology**
Waterways (mi)	3.7	3.5	1.4	5.2	**13.8**	
Ditches (mi)	12.2	13	22.6	31.2	**79**	
Stream Density (mi/mi2)	2.8	3.3	1.7	1.2	**2**	
Waterway Density (mi/mi2)	2.4	2.3	0.5	1.4	**1.4**	
Ditch Density (mi/mi2)	8.1	8.6	8	8.4	**8.3**	
Intact Wetland (ac)	75	41	37	29	**182**	**Wetlands**
Degraded Wetland (ac)	15	27	62	57	**161**	
Former Wetland (ac)	68	93	221	160	**542**	
Intact Wetland (% of catchment)	8%	4%	2%	1%	**3%**	
Degraded Wetland (% of catchment)	2%	3%	3%	2%	**3%**	
Former Wetland (% of catchment)	7%	10%	12%	7%	**9%**	

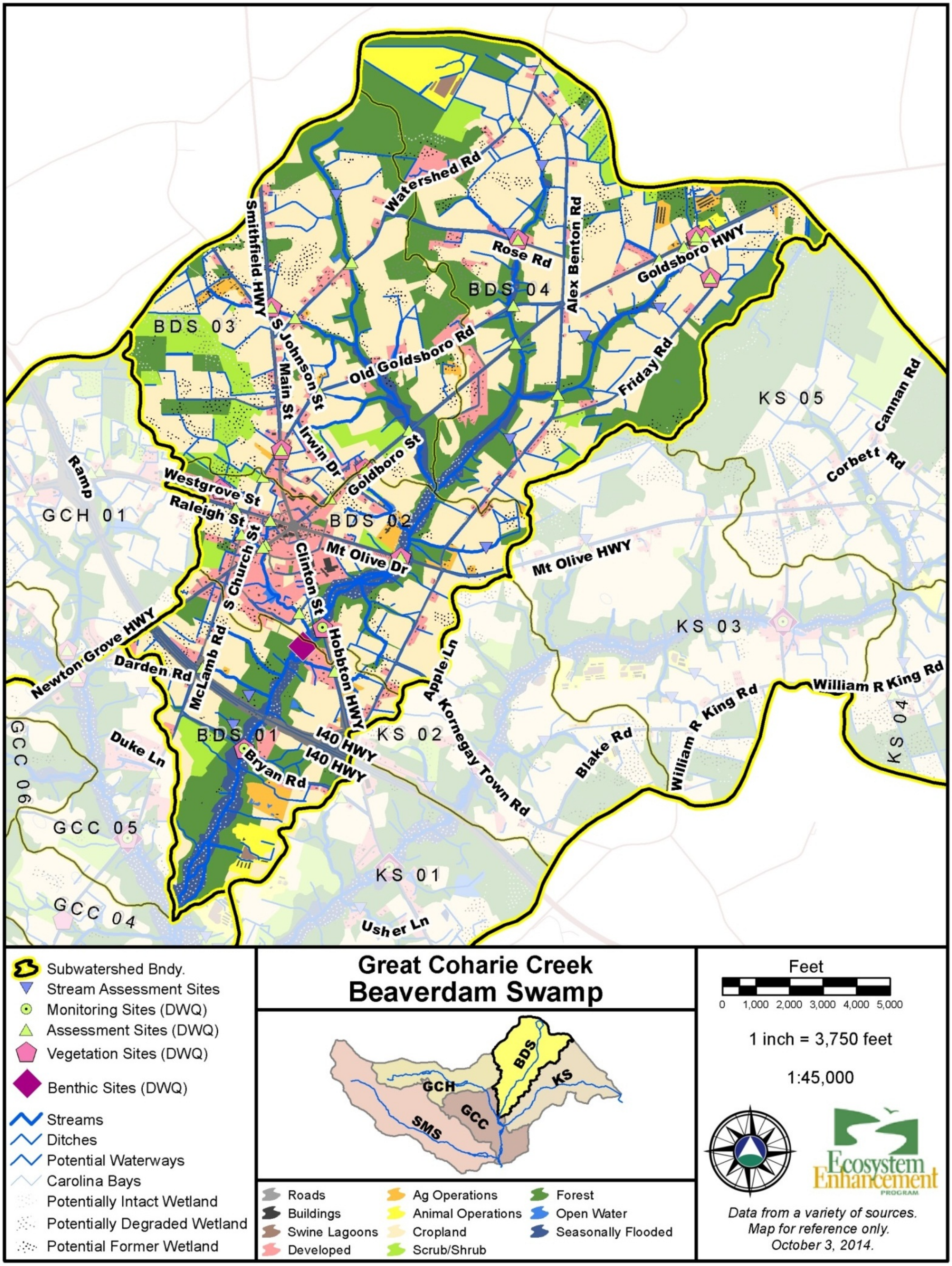

Figure 18. Beaverdam Swamp subwatershed conditions map. Colors indicate land use category as per the legend and land use tables in Section 3. Patterns are used to show wetlands with white dots being potentially intact wetlands. Detailed maps of each catchment are included in Appendix E.

BDS-01 is the downstream most catchment in this subwatershed, and is downstream of Newton Grove and Clinton St. This 1.5 square mile catchment contains the mainstem of Beaverdam Swamp and a portion of Interstate 40. The mainstem exists within a wide forested buffer and is inundated with seasonally flooded wetlands along its entire length with many flow obstructions. This catchment is rated as high function for hydrology, water quality and habitat. The tributaries, ditches and waterways all flow to the main channel and riparian floodplains.

BDS-02 is a mainstem catchment that contains nearly all of the Town of Newton Grove. This 1.5 square mile catchment is rated low function for hydrology, water quality and habitat. The mainstem is braided in places with multiple channels and contains seasonally flooded riparian floodplains along its length. This catchment also includes several tributaries, which have little to no riparian buffer. Ditches, waterways and streams drain developed and agricultural areas.

BDS-03 is tributary catchment dominated with agricultural land uses. This 2.8 square mile catchment is north of the mainstem of Beaverdam Swamp and contains several smaller tributaries. This catchment was rated at-risk for hydrology and at-risk - for water quality and habitat. The ditches, watershed and tributaries flow into the primary tributary, which has a forested riparian buffer and inundated, seasonally flooded areas along its downstream half. These seasonally flooded areas improve hydrology function, but the extensive, well-ditched agricultural lands and fairly narrow riparian buffer and fragmented scrub and forest lands impact the water quality and habitat functions.

BDS-04 is the uppermost catchment in Beaverdam Swamp. This 3.7 square mile catchment contains the mainstem of Beaverdam Swamp and another large tributary along with many ditches and waterways. This catchment was rated at-risk for hydrology and water quality and at-risk - for habitat function. The mainstem and major tributary have fairly narrow forested buffers with inundated, seasonally flooded areas along much of their length. These areas provide some measure of hydrology, water quality and habitat function, but the network of unbuffered ditches and waterways rapidly move water and sediment to the main channels. The narrow riparian corridors do not connect with the fragmented forests in the catchment.

3.6.5. Great Coharie Headwaters

The Great Coharie Headwaters subwatershed contains five catchments. There are three mainstem catchments (GCH-02, GCH-04, and GCH-05) and two tributary catchments (GCH-01 and GCH-03). Table 25 includes conditions and metrics for the Great Coharie Headwaters subwatershed and Figure 19 provides a map of the subwatershed. Detailed maps of the individual catchments are provided in Appendix E.

Table 25. Great Coharie Headwaters conditions and metrics. Shading indicates magnitude with higher percentages shown with darker colors. Shading is based on all 26 catchments, with darkest being highest among all catchments. For land use, colors indicate land use category to match maps shown in Section 3.

Great Coharie Headwaters (GCH)	GCH 01	GCH 02	GCH 03	GCH 04	GCH 05	GCH TOTAL	
Size (mi2)	1.6	1.6	1.1	1.4	2.4	**8.1**	**Size**
Size (ac)	1,000	1,044	709	873	1,547	**5,172**	
Open Water	1%	3%	0%	5%	0%	**2%**	**Land Use**
Seasonally Flooded	1%	6%	3%	9%	4%	**5%**	
Forest	23%	24%	35%	21%	30%	**27%**	
Scrub	6%	1%	1%	0%	1%	**2%**	
Cropland	52%	59%	51%	47%	53%	**53%**	
Animal Operations	0%	0%	0%	0%	0%	**0%**	
Ag Operations	0%	0%	1%	1%	1%	**1%**	
Lagoon	0%	0%	0%	0%	0%	**0%**	
Developed	5%	4%	6%	12%	7%	**7%**	
Road	11%	2%	2%	4%	2%	**4%**	
Building	0%	0%	0%	1%	1%	**1%**	
(H) Low Impact	25%	33%	38%	35%	35%	**33%**	**Catch-ment**
(M) Moderate Impact	58%	59%	52%	47%	54%	**55%**	
(L) High Impact	17%	7%	10%	18%	11%	**13%**	
(H) Low Impact	29%	49%	37%	42%	40%	**39%**	**25-50’ buffer**
(M) Moderate Impact	35%	30%	34%	20%	33%	**31%**	
(L) High Impact	36%	22%	29%	38%	27%	**30%**	
(H) Low Impact	49%	60%	68%	93%	61%	**65%**	**300’ buffer**
(M) Moderate Impact	29%	36%	21%	1%	26%	**25%**	
(L) High Impact	22%	5%	10%	5%	13%	**10%**	
Streams (mi)	2.6	4.6	1.4	2.2	3.1	**14**	**Surface Hydrology**
Waterways (mi)	3.2	3.5	1.2	3.4	3.3	**14.7**	
Ditches (mi)	15.4	7.3	7.3	9.1	17.4	**56.6**	
Stream Density (mi/mi2)	1.7	2.8	1.3	1.6	1.3	**1.7**	
Waterway Density (mi/mi2)	2.1	2.1	1.1	2.5	1.4	**1.8**	
Ditch Density (mi/mi2)	9.9	4.5	6.6	6.7	7.2	**7**	
Intact Wetland (ac)	13	43	4	33	18	**112**	**Wetlands**
Degraded Wetland (ac)	78	31	112	51	246	**519**	
Former Wetland (ac)	71	67	77	46	183	**443**	
Intact Wetland (% of catchment)	1%	4%	1%	4%	1%	**2%**	
Degraded Wetland (% of catchment)	8%	3%	16%	6%	16%	**10%**	
Former Wetland (% of catchment)	7%	6%	11%	5%	12%	**9%**	

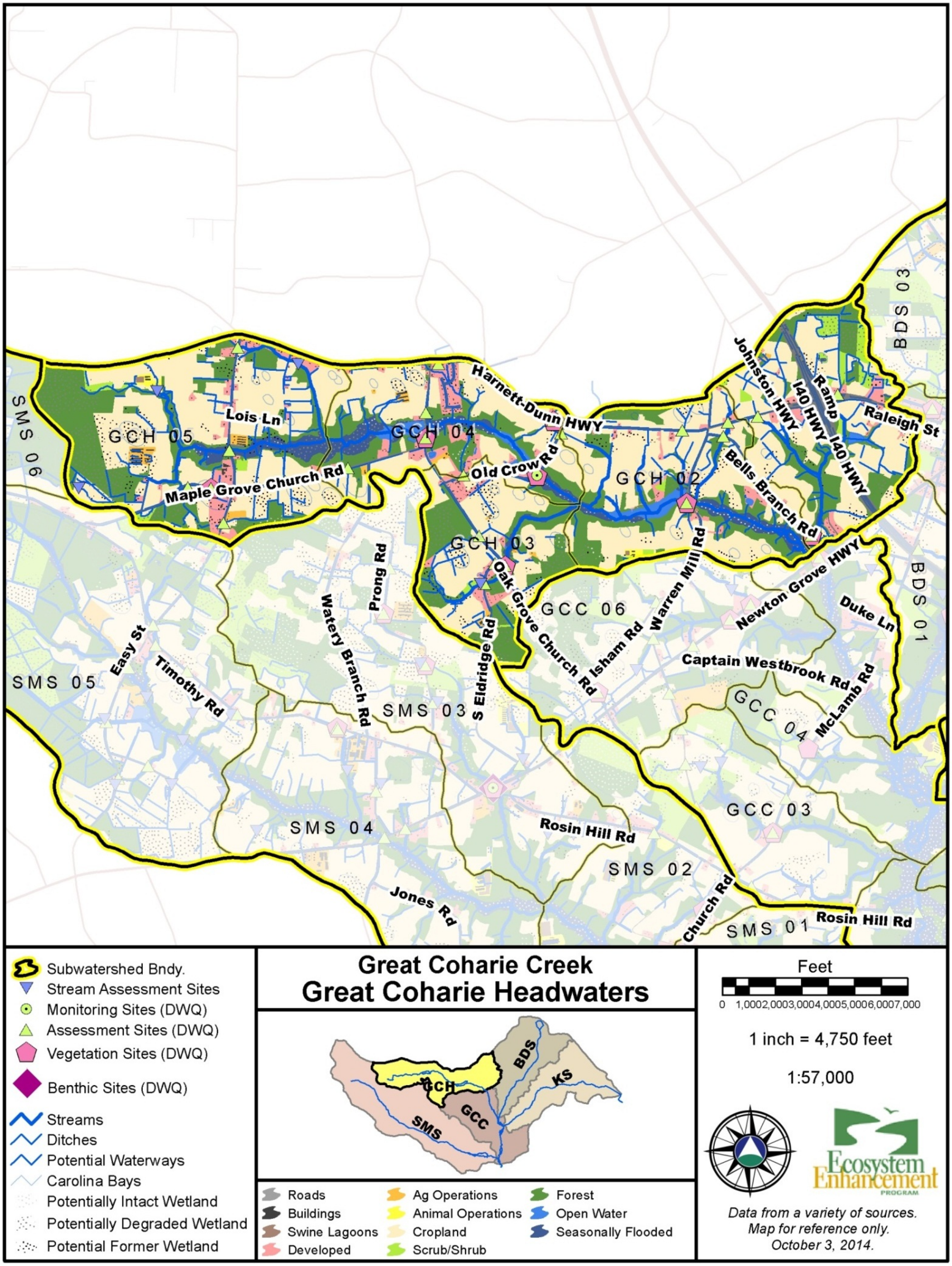

Figure 19. Great Coharie Headwaters subwatershed conditions maps. Colors indicate land use category as per the legend and land use tables in Section 3. Patterns are used to show wetlands with white dots being potentially intact wetlands. Detailed maps of each catchment are included in Appendix E.

GCH-01 is a tributary catchment that joins with the downstream end of GCH-02 and flows into GCC-05. This 1.6 square mile catchment is highly impacted and transected by Interstate 40 and NC 50/55 including the interchange. There is a central tributary that collects two smaller tributary branches, one of which flows under I-40. The other tributary originates from drainage ditches near the commercial development at the interchange. The lower two-thirds of the tributaries have a moderate forested riparian buffer and the mouth of the central tributary is impounded upstream of its confluence with Great Coharie Creek. This catchment was rated as at-risk - for hydrology function and low for water quality and habitat function. Extensive ditches drain cropland and developed areas.

GCH-02 is a mainstem catchment that flows into GCC-05 at Newton Grove Highway. This 1.6 square mile catchment contains the mainstem of Great Coharie Creek which is a series of beaver impoundments downstream of Warren Mill Rd. There is a large mill pond, Warren’s Mill Pond, upstream of Warren Mill Rd. There is a forested buffer along the entire mainstem and the channel is inundated or impounded along its entire length in this catchment. There are several waterways within the forested corridor in the downstream half of the catchment and several unbuffered tributaries north of the mainstem in the upper half of the catchment. This catchment was rated as at-risk + for hydrology, water quality and habitat functions. The mill pond and impounded channel improve hydrology and water quality functions, but the unbuffered ditches and tributaries negatively impact these functions. The riparian buffer, while intact through this reach, is narrower than downstream sections of Great Coharie Creek.

GCH-03 is a tributary catchment south of Great Coharie Creek. This 1.1 square mile catchment has a central tributary with a fairly narrow forested buffer. The downstream half is seasonally flooded. Several Carolina bays are drained through a network of ditches. Upstream of S Eldridge Rd, the channel is impounded in an inline farm pond. This catchment was rated as at-risk for hydrology and water quality functions and at-risk +for habitat function. The farm pond and forested inundated central tributary provide some hydrology and water quality function. There are several larger forested areas within the catchment that help improve habitat function.

GCH-04 is a mainstem catchment that flows into GCH-02. This 1.4 square mile catchment includes a large manmade impoundment, Blackman’s Pond, and extensive beaver impoundments upstream and downstream of Blackman’s Pond. The mainstem of Great Coharie Creek has a wide, forested buffer and an inundated floodplain along its entire length in this catchment. There are several lateral ditches and waterways that drain cropland, developed areas and animal operations. This catchment was rated as at-risk for hydrology and water quality functions and at-risk +for habitat function. The impoundments help improve hydrology and water quality functions, but the network of ditches impact these functions. The wide forested riparian zone provides an important habitat corridor. A debris jam and subsequent siltation on the upstream side of a roadway culvert at Old Crow Rd have created a large open water impoundment.

GCH-05 is the uppermost catchment and includes the origin and headwaters of Great Coharie Creek. This 2.4 square mile catchment contains a fairly wide forested, seasonally flooded riparian corridor with multiple beaver impoundments. Beyond the riparian buffer to the north and south are large areas of cropland with extensive ditches. The headwaters of Great Coharie Creek extend through an animal operation and pasture lands where cattle have access to the stream. In the western portion of the catchment, there is a large contiguous forested area that extends into SMS-06. This catchment includes multiple drained and cropped Carolina bays. This catchment was rated as at-risk for hydrology and water quality functions and at-risk +for habitat function. The extensive unbuffered ditches impact hydrology and water quality, but the areas drain to the mainstem channel into inundated floodplains which serve to retain and process nutrients. The forested riparian corridor and large forested tracts provide important habitat.

3.7. Conclusions

This section provides a summary of conclusions about watershed conditions including hydrology, water quality and habitat functions within the Great Coharie Creek LWP area. The vast network of streams, waterways and ditches has a profound influence on the hydrology and water quality of the system. The high density of ditches means that precipitation and accompanying sediment and pollutants are rapidly transported from the uplands through the ditches and waterways to the streams. However, the low slope of the ditches and streams, coupled with the numerous flow obstructions and dense aquatic vegetation serves to slow the water and decrease the velocity and stream energy in the mainstem channels.

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

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

1. **Reduce runoff and erosion** and by slowing water, nutrients and sediment at their source in the fields. This could be accomplished through agricultural BMPs, installing vegetated buffers along ditches and waterways, and allowing ditches to become naturalized with plants and wider flood-prone widths; and,
2. **Protect the riparian floodplains**. These seasonally flooded mainstem riparian zones are the heart and soul of the Great Coharie Creek and provide tremendous ecological functions. They help sustain the rich natural heritage in the Great Coharie Creek and the Black River.

SECTION 4. References

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