Goose Creek Watershed Management Plan

Completed by: Charlotte-Mecklenburg Storm Water Services
Version 1
October 31, 2009

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Executive Summary

The Goose Creek Watershed is located in southeastern Mecklenburg County and is almost entirely within the town limits or extraterritorial jurisdiction of Mint Hill. The watershed has been designated as habitat for the federally listed endangered Carolina Heelsplitter Mussel. This designation has brought about the implementation of a Site Specific Management Plan for new development in the watershed. In addition to the issues surrounding the Carolina Heelsplitter, the municipalities within the Watershed were required to develop a Water Quality Recovery Program for Fecal Coliform, which was the result of a Fecal Coliform TMDL. In addition to Fecal Coliform, the watershed is also identified on the NC 303(d) list for impaired biological integrity, likely a result of hydro-modification of the stream channel. Table 1 presents general statistics for the Goose Creek Watershed.

Table 1: General Goose Creek Watershed Statistics (portion of Goose Creek within Mecklenburg County).

Estimated Goose Creek Watershed Population	5616	
Goose Creek Watershed Area	6975 acres	
Stream Miles (Draining > 50 acres)	28 miles	
Dominant Land Uses	Rural Residential	34%
	Vacant	31%
	Low Density Residential	11%
	Medium/Low Density Residential	9%
	Transportation	8%
Major Political Jurisdictions	Town of Mint Hill	
Major Streams in the Goose Creek Watershed	Goose Creek	
	Duck Creek	
	Stevens Creek	

SECTION 1. INTRODUCTION

1.1 Purpose

The purpose of this Watershed Management Plan is to guide restoration, retrofit and preservation efforts aimed at achieving specific goals for improving water quality conditions in the Goose Creek Watershed in Mecklenburg County such that these waters meet or exceed their State designated uses and are no longer rated as impaired on 303(d) lists. Moreover, the plan seeks to restore the population of Lasmigona Decorata (Carolina Heelsplitter), a federally endangered freshwater mussel, in the watershed.

This Watershed Management Plan seeks to:

1. Summarize important information regarding the Goose Creek Watershed relative to water quality.
2. Describe current and historical water quality conditions in the watershed.
3. Describe current and previous efforts in the watershed to protect and restore water quality.
4. Describe water quality goals for the watershed.
5. Prioritize areas for restoration, retrofit and preservation efforts aimed at achieving water quality goals.
6. Describe the process forward for implementing water quality efforts.

The ultimate goal after complete implementation of this Watershed Management Plan is a fully functioning and supporting stream ecosystem in Goose Creek.

1.2 Background

The headwaters of the Goose Creek Watershed (including Goose, Duck and Stevens Creeks) are located in the southeastern portion of Mecklenburg County and lies within Mint Hill's jurisdiction. The creek flows from Mecklenburg County to the southeast into Union County and subsequently enters the Yadkin River in Union County. Figure 1 shows the location of the Goose Creek Watershed in Mecklenburg County along with its jurisdictional boundaries. Figure 2 presents a close up view of the Goose Creek Watershed.

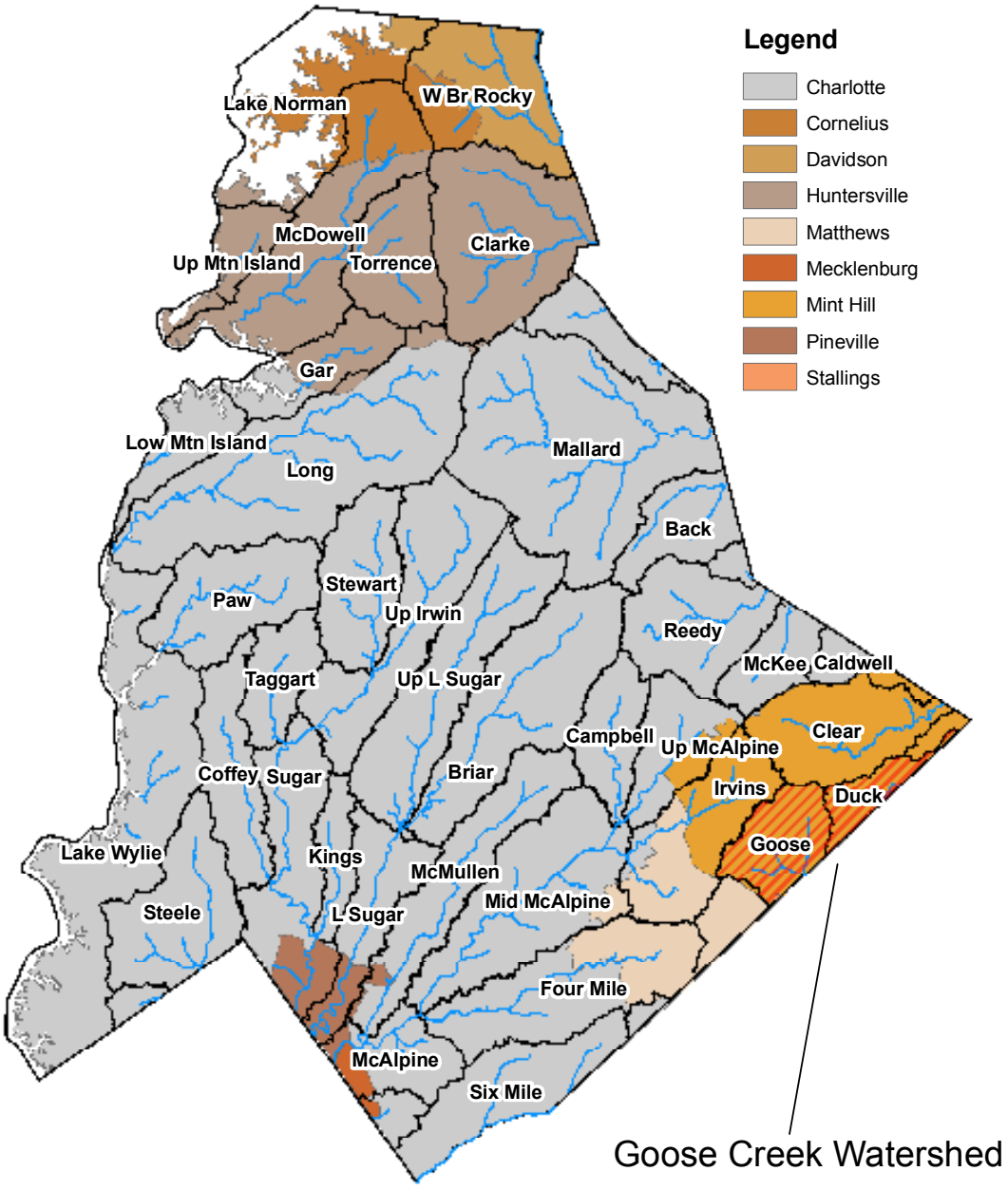

Figure 1: Mecklenburg County Watersheds and Jurisdictional Boundaries.

Figure 2: Special Features within the Goose Creek Watershed. Note: MY9, MY9A, MY9B denote Mecklenburg County water quality monitoring sites.

Historically, land in the Goose Creek Watershed was used for agriculture. However, within the past 20-30 years the population of the watershed has increased. Figure 3 shows a typical older residential development in the Watershed and Figure 4 shows more recent development. In addition to agricultural land-use, large lot residential and some commercial/institutional centered around Highway 51 and Lawyers Road are now notable. The relatively recent construction of 485 is expected to attract dense development at the Idlewild Road, Lawyers Road and Fairview Road exits. In fact, at the northeast corner of Lawyers Road and 485 a new mall (The Bridges) is under construction (currently on hold). In addition to the recent changes brought about by urbanization, drastic changes to the stream system have occurred in the last century. At some point in the past, the portions of Goose Creek were straightened either to prevent flooding or to improve the land for agricultural uses (Charlotte-Mecklenburg Storm Water Services, 1997).

Figure 3: Typical Residential Development in the Goose Creek Watershed.

Figure 4: Typical New Residential Development in the Goose Creek Watershed.

Goose Creek is listed in the 2006 North Carolina 303(d) list (North Carolina, 2004) as being impaired for fecal coliform . A total of 16.3 miles of Goose Creek are identified in the list, which includes the entire stream from its source to the Rocky River. Typically streams are listed on the 303(d) list dependant upon their intended uses. Intended uses are generally determined through the stream class. Goose Creek is a Class C Stream (see Table 2). In North Carolina, surface water quality regulations are defined for particular classes of use support. For instance, Class C waters must support aquatic life and secondary recreation (infrequent human body contact), while Class B waters must support aquatic life and primary recreation (frequent human body contact or swimming). Individual streams, lakes, and reservoirs (or portions of each) are assigned one or more classes. All of the contributing streams to a body of water receive the same designation when they are not specifically defined. Each class has a set of regulations, including water quality standards associated with it. If chemical/physical water quality monitoring reveals that a stream is not meeting a water quality standard, then it is considered "Impaired." If biological monitoring indicates a lack of abundance and/or diversity of aquatic life in a stream, then it is considered as having "Impaired biological integrity." Impaired streams are placed on the 303(d) list and a restoration method is specified such as the development of a total maximum daily load or TMDL.

A TMDL was written by the Mecklenburg County Water Quality Program (now know as Charlotte/Mecklenburg Storm Water Services (CMSWS)) in April 2005 and subsequently approved by the USEPA on July 8, 2005. The TMDL will be discussed at length in the next section of this document (Section 2).

Table 2: Goose Creek Stream Class Descriptions.

Stream Class	Description
C	Freshwaters protected for secondary recreation, fishing, aquatic life including propagation and survival, and wildlife. All freshwaters shall be classified to protect these uses at a minimum.

SECTION 2. CURRENT AND HISTORICAL CONDITIONS

2.1 Previous Work

Approximate Event Timeline for the Goose Creek Watershed

June 30, 1993: Carolina Heelsplitter included on the Endangered Species list. Goose Creek named as habitat for a small population.

January 17, 1997: Completion of the Recovery Plan for the Carolina Heelsplitter.

August 20, 2001: Mitigated Finding of No Significant Impact – Charlotte- Mecklenburg Utilities Proposed Increase in Interbasin Transfer from the Catawba River Basin to the Rocky River Basin.

March 14, 2000: EMC decision to approve the IBT with conditions. Condition #3 placed a "…moratorium on the installation of new interbasin transfer water lines… into the Goose Creek subbasin…until the impacts of additional urban growth on the (Carolina heelsplitter) are fully evaluated." This ruling effectively halted expansion of the supply of public water in the Goose Creek Watershed.

April, 2005: Final Goose Creek TMDL Submitted to USEPA

July 8, 2005: USEPA Approval of Goose Creek Fecal Coliform TMDL

August 10, 2006: Letter from NCDENR to Mecklenburg County, Mint Hill, Stallings and Indian Trail requiring the development of a Water Quality Recovery Program for implementation of the Goose Creek Fecal Coliform TMDL.

September 15, 2006: NC Court Decision (Filed October 13, 2006) requiring, among other things, that the NPDES permits for Stallings, Indian Trail, Mint Hill and Mecklenburg County be reopened and amended to include measures to protect the Carolina Heelsplitter. Among these are water quality standards for ammonia, copper, nitrate-nitrite and phosphorus. The document identifies standards presented in Table 3.

Table 3: Goose Creek Water Quality Standards

Constituent	Chronic Standard	Acute Standard
Phosphorus	0.1 mg/L	
Nitrate-nitrite	0.4 mg/L	
Copper	2.2 ug/L	3.6 ug/L
Ammonia	0.5 mg/L	1.75 mg/L

June 30, 2007: Implementation of Mint Hill's Post Construction Ordinances, which currently guide land development in the Goose Creek Watershed.

February 1, 2009: Implementation of the Site Specific Management Plan for the Goose Creek Watershed. This Plan guides all development in the watershed, eliminating the Mint Hill Post Construction Ordinance.

2.1.1 Goose Creek Fecal Coliform TMDL

In April 2005, Mecklenburg County, under contract with the State of North Carolina, completed a TMDL for fecal coliform for Goose Creek, North Carolina. The TMDL was subsequently approved by the USEPA on July 8, 2005. A copy of the TMDL is available at the following website:

http://h2o.enr.state.nc.us/tmdl/documents/GooseCk.FCTMDLApprovedbyEPAJuly0805.pdf

The TMDL specified fecal coliform load reductions to both permitted MS4s in the watershed and non-point sources of pollution. Essentially, the TMDL specifies load reductions of 92.5% for all sources of fecal coliform with the exception of WWTPs, whose allocation remained unchanged at permitted levels (200 c.f.u./100 ml).

2.1.2 Water Quality Recovery Program

On August 10, 2006 NC DENR submitted a letter to the permitted MS4s in the Goose Creek Watershed requiring them to develop a Water Quality Program (WQRP) for Fecal Coliform in the Goose Creek Watershed. Mecklenburg County partnered with the towns of Mint Hill, NC, Stallings, NC and Indian Trail, NC to develop the WQRP. The WQRP document, which describes each of the components of the program is included with this document as Appendix XX.

2.1.3 NC DOT

In September, 2004 Craig Allan (Department of Geography and Earth Sciences, UNC Charlotte) completed a report entitled Water Quality and Stream Stability Monitoring for Goose Creek Mecklenburg and Union Counties, North Carolina 2001-2003. The study was funded by the United States Department of Transportation to study the impacts of the construction of I-485 through the Goose Creek Watershed in Mecklenburg County. Allan cites hydromodification of the stream channel itself as a primary source of elevated TSS and turbidity levels measured during storm events. Similarly, Allan (2004) cited increased levels of phosphorus and nitrogen in storm flow.

2.1.4 Charlotte-Mecklenburg Utilities

Charlotte Mecklenburg Utilities initiated a study with the goal of establishing a Finding of No Significant Impact (FONSI) for the construction of a regional WWTP in the Goose Creek Watershed. The study was never completed because of the requirements put in

place to protect the Carolina Heelsplitter Mussel essentially prohibited construction of the plant.

2.1.5 North Carolina Ecosystem Enhancement Program

The North Carolina Ecosystem Enhancement Program (EEP) is currently conducting a study in the Goose Creek Watershed to establish a Local Area Watershed Plan (LAWP) to identify mitigation opportunities in the Watershed. In the past, EEP LAWPs have not met the needs of local governments in Mecklenburg County however the process has been modified and may provide useful information. No completion date was available at the time of preparation of this document. EEP has established a stakeholder group of technical resources that is participating in their process. They intend for the stakeholder group to assume the role of implementing the findings of the LAWP that are not pertinent to EEP goals. These findings may include ordinance modification, BMP construction, stream enhancement or restoration and education efforts.

2.2.1 Water Chemistry

Goose Creek baseflow samples are collected from MY9A, MY9B and MY9 (Figure 2). Table 4 presents a condensed set of information from the historical data collected at these sites. TN exceedances were detected 27% of the time and TP exceedences were detected 8% of the time. Fecal coliform concentrations in excess of 200 c.f.u./100 ml were detected approximately 82% of the time. Additionally, copper exceedences were recorded in 68% of the samples and ammonia in 7% of the samples. Figure 5 shows the percentages of these exceedances. Stream Use Support Index (SUSI) values have tended to oscillate since 2007 but have remained below threshold values, which is a strong indicator of a non-supporting watershed (Figure 6). The most notable reason for the lowest values is the extreme drought that has occurred in the piedmont of North Carolina in the past several years.

Table 4: Baseflow Water Chemistry Statistics.

All Goose Creek Monitoring Sites	Total N	Total P	TSS	Fecal Coliform	Copper	Ammonia
Action Level:	1.5 ppm	0.4 ppm	50	200 cfu/100Ml	2.2 ug/L	0.5
Sample size	186	202	48	463	121	204
MIN	0.35	0.02	2	1	2	0.05
MAX	10.5	2.1	43	58000	36	2.5
MEAN	1.5	0.2	5.2	2398	6.2	0.22
MEDIAN	1.1	0.13	2.8	500	3.6	0.10
% samples over Action Level	27%	8%	0%	82%	68%	7%

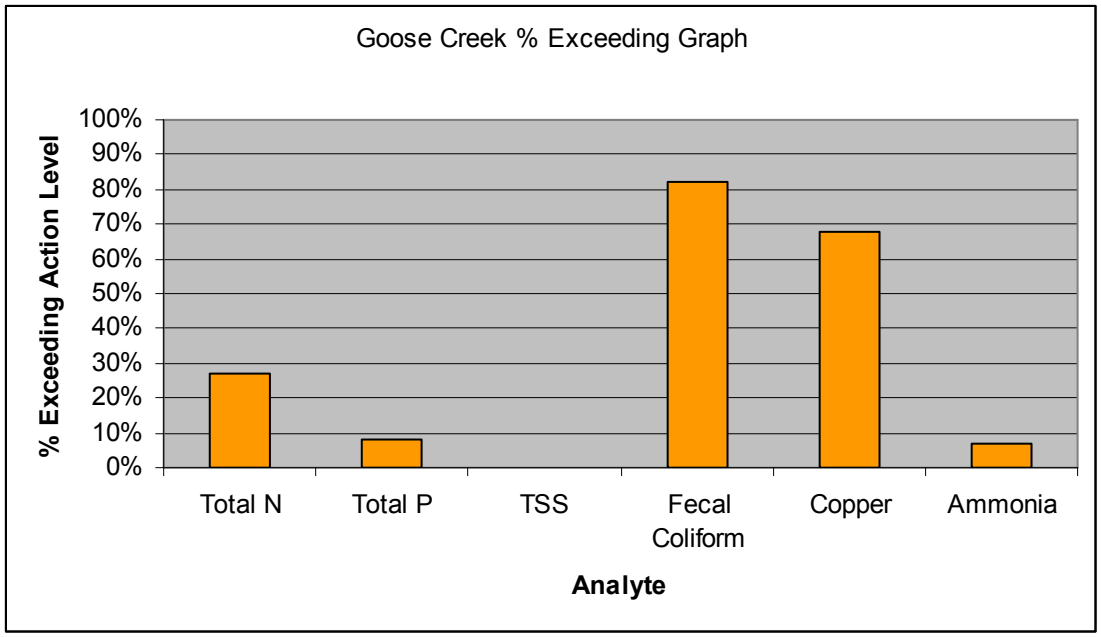

Figure 5: Percent Exceeding Graph for Goose Creek Samples.

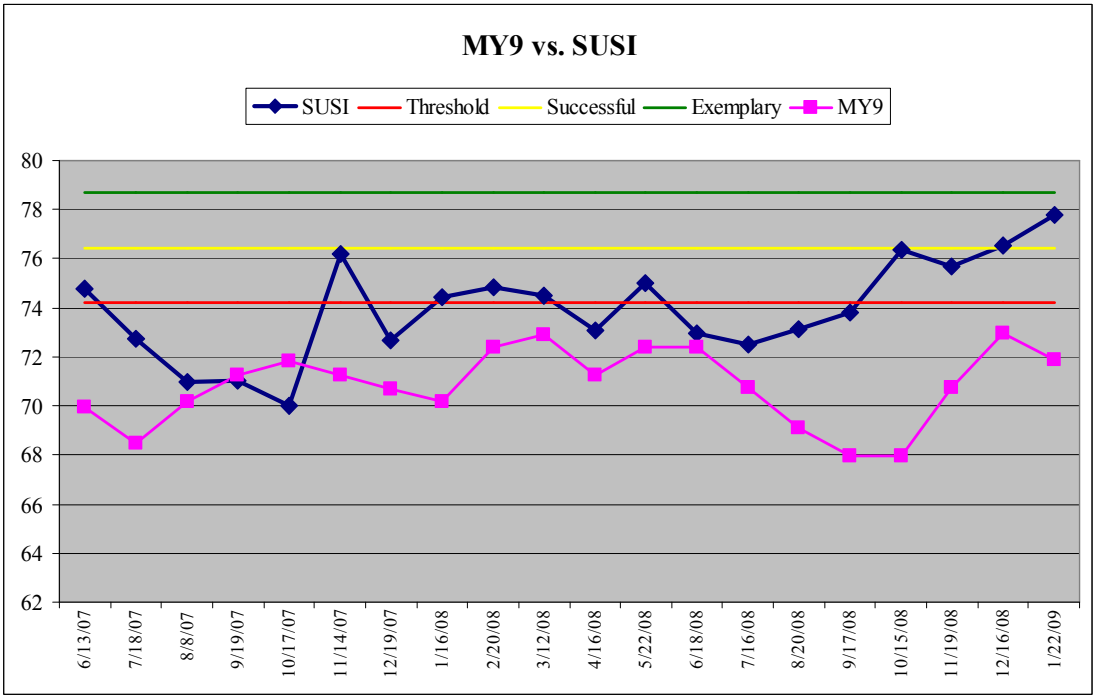

Figure 6: Historical SUSI Scores for Goose Creek

2.2.2 Biological

Currently, the benthic macroinvertebrate community in Goose Creek is monitored annually by Mecklenburg County at Stevens Mill Road in Union County (site MY9). Previously, samples were collected at MY9A and MY9B, which are just upstream of I-

485 on Goose and Stevens Creeks respectively (Figure 2). The EPT taxa richness was generally below 10 species for all samples taken since 1999 in Goose Creek. Figure 7 presents the benthic macrinvertebrate scores for Goose Creek since 1995. As can be discerned from the graph, Goose Creek has exhibited a general decline in its macroinvertebrate population. However, it is important to note that the macroinvertebrate populations in Goose Creek are very sensitive to drought as Goose Creek tends to dry up more readily than other creeks with a similar drainage area. This is likely due to the drainage area being partially within the Carolina Slate Belt

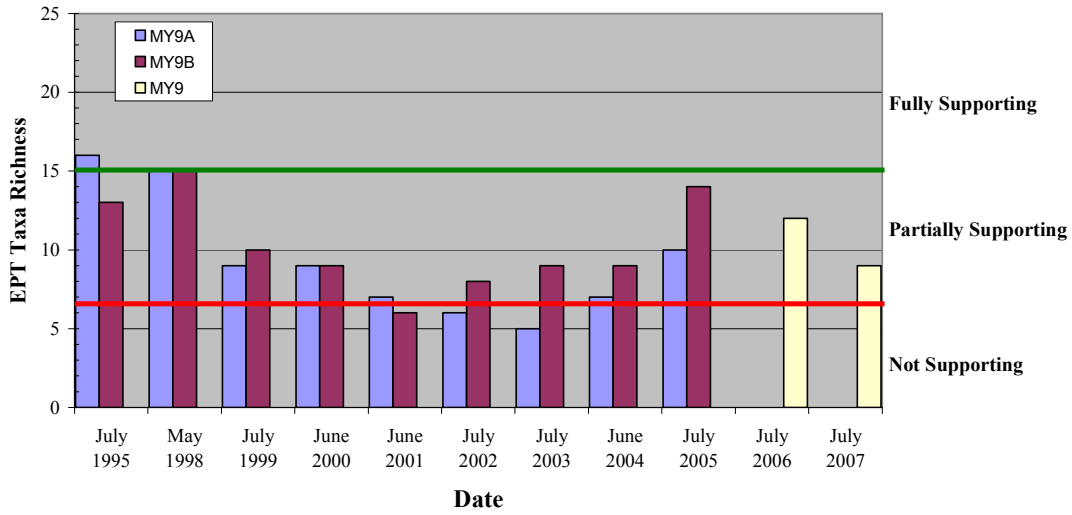

Figure 7: Goose Creek Benthic Macroinvertebrate Scores.

The N.C. Department of Environment and Natural Resources (NCDENR) performs monitoring for macroinvertebrates and the Carolina Heelsplitter in Goose Creek. The macroinvertebrate sample results are presented in Table 5.

Table 5: NCDENR Macroinvertebrate Sample Results

Site	Stream	County	Road	Bioclassification
SSB-3	Goose Creek	Mecklenburg	SR 1004	Good
SSB-4	Goose Creek	Union	Glamorgan Rd.	Good
SSB-5	Goose Creek	Union	SR 1524	Good
SSB-6	Goose Creek	Union	Below Fairfield	Fair
SSB-7	Goose Creek	Union	SR 1525	Poor
SSB-8	Goose Creek	Union	SR 1533	Fair
B-5	Goose Creek	Union	US 601	Poor
SSB-9	Goose Creek	Union	SR 1547	Fair
SSB-1	Stevens Creek	Mecklenburg	Maple Hollow Rd.	Good
SSB-2	Stevens Creek	Mecklenburg	Thompson Rd	Not Impaired
SSB-10	Duck Creek	Union	US 601	Fair

The distribution of the population with the watershed is currently unknown; however it is likely that no supporting populations of the mussel are in Mecklenburg County because

of the high likelihood of Goose Creek going dry within the County. Specific information about the Carolina Heelsplitter can be found at the following website:

http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Lasmigona+decorata

2.2.4 Stream Flow

A watershed will generate larger volumes of storm water runoff and discharge this runoff at higher rates as the amount of imperviousness increases as a result of development. The stream channels that receive the additional runoff are exposed to increased hydraulic forces that can lead to morphologic instabilities through erosion – a process that reduces the availability and quality of aquatic habitat. Aquatic species are dependent upon the channel boundary for shelter, foraging, reproduction, and rest. When boundary materials regularly erode, the aquatic habitat is impacted and unlikely to support a diverse, healthy aquatic community. Therefore, addressing the source of the habitat degradation, additional storm water runoff in this case, will help reduce impairment to in-stream biological communities (Tetra Tech, 2004)

2.2.5 Land Use/Land Cover

The land-use/land-cover data set used for this Watershed Management Plan was developed by Tetra Tech Inc. (2004) for the Post Construction Ordinance development process. The data set was developed through interpretation of a combination of parcel information, aerial photographs, and tree canopy data. The process is more thoroughly described in Tetra Tech Inc. (2004). The land-use data set provides a distribution and classification of all land-uses in the Goose Creek Watershed. The land-use categories represented in the Goose Creek Watershed are presented in Table 6 and the distribution of the land-uses for the Goose Creek Watershed is shown in Figure 8.

Table 6: Goose Creek Land Use Categories.

Land Use Class	Abbreviation
Agriculture	AG
Heavy Commercial	COMM-H
Light Commercial	COMM-L
Forest	FRST
Golf Course	GC
High Density Residential	HDR
High Density Multifamily Residential	HMFR
High Density Mixed Urban	HMX
Heavy Industrial	IND
Institutional	INS
Interstate Corridor	INTERSTATE
Low Density Residential	LDR
Medium Density Residential	MDR
Meadow	MEADOW
Multi Family Residential	MFR
Medium Low Density Residential	MLDR
Mixed Urban	MX
Office/Industrial	OI-H
Light Office/Light Industrial	OI-L
Park	PARK
Rural Residential	RR
Ultra High Density Mixed Urban	UHMX

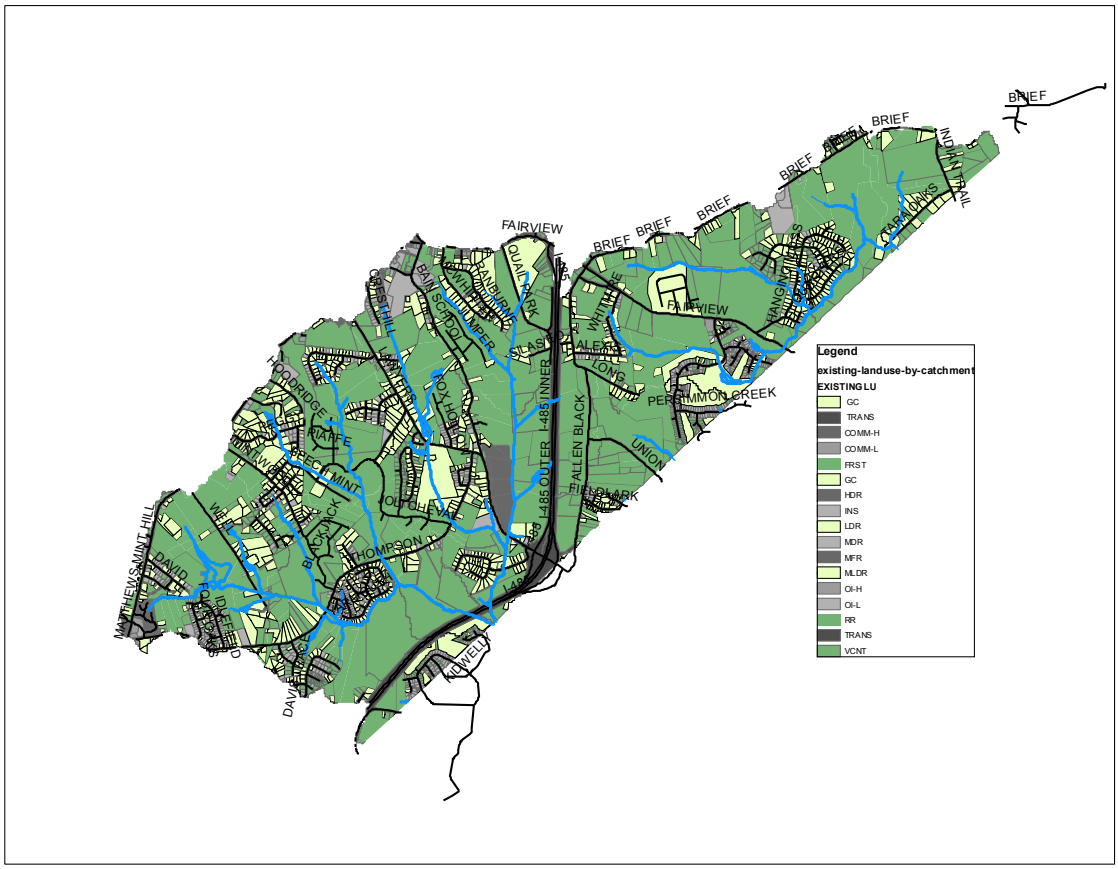

Figure 8: Distribution of Land Uses in the Goose Creek Watershed.

2.2.6 Soils

The distribution of soils within the Goose Creek Watershed was determined through the Soil Survey of Mecklenburg County (USDOA – SCS, 1980). The hydrologic soil types found in the Goose Creek Watershed are B and C. A description of each soil type and distribution within the watershed are shown in Table 7. Figure 9 shows the location of the hydrologic soil groups in the Goose Creek Watershed.

Table 7: Hydrologic Soil Groups Found Within the Goose Creek Watershed.

Hydrologic Soil Group	Description (USDOA –SCS, 1980)	Distribution with Goose Creek Watershed
B	Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission	6314 Acres (88% of watershed)
C	Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water of soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.	856 acres (12% of watershed)

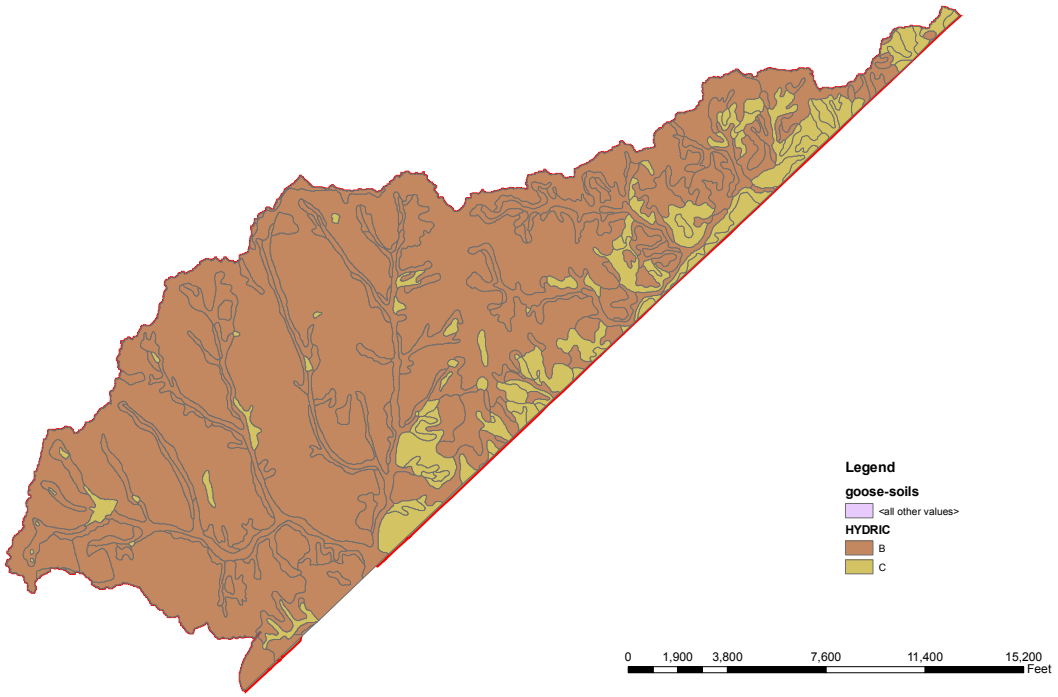

Figure 9: Distribution of Hydrologic Soil Groups in the Goose Creek Watershed.

2.3 Current Watershed Protection Efforts

2.3.1 S.W.I.M. Buffer Ordinance

A countywide stream buffer system was established in 1999 as part of the Surface Water Improvement and Management (S.W.I.M.) strategy, otherwise known as S.W.I.M. buffers. According to S.W.I.M., streams have the primary natural function of conveying storm and ground water, storing floodwaters and supporting aquatic and other wildlife. The buffer is the vegetated land adjacent to the stream channel, which functions to protect water quality by filtering pollutants and to provide both storage for floodwaters and suitable habitat for wildlife. The ordinance was in effect until Mint Hill's Post Construction ordinance took effect on June 30, 2007. However, property developed under the S.W.I.M. buffer ordinance will remain subject to it.

Required stream buffer widths vary from 35 to 100 feet or the entire 100 year floodplain, whichever is greater, based on the size of the upstream drainage basin. In Mint Hill, S.W.I.M. buffer requirements begin at a point where the stream drains 50 acres. Table 8 presents the S.W.I.M. buffer requirements for Mint Hill. Figure 10 shows the extent of the S.W.I.M. buffers in the Goose Creek Watershed.

Table 8: S.W.I.M. Buffer Requirements for the Goose Creek Watershed.

Jurisdiction	Date Ordinance Adopted	Total Buffer Widths		
		≥ 640 acres	≥ 300 acres	≥ 50 acres
Mint Hill	October, 1999	total = floodway + 100% of floodfringe but no less than 100 ft streamside = 30ft managed use = 45 ft upland = remainder	total = 50 feet streamside = 20ft managed use = 20ft. upland = 10ft	total = 35 ft streamside = 20ft managed = none upland = 15ft

All buffers are measure horizontally on a line perpendicular to the surface water, landward from the top of the bank on each side of the stream.

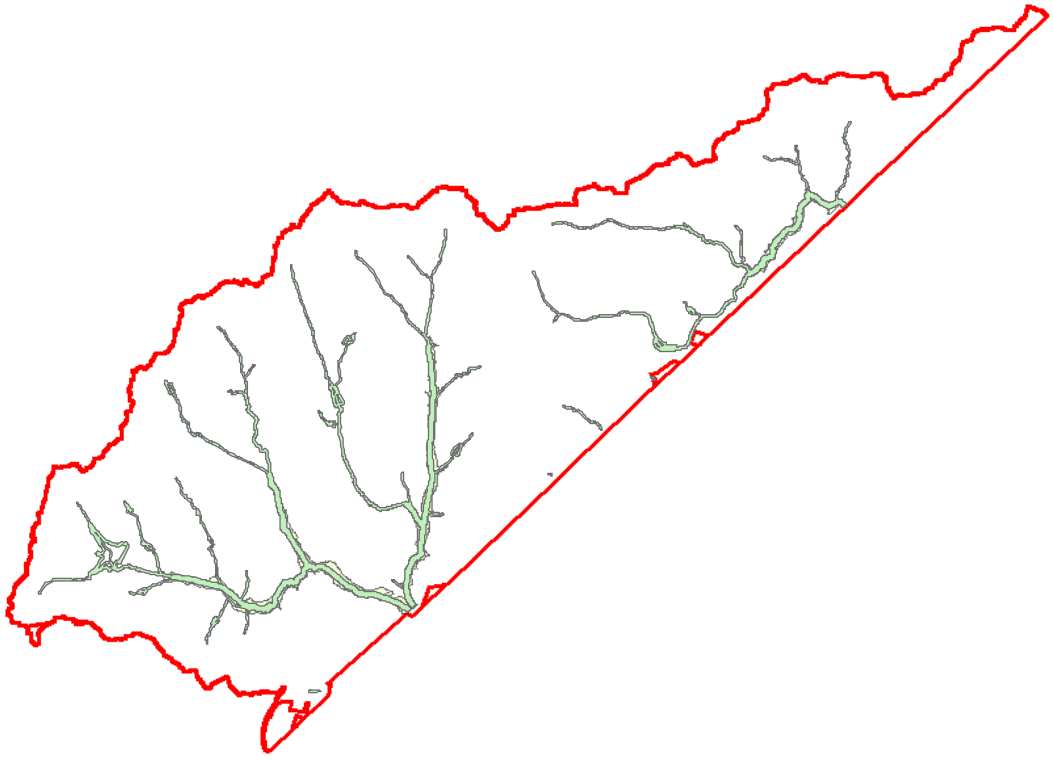

Figure10: Approximate Extent of the Goose Creek Watershed S.W.I.M. Buffers.

2.3.2 Post Construction Buffers

On June 30, 2007, Mint Hill implemented the Post Construction Ordinance that required 100-foot buffers on all dashed streams on USGS topographic maps and 200-foot buffers on all solid streams on USGS topographic maps. The Post Construction Ordinance was replaced by the Site Specific Management Plan (developed by NCDENR) for the Goose

Creek Watershed on February 1, 2009. Both ordinances apply but the more stringent requirement must be met. Properties developed from June 30, 2007 through February 1, 2009 are required to conform to the Post Construction Buffers. Figure 11 shows the approximate extent of the Goose Creek Watershed Post Construction Buffers.

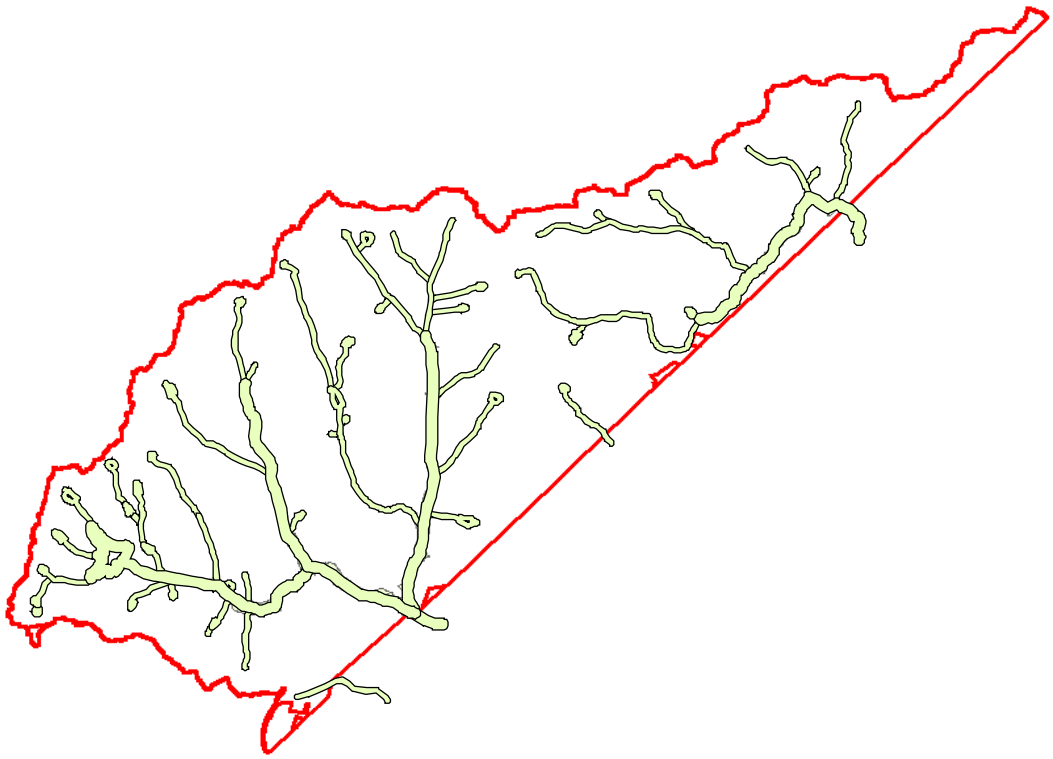

Figure 11: Approximate Extent of the Goose Creek Watershed Post Construction Buffers.

2.3.3 Goose Creek Watershed Site Specific Management Plan.

The Goose Creek Site Specific Management Plan was adopted on February 1, 2009 and applies to the entire Goose Creek Watershed. The expressed purpose of the ordinance is to protect the endangered Carolina Heelsplitter Mussel. The ordinance places specific controls on all new development in the watershed including the following:

1. Controls stormwater for all projects disturbing more than one acre. These requirements include the removal of 85% TSS and control and release of the 1 year 24 hour storm at pre-development rates.
2. Controls discharges from WWTPs. No new WWTP discharges will be permitted.
3. Controls toxicity to streams for specific parameters. Ammonia is to be reduced to 0.5 mg/L from all discharges to Goose Creek.
4. Maintains riparian buffers. All waterbodies within the 100-Year Floodplain will have

a 200 foot buffer, other waterbodies will have a 100 foot buffer. These buffers are essentially the same as the Post Construction Buffers.

For the purpose of this Watershed Management Plan, it is assumed that the Site Specific Management Plan for the Goose Creek Watershed will mitigate future impacts to water quality from new development. For this reason, the remainder of the Plan and the recommendations listed are focused upon reducing pollution sources from existing development where limited or no water quality mitigation efforts have been required.

2.3.4 BMP Retrofits and Land Acquisition

Public property in the Goose Creek Watershed is limited. Figure 12 shows the distribution of these properties.

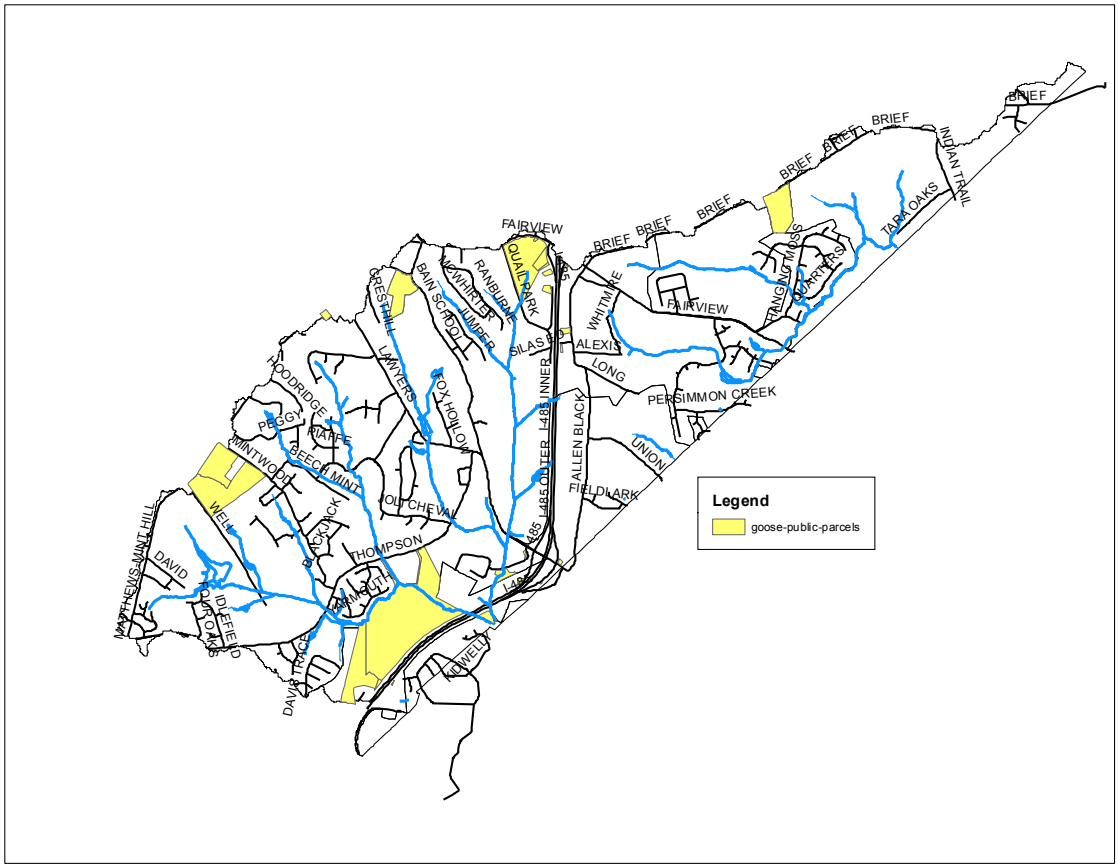

Figure 12: Public Property in the Goose Creek Watershed.

<u>Goose Creek Raingarden Project</u>

A grant was obtained by CMSWS with the goal of reducing the discharge of non-point source pollutants from land development activities and improving water quality conditions in Goose Creek. Specifically, the grant seeks to protect habitat for the Carolina heelsplitter through the completion of retrofitting LID structures into existing

developments within the Goose Creek watershed in Mint Hill. These structures also serve as demonstration projects for the use of LID techniques. Educational signage was incorporated into the demonstration projects to promote the proper implementation of LID.

The first of the project sites is located at the Mint Hill Park on Fairview Road. The 52-acre park located in the headwaters of the Goose Creek watershed has approximately 3 acres of impervious surface, including a large parking area. It has soccer and baseball fields, tennis and handball courts, a playground, and nature trails. Prior to the project, a curb and gutter system conveyed storm water from parking lots, trails and outbuildings to a detention basin before discharging into Goose Creek. The project re-routed storm water from 4.9 acres through LID BMPs. The other LID demonstration project is located at the Bain Elementary School in the Goose Creek watershed within the Town of Mint Hill. This project treated previously untreated runoff from approximately 1 acre of parking lot with a raingarden.

2.3.5 Existing NPDES Permitted WWTPs

At the time of writing of the Goose Creek Fecal Coliform TMDL there were six permitted WWTPs. Since that time the Hunley Creek and Fairview Elementary facilities have been taken off line. Table 9 presents the remaining permitted dischargers.

Table 9: NPDES Permitted Dischargers in the Goose Creek Watershed

Facility Name	Address	NPDES ID	Permitted Flow (cfs)
Oxford Glen	15349 Bexley Place	NC0063584	0.075
Ashe Plantation	Quarters Lane	NC0065749	0.154
Country Woods	Country Woods Dr	NC0065684	1.036
Fairfield Plantation	Stoney Ridge Rd	NC0034762	0.108

SECTION 3. WATERSHED INDICATORS AND GOALS

3.1 Upland

3.1.1 Upland Water Quality Indicators

Upland water quality is associated with pollutants in storm water runoff from the watershed draining to Goose Creek. The upland water quality indicators selected for this Watershed Management Plan are Total Suspended Sediment (TSS), Total Phosphorus (TP) and Total Nitrogen (TN). These pollutants are indicative of the impact that contaminated storm water runoff has on water quality. Moreover, they are capable of being accurately simulated with relatively simple methods (unlike temperature or fecal coliform) and are indicators of other parameters of concern.

3.1.2 Upland Water Quality Goals

Tetra Tech (2004) conducted an analysis of watershed scale upland loading rates for existing conditions for all watersheds in Mecklenburg County for TSS, TN and TP. They correlated the loading rates back to biological health and scored each watershed based upon the results. They were able to determine that watersheds capable of sustaining a fully supporting biological community displayed very similar upland pollutant loading rates for TSS, TN and TP. Similarly, the Goose Creek Fecal Coliform TMDL (MCWQP and NCDENR, 2005) presented a necessary reduction in upland fecal coliform of 92.5% to attain the in-stream standard. Upland fecal coliform reductions of 92.5% are essentially unattainable using currently available technology and techniques. Treatment for fecal coliform will be optimized to the maximum extent practicable using existing technology and techniques and working with site specific constraints. The upland goals for ammonia and copper were developed through the estimated loading rates from the rural residential land uses. The upland loading rate goals and percent reductions are presented in Table 10.

Table 10: Upland Pollutant Loading Rate Goals.

Upland Pollutant Loading Rate Goals
1. TN $\leq$ 4 lbs/ac/year
2. Ammonia $\leq$ 0.2 lbs/ac/year and End of Pipe concentrations < 0.5 mg/lt
3. TP $\leq$ 0.6 lbs/ac/year
4. TSS $\leq$ 0.22 tons/ac/year
5. Fecal Coliform: 92.5% reduction in upland fecal coliform.
6. Copper $\leq$ 0.01 lbs/ac/year

In addition to the loading rate goals, a specific concentration goal for ammonia of 0.5 mg/L has been adopted for new development. It is estimated that attaining the TN goal listed in Table 10 for existing development will result in attainment of the 0.5 mg/L goal listed in the Site Specific Management Plan as well. The TN goal of $\leq$ 4 lbs/ac/year equates to a loading rate of a forested tract. Forested tracts have proven to be the most sustainable land-cover for the Carolina Heelsplitter, indicating this goal will be effective.

Similarly, a 92.5% reduction in fecal coliform bacteria in the watershed was established in the TMDL. To attain this goal, all stormwater originating from built upon areas will need to be treated using either a bioretention cell or infiltration trench. These BMPs are the only ones capable of removing 90% of fecal coliform from stormwater runoff.

The goals presented in Table 10 are appropriate to be applied to retrofit BMP projects as a catchment wide design standard. In other words, retrofit BMP projects in a particular catchment should strive to meet the goals in Table 10; however, it is recognized that each individual project may not meet the goals.

3.2 In-Stream

3.2.1 In-Stream Water Quality Indicators

In-stream water quality is associated with pollutants in the stream channel. The in-stream water quality indicator selected for this Watershed Management Plan is TSS. This indicator will provide an indication of the TSS pollutant load conveyed by the channel.

3.2.2 In-Stream Water Quality Goals

Tetra Tech, Inc. (2002) summarized several reports pertaining to sediment production and biological health. Simmons (1993) summarized sediment characteristics of 152 North Carolina streams and rivers (including 100 within the Piedmont region) from data taken during the 1970s. Crawford and Lenat (1989) provide estimates of annual sediment yield from three (3) Piedmont watersheds near Raleigh, N.C., including 0.13 ton/acre for a predominantly forested watershed, 0.31 ton/acre from an agricultural watershed, and 0.59 ton/acre from an urban watershed. In both studies, sediment yield was estimated from in-stream suspended sediment concentrations, so the annual areal sediment yields reflect not only sediment from the land surface but also in-stream sediment transport and sediment from bank erosion/collapse. Crawford and Lenat (1989) performed extensive biological sampling in the three watersheds they studied and calculated metrics for taxa richness, abundance, and pollution tolerance for invertebrates and fish. In summarizing their biological data, they rated the forested watershed as having high measures of biotic characteristics, the agricultural watershed as having medium to high measures, and the urban watershed as having low measures. Under North Carolina water quality regulations, streams and lakes must be able to support aquatic life. A rating of Fair or Poor for Benthic Invertebrate Bioclassification or Fish Community Structure prevents a water body from being rated as “fully supporting” under Section 305(b) of the Clean Water Act. Based on the two studies investigated by Tetra Tech, Inc., an approximate in-stream sediment load goal of 0.30 ton/acre/year is recommended as a goal.

Currently, in-stream data allowing assessment of the sediment load goal of 0.30 tons/acre/year is not available in the Goose Creek Watershed. In order to determine progress toward the goal, it is proposed that two (2) long term sediment monitoring stations be installed in the Goose Creek Watershed. These sites should coincide with long term monitoring sites established for assessing channel properties (permanent cross

sections, etc.). One site should be established on Duck Creek near Tara Oaks and the other site should be established upstream of The Bridges Mall Site. Data collected at these sites will allow the development of an annual sediment versus time flow curve. Each year will be compared against previous years to determine if the sediment carrying characteristics of Goose Creek (and hence the sediment loads) are improving. Also, the data collected will be used to estimate progress toward attaining the overall goal of 0.30 tons/acre/year. Table 11 presents the in-stream water quality goals.

Table 11: In-Stream Water Quality Goals.

In-Stream Water Quality Goals
1. TSS $\leq$ 0.3 tons/ac/year
2. Benthic Macroinvertebrates = Fully Supporting
3. Fish = Fully Supporting
4. Attainment of fecal coliform standard (200 c.f.u./100 ml)
5. Attainment of ammonia end of pipe goal of 0.5 mg/L

Monitoring to determine compliance with these goals is presented in Appendix A.

SECTION 4. WATERSHED ASSESSMENT

4.1 Upland Characterization

In order to prioritize areas of the Goose Creek Watershed, an upland characterization methodology was developed based upon work completed by Tetra Tech, Inc. (2004) for the Post Construction Ordinance Stakeholder Group. The resulting prioritization will be used to guide property acquisition for installation of water quality BMPs and to focus efforts on voluntary retrofitting of existing upland sources of pollution.

The upland characterization was completed through an evaluation of existing levels of pollutant loading, impervious cover and buffer impacts. Specifically, the indicators used were Total Phosphorus (TP), Total Nitrogen (TN), Total Suspended Sediment (TSS), Fecal Coliform, ammonia, Copper and percent of the stream buffer currently un-forested. The information presented in this Section of the Watershed Management Plan deals only with existing sources of pollution in the Goose Creek Watershed. For the purpose of this document, it was assumed that future sources of pollution will be attenuated through implementation of the Site Specific Management Plan, which is presented in Section 2.3.3.

4.1.1 Methodology

The basis for the upland characterization presented herein is an updated existing land-use dataset developed by Tetra Tech Inc. (2004). The land-use data set was developed through interpretation of a combination of parcel information, aerial photographs, and tree canopy data. The process is more thoroughly described in Tetra Tech Inc. (2004). Development in the watershed that has occurred since 2004 was manually entered into the data set. The land-use data set provides a distribution and classification of all land-uses in the Goose Creek Watershed. The land-use categories, along with abbreviations and typical impervious percentages seen in the Goose Creek watershed are presented in Table 12.

Table 12: Goose Creek Land Use Categories and Abbreviations.

Land Use Class	Typical Lot Size	Percent Impervious	Abbreviation
Heavy Commercial	Variable	85	COMM-H
Light Commercial	Variable	45	COMM-L
Forest	NA	0	FRST
Golf Course	NA	8	GC
High Density Residential	0.125 – 0.25 ac	41	HDR
High Density Multifamily Residential	Variable	70	HMFR
High Density Mixed Urban	Variable	70	HMX
Heavy Industrial	Variable	66	IND
Institutional	Variable	40	INS
Interstate Corridor	NA	36	INTERSTATE
Low Density Residential	2 – 5 ac	9	LDR
Medium Density Residential	0.25 – 0.5 ac	30	MDR
Meadow	NA	0	MEADOW
Multi Family Residential	<0.125	60	MFR
Medium Low Density Residential	0.5 – 2 ac	19	MLDR
Mixed Urban	Variable	60	MX
Office/Industrial	Variable	72	OI-H
Light Office/Light Industrial	Variable	30	OI-L
Park	NA	9	PARK
Rural Residential	>5 ac	4	RR
Ultra High Density Mixed Urban	Variable	90	UHMX

The distribution of the land-uses for the Goose Creek watershed is shown in Figure 8.

The land-use data for the Goose Creek Watershed was sub-divided into catchments using GIS software. The catchments were delineated using the Watershed Information System (WISe) with an approximate drainage area of 1 square mile per catchment. Catchments with very small drainage areas were merged into nearby catchments to reduce the number of reporting units. A total of 14 catchments were delineated for the Goose Creek Watershed. Figure 13 shows the distribution of the catchments in the Goose Creek Watershed.

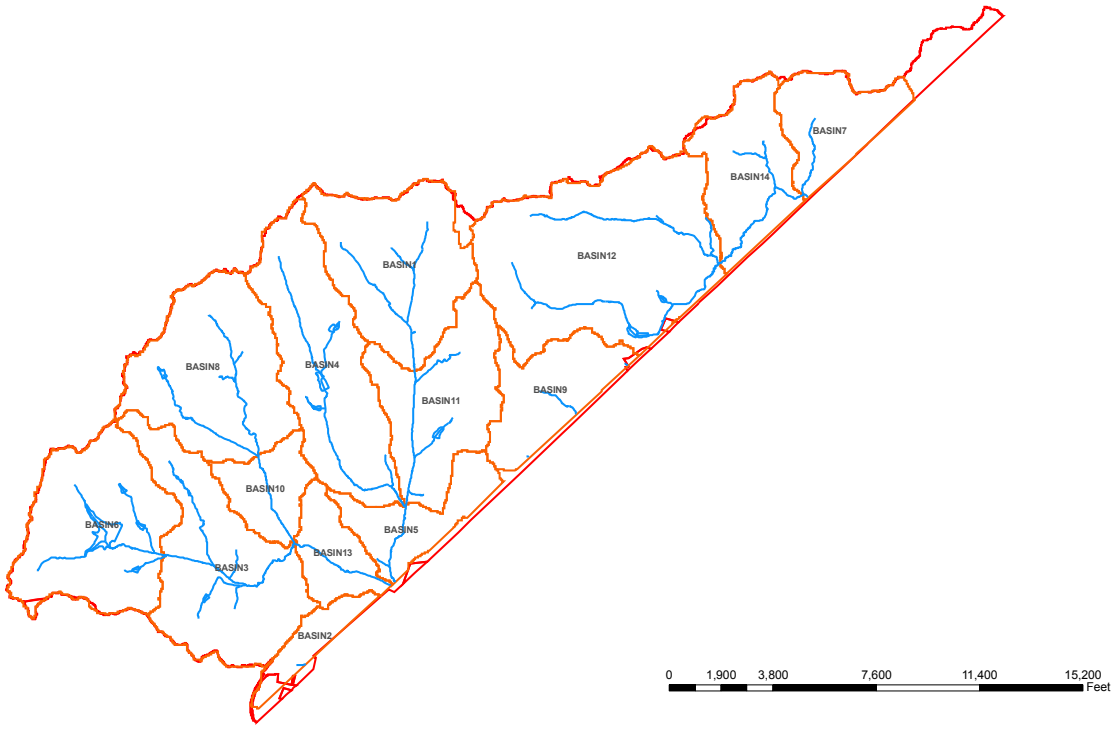

Figure 13: Goose Creek Watershed Catchments.

The upland pollutant loading rates by land-use for TP, TN and TSS were adopted from Tetra Tech Inc. (2004) and are listed in Table 13. Loading rates for ammonia and fecal coliform were calculated using annual runoff estimates and concentrations within the Site Evaluation Tool (Tetra Tech, Inc., 2005). Catchment loading rates were determined by multiplying the area of each land-use in the catchment by the appropriate loading rate and summing the total for all land-uses within the catchment. Catchment scale loading rates for the Goose Creek Basins are provided in Table 14.

Table 13: Upland Pollutant Loading Rates by Land-Use.

LAND-USE	TN (lbs/ac/year)	TP (lbs/ac/year)	TSS (tons/ac/year)	Ammonia (lbs/ac/year)	Fecal Coliform (c.f.u./year x 10^{10})	Copper (lbs/ac/year)
COMM-H	19.44	2.85	0.76	4.38	38	0.124
COMM-L	12.44	1.88	0.69	2.05	20	0.070
GC	5.17	0.83	0.47	0.22	4	0.012
HDR	8.73	1.4	0.47	1.14	18	0.064
INS	8.63	1.39	0.48	1.15	18	0.063
INTERSTATE	7.81	1.25	0.4	3.65	16	0.118
LDR	4.1	0.66	0.28	0.39	4	0.016
MDR	7.61	1.24	0.52	0.87	13	0.035
MEADOW	2.39	0.38	0.13	0.11	0.3	0.006
MFR	10.65	1.68	0.39	2.65	27	0.090
MLDR	6.5	1.07	0.57	0.61	9	0.024
OI-H	11.87	1.86	0.34	1.94	32	0.106
OI-L	7.61	1.24	0.52	0.90	13	0.035
RR	3.59	0.59	0.3	0.16	2	0.009

Note: See Table 12 for abbreviation descriptions.

Table 14: Catchment Loading Rates

Basin ID	Fecal Coliform (cfu/year)	TN (lbs/year)	TP (lbs/year)	TSS (tons/year)	Ammonia (lbs/year)	Copper (lbs/year)
BASIN1	3.0E+13	2762	444	191	405	15.4
BASIN2	8.6E+12	663	107	46	122	4.5
BASIN3	3.1E+13	3030	490	216	374	14.5
BASIN4	4.6E+13	3637	585	252	468	18.3
BASIN5	1.7E+13	1250	201	80	308	10.6
BASIN6	3.8E+13	3194	513	221	426	16.3
BASIN7	7.6E+12	1055	170	77	92	3.9
BASIN8	3.1E+13	2974	481	215	338	13.5
BASIN9	1.1E+13	1338	216	98	128	5.4
BASIN10	6.1E+12	783	126	58	75	3.1
BASIN11	3.9E+13	2952	459	168	573	18.9
BASIN12	4.5E+13	4723	763	346	503	20.3
BASIN13	5.8E+12	713	114	46	106	4.0
BASIN14	1.6E+13	1718	279	134	166	6.8

The percent of impacted buffer in the Goose Creek Watershed was also characterized. The characterization was completed using tree canopy data for Mecklenburg County intersected with the FEMA floodplain delineation and the S.W.I.M. and Watershed buffer coverages. The resulting GIS dataset, which depicts the presence or absence of tree canopy within stream buffers, was intersected with the catchment coverage to determine the percent of un-forested buffer within each catchment. Figure 14 shows the distribution of forested and un-forested buffer within the Goose Creek Watershed.

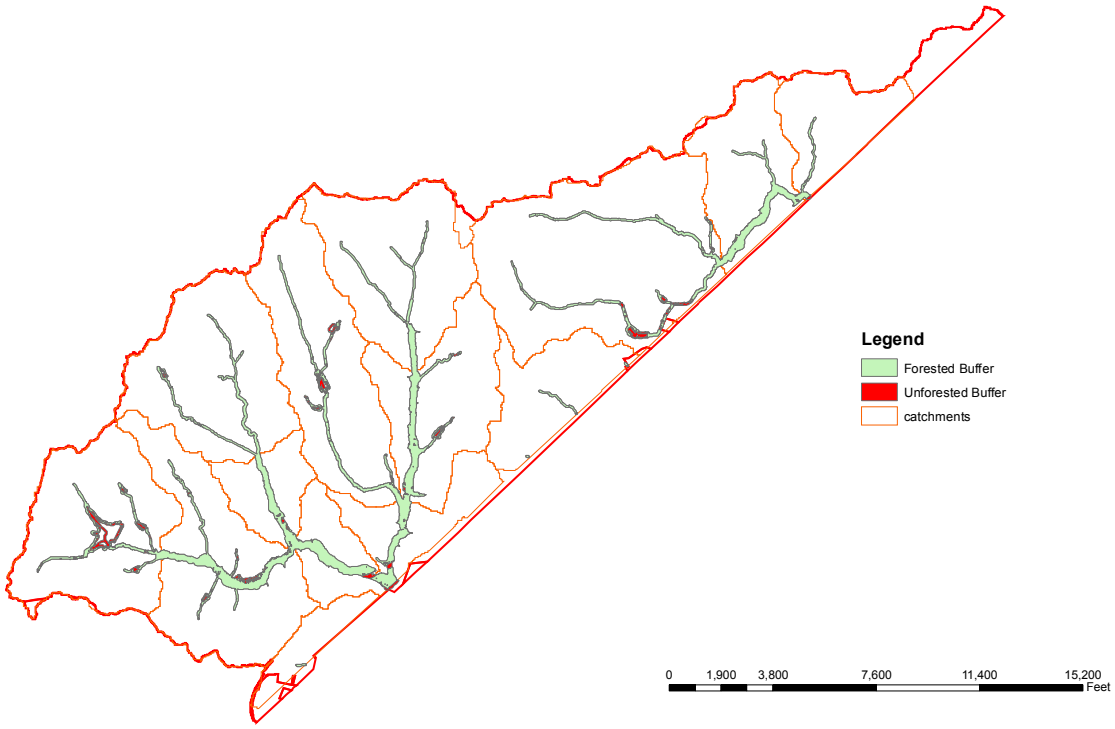

Figure 14: Distribution of Forested and Un-forested Stream Buffers within the Goose Creek Watershed.

Levels of impervious area, which are indicative of level of development, for the Goose Creek Watershed were characterized by catchment. Impervious percentages by catchment were determined by multiplying the area of each land-use within the catchment by the appropriate impervious percentage (Table 12) and summing the resulting impervious areas for the entire catchment. Catchment area, impervious area and impervious percentage information is presented in Table 15.

Table 15: Catchment Area, Impervious Area and Impervious Percentages

Basin ID	Total Area (ac)	Impervious Area (ac)	Impervious Percentage
BASIN1	637.5	70.2	11%
BASIN2	127.9	20.0	16%
BASIN3	726.0	76.6	11%
BASIN4	713.5	106.6	15%
BASIN5	254.9	40.3	16%
BASIN6	681.7	85.8	13%
BASIN7	297.5	19.3	6%
BASIN8	694.0	73.1	11%
BASIN9	341.2	29.3	9%
BASIN10	210.7	15.6	7%
BASIN11	523.6	92.8	18%
BASIN12	1137.9	111.2	10%
BASIN13	201.8	16.9	8%
BASIN14	403.6	36.4	9%

4.1.2 Results

Results for each of the basins for each indicator evaluated were ranked to determine the basins with the highest level of impairment. Table 16 presents the ranks for all 14 Goose Creek Basins.

Table 16: Results of Upland Impairment Characterization. Note: Higher rank indicates increasing level of impairment (Basin 11 most impaired).

Basin ID	Fecal Rank	TN Rank	TP Rank	TSS Rank	NH4 Rank	Cu Rank	Average Rank	Overall Rank
BASIN11	1	1	1	5	2	2	2	1
BASIN2	2	2	2	1	3	3	2	2
BASIN5	3	4	4	6	1	1	3	3
BASIN4	4	3	3	2	4	4	3	4
BASIN6	5	5	5	4	6	6	5	5
BASIN1	6	6	6	9	5	5	6	6
BASIN8	7	7	7	7	9	9	8	7
BASIN14	9	8	8	3	11	11	8	8
BASIN3	8	9	9	10	8	7	9	9
BASIN12	10	10	10	8	10	10	10	10
BASIN9	11	11	11	11	12	12	11	11
BASIN13	13	14	14	14	7	8	12	12
BASIN10	12	12	12	12	13	13	12	13
BASIN7	14	13	13	13	14	14	14	14

Figures 15 – 21 present the overall ranking based upon the results of the upland characterization for Fecal Coliform, TN, TP, TSS, NH4, Cu and Overall Impairment respectively. Note that darker colors indicate increased levels of impairment.

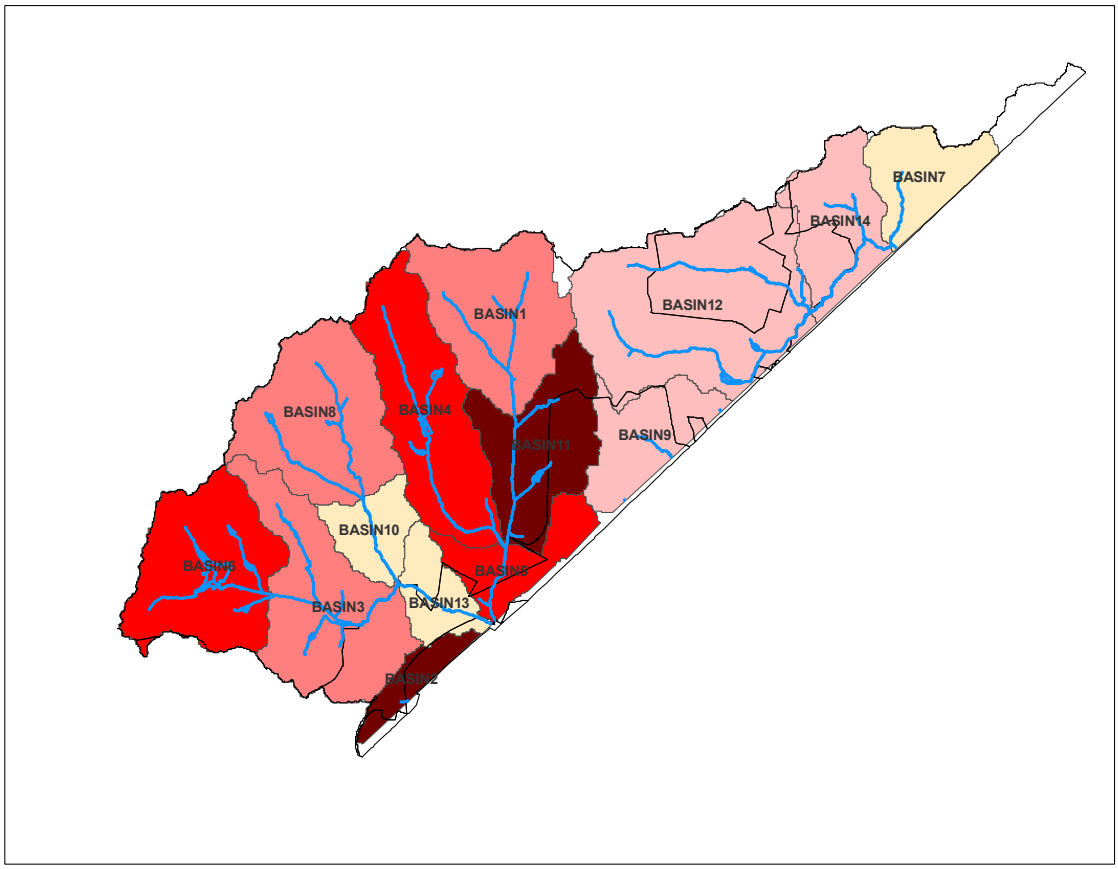

Figure 15: Fecal Coliform Rank.

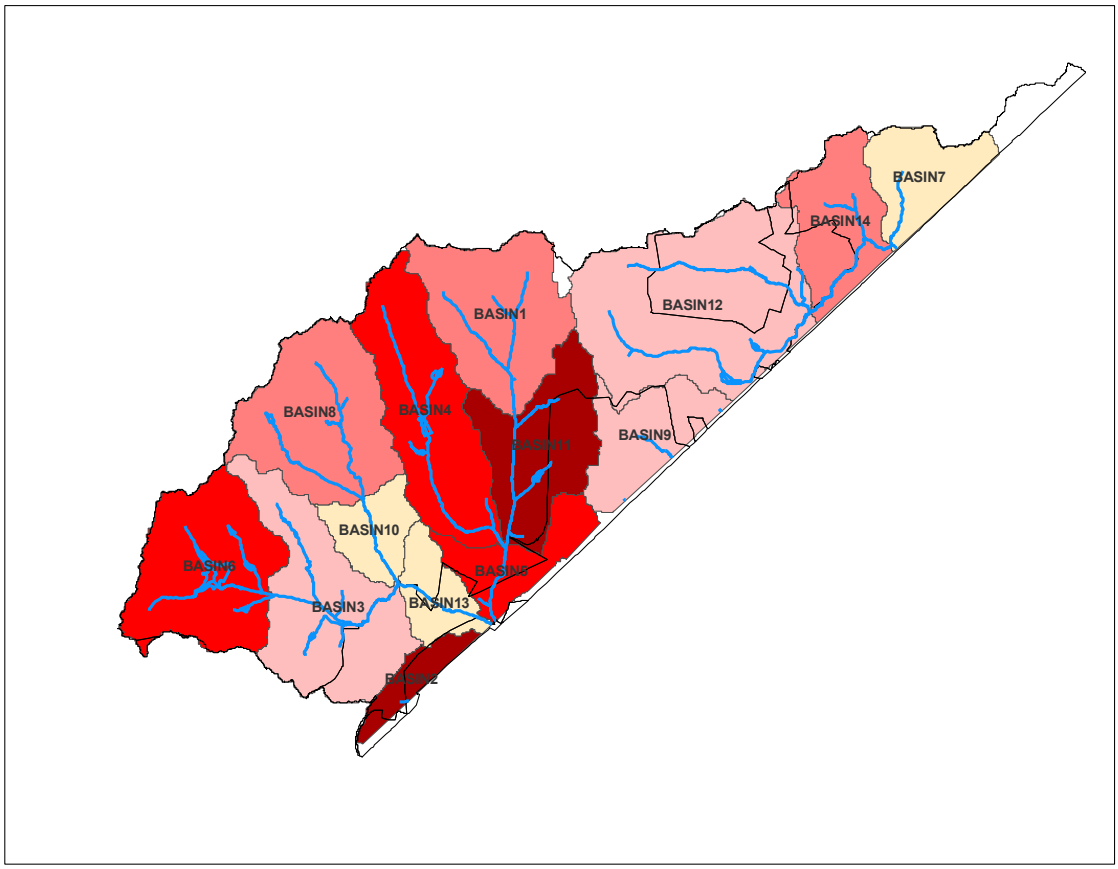

Figure 16: TN Ranking.

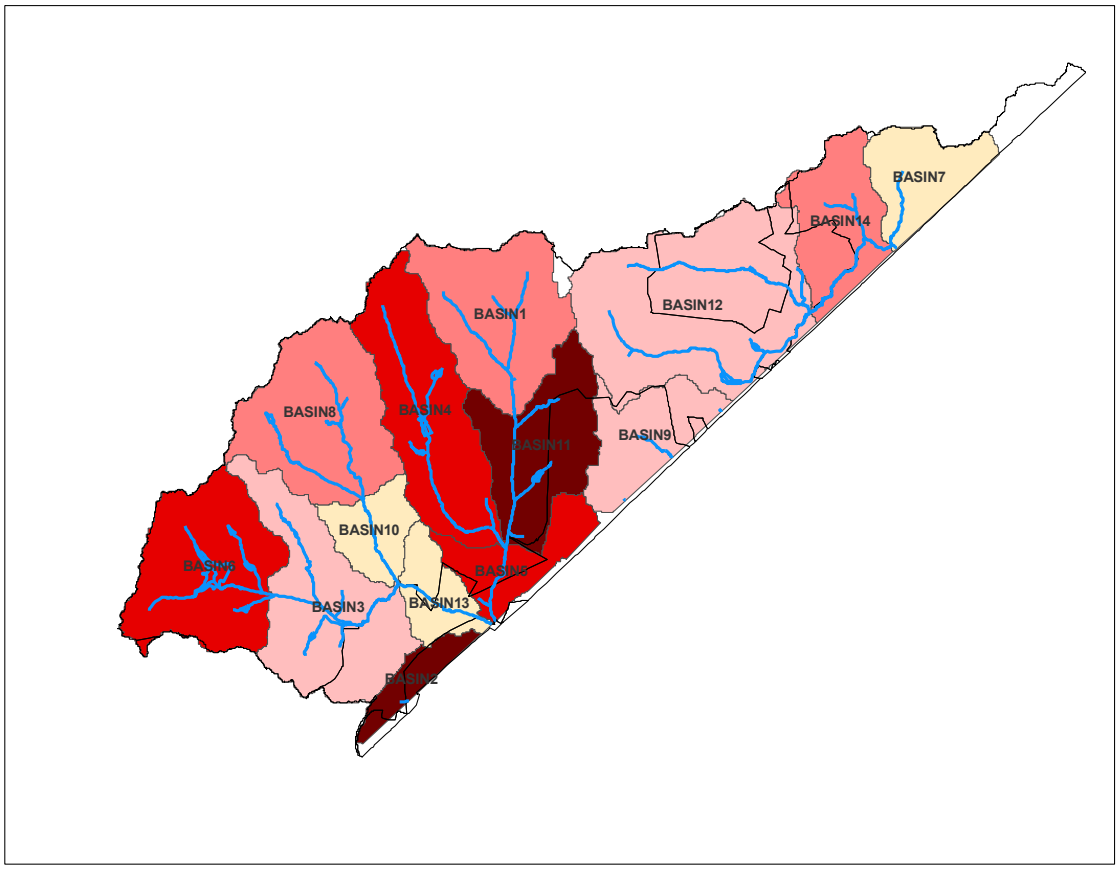

Figure 17: TP Ranking.

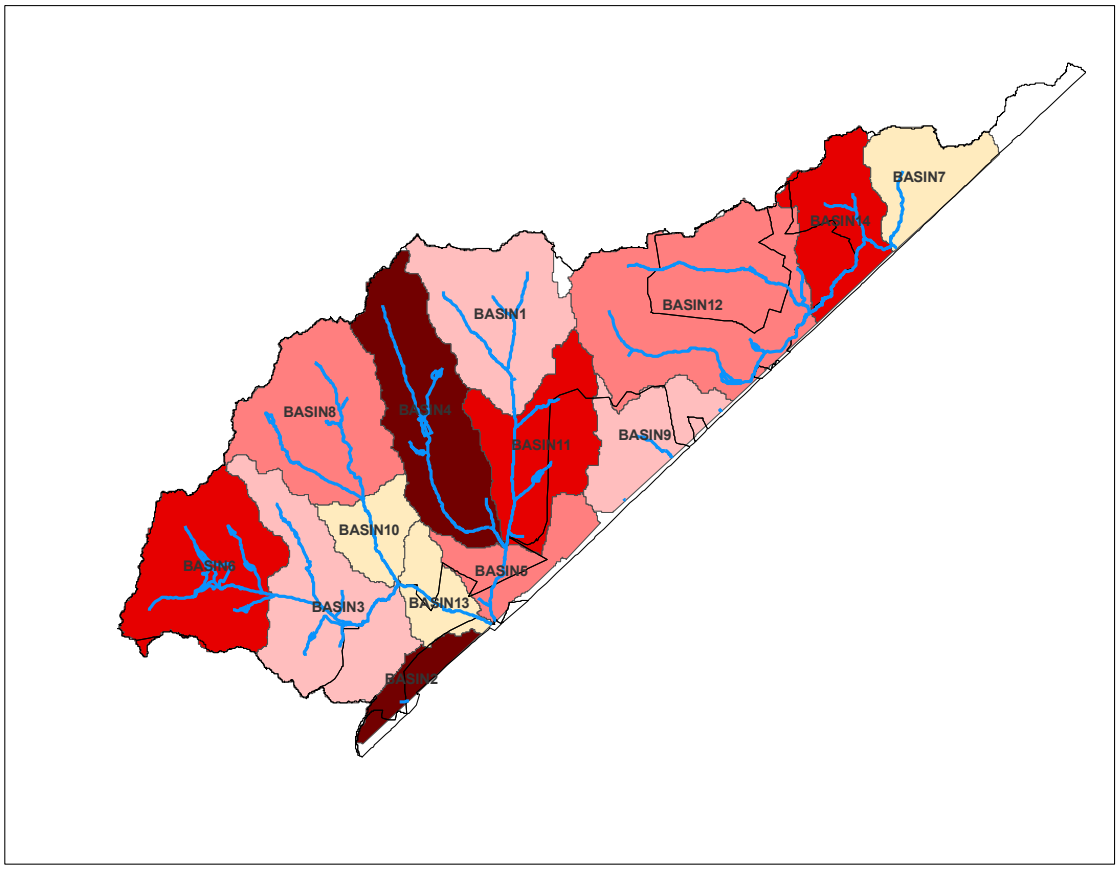

Figure 18: TSS Ranking.

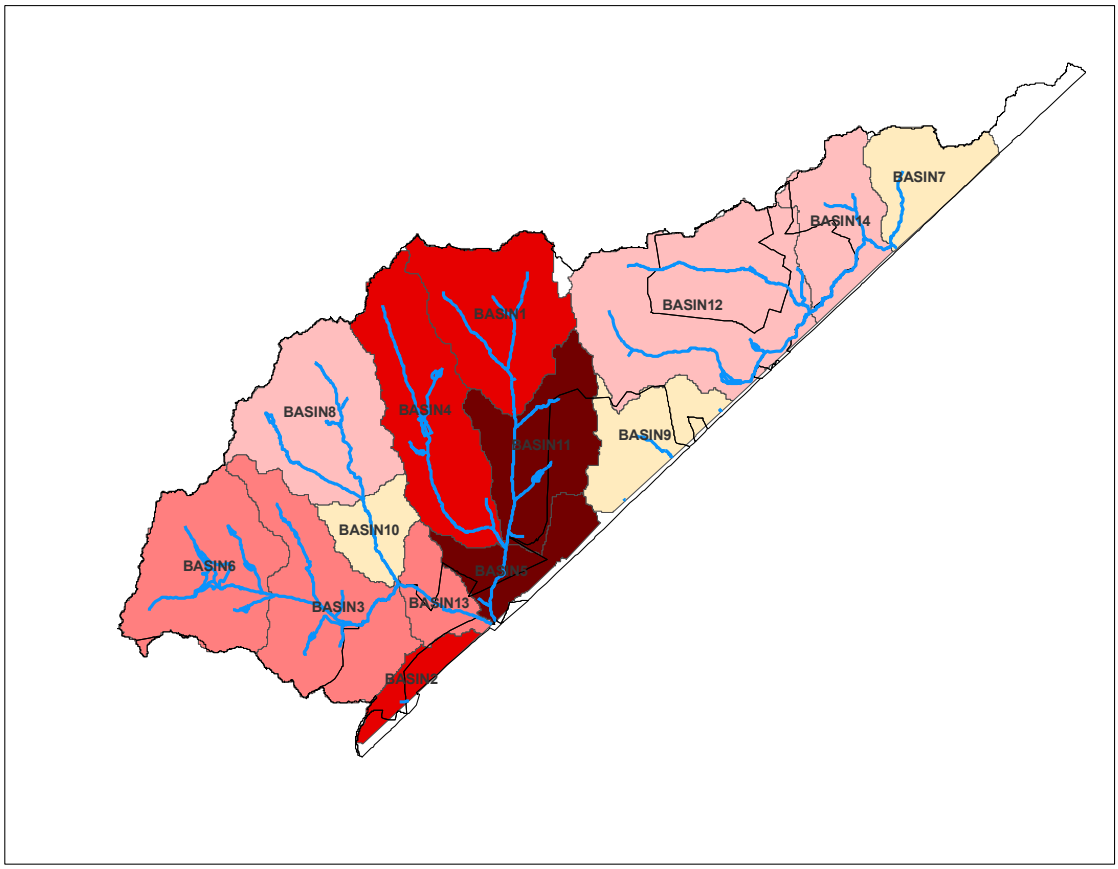

Figure 19: NH4 Ranking.

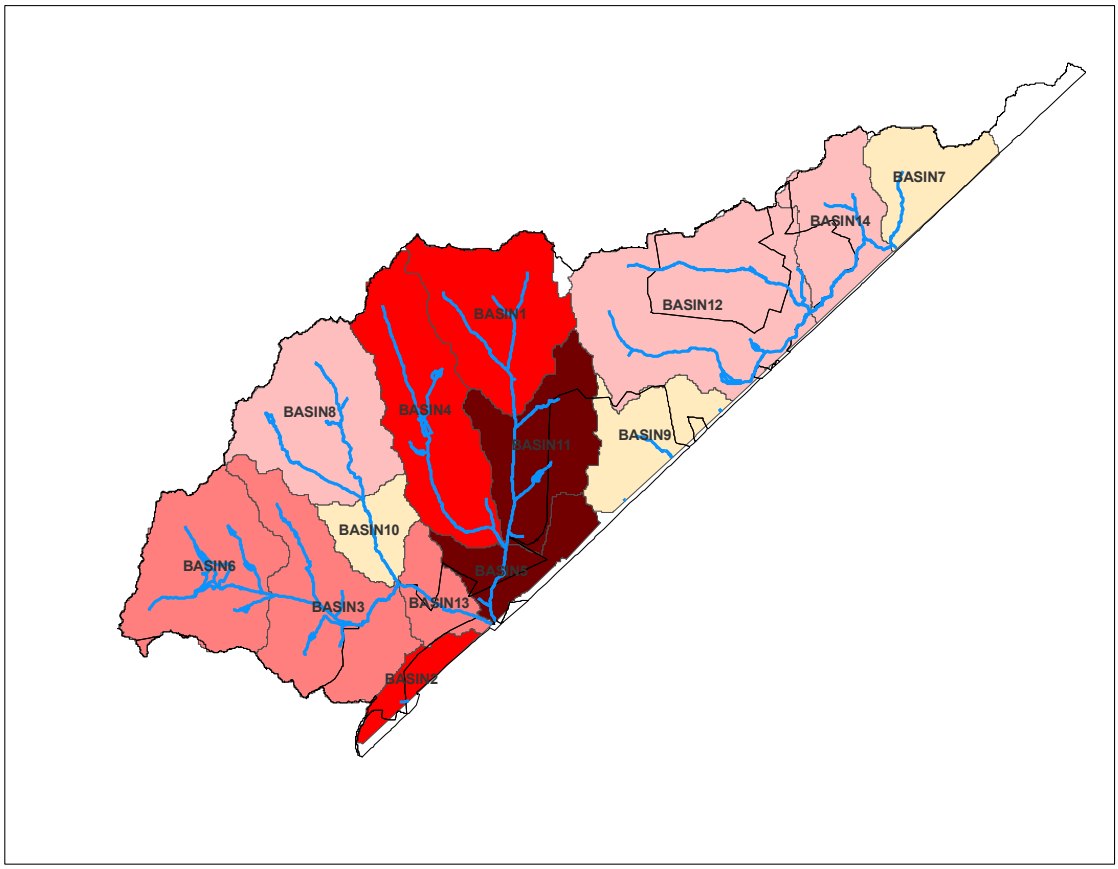

Figure 20: Cu Ranking.

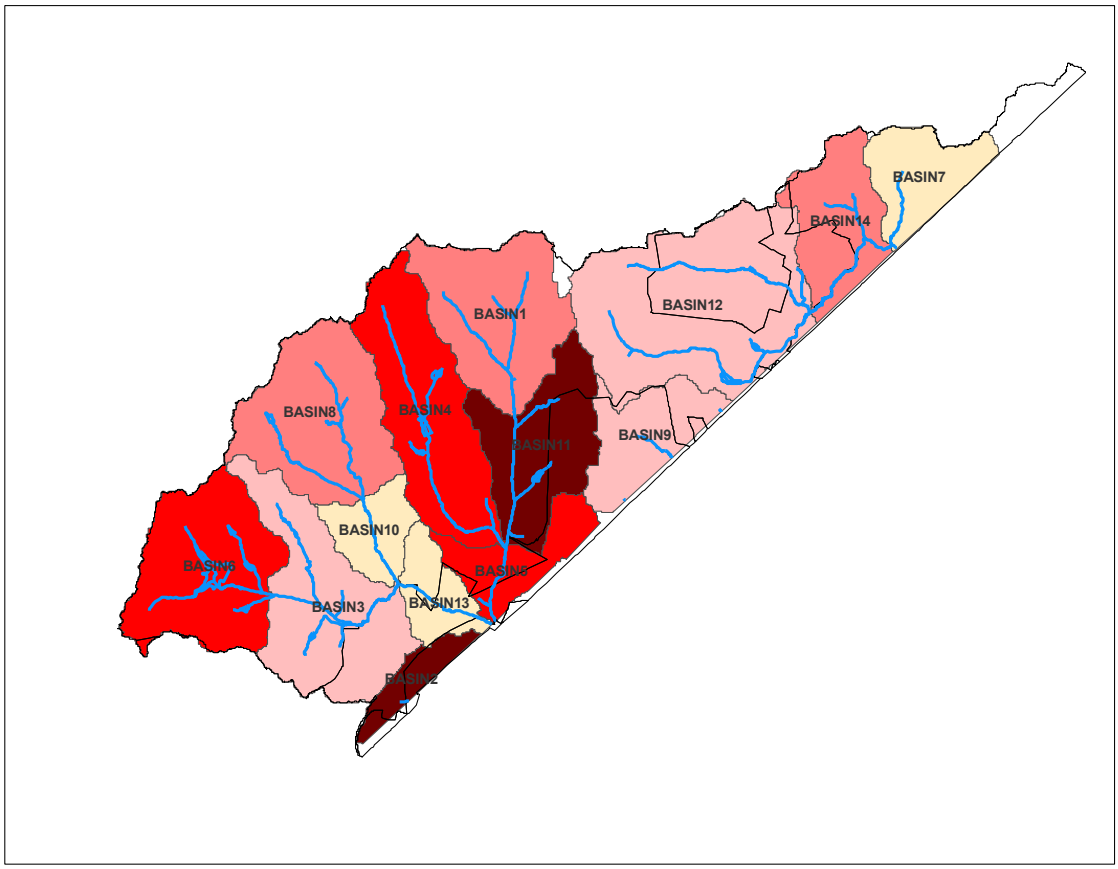

Figure 21: Overall Impairment (based upon upland pollutant load).

4.2 Stream Channel Characterization

In order to prioritize areas of the Goose Creek Watershed for stream channel restoration, enhancement and preservation, a characterization methodology was developed by MCSWS. The characterization was completed through an evaluation of existing stream channel conditions that allowed reach-level prioritization based on biological integrity and geomorphic stability, as well as predicted bank erosion rates.

4.2.1 Methodology

MCSWS utilized base data in GIS format, including recent aerial photography, stream locations, roads and parcel boundaries. Using GIS, the Goose Creek Watershed was divided into 30 separate reaches (Figure 22). For the purposes of this study, Buck defines a reach as a discrete segment of stream that consistently exhibits a set of physical features that appear to be significantly different from its contiguous upstream and downstream segments. Twelve basins were chosen for assessment that appeared to represent a range of stream conditions and land uses found throughout the watershed. Because perennial streams were to be assessed, only streams receiving 100 acres or greater of drainage were

chosen, which resulted in 30 individual reaches approximating 30 miles of stream for direct assessment.

Stream Classification

Each reach was visually classified according to the Rosgen classification system (Rosgen, 1994). This heirarchial methodology categorizes streams based on geomorphic features that describe channel geometry in the three dimensions of planform, cross-section and longitudinal profile. Most of these parameters are expressed as dimensionless ratios such as width/depth. The use of dimensionless ratios allows categorization and comparison of streams of varying sizes.

Bank Erosion

Streambank erosion rates were determined by measuring the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) (Rosgen, 2001) throughout each study reach. This semi-quantitative method is widely used in North Carolina and is based on measured values and visual estimates made at discrete sections of streambank. BEHI provides results in adjective ratings, ranging from very low to extreme. BEHI is based on the following:

- bank height/bankfull height
- root depth/bank height
- root density (%)
- bank angle
- surface protection (%)
- bank materials and stratification

NBS provides a measurement of the distribution of flow through a cross section. The near bank region is that third of stream cross section nearest a bank being studied. Rosgen (1996) correlated the ratio of shear stress in the near bank region to mean shear stress and developed an adjective rating system for reporting. Reasonably accurate estimates of NBS can be made quickly using professional judgment.

Erosion rates have been associated with the adjective ratings for bank erodibility and near-bank stress based on data collected from Colorado. Data collected at the Mitchell River in North Carolina supports the use of the Colorado data (Rosgen, 2001). The erosion rate was then multiplied by the height and length of the streambank. Rates are expressed as cubic feet of sediment eroded annually per linear foot of streambank. Total tons per year were also calculated for each study reach.

Channel Evolution

Simon's Channel Evolution Model (1989) was used to assign one of the six stages listed below to each reach based on field observations.

- Stage I**:** The waterway is a stable, undisturbed natural channel.
- Stage II: The channel is disturbed by some drastic change such as forest clearing, urbanization, dam construction, or channel dredging.

- Stage III: Instability sets in with scouring of the bed.
- Stage IV: Destructive bank erosion and channel widening occur by collapse of bank sections.
- Stage V**:** The banks continue to cave into the stream, widening the channel. The stream also begins to aggrade, or fill in, with sediment from eroding channel sections upstream.
- Stage VI: Aggradation continues to fill the channel, re-equilibrium occurs, and bank erosion ceases. Riparian vegetation once again becomes established.

Habitat Assessment

Mecklenburg County Habitat Assessment Protocol forms were completed by field staff and assigned a score per parameter with a total possible score of 200 being the best. The parameters of the habitat assessment are broken into primary, secondary, and tertiary categories. Primary parameters describe those instream physical characteristics that directly affect the biological community. Primary conditions evaluate substrate and available cover, embeddedness, epifaunal substrate, velocity and depth regimes, and pool variability. Secondary parameters (channel alteration, bottom scouring and deposition, channel shape, and channel sinuosity) relate to channel morphology, which controls the behavior of stream flow and the sediment deposits the stream collects. The tertiary parameters in the habitat assessment matrix include bank stability, bank vegetative protection, and the riparian vegetative zone. Each stream reach was photographed using a digital camera so that all aspects of the study area were photo-documented.

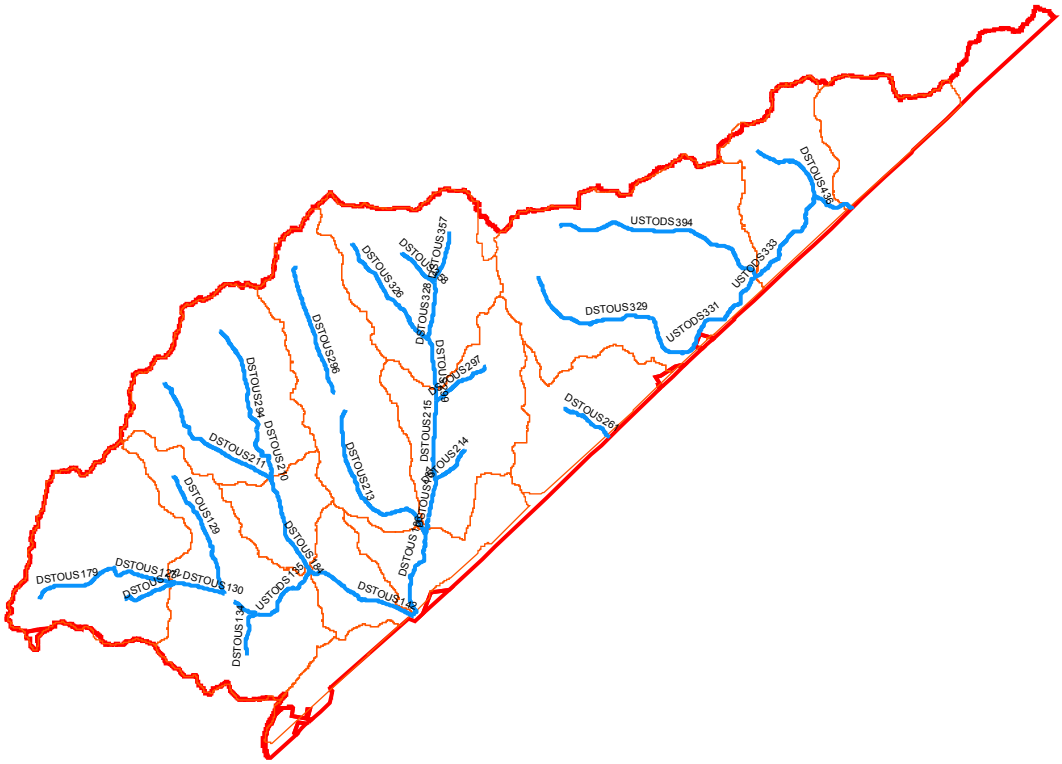

Figure 22: Goose Creek Stream Characterization Reaches.

4.2.2 Results

A total of 30 study reaches were delineated and assessed. Reach lengths varied from several hundred feet to over 7000 feet. The number of reaches per basin ranged from three to seventeen. Once in the field the predetermined reach lengths (based on drainage) were sometimes broken into smaller reaches or combined into larger reaches based on field observations. For example, if the land use adjacent to the stream channel changed significantly (e.g., forest to industrial) a new reach would begin. Due to the large number of study reaches, data was also compiled and presented per basin (Table 17) to aid in management efforts.

Table 17: Results of Stream Channel Characterization.

Reach	Erosion Rate (ft3/year/ft)	Sediment Production (Tons/Year)	MHAP Score	Rank
DSTOUS127	0.13	16	144	16
DSTOUS129	0.55	158	143	25
DSTOUS130	0.66	0.03	157	21
DSTOUS132	0.53	54	149	19
DSTOUS134	0.57	49	138	15
DSTOUS142	1.0030	214	121	5
DSTOUS179	0.10	15	144	27
DSTOUS184	1.85	335	122	6
DSTOUS186	1.12	221	130	8
DSTOUS187	0.80	55	137	13
DSTOUS210	1.22	136	125	7
DSTOUS211	0.62	172	131	30
DSTOUS213	0.59	189	132	24
DSTOUS214	0.19	15	146	17
DSTOUS215	0.60	83	134	10
DSTOUS261	1.02	106	146	18
DSTOUS294	0.60	123	115	23
DSTOUS296	0.55	135	95	1
DSTOUS297	0.55	61	136	12
DSTOUS299	1.48	162	109	4
DSTOUS326	0.78	179	111	22
DSTOUS328	0.39	39	136	11
DSTOUS329	0.85	212	108	2
DSTOUS357	0.42	40	109	3
DSTOUS358	1.14	91	92	14
DSTOUS436	0.690	102	131	9
USTODS135	1.45	210	124	29
USTODS331	0.21	46	108	26
USTODS333	1.19	450	117	28
USTODS394	0.86	339	154	20

Note: Decreasing MHAP score indicates greater impact.

A single erosion rate was calculated for each of the 30 reaches based on BEHI/NBS. Based on correspondence with D. Rosgen (2008), categories of erosion rates are best assigned adjectives by orders of magnitude; therefore, rates of 0.01 feet/year are assigned the adjective ‘Low”, 0.1 feet/year are “Moderate”, and greater than or equal to 1.0 feet/year are “High.”

4.3 Fecal Coliform Assessment

As described earlier in this document, a WQRP for the Goose Creek Watershed was initiated after receipt of the August 10, 2006 letter from NC DENR. A part of the WQRP was to catalog the storm water outfalls in the watershed. In order to satisfy the requirements of this inventory, all streams draining more than 50 acres were walked by MCWQP personnel. A part of the walk was to visually inspect the channel and buffer areas for evidence of fecal coliform discharges and to collect stream and end of pipe samples to be analyzed for fecal coliform. The results of the stream walks can be found in the MCWQP, 2007. In addition to the stream walks, the WQRP requires monitoring of storm drain outfalls, in stream monitoring and associated follow-up activities. These activities are outlined in MCWQP, 2009. Currently, the MCWQP has teamed with the Mecklenburg County Ground Water and Waste Water Program to evaluate septic systems in the watershed. At the time of writing of this plan a pilot study had been completed on a small area of the watershed. Approximately 180 inspections were conducted and 5 systems were found to be failing. Based upon these results the pilot study will be expanded throughout the Goose Creek Watershed in Mecklenburg County and is expected to be completed by the end of FY2011.

SECTION 5. CANDIDATE RESTORATION, RETROFIT AND PRESERVATION SITES

5.1 Upland BMP Retrofit Sites

The intent of this section is two fold:

1. Identify publicly owned parcels that are significant sources of pollution that would benefit from BMP retrofit.
2. Identify catchments for detailed field investigation to identify privately owned parcels that are significant sources of pollution and appropriate for BMP retrofit.

All retrofit BMPs installed in the Goose Creek Watershed should be designed with the Upland Pollutant Loading Rate Goals (Table 11) as a design standard.

5.1.1 Priority Basins

Based upon the upland pollutant load analysis, BMP retrofit efforts should be concentrated on or downstream of the most impacted basins. The 6 most impacted basins were focused upon for this plan. Figure 23 shows the extent of these focus basins within the Goose Creek Watershed. The following Section discusses each focus basin in detail.

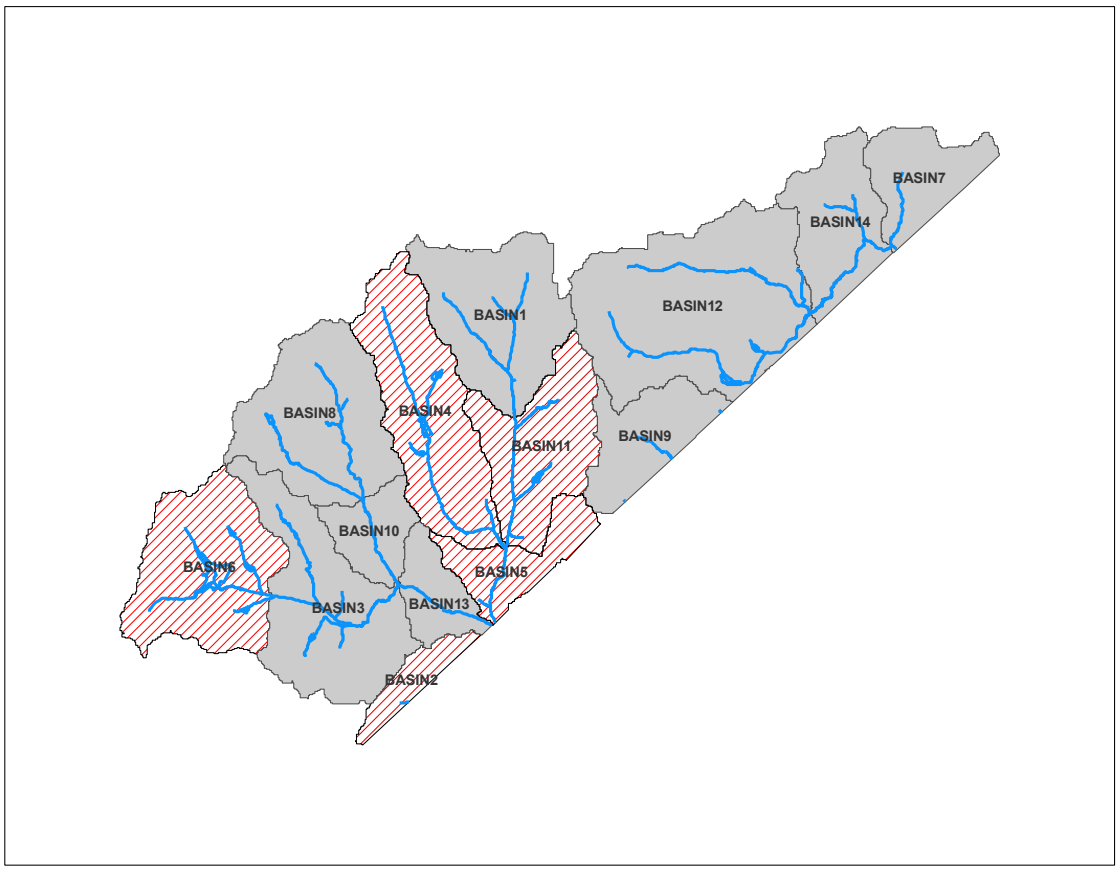

Figure 23: Focus Basins within the Goose Creek Watershed.

Focus Basin 11 (The Bridges)

Focus Basin 11 has the highest estimated pollutant loads in the entire Goose Creek Watershed. Figure 24 shows the extent of the Basin. The primary reason for Basin 11 receiving the highest ranking is The Bridges mall site. Although the mall has not yet been built, grading permits have been issued and land clearing begun. Moreover, this basin contains much of the I-485 Lawyers Road interchange and a significant portion of I-485 north of the interchange. A limited amount of single family residential is also present in the basin. It is very likely that after the mall is constructed storm water volume and velocity as well as pollutant runoff will increase. Currently NCDOT owns one small parcel in the northeast portion of the basin on the drainage divide. This parcel may be suitable to treat a small portion of I-485.

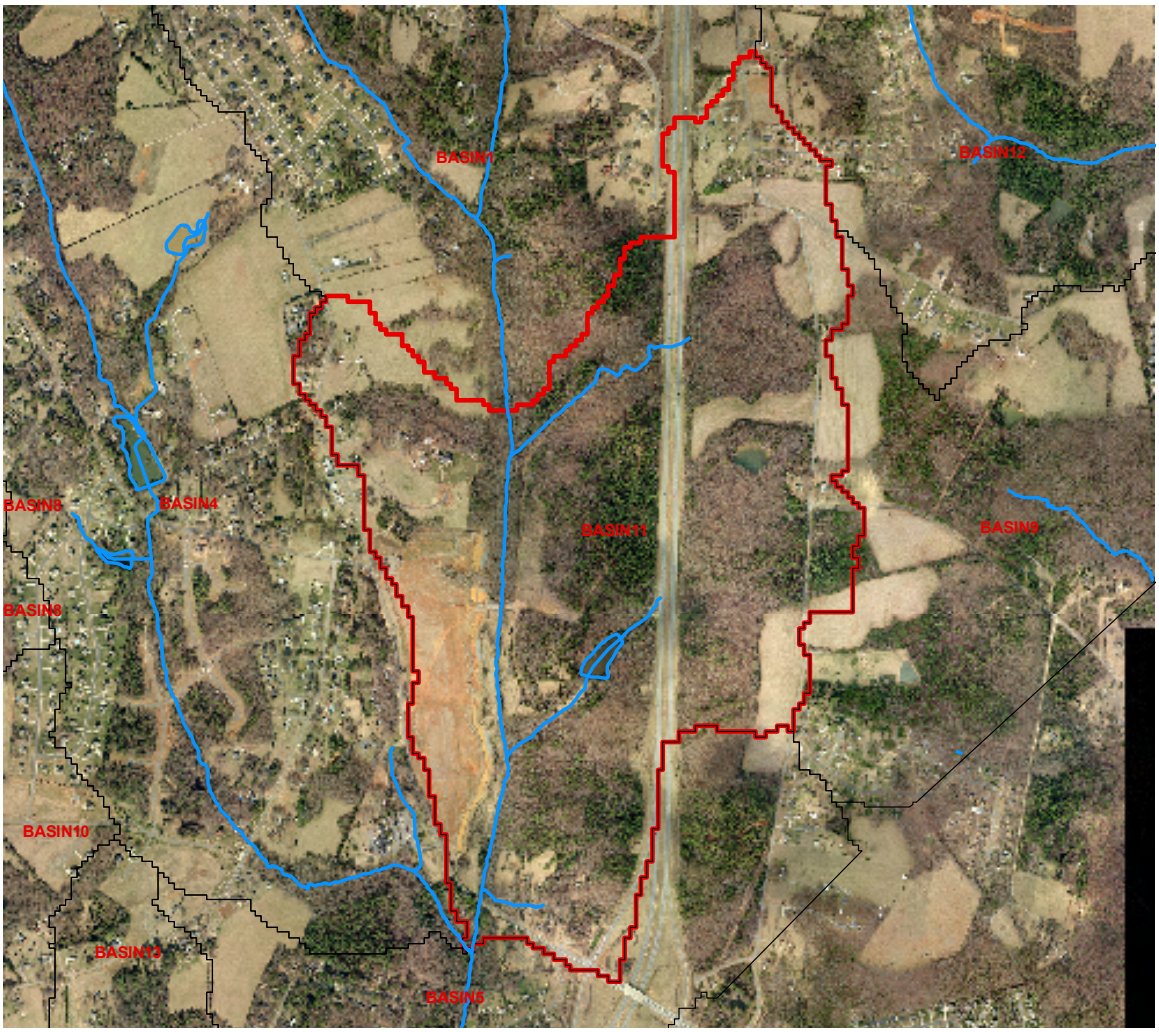

Figure 24: Focus Basin 11

Focus Basin 2 (Shannamara)

Focus Basin 2 has the second highest estimated pollutant loads (normalized by area) in the entire Goose Creek Watershed. Figure 25 shows the extent of Focus Basin 2. The

combination of I-485 road surface, golf course and medium density residential combines to cause the high pollutant loads. There appears to be minimal opportunity for land acquisition in Focus Area 1, however NC DOT has indicated their desire to partner with MCSWS within road ROW. There is very limited retrofit opportunity within the Shannamara neighborhood.

Figure 25: Focus Basin 2

Focus Basin 5 (Lawyers Road and I-485)

Figure 26 shows the extent of Focus Basin 5. It is comprised of I-485 with limited large lot residential. The key to this basin is capturing and treating runoff from I-485. NC DOT owns property where runoff from I-485 enters Goose Creek. During the site evaluation there appeared to be an impoundment on this property that may partially treat the runoff. Additional measures will need to be constructed to provide additional treatment to meet the goals outlined previously, particularly for NH4 and fecal coliform.

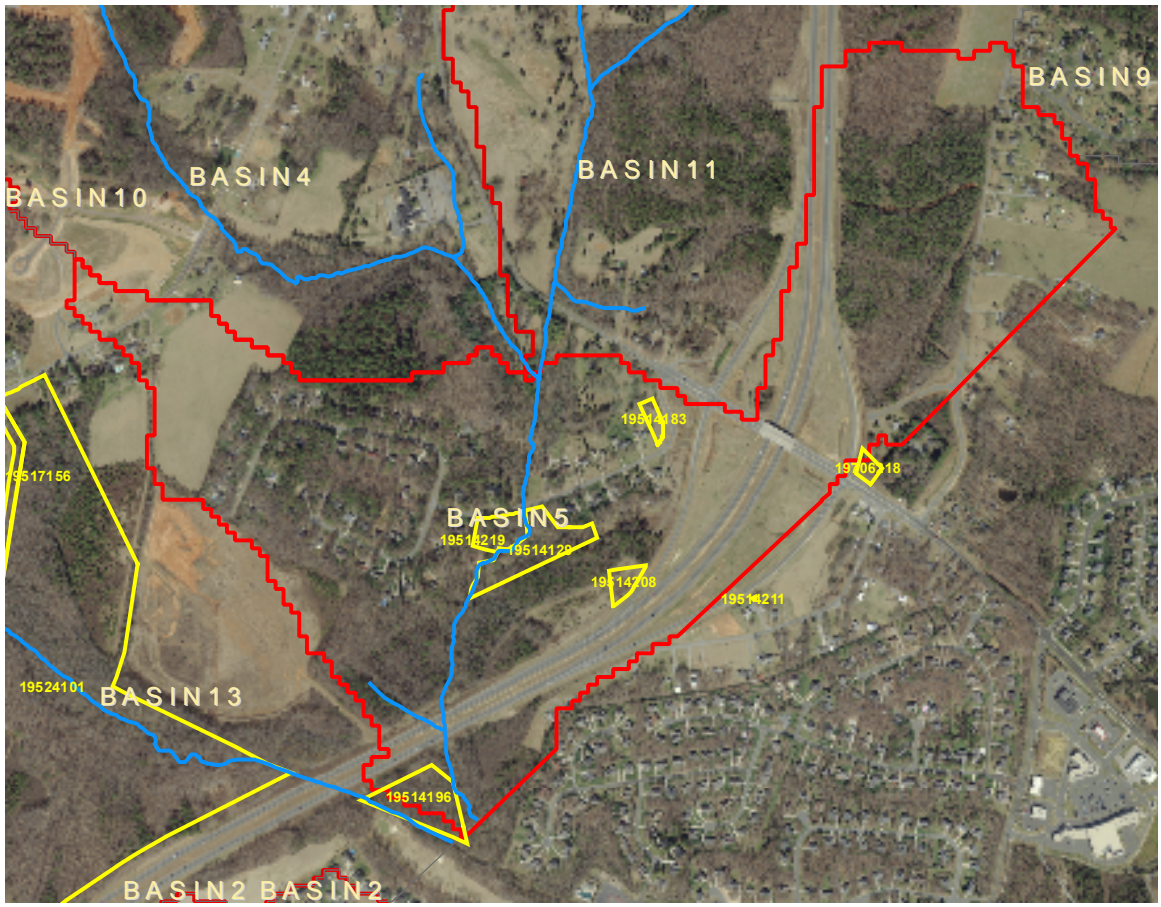

Figure 26: Focus Basin 5 (Note: Publicly owned property shown in yellow).

Focus Basin 4 (Lawyers Road)

Figure 27 displays the extent of Focus Basin 4. It is essentially bisected by Lawyers Road from north to south. There is a substantial impoundment located in the center of the basin that could be retrofitted to provide detention and additional water quality treatment. The pond is currently poorly maintained and possibly a source of sediment. The headwaters of the basin are located at NC 51 and dominated by Queens Grant School. Bain Elementary School has an existing rain garden that treats a portion of a parking lot. Additional infiltration features should be retrofitted into the site. The basin is typified by agricultural plots with large lot residential and less medium density residential.

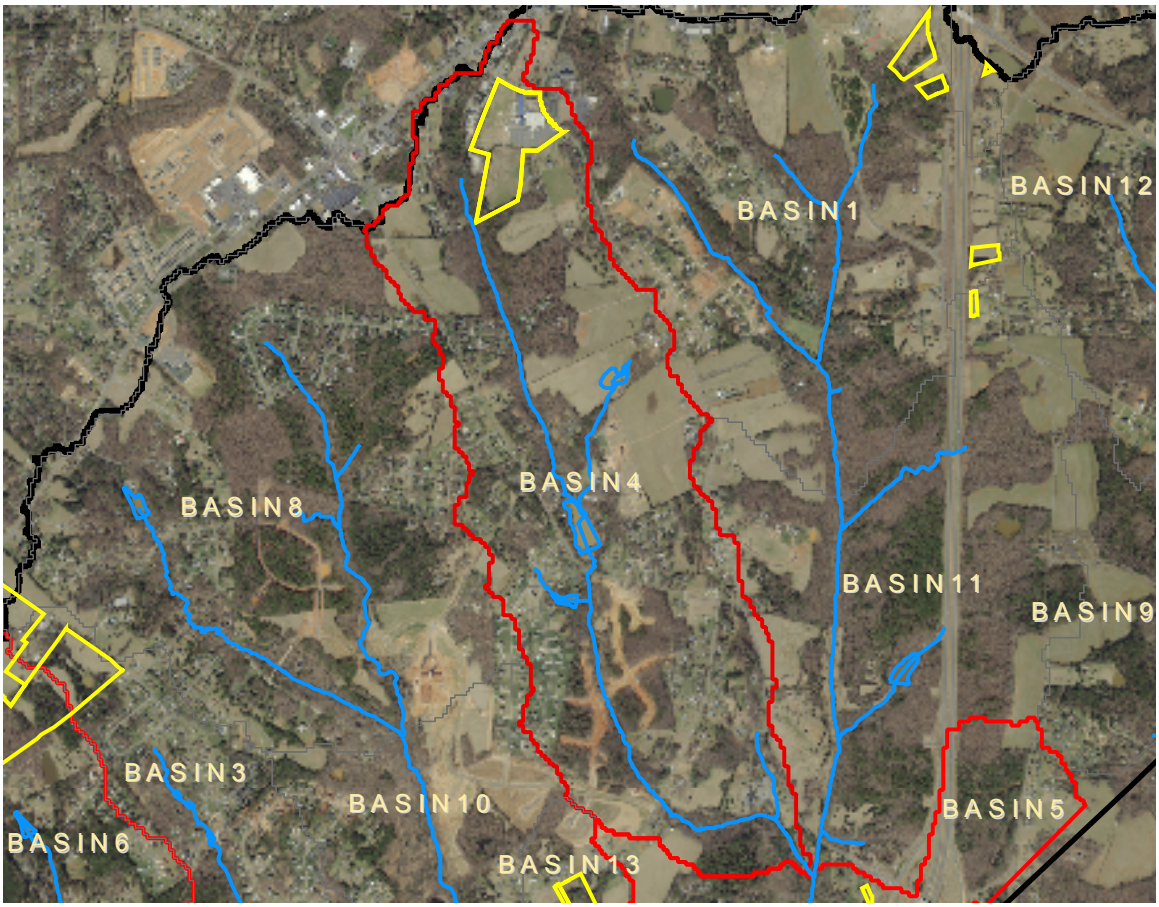

Figure 27: Focus Basin 4.

Focus Basin 6 (Well Road)

Figure 28 shows the distribution of Focus Basin 6, which is dominated by McWhirter Lake. It is essential for this catchment that McWhirter Lake remain intact and enhanced if possible. It provides significant treatment for several medium density residential developments and commercial areas.

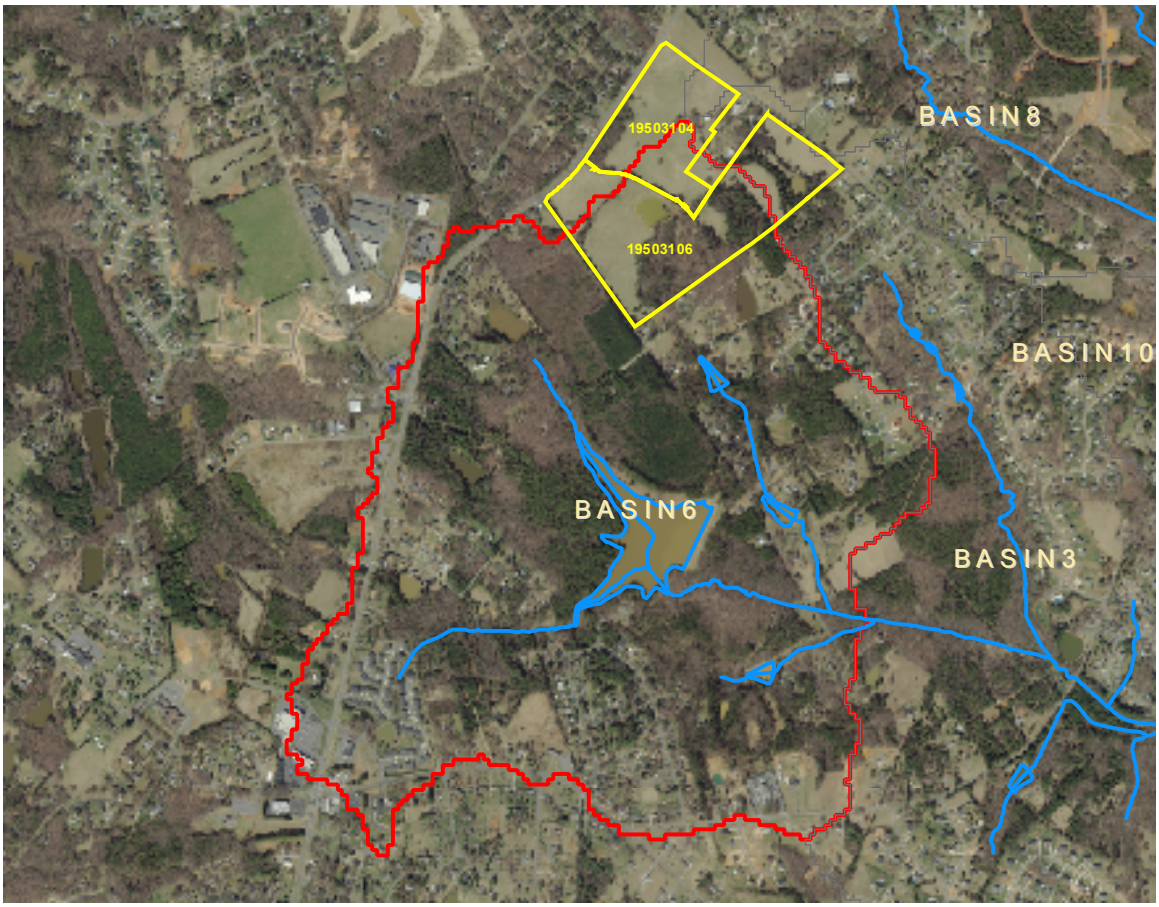

Figure 28: Focus Basin 6 (Public Parcels in Yellow).

Public Parcels

The intent of this Section is to identify publicly owned parcels for BMP retrofit. Specifically, publicly owned parcels that are significant sources of pollution and are located in one of the "Focus" areas have been assigned the highest priority.

There are currently 20 parcels in public ownership in the Goose Creek Watershed. These parcels are located throughout the watershed, but are mainly focused in areas around I-485 and Lawyers Road. Where beneficial to water quality, these properties should be further investigated to determine the final suitability for BMP installation using this report as a guide. Figure 29 shows the distribution of the parcels in public ownership in the Goose Creek Watershed. The parcels were evaluated and prioritized using the following criteria:

1. Position either on or downstream of a basin with a high or moderately high overall rank for upland pollutant loading.
2. Proximity to the stream. Parcels directly adjacent to the stream were ranked higher.
3. Parcels with adequate space for installation of reasonably sized BMPs were ranked higher. If there did not appear to be enough space for a BMP, the parcel was disqualified.
4. Parcels receiving runoff from more than two square miles were disqualified.
5. Parcels able to treat high concentrations of impervious area, regardless of size were ranked higher.

Of the 20 public parcels in the Goose Creek Watershed, 4 meet the criteria listed above. The Priority Parcels are presented in Table 18. Figures 30 – 32 are aerial photos of the High Priority Parcels.

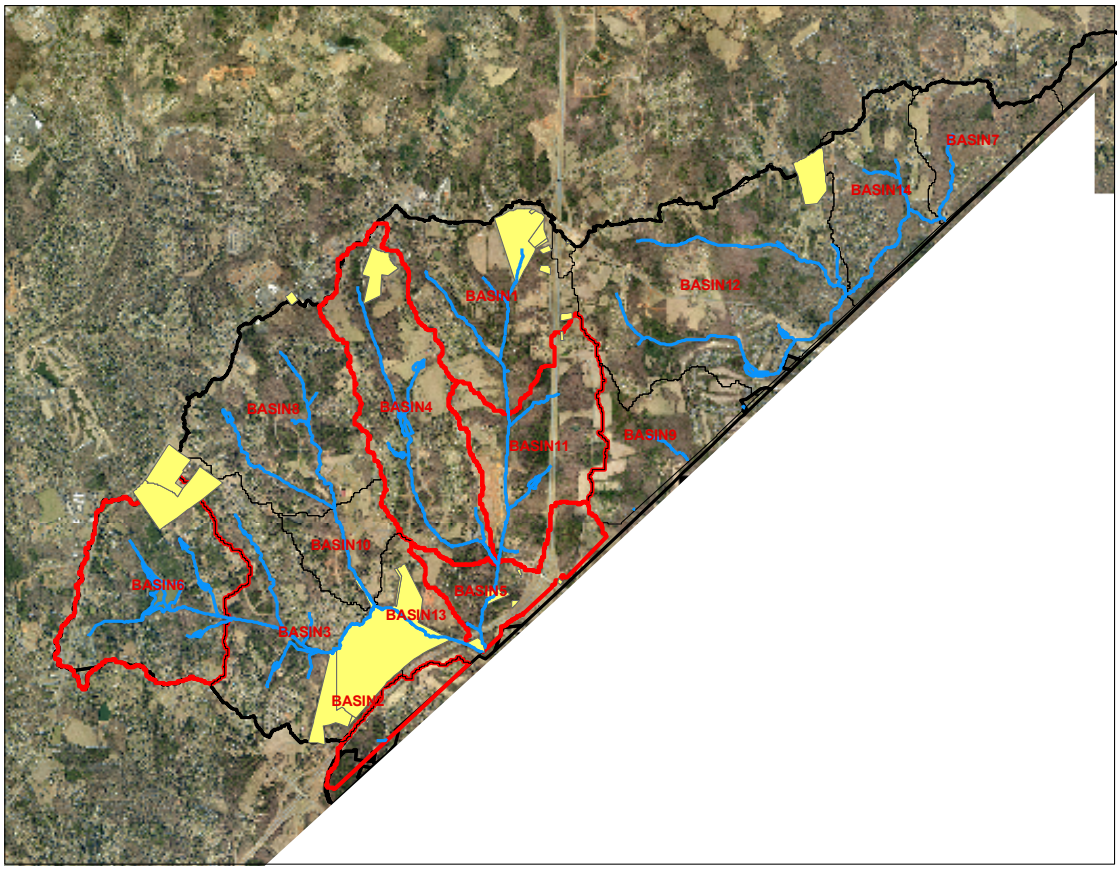

Figure 29: Goose Creek Watershed Public Parcels.

Table 18: Public Parcels Meeting BMP Criteria and Priority.

Parcel	Owner Info.	Priority
19701146	CHARLOTTE MECKLENBURG SCHOOLS	Medium
19514129	DEPT OF TRANSPORTATION	High
19514183	DEPT OF TRANSPORTATION	Low
19514196	DEPT OF TRANSPORTATION	Low
19514208	DEPT OF TRANSPORTATION	Low
19514211	DEPT OF TRANSPORTATION	Medium
19514219	DEPT OF TRANSPORTATION	High
19523107	DEPT OF TRANSPORTATION	Low
19523204	DEPT OF TRANSPORTATION	Low
19704137	DEPT OF TRANSPORTATION	Low
19704138	DEPT OF TRANSPORTATION	Low
19706218	DEPT OF TRANSPORTATION	Low
19720106	DEPT OF TRANSPORTATION	Low
19720111	DEPT OF TRANSPORTATION	Low
19720199	DEPT OF TRANSPORTATION	Low
19503104	MECKLENBURG COUNTY	Low
19503106	MECKLENBURG COUNTY	Low
19517156	MECKLENBURG COUNTY	Low
19523106	MECKLENBURG COUNTY	Low
19524101	MECKLENBURG COUNTY	Low

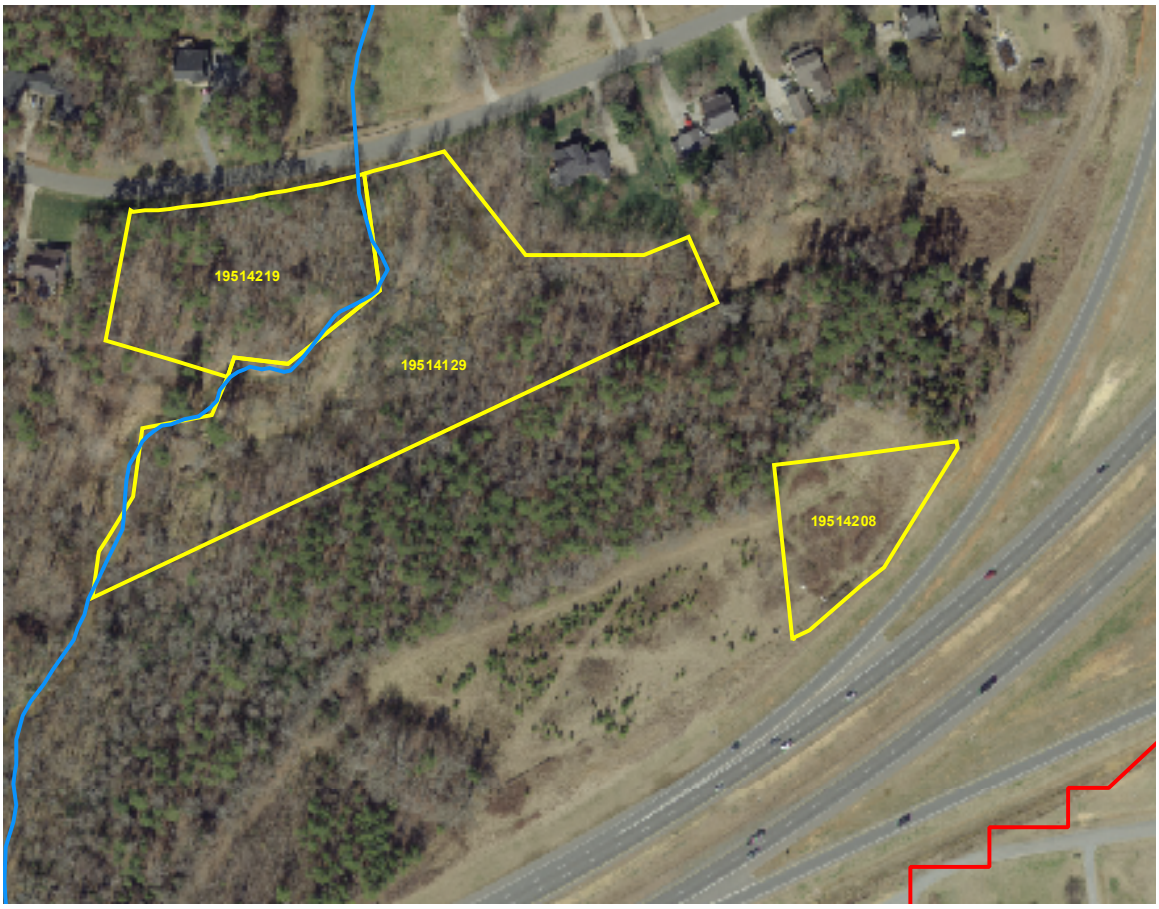

Figure 30: Aerial Photo of Parcels 19514219 (High Priority), 19514129 (High Priority) and 19514208 (Low Priority).

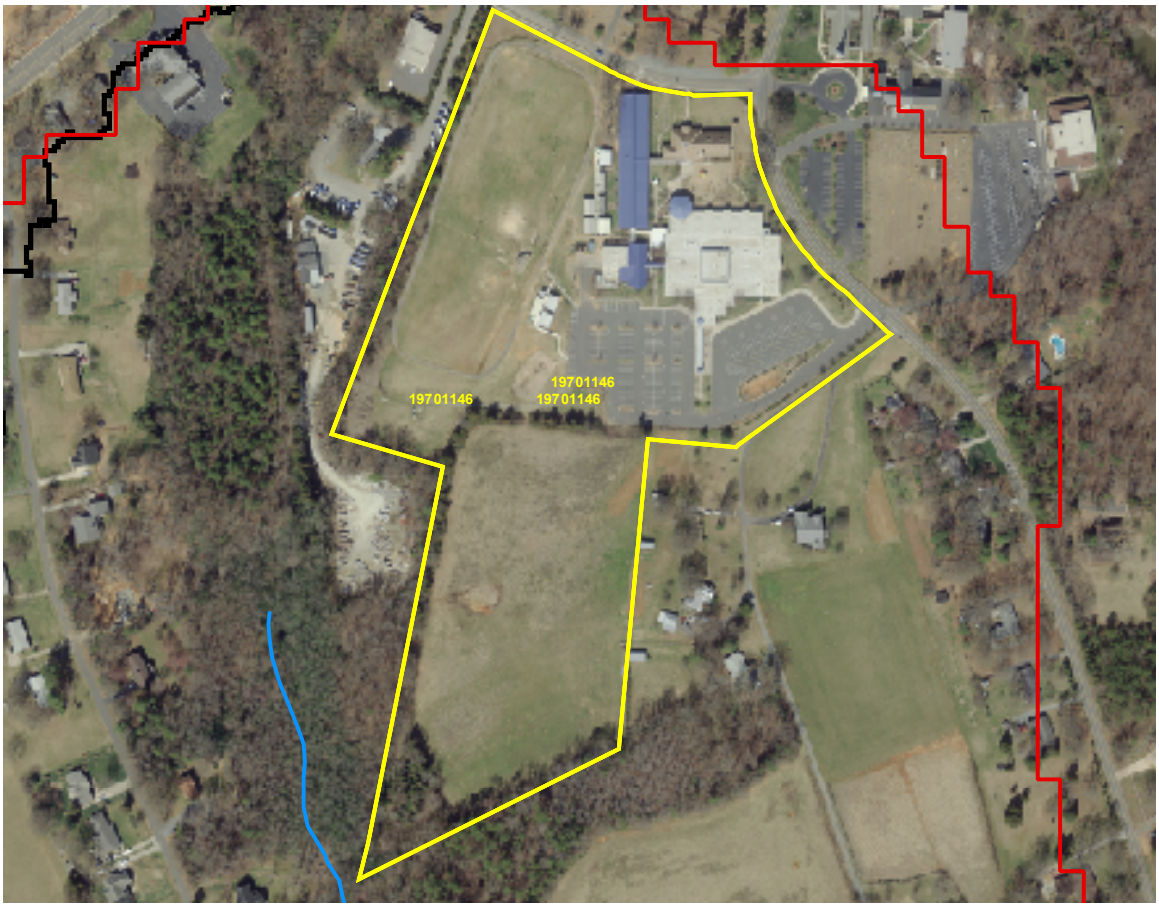

Figure 31: Aerial Photo of Parcel 19701146 (Medium Priority).

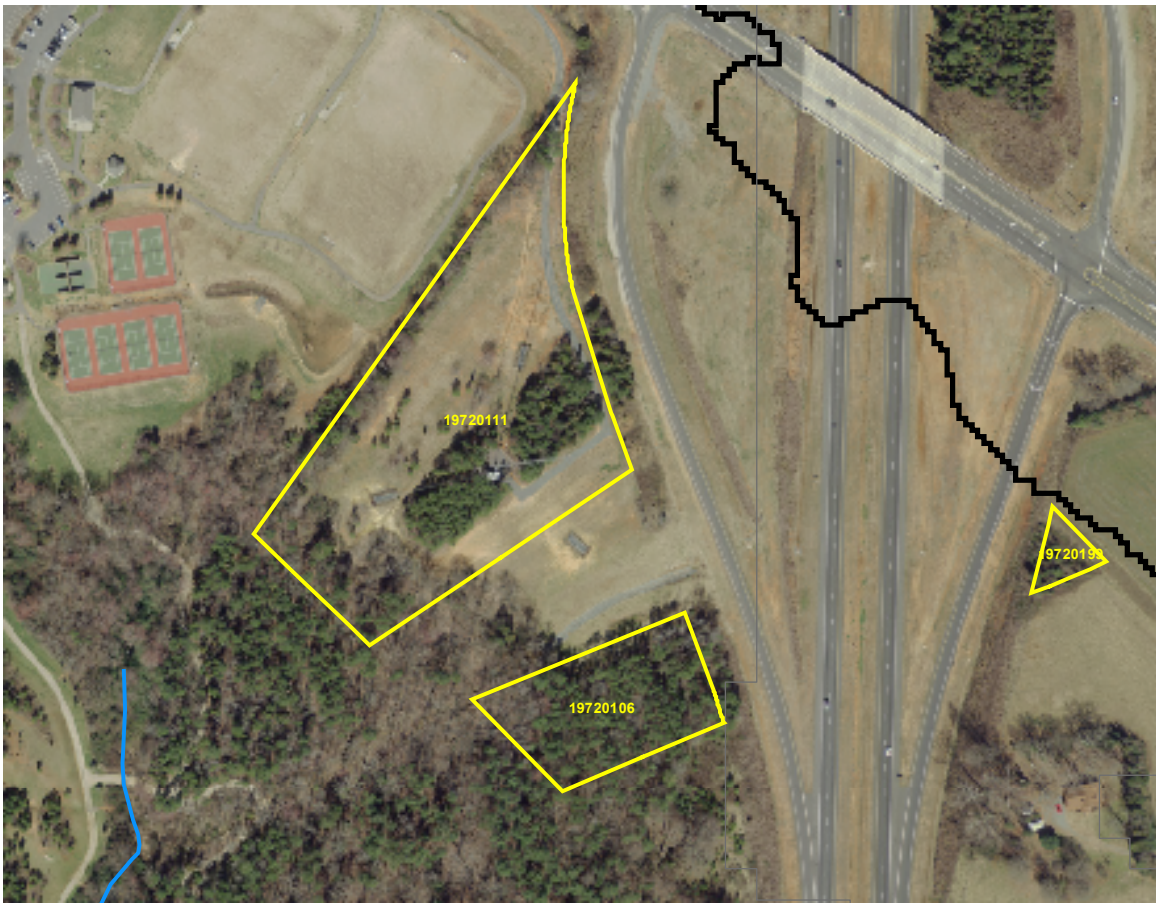

Figure 32: Aerial Photo of Parcels 19720111(Low Priority) and 19720106 (Low Priority).

5.2 Stream Channel Management Opportunities

The management opportunities outlined in this plan are based on numerous considerations. The analysis of collected data easily allows a ranked hierarchy based on need; however, project feasibility is of equal importance and takes in account additional factors. For example, the location of utility right-of-ways can constrain design parameters or could be costly to relocate. The number of private property owners within the proposed project area plays a crucial role in determining scope and size. The procurement of easements can be challenging and time consuming, as a result, the lower number of adjacent land owners is considered more favorable. The presence and condition of a riparian buffer can also be a deciding factor during the prioritization process. A stream with little to no buffer is often highly prioritized. An intact buffer can hasten the lateral instability commonly found in the streams of Goose Creek Watershed. Also, riparian buffers with large mature trees increase cost and may limit restoration and enhancement techniques available. Table 19 identifies the highest priority stream reaches in the Goose Creek Watershed.

For the purposes of mitigation credit, the US Army Corps of Engineers defines restoration and enhancement as follows (USACE, 2003):

Restoration – the process of converting an unstable altered or degraded stream corridor, including adjacent buffers and flood prone areas, to its natural stable condition. Restoration is based on reference conditions and includes restoring the appropriate channel dimension, pattern and profile. For impacts to fair or poor quality waters, the mitigation credit ratio is generally 1.0 (i.e. for every 100 feet of stream impact, 100 feet of stream restoration would be required for mitigation).

Enhancement Level I – mitigation category that includes improvements to the stream channel and riparian zone that restore dimension and profile, but do not address pattern. required for every 100 feet of impact).

Enhancement Level II – mitigation category for measures that improve channel stability, water quality and habitat, but fall short of restoring both dimension and profile. Examples include bank stabilization, vegetating riparian buffers and using in-stream structures to enhance stability and habitat.

Table 19: Highest Priority Goose Creek Stream Reaches

Reach	Rank
DSTOUS296	1
DSTOUS329	2
DSTOUS357	3
DSTOUS299	4
DSTOUS142	5
DSTOUS184	6

Reach DSTOUS296

Reach DSTOUS296 is located in Basin 14 upstream of an impoundment (see Figure 33). There is rip-rap on the upstream portion of the reach and the trees have good root depth. Gravel riffles, and a beaver dam are present. 300 ft of stream has been denuded from beaver dam breach. Woody debris and root mats form habitat. Some mid-channel bars exist. Bedrock nick-points present. Recommendation is Enhancement Level 1.

Recommendation: Enhancement Level 1
Estimated Cost: $844,735
System: Minor

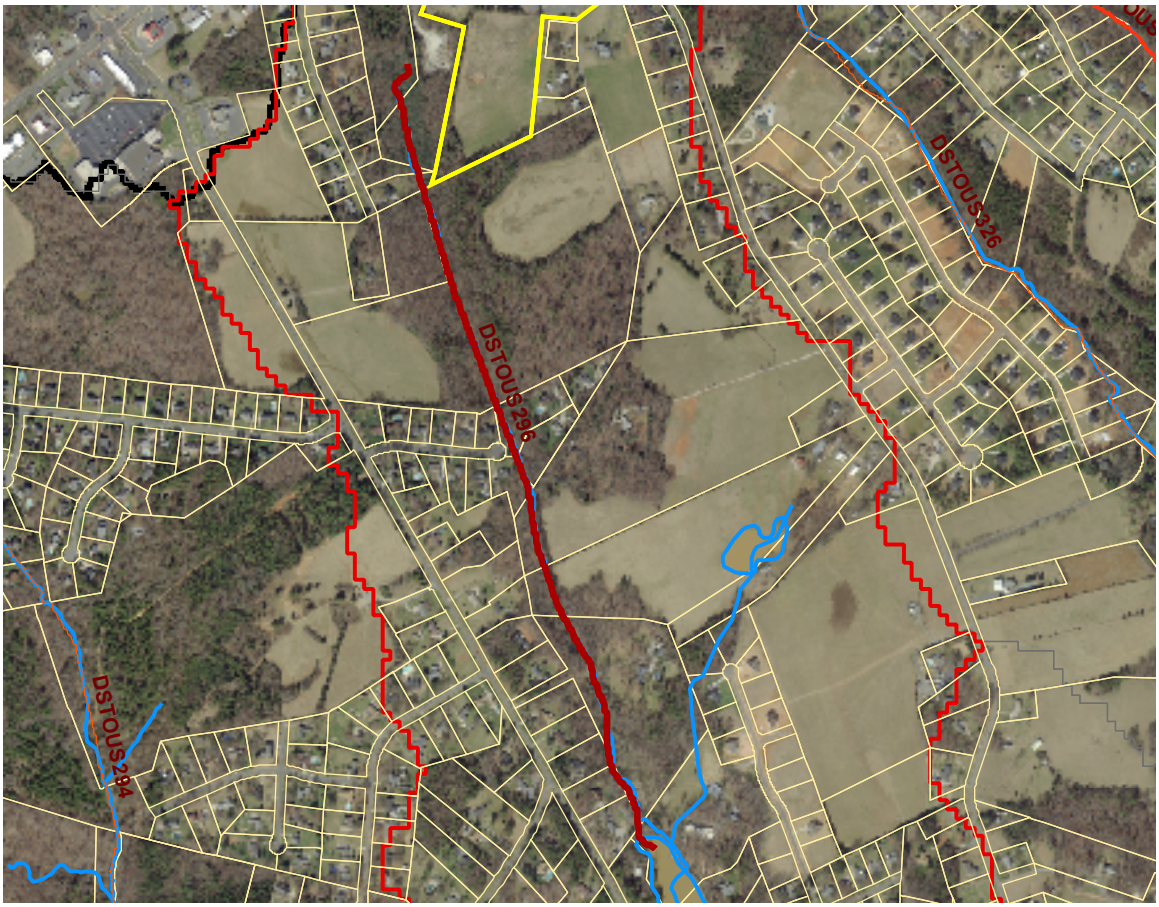

Figure 33: Reach DSTOUS296 Area Map.

Reach DSTOUS329

Reach DSTOUS329 is located in Basin 12 and flows through a relatively undeveloped stream corridor (see Figure 34). There is a well-vegetated buffer, except the downstream left bank is pasture. Banks are vegetated thoroughly with shrub and trees. Bed is composed of silt and sand. Several beaver dams are present. Downstream area has extreme bank erosion from cattle.

Recommendation:	Enhancement Level 1
Estimated Cost:	$851,879
System:	Minor

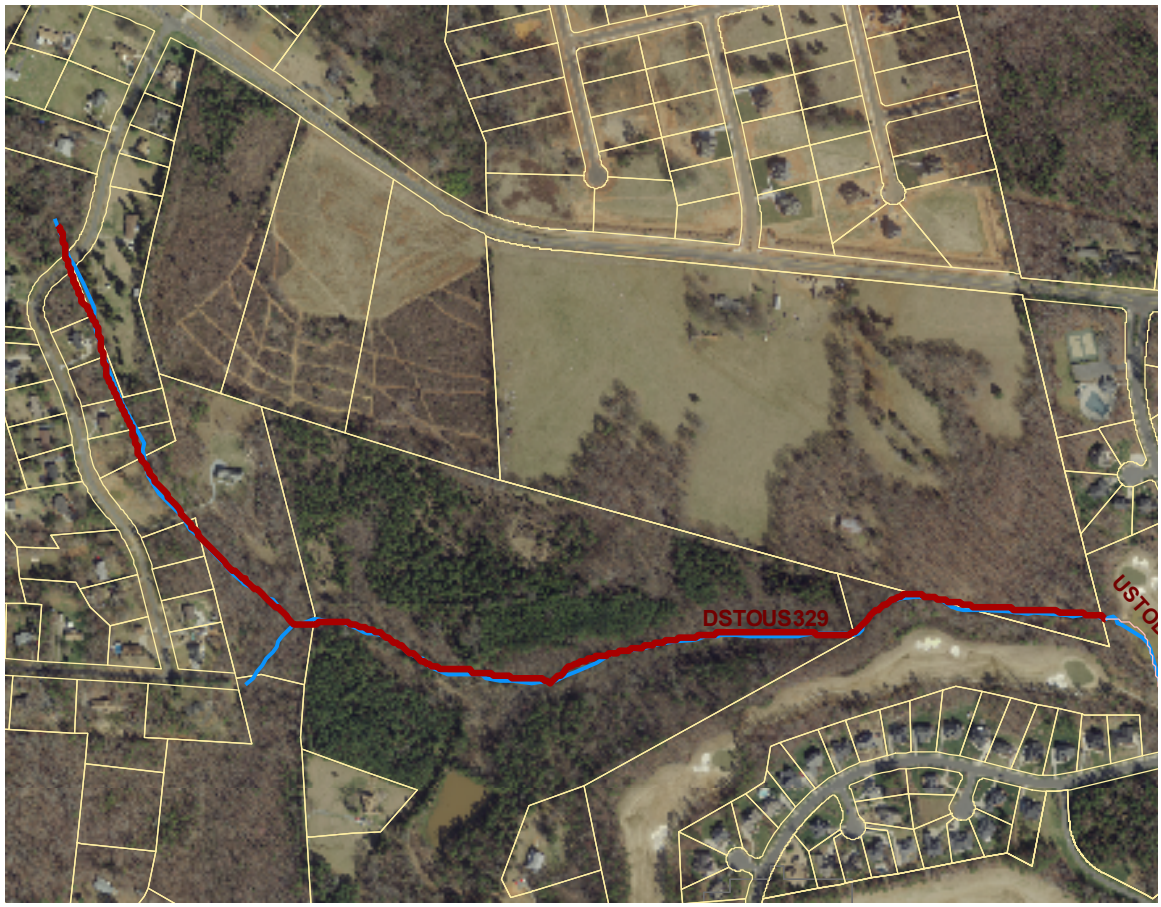

Figure 34: Reach DSTOUS329 Area Map.

Reach DSTOUS357

Reach DSTOUS357 is located in Basin 1 and flows through a relatively undeveloped stream corridor (see Figure 35). A significant head-cut is present and the stream has a sandy bottom. Several bedrock nick-points were noted. Numerous deep pools below blockages have formed. Poor riffle pool sequence was noted. Numerous vegetated point bars and bank full benches present. Reach receives significant concentrated runoff from I-485.

Recommendation:	Restoration
Estimated Cost:	$349,193
System:	Minor

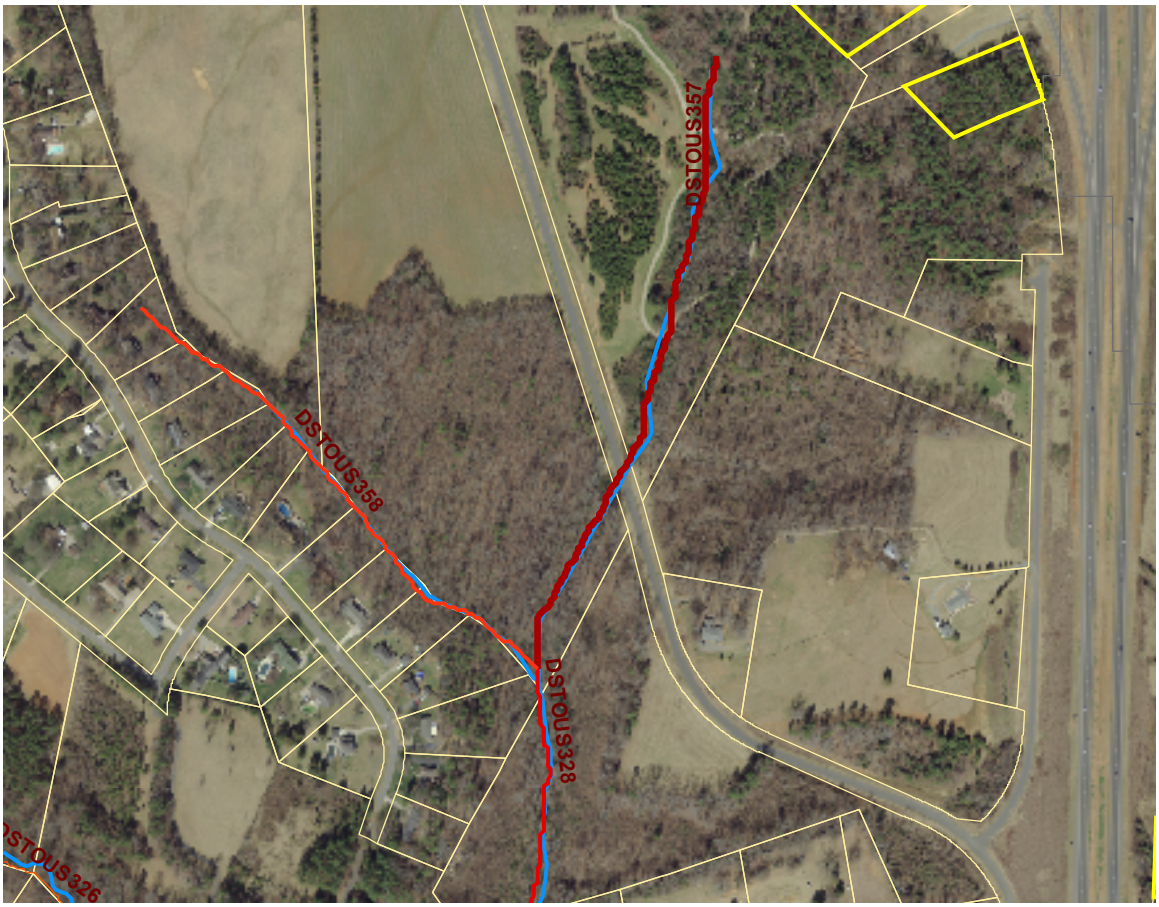

Figure 35: Reach DSTOUS357 Area Map.

Reach DSTOUS299

Reach DSTOUS299 is located in Basin 1 and flows through a relatively undeveloped stream corridor downstream of DSTOUS357 (see Figure 36). It may be beneficial to combine these two projects into a single effort. Livestock have access to the stream causing significant localized erosion and cows were noted in-stream at the time of assessment. Fencing of the livestock out of the creek should be a part of any restoration or enhancement effort. Notable bedrock and cobble are present. Pools are actively filling with sand and silt. Most of the entire stream reach is severely impacted by cattle. High BEHI with low NBS was noted. Good ripple pool sequence, very long riffles with cobbles and boulders.

Recommendation:	Restoration
Estimated Cost:	$397,271
System:	Major

Figure 36: Reach DSTOUS299 Area Map.

Reach DSTOUS142

Reach DSTOUS142 is located in Basin 13 and flows through a relatively undeveloped stream corridor that is almost entirely in public ownership (see Figure 37). Good riffle pool frequency; pools shallow; riffles embedded with course sand. Mid-channel bars present. Bed is fully shaded with mature vegetation. Habitat consists of large cobble and boulders. Banks are raw due to little surface coverage, good root depth from hardwoods at top of bank. Bedrock nick-points throughout the reach were noted.

Recommendation:	Restoration
Estimated Cost:	$774,953
System:	Major

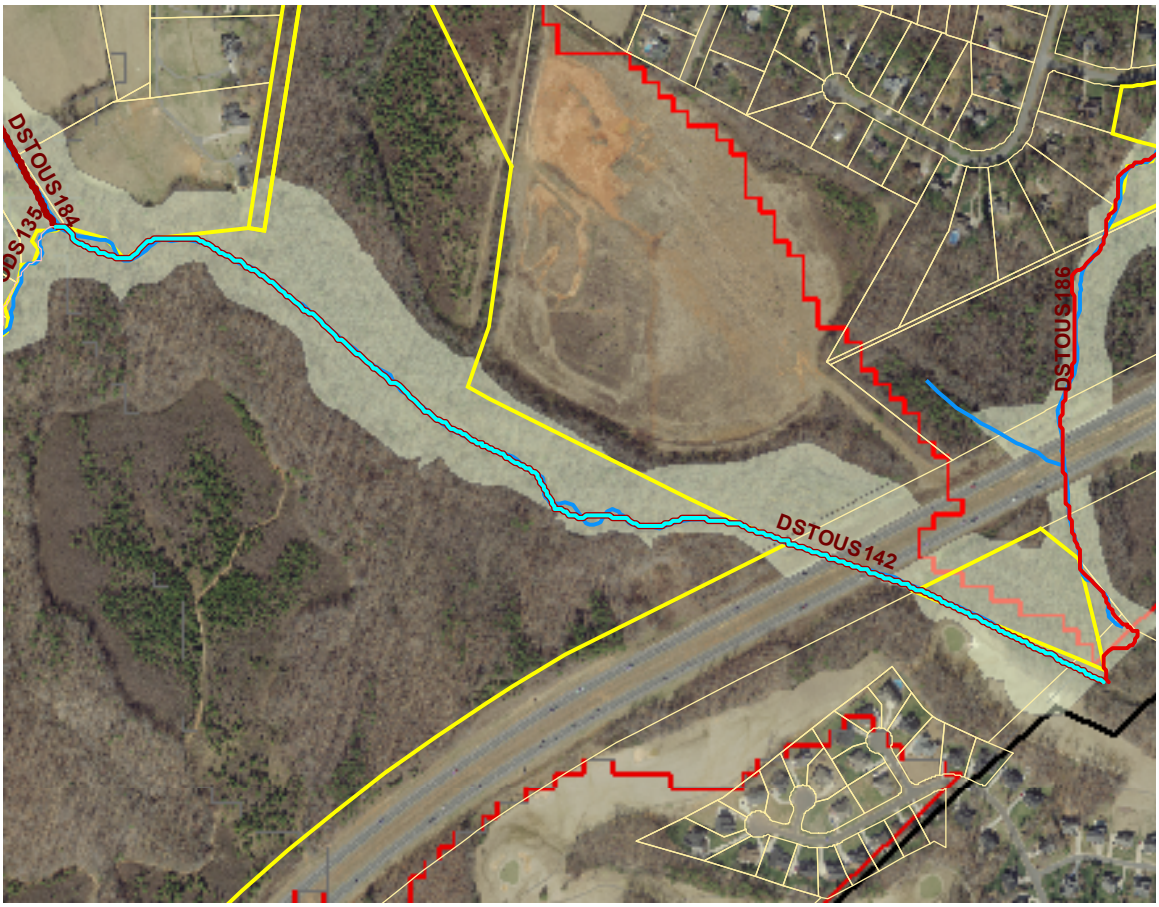

Figure 37: Reach DSTOUS142 Area Map.

Reach DSTOUS184

Reach DSTOUS184 is located in Basin 10 and flows through a developed stream corridor just upstream of DSTOUS142 (see Figure 38). These 2 reaches should be combined into a single project if possible. Stream is vertically stable, and actively aggrading with coarse sediment from upstream bank erosion. Stream is over-widening. Left bank buffer protection is inadequate and a good candidate for reforestation. Gravel and small boulder riffles present with poor frequency. Good pool depth variation bed is partially shaded. Banks are partially vegetated with grass and shrubs. Deep pools are limited to meanders and are actively filling with sand. Mid-channel bars of gravel were noted. Log jams were observed within the lower portion of the bank. Good surface protection. Invasive plant species are present throughout. Several transverse bars present. Habitat consists of undercut banks and large cobble.

Recommendation:	Restoration
Estimated Cost:	$660,333
System:	Major

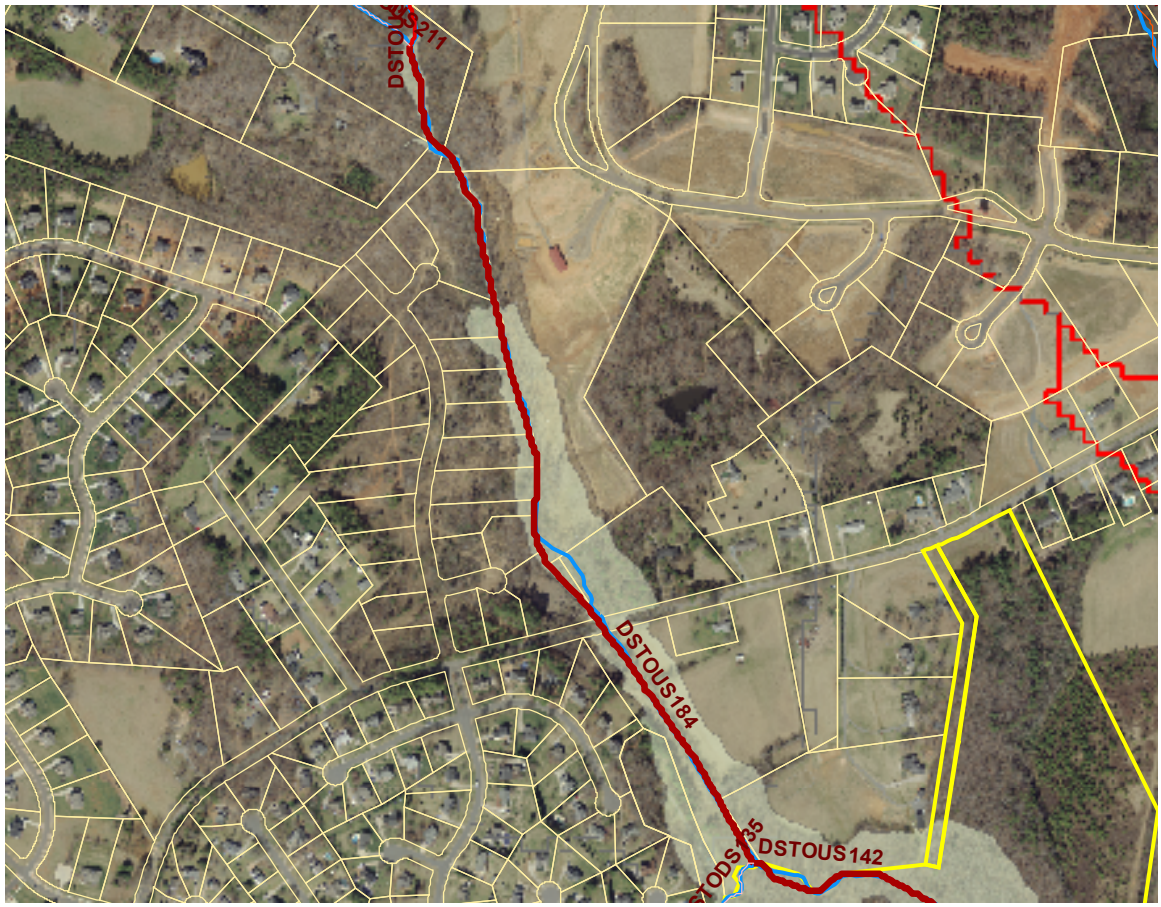

Figure 38: Reach DSTOUS184 Area Map.

5.3 Stream Buffer Restoration Areas

The intent of this section is to identify basins with the highest percentage of impacted (un-forested) stream buffer. Table 20 and Figure 39 present the results of the tree canopy analysis. All of the basins had more that 74% of the buffer forested which is significant. Also, the data utilized to prepare the estimates is almost 10 years old and a grant has been applied for to update the information. At this time, it is recommended that prior to the initiation of any projects the analysis be redone with the anticipated updated information.

Table 20: Results of the Stream Buffer Tree Canopy Analysis

Basin	Percent of Buffer Intact	Rank
BASIN6	74%	1
BASIN5	81%	2
BASIN4	87%	3
BASIN12	89%	4
BASIN2	89%	5
BASIN3	89%	6
BASIN11	91%	7
BASIN13	91%	8
BASIN1	91%	9
BASIN9	93%	10
BASIN8	95%	11
BASIN10	95%	12
BASIN14	96%	13
BASIN7	98%	14

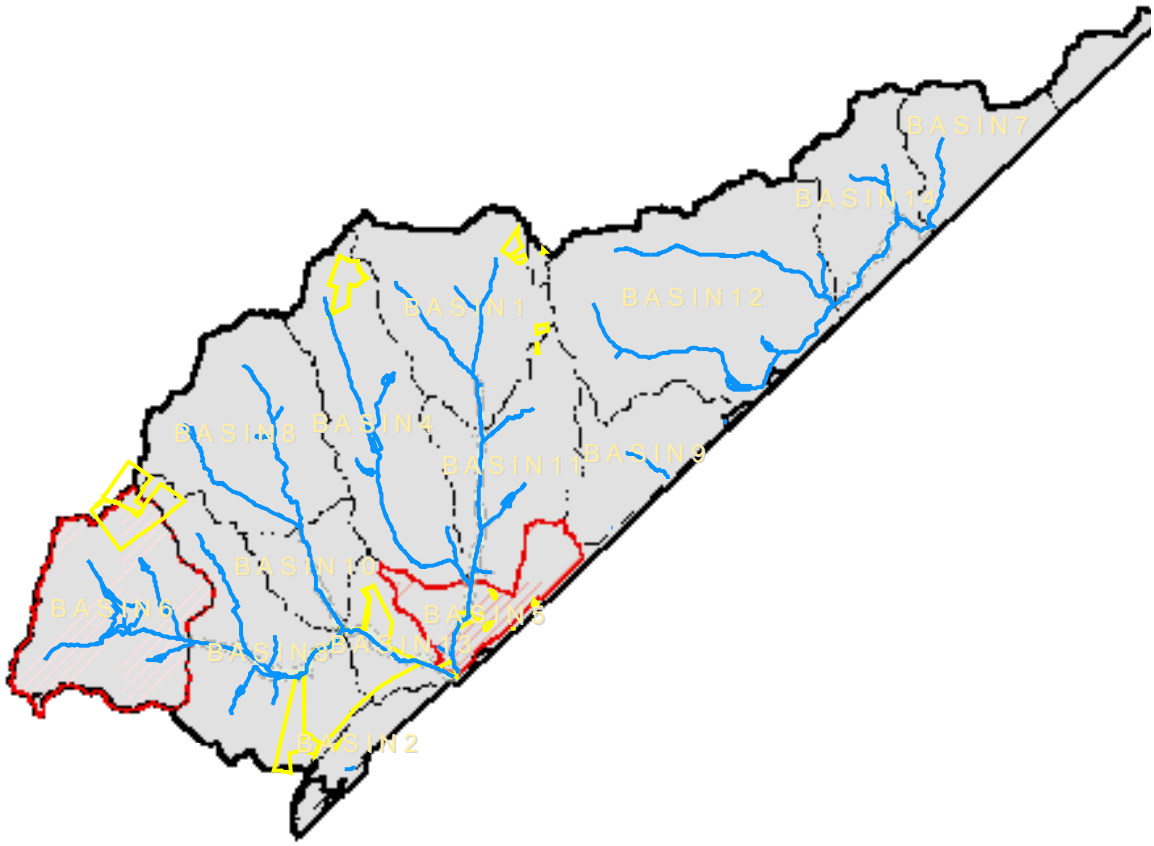

Figure 39: Results of the Tree Canopy Analysis (priority basins are outlined in red).

5.4 Master Planning for Restoration, Retrofit and Preservation Projects

A minimum of two (2) detailed Master Plans will be developed to guide restoration, retrofit and preservation projects in the Goose Creek Watershed. The goal of these Master Plans is to restore Goose Creek to a fully functioning and supporting stream ecosystem. The Master Planning process will start in the Focus Basins identified in Section 5.1.1 where the most impaired catchments are located. The planning process will begin with a thorough evaluation of all properties (including public and private) located in these Focus Basins to identify specific opportunities for restoration, retrofit and preservation projects, including properties to be recommended for acquisition by the County due to their water quality benefit. After the tree canopy data set is updated (expected in January 2010) specific recommendations will be made regarding buffer reforestation projects. The highest priority will be given to potential projects (including BMP retrofits, buffer reforestations and stream channel restorations) located on publicly owned properties. However, public property in the watershed is limited. Consideration will be given to the initiation of these projects as soon as possible. Once potential projects have been identified, a draft budget will be developed and funding sources specified. If grants will be included as a funding source, the grants and funding cycles will be specified as well as the necessary local match. At a minimum, the Master Plans will include the following:

- Specific location of all recommended projects (include on map).
- Detailed description of the projects, including type, size, etc. (include preliminary design sketches of the projects)
- Water quality benefit of the projects, including an estimate of pollutant removal capabilities.
- Budgets and funding sources for the projects.
- Individual project prioritization.
- Major or minor system.

An important component of maintaining water quality conditions in Goose Creek is ensuring the proper operation and maintenance of BMPs and septic systems installed to date to mitigate impacts from existing development as well as retrofit BMPs installed through the implementation of the Master Plans. This effort will begin in April of 2009 and continue through December 2009 and will include the identification and inspection of all existing BMPs and at least 200 septic systems in the watershed. Deficiencies detected will be reported to responsible parties for correction. A regular schedule of BMP inspections in the watershed will be developed and implemented for both public and private BMPs.

SECTION 6. MEASURING SUCCESS AND ADAPTIVE MANAGEMENT

6.1 Establishing an Ongoing Water Quality Monitoring Program

As discussed in Section 2.2, Mecklenburg County has historically collected water and macroinvertebrate samples from Goose Creek at monitoring site MY9, which is located at Stevens Mill Road in Union County approximately 4000 feet downstream of the Mecklenburg County and Union County line (see Figure 2). There is a USGS stream gage at Goose Creek and Mill Grove Road in Union County. A thorough evaluation has been completed of the historical chemical, physical and biological monitoring activities in the watershed and routine monitoring is being conducted to provide baseline data to measure the effectiveness of restoration measures as they are implemented

6.2 Annual Status Report

By December 31 of every year beginning in 2009 and continuing through the completion of the Watershed Management Plan (anticipated for December 31, 2024), the Mecklenburg County Water Quality Program will complete a Goose Creek Watershed Management Plan Annual Status Report to at a minimum include the following information:

- Status of compliance with goals identified in Table 12.
- Status of all projects underway in the watershed.
- Recommended changes to Watershed Management Plan.

This report will be made available to all the key players involved in the implementation of the Watershed Management Plan, including the Director of Water & Land Resources, Manager of Storm Water Engineering, Manager of the Water Quality Program, Supervisor of the Yadkin Section and a representative from the Town of Mint Hill. This group will serve as the "Watershed Management Evaluation Team."

6.3 Adaptive Management

The Watershed Management Evaluation Team will meet at least annually following the completion of each Watershed Management Plan Annual Status Report to evaluate the effectiveness of the Plan at meeting the goals reported as outlined in Section 6.2. This evaluation will be based on the data and information contained in the Annual Report as well as other pertinent facts and information provided regarding the effectiveness of the Plan at meeting established goals. During these meetings, consideration will also be given as to the effectiveness of the goals at measuring the effectiveness of the Plan. It may be necessary that goals be changed or that changes be made to the Plan. These changes will be reflected in the Watershed Management Plan and will become effective immediately.

SECTION 7. CONCLUSION

The Goose Creek Watershed has been designated critical habitat for the federally endangered Carolina Heelsplittter mussel and a Water Quality Recovery Program for fecal coliform has been developed for the watershed. Implementation of the Site Specific Management Plan is expected to prevent continued degradation of stream water quality from new development; however, pre-existing sources of pollution remain partially or completely un-mitigated. In order to restore the water quality in Goose Creek, pre-existing sources of pollution will need to be mitigated and in-stream stressors to benthic macroinvertebrate life removed. In this way Mecklenburg County can achieve its ultimate goal for Goose Creek of improving water quality conditions such that designated uses are met and the creek is no longer impaired. The effective implementation of this Watershed Management Plan will enable this to be accomplished but it will take time. It is currently anticipated that this process will take a minimum of 15 years between 2009 and 2024.

Appendix A
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