Total Maximum Daily Load for Addressing Impaired Biological Integrity in the Headwaters of Swift Creek Watershed, Neuse River Basin

February 2009
EPA Approval Date: March 12, 2009
North Carolina Department of Environment and Natural Resources
Division of Water Quality

Table of Contents

APPENDICES

SUMMARY

Based on the "weight of evidence" analysis for Swift Creek, the two most important factors are scour and toxicity (episodic); the impacts of enrichment and habitat degradation are more localized. The limitation of macroinvertebrate recolonization from the blockage of drift by impoundments (hydromodification) is also of concern. Although habitat degradation due to limited microhabitat was not viewed as a primary cause of impairment, combined with other causes of impairment, the cumulative effect can result in impairment. All of the stressors and indicator parameters are associated with the high levels of development in the Swift Creek watershed.

A TMDL must address stressors believed to be contributing to the impairment. Where the major cause of impairment is stormwater runoff, the use of surrogate indicators expressed as quantitative targets is appropriate in TMDL development. Because of stormwater-associated pollutants and the effects on the system's hydrology, these targets are used as surrogates to estimate stormwater pollutant load reductions needed to meet water quality standards.

IMPLEMENTATION SUMMARY

The goal of this TMDL is to achieve water quality standards, in this case, a benthic macroinvertebrate community bioclassification of Not Impaired, Good-Fair, or better. Achievement of this water quality standard may be met by implementing management practices designed to mitigate the effects of stormwater runoff. Eliminating impervious cover (IC) is not necessary to reach the TMDL target reductions. Aquatic life (biological community) will be the measure of TMDL success.

When the TMDL is implemented, stressors (scour and toxicity, for example) will be reduced or not delivered to the waterbody in the first place.

INTRODUCTION

Section 303(d)(1)(C) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each State to develop a Total Maximum Daily Load (TMDL) for each impaired segment on the Section 303(d) list, taking into account seasonal variations and a protective margin of safety (MOS) to account for uncertainty. Traditionally, a TMDL reflects the total pollutant loading of the impairing substance a waterbody can receive and still meet water quality standards.

This TMDL addresses the following benthic macroinvertebrate sites (compliance points) with the most current (year) bioclassification: Swift Cr at SR 1152 (Holly Springs Rd), Fair (2005); Swift Cr at SR 1300 (Kildare Farm Rd.), Fair (2001); Swift Cr at US 1, Poor (2000); Swift Cr at McKenan Rd, Not Rated (2000); Swift Cr at Old Raleigh Rd, Not Rated (1989); Williams Cr at Old Raleigh Rd, Not Rated (2000); Williams Cr at US 64, Not Rated (2000). These waters have been on the NC 303(d) list of impaired waters since 1998. These sites comprise three assessment units in the Neuse River Basin that are listed in the draft 2008 303(d) list for impaired biological integrity: Swift Creek, Assessment Unit 27-43-(1)a (from source to the confluence of Williams Creek); Swift Creek, Assessment Unit 27-43-(1)b (from the confluence of Williams Creek to the

backwaters of Lake Wheeler); and Williams Creek, Assessment Unit 27-43-2 (from source to Swift Creek).

The purpose of this report is to establish a TMDL to address the aquatic life impairments in the upper Swift Creek watershed. The goal is to provide the basis for improving the watershed ecosystem through implementation of best management practices such that the beneficial uses of the waterbodies are restored. Upon approval by EPA, this TMDL becomes part of the Neuse River Basinwide Water Quality Plan.

In 2002, EPA provided clarifications on existing regulatory requirements for establishing wasteload allocations (WLAs) for stormwater discharges in TMDLs (EPA Memorandum 2002). Specific key points of the memorandum include:

- EPA expects that most Water Quality Based-Effluent Limits (WQBELs) for NPDES-regulated municipal and small construction stormwater discharges will be in the form of Best Management Practices, and that numeric limits will be used only in rare instances.

- When a non-numeric WQBEL is imposed, the permit's administrative record, including the fact sheet when one is required, needs to support that the BMPs are expected to be sufficient to implement WLA in the TMDL.

- It may be reasonable to express allocations for NPDES-regulated stormwater discharges from multiple point sources as a single categorical wasteload allocation when data and information are insufficient to assign each source or outfall individual WLAs.

- EPA expects TMDL authorities to make separate allocations to NPDES-regulated stormwater discharges (in the form of WLAs) and unregulated stormwater (in the form of load allocations). EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability in the system.

APPLICABLE SURFACE WATER QUALITY STANDARDS AND RULES

TMDLs are established to achieve and maintain water quality standards. A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include aquatic life survival and propagation, swimming, drinking water supply, and shellfish harvesting. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ among waters with different designated uses.

The surface water classifications for Swift and Williams Creeks are protected for Class C uses. All waters in North Carolina have the base classification of "C." Class C waters are protected for aquatic life propagation and biological integrity (including fishing and fish), wildlife, secondary recreation, agriculture and other uses suitable for Class C. There are no restrictions on watershed development or types of discharges associated with Class C (15A NCAC 02B.0211, 2007).

In addition to the base Class C designation, the waterbodies in this watershed are also classified as WS-III. Waters classified as WS-III are used as sources of potable water where a more protective WS-I or II classification is not feasible. General discharge permits only are allowed near the water supply intake whereas domestic and nonprocess industrial discharges are allowed in the rest of the water supply watershed. Waters classified as WS-III are generally in low to moderately developed watersheds. Controlling nonpoint sources and stormwater discharges of pollution that would otherwise adversely impact the waters for use as water supply or any other designated use shall be required by local programs (15A NCAC 02B.0215, 2007) The upper Swift Creek watershed was approved for classification to WS-III on August 3, 1992.

In addition, because the Swift Creek watershed is in the Neuse River Basin, waters are classified Nutrient Sensitive Waters (NSW). This supplemental classification is intended for waters needing additional nutrient management due to their experiencing or being subject to excessive growth of microscopic or macroscopic vegetation. In general, management strategies for point and nonpoint source pollution control require control of nutrients (nitrogen and/or phosphorus usually) (15A NCAC 02B.0233, 2007). The Neuse River Basin-Nutrient Sensitive Waters Management Strategy: Basinwide Stormwater Requirements are designed for local governments to implement their own stormwater management plan (15A NCAC 02B.0235, 2007). This requirement has been in effect since August 1, 1998.

This TMDL addresses three assessment units in the Neuse River Basin that are listed in the draft 2008 303(d) list for impaired biological integrity. Impairment for biological integrity is based on a narrative standard that pertains to the aquatic life use designation. Biological integrity means "the ability of an aquatic ecosystem to support and maintain a balanced and indigenous community of organisms having species composition, diversity, population densities and functional organization similar to that of reference conditions" (15A NCAC 02B.0202, 2007).

Habitat evaluation is not currently linked to the North Carolina Piedmont bioclassification ratings so there are no thresholds or breakpoints distinguishing "condition groups" (e.g., Excellent, Good, Good-Fair, Fair, or Poor); higher overall scores simply represent better aquatic habitat than lower overall scores. To reduce the subjectivity of visual interpretations of the habitat components, the DWQ assessment form provides definitions of various conditions and the associated score (NCDWQ 2006).

The DWQ methodology (2006) for evaluating instream aquatic habitat focuses on eight key components that affect the availability and suitability of habitat. The components are rated individually and the summation of the scores ranges from 0 to 100, with 100 reflecting the highest quality habitat. The eight components and their relative weight to the overall score are:

- Channel modification (5)
- Instream habitat types (20)
- Bottom substrate (15)
- Pool variety (10)
- Riffle habitats (16)
- Bank stability and vegetation (14)

• Light penetration (10)
• Riparian vegetative zone width (10)

DWQ's criterion for assessing aquatic life as impaired is a biological community at a benthic macroinvertebrate or fish sampling site with a bioclassification of Poor, Fair or Severe Stress. The criterion for assessing aquatic life as supporting is a bioclassification of Good-Fair, Good, Excellent, Not Impaired, Natural or Moderate Stress at a biological community sampling site.

Biological impairments to Swift and Williams Creek were identified using bioassessment protocols outlined in the North Carolina's *Standard Operating Procedure for Benthic Macroinvertebrates* (NCDWQ 2006). Upper Swift Creek and Williams Creek have carried benthic macroinvertebrate bioclassifications of Fair, Poor and Not Rated throughout the period of record. The NCDWQ Biological Assessment Unit has sampled this watershed since the 1980s.

WATERSHED DESCRIPTION

The Swift Creek watershed including Williams Creek is located in the Neuse River Basin in Wake County, southwest of Raleigh, North Carolina (Figure 1). The drainage area is less than 36 square miles and is assigned the USGS 14-digit hydrologic unit code (HUC) 03020201110010. Portions of Cary and Apex are located within this HUC. The TMDL watershed is defined as Swift Creek from source to backwaters of Lake Wheeler and all tributaries draining to this portion of Swift Creek including Williams Creek (Figure 1). The predominant land use is highly developed with extensive residential subdivisions and office parks/commercial areas. Extensive development occurred during the 1980s and 1990s. Impervious surfaces (areas such as roof tops, roads and parking lots that prevent infiltration of precipitation into the soil) cover approximately 20% of this watershed. Significant impacts to stream biota can generally be expected with this degree of unmitigated impervious cover (Schueler, 1994).

Upland soils of the watershed consist of a variety of soil associations (Cawthorn, 1970), corresponding to the three major geologic belts running in a north-south direction through the study area. The western edge of the study area (encompassing the headwaters of Williams Creek, above Summit Lake, and the headwaters of Apex Branch) is in a Triassic basin. Soils of the Mayodan-Granville-Creedmore association predominate. The middle portion of the upper Swift Creek watershed, from the head of Summit Lake to approximately the Kildaire Farm Road area, is in the Carolina Slate Belt. Approximately 55% of the study area consists of Slate Belt soils, which are primarily of the Herndon-Georgeville association (NCDWQ-WARP Report 2003). The Raleigh Belt includes the eastern third of the watershed. Predominant soils are of the Appling and Cecil-Appling associations, derived primarily from crystalline materials (mostly granite, gneiss and shist) and mudstone. Soils along Swift Creek between Holly Springs Road and Lake Wheeler are largely of the Wehadkee series. These are nearly level poorly drained soils formed in sandy alluvium and are common along streams in Wake County.

While the mainstem of upper Swift Creek is not impounded, almost all significant tributaries are impounded. Summit Lake, on Williams Creek, was constructed as a water supply reservoir for Apex, although it is no longer used for that purpose (NCDWQ-

WARP Report 2003). The other impoundments were constructed as amenities and several are associated with golf course communities. With the exception of Williams Creek, all of these impoundments are located near the mouths of the tributaries. In total, streamflows from 13 square miles (63% of the drainage area above Holly Springs Road) are affected by these impoundments. An additional impoundment, Kildaire Farm Lake (Lake Kildaire), located on Cary Branch upstream of MacGregor Downs Lake, covers 40 acres and was built in the 1980s as part of the Kildaire Farm development. Only Regency Park Lake is required to make a minimum release. The largest unimpounded stream in the study area is Apex Branch, the tributary of Williams Creek draining portions of downtown Apex.

Existing Land Use

The North Carolina Ecosystem Enhancement Program (EEP) Local Watershed Plan (LWP), *Swift Creek Detailed Assessment & Targeting of Management Report* estimated existing percent imperviousness using USEPA (1999) land cover GIS coverage (EEP 2005). For purposes of this TMDL, 'subwatershed' refers to the subwatersheds delineated in this EEP report. In addition, the Wake County parcel coverage was obtained in January 2005 to determine parcels that had been developed since 1998; H. Fisher with Tetra Tech (pers. comm. through R. Breeding, EEP, March 26, 2008) verified this. The coverage of newly developed parcels was overlaid with the original EPA land use dataset to generate the "existing" land use coverage that represented current conditions. Subwatershed scale imperviousness was calculated using average imperviousness percentages for each of the land uses. These percentages were applied to the existing land use classes to estimate the subwatershed scale imperviousness estimates. Subwatersheds draining to the impaired segments have imperviousness percentages ranging from 15 to 40.

The EEP study examined the linkages between population growth and development by looking at population trends in the Swift Creek Study Area (based on U.S. Census data from 1990 and 2000). EEP compared the two data sets in GIS to generate population rate changes from 1990 and 2000. The GIS analysis illustrated how population has increased over 100% for certain subwatersheds, including those in Cary and Apex. The dramatic increases in the subwatersheds located in Cary and Apex are due to higher development in the incorporated areas as well as the location of major highways in these areas (Hwy 1 and Hwy 64).

Existing land use based on the 1999 data has the following distribution:
1) Woody Vegetation – 42%
2) Urban – low density –28%
3) Urban – medium density – 12%
4) Agriculture – 7%
5) Urban – high density – 4%
6) Wetlands – 3%
7) Water – 3%
8) Barren – 0.2%

Additional information on land use trends and projected future land use in this watershed can be found in Appendix 1.

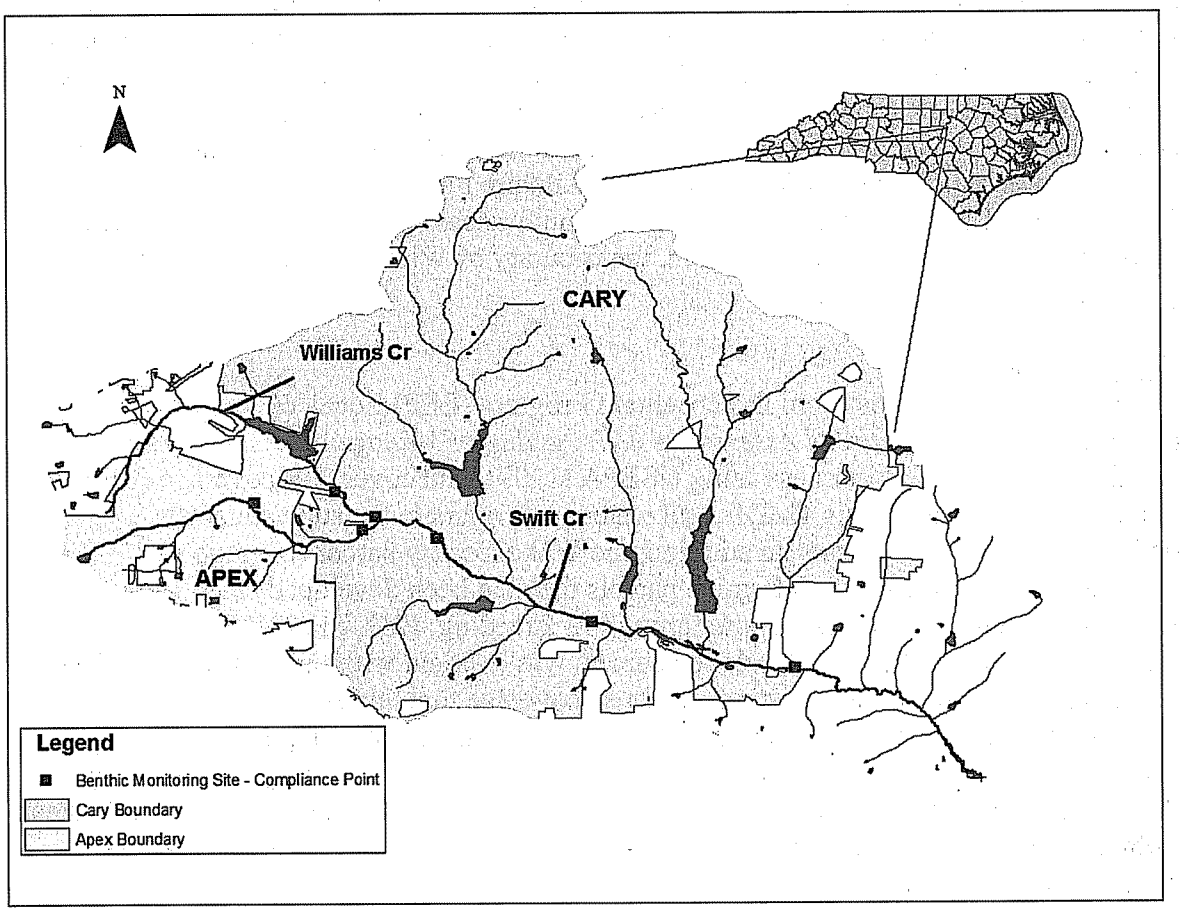


Figure 1. Upper Swift Creek TMDL watershed

POLLUTANT SOURCE ASSESSMENT

This TMDL report largely draws its information from a multi-phase project that was initiated in 2003 by the North Carolina Ecosystem Enhancement Program (EEP) to develop a Local Watershed Plan (LWP) for the Upper Swift Creek watershed in the Neuse River Basin. The area of interest for the TMDL is a smaller subset of the Upper Swift Creek watershed. A Watershed Characterization of the Swift Creek watershed (Phase I) was completed in March 2004. This effort compiled existing data and assessment information pertaining to the study area. In September 2004, EEP completed a *Preliminary Findings Report* and initiated the Detailed Assessment (Phase II) and Management Identification (Phase III) steps of the project in order to identify the primary stressors to watershed functions and establish appropriate indicators necessary to measure conditions in the watershed in terms of those stressors. The *Detailed Assessment and Management Report* (NCEEP 2005) described the conceptual model used to link the specific stressors identified in the *Preliminary Findings Report* and subsequent reconnaissance with appropriate indicators of watershed function. The TMDL for the Swift Creek watershed and its subsequent implementation plan will focus on the LWP identified areas of greatest need and risk.

The EEP Local Watershed Plan (LWP) for the Swift Creek watershed included a rigorous source assessment methodology and stressor identification process. As previously discussed, the EEP LWP for the upper Swift Creek watershed was initiated to complement existing efforts to identify problems in the watershed. DWQ's Watershed Assessment Restoration Program (WARP) conducted an assessment study of upper Swift Creek in 2000 and 2001. The assessment analyzed the causes of impairment by measuring various water quality chemical, physical and biological parameters. Major watershed activities and sources of pollution contributing to those causes (such as stream bank erosion or stormwater runoff from particular urban/rural areas) were also identified. Conclusions of the study showed aquatic organisms in upper Swift Creek are heavily impacted by multiple stressors associated with high levels of development in the watershed.

The relative contribution of these stressors cannot be clearly differentiated based on the available data. However, candidate causes of impairment such as hydromodification and associated scour due to storm flows resulting from high density development were determined as likely contributors to the biological impairment. Specific toxics of concern were not identified. A number of impoundments in the watershed were identified as contributing to the possible limiting factor of downstream macroinvertebrate recolonization. The findings from the source assessment and stressor identification process will be discussed and demonstrate why no single pollutant or group of specific pollutants have been identified as the cause of impairment in the watershed.

Significant contributors to impairment of Swift Creek and Williams Creek include the NPDES Stormwater Phase II permit holders of the Town of Apex (NCS000446) and the Town of Cary (NCS000247), as well the NPDES Stormwater Phase I permit holder NC Department of Transportation (NCDOT) (NCS000250). The Town of Apex, Town of Cary, and NCDOT comprise 10%, 56%, and 5% of the land area respectively. The remaining 29% of the land area is within Wake County. More information regarding percentage composition of land area for the above permit holders can be found in Appendix 2. There is one individual industrial stormwater permit, Apex Lumber Co., Inc. (NCG210234-timber products) in this watershed.

STRESSOR IDENTIFICATION

A study conducted by the Planning Branch of DWQ in the Upper Swift Creek Area (upstream of Holly Springs Road) in 2003, referred to as the WARP study, included a detailed evaluation of the causes of impairment. The following paragraphs summarize the findings of that analysis. The WARP study included the following primary tasks:

- Identification of the most plausible potential "candidate" causes of impairment in the watershed
- Collection of additional data
- Characterization of the causes of impairment using a "strength of evidence" approach

The strength of evidence approach involves a logical evaluation of several sources of "evidence" to determine which evidence supports or does not support the correspondence of the candidate stressor to the impairment. The evaluation also included analysis of whether candidate stressors were primary causes of impairment, secondary causes of

impairment, part of the cumulative cause of impairment, a contributing stressor, a potential cause or contributor, or an unlikely cause or contributor. Other sources of evidence evaluated included benthic macroinvertebrate community data, habitat and riparian area assessment, chemistry, toxicity data, current watershed activities, land uses, and pollutant sources.

The following candidate causes were determined to not be significant or primary causes of impairment in Swift Creek:
Habitat degradation – Sedimentation. The Neuse River Basinwide Water Quality Plan (NCDWQ 2002) listed sediment as a potential cause for impairment based on biological data. This hypothesis was tested using the weight of evidence approach using available data (benthic macroinvertebrate community data, habitat and geomorphic evaluation, and watershed history and characteristics). Results of the analysis indicated that substantial sediment accumulation and resulting habitat degradation in Swift Creek and tributaries (upstream of Holly Springs Road) is not evident based on stream surveys and habitat assessments conducted in conjunction with biological sampling. Therefore, there is little evidence that sedimentation alone is severe enough to be considered a cause of impairment overall for Swift Creek (although there are some localized areas of exception) that can be mitigated in the implementation plan.

Habitat degradation – lack of key microhabitat. Benthic macroinvertebrate community data, habitat and geomorphic evaluation and watershed history and characteristics were utilized in this evaluation of causes of impairment. Although there are areas with poor habitat (including deep uniform stream channels, little habitat diversity, no riffles and very low baseflow velocities), the lack of key microhabitat is not viewed as a primary limiting factor for benthos.

The following candidate causes were determined to be significant causes of impairment in Swift Creek:

Hydromodification and associated scour due to storm flows (resulting from high density development). Habitat and riparian area assessments, stream observation during storms and watershed characteristics were reviewed to assess stormflow scour as a cause of impairment in the watershed. The EEP study provided erosive velocity estimates (derived from hydrologic and hydraulic modeling), which were used to determine which stream banks are most susceptible to erosion from scour based on an analysis of peak flows and associated in-stream velocities, soil type, and vegetation. This analysis will be useful in the overall implementation of the TMDL and decreasing impacts on the habitat watershed function. Scour was hypothesized to be the most pervasive stressor in the watershed. Associated with the removal of organisms and microhabitat during storms, stormflow scour was determined as a likely contributor to habitat degradation and dislodging of organisms.

The EEP study used the Bank Erosion Hazard Index (BEHI) to predict risk of streambank erosion. The BEHI provides a numerical value between 0 and 60 that describes the ability of a streambank to resist erosion – the higher the index, the lower the resistance and the lower the predicted stability of the streambank. The highest BEHI scores were within the TMDL watershed (Figure 1) area of the report. The BEHI also provides an

indicator of the incision of the channel –the extent to which the channel generates or has generated sediment due to downcutting of the channel bed. Most sites in the TMDL watershed had a channel incision category of 'Highly Unstable'.

The BEHI results for the Swift Creek watershed also indicated that there were low percentages of surface protection on evaluated streambanks. The surface protection relates to the ability of soils on the surface of the streambank to resist detachment. On average, the surface protection was approximately 25 percent, meaning that only one quarter of the surface soils were protected from detachment by woody groundcover, vegetation, and debris (e.g., logs and rocks) that would not readily be mobilized by high flows. Lower percentages of surface protection result in increased exposure of streambank soils to erosional forces.

The EEP report identified water quality impacts from population growth and development as the major issues in this watershed. Increasing development is associated with an increase in the amount of impervious surface, leading to extremely high flows after rain events, and very low flows during low rainfall periods.

Toxicity (resulting from residential and commercial development). Water chemistry data, in-stream bioassay data, sediment chemistry and bioassay data, watershed characteristics, and benthic community data were utilized in the evaluation of toxicity as a cause of impairment. Although toxic impacts are very episodic and difficult to identify, data on benthic community composition, midge deformities and one acute bioassay failure during a storm suggest that toxicity is evident at least periodically in the watershed due to runoff. The EEP LWP identifies toxic effects as localized and sporadic due to runoff.

Hydromodification (resulting from dams). Impacts from dams include the following:

- Prevention of downstream colonization of aquatic populations
- Lower water levels below dams
- Change in temperature and dissolved oxygen
- Change in food type

Although it is difficult to isolate these impacts from those of lower baseflows associated with urbanization and organic enrichment, there is evidence that the lowered water levels below dams are an important stressor to the biological communities in Swift Creek.

Organic and nutrient enrichment. Benthic community data and water quality monitoring data were utilized to evaluate organic and nutrient enrichment as a potential cause of stress on the biological community. The nutrient rules for the Neuse River Basin are applied in the Swift Creek watershed. Although it was difficult to distinguish between the impacts of lower base flows (associated with urbanization) and organic and nutrient enrichment based on dissolved oxygen, there is evidence that enrichment is associated with intermittent and localized impacts in the watershed (EEP Swift Creek LWP 2005).

Conclusions. Based on the "weight of evidence" analysis presented in the WARP study for Swift Creek, the two most important factors are scour and toxicity (episodic); the impacts of enrichment and habitat degradation are more localized. The limitation of macroinvertebrate recolonization from the blockage of drift by impoundments (hydromodification) is also of concern. Although habitat degradation due to limited microhabitat was not viewed as a primary cause of impairment, combined with other causes of impairment, the cumulative effect can result in impairment. All of the stressors and indicator parameters discussed above are associated with the high levels of development in the Swift Creek watershed. The findings of this analysis are most likely applicable to the remainder of the Swift Creek watershed (to downstream of Lake Benson) as these areas are also experiencing rapid development.

WATER QUALITY TARGET

Extensive national and state level research shows strong correlations between impairment and watershed development. Stormwater runoff from impervious surfaces can carry a complex array of potential pollutants that can impact the aquatic community. Because of the uncertainty in identifying specific pollutants in urbanized stormwater runoff, difficulties arise in quantifying the real target (biological integrity) in a TMDL.

A TMDL must address stressors believed to be contributing to the impairment. Where the major cause of impairment is stormwater runoff, the use of surrogate indicators expressed as quantitative targets is appropriate in TMDL development. Because of stormwater-associated pollutants and the effects on the system's hydrology, these targets are used as surrogates to estimate stormwater pollutant load reductions needed to meet water quality standards.

Research conducted by The Center for Watershed Protection (CWP) indicated that variability in stream quality indicator data is usually dampened when impervious cover (IC) exceeds 10%, which presumably reflects the stronger influence of stormwater runoff on stream quality indicators. In particular, the chance that a stream quality indicator will attain a high quality score is sharply diminished at higher IC levels. This trend becomes pronounced within the 10 to 25% IC range and almost inevitable when watershed IC exceeds 25%. This pattern suggests that IC is a more robust and reliable indicator of overall stream quality beyond the 10% IC threshold (CWP 2003).

According to 'Estimating and Projecting Impervious Cover in the Southeastern United States' (USEPA 2005), degraded benthic community sites are evident as impervious area increases. Specifically, from sites in North Carolina with a total impervious area greater than 10%, 62% were degraded. In contrast, 90% of sites with less than 10% IC were not degraded. The goal of this target is to achieve water quality standards, in this case, a benthic macroinvertebrate community bioclassification of Good-Fair, Not Impaired or better.

Based on the above findings, a total watershed impervious cover (IC) of 10% was used as the surrogate target for this TMDL, to be implemented through stormwater management. Achievement of this water quality standard may be met by implementing

management practices designed to mitigate the effects of stormwater runoff. Because IC is a surrogate measure, eliminating IC is not necessary in reaching the TMDL target reductions. Measuring the aquatic life (biological community) directly will be the method for assessing attainment of the TMDL goal. "TMDLs may be established using a pollutant-by-pollutant or biomonitoring approach." (40 CFR 130.7(c)(1)(i))

MARGIN OF SAFETY

A Margin of Safety (MOS) is required as part of a TMDL in recognition of many uncertainties in the understanding and simulation of water quality in natural systems. For example, knowledge is incomplete regarding the exact nature and magnitude of pollutant loads from various sources and the specific impacts of those pollutants on the chemical and biological quality of complex, natural water bodies. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection.

A 1% IC Margin of Safety (MOS) was subtracted from the surrogate TMDL target to account for uncertainty in the analysis, resulting in a combined WLA and LA target of 9%. The goal of the TMDL is to reduce impacts from stormwater on the aquatic life in (upper) Swift and Williams Creeks.

WASTELOAD ALLOCATION (WLA) AND LOAD ALLOCATION (LA)

As previously discussed, there are no continuous NPDES wastewater discharges or permitted animal operations in this watershed. There are three intermittent NPDES permitted dischargers to the Swift Creek watershed. The Towns of Cary and Apex are regulated under Phase II NPDES Stormwater permits. NC Department of Transportation is regulated under a Phase I NPDES Stormwater permit. The WLA portion of this TMDL applies to these Phase I and II NPDES permits. There is one individual industrial stormwater permit issued in this watershed. There are also unincorporated areas of Wake County in this watershed (Figure 1).

Sufficient data from stormwater discharges are unavailable for each subwatershed. Stormwater discharges are highly variable in frequency and duration. It is reasonable to express allocations for NPDES-regulated stormwater discharges from multiple point sources as a single categorical wasteload allocation when data and information are insufficient to assign each source or outfall individual WLAs. This TMDL applies the surrogate 9% IC target to the stormwater drainage area affecting both regulated and non-regulated sources in this watershed.

To calculate the equivalent of % IC reductions required to achieve the TMDL target:

Equivalent of percent IC reduction = [(IC Current Condition – surrogate IC Target)/IC Current Condition)] x 100
where surrogate IC Target = 9%

The equivalent of percent IC reductions was calculated for each subwatershed. Subwatersheds were delineated by the Floodplain Mapping Project for catchments

ranging from 0.1 to 2 mi^2 in size. The subwatershed ID refers to the catchments identified in the 2005 EEP LWP report (see Appendix 3). The current condition (Appendix 4) was calculated from analysis of existing percent imperviousness using USEPA (1999) land cover GIS coverage for the EEP LWP, *Detailed Assessment and Targeting Management Report (NCEEP 2005)*. The range for the TMDL watershed is 40 – 77.5% equivalent IC reductions.

Achieving the equivalent %IC reductions will require mitigation of the adverse impacts of stormwater, including but not limited to reducing pollutant loading and reducing the volume of storm runoff. Such actions could include disconnecting IC, installing infiltration basins, eliminating illicit discharges, etc.

TMDL IMPLEMENTATION

EPA is not required to, and does not, approve TMDL implantation plans. This section is intended to provide some initial assistance for implementing this TMDL.

The linkage of the TMDL with the NPDES Stormwater Phase I and II permits will constitute a significant portion of the implementation. The goal of this TMDL is to reduce the effects of stormwater impacts to the receiving streams so that water quality standards for biological integrity are met. Attainment of such a standard is achieved when a benthic macroinvertebrate community sample receives a bioclassification of Not Impaired, Good-Fair or better. Compliance will be measured in the same three impaired assessment units referenced in the Introduction section of this document.

Implementation for this TMDL will best be accomplished through incorporating an adaptive management strategy for stormwater runoff. Such a strategy should include one or more of the following for new or existing development:

- Installing engineering BMPs to reduce the impacts of stormwater runoff from impervious areas.
- Minimizing additional disturbance to maintain existing natural buffering capacity
- Disconnecting impervious cover from the surface waterbodies to reduce peak flows and volumes of stormwater runoff.
- Reducing impervious cover.
- Adopting land use ordinances that require or allow Low Impact Development (LID) techniques or other non-structural best management practices.
- Detecting and eliminating illicit discharges.
- Developing an educational component and outreach program.

Affected entities may propose alternative measures that meet the intent of the TMDL.

Stormwater impacts include erosion and damage to instream aquatic habitat, a complex mix of pollutant loading, and lack of infiltration to provide stable base flow to streams. When the TMDL is implemented, stressors (scour and toxicity, for example) will be reduced or not delivered to the waterbody in the first place.

The waterbodies draining this watershed with greater than 9% IC are located in urbanized areas that are subject to the requirements of North Carolina's NPDES Phase II Stormwater permit. Several efforts for addressing stormwater runoff are currently in

a Stormwater Management Plan and ordinances approved by the DWQ. The plan includes educational and regulatory initiatives to ensure sound development. Ordinances approved by NCDENR and adopted by Cary and Apex address requirements for new development, illicit discharges detection and elimination, watershed protection, and sediment and erosion control. The Towns of Cary and Apex were issued NPDES Stormwater Permits, effective July 1, 2005. Under the NPDES permits stormwater runoff from new development that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale must be controlled and treated in accordance with the conditions of the permit and the Stormwater Management Plan. The permit and Stormwater Management Plan mandate:

1. A public education and outreach program on the impacts of stormwater discharges and how to reduce pollutants in stormwater runoff.
2. A public involvement and participation program.
3. A program to detect and eliminate illicit discharges within the jurisdictional area.
4. A program to reduce pollutants in any stormwater runoff from construction activities resulting from a land disturbance of greater than or equal to one acre.
5. A program to address post-construction stormwater runoff from new development that cumulatively disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale; and
6. A pollution prevention/good housekeeping program for municipal operations that addresses operation and maintenance, including a training component, to prevent or reduce pollutant runoff from those operations.

Cary and Wake County are subject to the Neuse River Basin –Nutrient Sensitive Waters Management Strategy: Basinwide Stormwater Requirements (15A NCAC 02B.0235). In addition, all local jurisdictions are required to meet the WS-III classification requirements that pertain to point/nonpoint sources and stormwater pollution control criteria for this watershed (15A NCAC 02B.0215).

Unincorporated areas of Wake County are encouraged to implement voluntary stormwater management practices to reduce the impacts from stormwater runoff in this watershed. Wake County developed a Stormwater Management Task Force charged with considering the environmental and fiscal benefits of a countywide collaborative stormwater program. In November 2007, a final report and implementation plan were produced which addressed managing stormwater runoff in a rapidly growing county through collaborative efforts with local governments.

Since implementation is expected to meet TMDL requirements at the compliance points (benthic macroinvertebrate sites), an ongoing biological monitoring program is critical in assessing the effectiveness of the implementation efforts. DWQ will continue monitoring the biological communities in this watershed to track TMDL implementation and attainment of water quality standards. This will be an iterative process to meet TMDL targets for attaining a bioclassification of Good-Fair or better at the compliance points.

This process is recognized as a lengthy process possibly spanning over multiple permit cycles.

IMPLEMENTATION RESOURCES

Resources are available for your review to assist in the implementation of this TMDL.

The *NC Division of Water Quality 2007 Stormwater BMP Manual* provides guidance for meeting stormwater regulations and designing stormwater BMPs that meet water quality objectives. The manual can be located here:
http://h2o.enr.state.nc.us/su/bmp_updates.htm

Additional guidance for restoring the impaired biological communities can be found in the NCEEP Swift Creek LWP (2005). The LWP can be found here:
http://www.nceep.net/services/lwps/Swift_Creek/Swift%20Creek.pdf

The Center For Watershed Protection has produced a series of Urban Subwatershed Restoration Manuals. The manuals provide comprehensive information on watershed restoration techniques by introducing an integrated framework for restoration and techniques for assessing urban watersheds. The manual series can be located here:
http://www.cwp.org/PublicationStore/USRM.htm

The North Carolina State University is developing a NC Low Impact Development Manual. The manual is intended to help building professionals, consultants and government staff with examples of BMPs from different ecoregions and successful case studies. The manual should be available in January 2009. It will be found here:
http://www.bae.ncsu.edu/programs/extension/wqg/.

REFERENCES

Cawthorn, J.W. 1970. *Soil Survey of Wake County North Carolina.* USDA Soil Conservation Service.

Center for Watershed Protection. 2003. *Impacts of Impervious Cover on Aquatic Systems.*

Connecticut Department of Environmental Protection. 2007. *A Total Maximum Daily Load Analysis for Eagleville Brook, Mansfield, CT.*–Final.

North Carolina Department of Environment and Natural Resources. Division of Water Quality. 2007. *Fresh Surface Water Quality Standards for Class C Waters, 15A NCAC 02B.0211.*

North Carolina Department of Environment and Natural Resources. Division of Water Quality. 2007. *Fresh Surface Water Quality Standards for Class WS-III Waters, 15A NCAC 02B.0215.*

North Carolina Department of Environment and Natural Resources. Division of Water Quality. 2007. *Neuse River Basin –Nutrient Sensitive Waters Management Strategy: Basinwide Stormwater Requirements, 15A NCAC 02B.0235.*

North Carolina Department of Environment and Natural Resources. Division of Water Quality. 2002. *Neuse River Basinwide Water Quality Plan.*

North Carolina Department of Environment and Natural Resources. Division of Water Quality. 2006. *Standard Operating Procedures For Benthic Macroinvertebrates.*

North Carolina Department of Environment and Natural Resources. Division of Water Quality. 2003. Watershed Assessment Restoration Program. Planning Branch. *Assessment Report: Biological Impairment in the Upper Swift Creek Watershed.* June.

North Carolina Department of Transportation. April 2008. *Stormwater Management Report.*

North Carolina Department of Transportation. July 2008. Upper Swift Creek Land Area Distribution GIS Analysis. Analysis based upon Upper Swift Creek Watershed Boundary, Town of Cary and Apex 2008 Parcel Coverage and NCDOT 2008 Upper Swift Creek Right-of-Way Boundary.

North Carolina Division of Water Quality. 2007. Stormwater Best Management Practices Manual.

North Carolina Division of Water Quality. 2006. Draft TMDL Water Quality Recovery Program Guidance Document.

North Carolina Ecosystems Enhancement Program. 2005. *Upper Swift Creek Local Watershed Plan.*

Schueler, T.R. 1994. *The Importance of Imperviousness.* Watershed Protection Techniques1, 100-111.

United States Environmental Protection Agency. 2005. *Estimating and Projecting Impervious Cover in the Southeastern United States.* EPA/600/R-05/061.

United States Environmental Protection Agency, Memorandum. 2002. *Establishing TMDL Wasteload Allocations (WLAs) for Stormwater Sources and NPDES Permit Requirements Based on Those WLAs.*

Wake County NC Government. 2008. *The Swift Creek Land Management Plan.* http://www.wakegov.com/planning/landuse/SwiftCreekLMP.htm

Appendix 1 - Land Use Trends in the Swift Creek Watershed

(Source: NC Ecosystem Enhancement Program Upper Swift Creek Local Watershed Plan 2005. Note: The TMDL watershed is only a subset of this larger watershed. See Figure 1 for TMDL watershed.)

Land use trends in the study area were analyzed using available land use and/or land cover data including the following:

- 1976 Land Cover Data from EPA
- 1996 Land Cover Data from EPA
- 1999 Land Use Data from EPA
- Future Land use based on zoning from the municipalities of Apex, Cary, Garner, Raleigh and Wake County.

The earliest land cover data set used for the analysis represents land cover for 1976. The land use distribution in 1976 (in order of dominance) in the watershed is as follows:
1) Woody Vegetation – 61%
2) Agriculture – 16%
3) Urban – medium density – 10%
4) Urban – high density – 8%
5) Water – 3%
6) Urban – low density – 2%
7) Wetlands – 1%
8) Barren – 0%

Based on the 1996 land cover data set, the land use distribution (in order of dominance) is as follows:
1) Woody Vegetation – 60%
2) Wetlands – 17%
3) Urban – medium density – 7%
4) Urban – high density – 5%
5) Agriculture – 4%
6) Urban – low density –6%
7) Water – 3%
8) Barren – 0.1%

Since the 1999 dataset was the most recent land use data available, it was selected to portray existing conditions in the watershed. The 1999 land use was developed from the Landscape Characterization Branch of EPA based on interpretation of SPOT 4 and Landsat 7 Satellite imagery from October of 1998 to October of 1999. In addition, this data set was utilized for the Wake County Watershed Management Plan in the following aggregated land use categories and associated imperviousness:

- Urban – high density (85% impervious)
- Urban – medium density (53%)
- Urban – low density (22.5%)
- Agriculture (2%)
- Woody Vegetation (1%)
- Water (0%)
- Wetlands (1%)

- Barren (1%)

The 1999 land use was selected as the baseline condition for existing land use, the other land use and land cover data sets required manipulation into the seven land use categories listed above for comparison purposes. The manipulation required assumptions to be made about the various land cover data sets based on land cover descriptions and associated imperviousness and aggregation into the seven land use categories. Because of this, the land use trends analysis has some limitations. However, for purposes of the local watershed plan and the TMDL, the analysis is useful.

Existing land use based on the 1999 data has the following distribution:
1) Woody Vegetation – 42%
2) Urban – low density –28%
3) Urban – medium density – 12%
4) Agriculture – 7%
5) Urban – high density – 4%
6) Wetlands – 3%
7) Water – 3%
8) Barren – 0.2%

Imperviousness is often used as an indicator of potential functional loss. Subwatershed scale imperviousness was calculated using average imperviousness percentages for each of the land uses. These percentages were applied to the existing land use classes to estimate the subwatershed scale imperviousness estimates shown in Appendix 3. Review of the red highlighted areas illustrates the "hot spots" of development in the watershed since red indicates an impervious increase. As suspected, there are red markings in the incorporated areas of the EEP study area (including Apex, Cary, Raleigh and Garner) as well as in areas along the major highways (including Highway 1, Highway 64, Highway 401 and Highway 70).

Future Land Use Projections

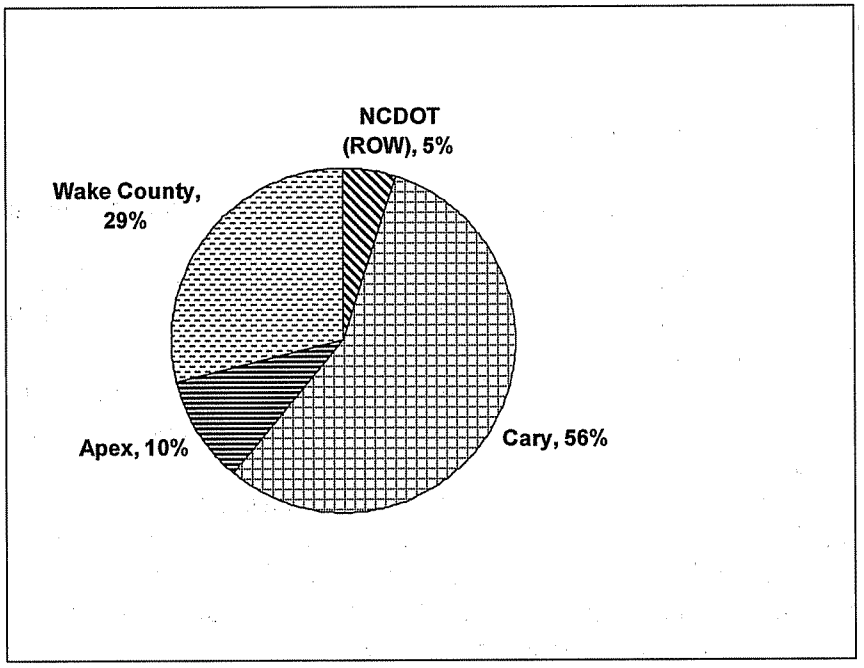
For the EEP study a separate Loading Simulation Program in C+ (LSPC) modeling system was developed to predict changes in hydrology and NPS loadings as the watershed reached its maximum development potential. The basis for the future conditions model was the parcel database and zoning coverages. These describe the boundaries of land parcels and define how they are currently intended to develop. While parcels can be rezoned, this approach provides a general understanding of how the county and local jurisdictions intend for areas within the watershed to develop. Preliminary efforts to develop the future land use coverage assumed that all parcels would be fully developed according to the allowed use. Some of the resource advisory committee members expressed an opinion that many currently developed parcels are not likely to be redeveloped or "in-filled." However, to assume that all parcels that have some type of structure on them would remain at their current development level would underestimate future conditions because larger lots in urban areas are likely to be subdivided as in-fill becomes an economically attractive option.

To balance these two extremes, the following rules were applied by Tetra Tech to generate revised future land use coverage:

• All areas currently identified as being vacant, agriculture, or farm will develop to the full extent allowed by the underlying zoning.
• All residential parcels greater than 0.5 acres will be considered as dividable and will develop to the full extent allowed by the underlying zoning. This rule does not apply to parcels identified as:
    o Apartment,
    o Golf Course,
    o Home Owners Association, or
    o Exempt.
• All other parcels will retain the current land use as described by the existing land use GIS coverage.
• The Medium Density Urban modeling class includes a mix of commercial and medium density residential zoning classes. The 1990 Swift Creek Land Management Plan (LMP), however, caps imperviousness for residential areas at 30 percent in the non-critical area. All residential parcels less than 40,000 sf in the non-critical areas, as defined by the Swift Creek LMP, were therefore assigned to the Low Density Urban class (15 percent - 30 percent imperviousness).
• Non-residential parcels outside of downtown areas were assigned an imperviousness of 50 percent. This level of impervious was calculated based on existing levels of commercial and industrial development in the watershed. It is assumed that these areas will be developed to the maximum allowed. Therefore, non-residential will be reassigned to the High Density Urban class (70 percent impervious).
• The R-40W zoning class will be assigned to the Very Low Density modeling class. While higher impervious is allowed under the Swift Creek Land Management Plan, comments indicated that development will not exceed the 15 percent limit above which stormwater controls would be required.
• Aggregate zoning classifications, such as Planned Development District, were classified based on average imperviousness characteristics. Where available, more detailed parcel level equivalent zoning information will be used to provide a better spatial distribution of the proposed land uses.

The land use trends analysis including the analysis of associated imperviousness , the analysis of potential pollution sources and information on hydrologic alterations were utilized to complete the assessment. For example, subwatersheds with over 25% overall imperviousness were indicated for having urban and rural development as causes of pollution. In addition, subwatersheds containing large impoundments or just downstream of large impoundments were indicated as having hydrologic alterations. Based on the available data and the analysis of causes and sources of problems on a subwatershed basis, the primary cause of problems was increased imperviousness associated with urban and rural development.

Appendix 2 – Upper Swift Creek Land Area Distribution



Upper Swift Creek Land Area Distribution (Source: NCDOT July 2008)

Stormwater from Apex, Cary and NCDOT is conveyed to streams through the NPDES regulated Municipal Separated Storm Sewer System (MS4). Apex and Cary manage traditional parcel based MS4s, while NCDOT manages a non-traditional linear system. The differences between parcel MS4s and linear MS4s affect how pollutants are delivered and managed. Specific differences include the following:

- Land Management and Control
- Pollutant load, source, fate and transport
- Maintenance activities
- Hydromodification

(NCDOT April 2008)

Appendix 3 – Existing Percent Imperviousness by Subwatershed for the Entire Upper Swift Creek Watershed

(Source: NC Ecosystem Enhancement Program Upper Swift Creek Local Watershed Plan 2005. Note: The TMDL watershed is only a subset of this larger map, see Figure 1 for TMDL watershed.)

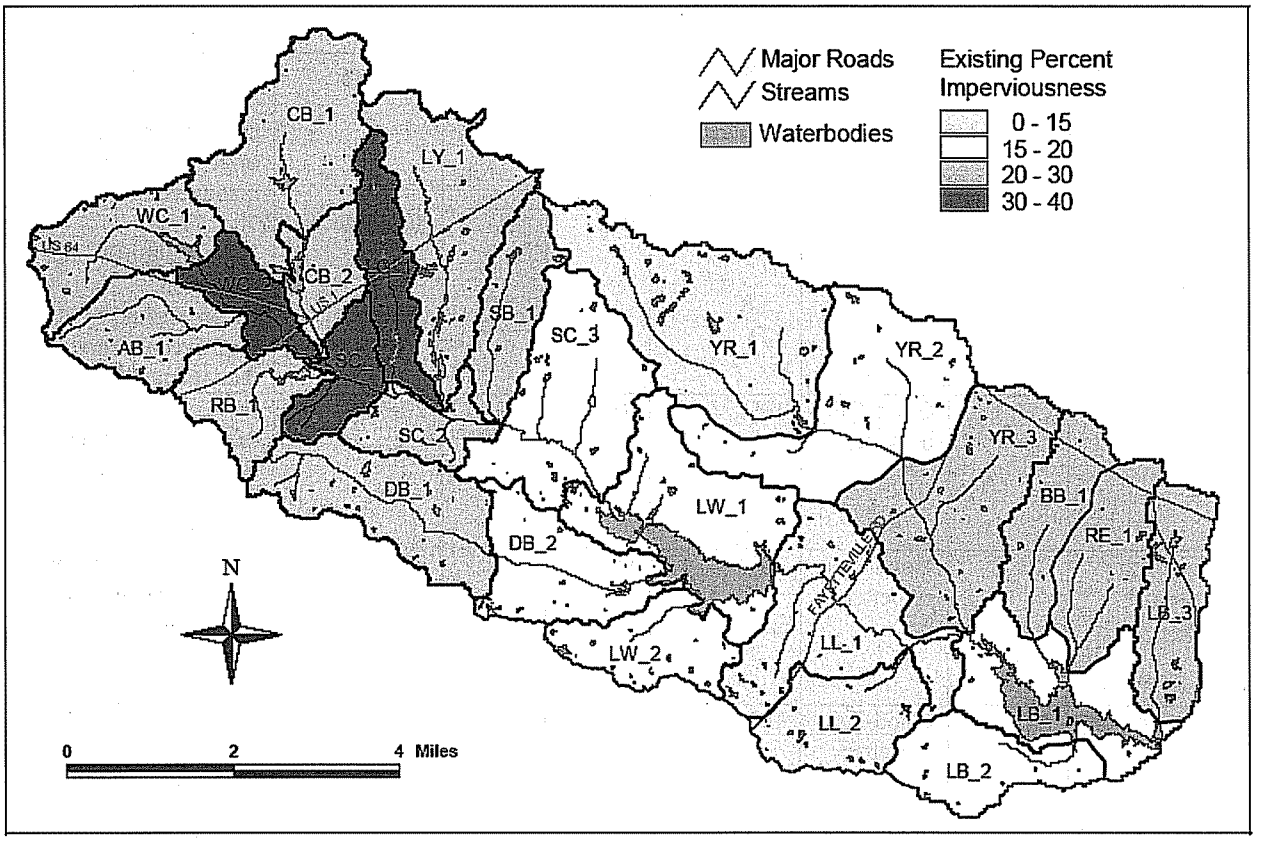


Figure 3-3. Estimated Existing Imperviousness

Appendix 4 – TMDL Targets, Surrogate Targets, and Equivalent Percent Reductions for Upper Swift Creek TMDL Watershed **

Waterbody Name+	Sub-water-shed ID+	TMDL Target Bioclassi-fication	Percent Impervious Cover				Equivalent % Reduction ++
			TMDL Surrogate Target	WLA and LA*	MOS*	Current Condition+	
Upper Williams Creek	WC_1	Good-Fair or better	10%	9%	1%	20-30%	55 – 70% Equivalent of % IC reduction accomplished by improved stormwater management.
Lower Williams Creek	WC-2	Good-Fair or better	10%	9%	1%	30-40%	70 – 77.5% Equivalent of % IC reduction accomplished by improved stormwater management.
Upper Cary Branch	CB_1	Good-Fair or better	10%	9%	1%	20-30%	55 – 70% Equivalent of % IC reduction accomplished by improved stormwater management.
Lower Cary Branch	CB_2	Good-Fair or better	10%	9%	1%	20-30%	55 – 70% Equivalent of % IC reduction accomplished by improved stormwater management.
Apex Branch	AB_1	Good-Fair or better	10%	9%	1%	20-30%	55 – 70% Equivalent of % IC reduction accomplished by improved stormwater management.
Regency Branch	RB_1	Good-Fair or better	10%	9%	1%	20-30%	55 – 70% Equivalent of % IC reduction accomplished by improved stormwater management.
Swift Creek Hemlock Bluffs	SC_1	Good-Fair or better	10%	9%	1%	30-40%	70 – 77.5% Equivalent of % IC reduction accomplished by improved stormwater management.
Swift Creek Lochmere GC	SC_2	Good-Fair or better	10%	9%	1%	20-30%	55 – 70% Equivalent of % IC reduction accomplished by improved stormwater management.
Long Branch	LO_1	Good-Fair or better	10%	9%	1%	30-40%	70 – 77.5% Equivalent of % IC reduction accomplished by improved stormwater management.

Lynn Branch	LY_1	Good-Fair or better	10%	9%	1%	20-30%	55 – 70% Equivalent of % IC reduction accomplished by improved stormwater management.
Speight Branch	SB_1	Good-Fair or better	10%	9%	1%	20-30%	55 – 70% Equivalent of % IC reduction accomplished by improved stormwater management.
Swift Creek u/s Wheeler	SC_3	Good-Fair or better	10%	9%	1%	15-20%	40 – 55% Equivalent of % IC reduction accomplished by improved stormwater management.

** Subwatershed ID are catchments contained in the TMDL watershed. See Figure 1 for TMDL watershed.

+ *Source: NCEEP Swift Creek LWP (2005) Figure 3-3, Estimated Existing Imperviousness*

*WLA and LA = Surrogate Target - MOS
WLA = Wasteload Allocation
LA = Load Allocation
MOS = Margin of Safety.

++ Equivalent of %IC reduction means actions that mitigate the adverse impacts of stormwater, including but not limited to reducing pollutant loading and reducing the volume of storm runoff. Such actions could include disconnecting IC, installing infiltration basins, eliminating illicit discharges, etc.

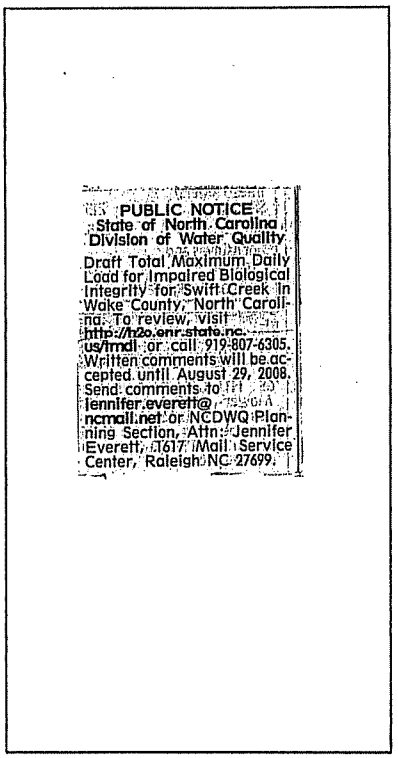
ATTACHMENT A

Public Notice
A public notice was posted to the DWQ TMDL website and notice was sent to a mailing list of interested parties.

Notice was also posted in the Raleigh NC News and Observer newspaper. The Affidavit of Publication is provided below.

AFFIDAVIT OF PUBLICATION

NORTH CAROLINA.
Wake County.) Ss.

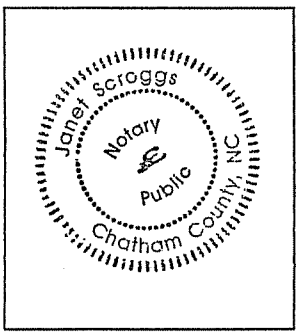


PUBLIC NOTICE
State of North Carolina
Division of Water Quality
Draft Total Maximum Daily Load for Impaired Biological Integrity for Swift Creek in Wake County, North Carolina. To review, visit http://h2o.enr.state.nc.us/tmdl or call 919-807-6305. Written comments will be accepted until August 29, 2008. Send comments to jennifer.everett@ncmail.net or NCDWQ Planning Section, Attn: Jennifer Everett, 1617 Mail Service Center, Raleigh NC 27699.

Before the undersigned, a Notary Public of Chatham County North Carolina, duly commissioned and authorized to administer oaths, affirmations, etc., personally appeared Debra Peebles, who, being duly sworn or affirmed, according to law, doth depose and say that she is Billing Manager-Legal Advertising of The News and Observer a corporation organized and doing business under the Laws of the State of North Carolina, and publishing a newspaper known as The News and Observer, in the City of Raleigh , Wake County and State aforesaid, the said newspaper in which such notice, paper, document, or legal advertisement was published was, at the time of each and every such publication, a newspaper meeting all of the requirements and qualifications of Section 1-597 of the General Statutes of North Carolina and was a qualified newspaper within the meaning of Section 1-597 of the General Statutes of North Carolina, and that as such she makes this affidavit; that she is familiar with the books, files and business of said corporation and by reference to the files of said publication the attached advertisement for NC DIVISION OF WATER QUALITY was inserted in the aforesaid newspaper on dates as follows: 07/29/08

Account Number: 73350833

The above is correctly copied from the books and files of the aforesaid Corporation and publication.



Debra Peebles, Billing Manager-Legal Advertising
Wake County, North Carolina

Sworn or affirmed to, and subscribed before me, this 30 day of JULY , 2008 AD ,by Debra Peebles.

In Testimony Whereof, I have hereunto set my hand and affixed my official seal, the day and year aforesaid.

Janet Scroggs, Notary Public

My commission expires 14th of March 2009.

ATTACHMENT B

Public Comment

The public comment period extended from July 29, 2008 through August 29, 2008. Comments were received from eight entities:
Neuse River Foundation, Wake County, City of Greensboro, City of Durham, Town of Cary, NC Department of Transportation, Upper Neuse River Basin/Triangle J. COG, and US Environmental Protection Agency. These comments with NC Division of Water Quality responses are provided below.

Meetings

In addition, the following meetings were held with the affected MS4s:

- Town of Cary and Town of Apex (jointly) on May 29, 2008
- NC Department of Transportation on May 27, June 17, and July 23, 2008
- Town of Cary on September 26, 2008

Other meetings were held with interested parties:

- Cities of Durham, Raleigh, Greensboro and Charlotte (jointly) on September 25, 2008
- Wake County on September 30, 2008.

Swift Creek TMDL Responsiveness Summary

1). One comment - Supports using the NC Watershed Assessment Restoration Program and NCEEP Local Watershed Program stressor identification process to identify potential causes of impairment.
Response: Thank you for your support.

2). One comment - In the TMDL report, DWQ does not clearly state whether it is actually citing the March 2003 publication by the Center for Watershed Protection (CWP) as the basis for their selection of 10% maximum built upon area.
Response: We have revised the text for clarification.

3). One comment - Throughout the TMDL report, DWQ implies that NPDES permitted dischargers do not need to comply with the 9% Impervious Cover WLA. Permit compliance will be indeterminate if there is not a method to comply with the WLA.
Response: The goal of this TMDL is to achieve a bioclassification of Good-Fair or better, not necessarily to achieve the surrogate target. In the TMDL, impervious cover is used as a surrogate target. We anticipate that a variety of management approaches, such as disconnecting 'hot spots' and installing bioretention structures, may move the stream closer to the water quality target than documenting the current and future extent of impervious cover. Through the MS4 permit process the Division will work with permitees to further clarify compliance expectations.

4). One comment - The TMDL does not list a specific source of pollution to track but a list of surrogates that all combined may lead to the impairment of Swift Creek.
Response: There is a list of stressors (not surrogates) in the TMDL. Because the impairment cannot be attributed to a specific pollutant, impervious cover (IC) was used as a surrogate measure of the complex array of stressors associated with stormwater. There are several citations in the Federal Regulations that support the use of surrogate measures and biocriteria for TMDL development. For example, 40 CFR §130.2-(i) states "TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure." In addition, 40 CFR §130.7 (c)(1)(i) states "TMDLs may be established using a pollutant-by-pollutant or biomonitoring approach."

5). Two comments - Water Supply rules were adopted in 1993 and the Neuse Buffer rules were adopted in 1997. Stormwater management is required in Phase I and II permits. One commenter would like to further study and model the effects that our current ordinances have on the stream.
Response: The Water Supply and Neuse Rules were not aimed at restoring biological integrity and do not address existing development. Further studying and modeling could be appropriate first steps for the commenter to evaluate the rules' effectiveness.

6). Two comments - The 9% (10% WLA/LA - 1 % MOA) impervious cover target does not appear to be necessarily related to a site-specific surface water condition in Swift

Creek. The commenters question how addressing such a surrogate target can guarantee or prove that if achieved, the biological community will attain a rating of "good-fair" or better. Furthermore, the TMDL states that a literature review was utilized in establishing the surrogate target based on recommendations from research in other regions of the country.
Response: The surrogate target was based on work done in NC. According to 'Estimating and Projecting Impervious Cover in the Southeastern United States' (USEPA 2005), degraded benthic community sites are evident as impervious area increases. Specifically, of sites in North Carolina with a total impervious area greater than 10%, 62% were degraded. In contrast, 90% of sites with less than 10% IC were not degraded. The TMDL has been revised for clarification. The goal of this TMDL is to achieve a bioclassification of Good-Fair or better, not necessarily to achieve the surrogate target.

7). Two comments - Page 5. NCDWQ should add the appropriate text describing the existing water quality data for upper Swift Creek and Williams Creek, particularly those data that support the 303(d) listing. A map showing the locations of monitoring data should also be included.
Response: Water quality information is given in the 'Pollutant Source Assessment' section of the report. Figure 1 in the report is a map showing monitoring locations.

8). One comment – In summarizing the existing regulatory mandates in the Swift Creek Watershed, the Report does not reference the Swift Creek Land Management Plan (SCLMP) and Performance Standards, which are mandated by the State. Jurisdictions subject to the SCLMP cannot approve any development inconsistent with plan. We would like to receive information from NCDENR as to whether or not the SCLMP performance standards meet, exceed, or are in conflict with the proposed standards of the TMDL
Response: The SCLMP is referenced on page 21 in Appendix 1. The SCLMP standards are consistent with the TMDL, but may not be sufficient to bring the impaired streams into compliance with instream standards for biological integrity. The SCLMP was not aimed at restoring biological integrity. An adaptive management approach is appropriate.

9). One comment - We are committed to preserving, restoring and maintaining the biological, chemical, and physical integrity of our streams. We want to be certain that NCDENR works with us to discover and evaluate all of the known and unknown impacts associated with using the TMDL process in this manner.
Response: DWQ looks forward to working with you beginning with our meeting on September 30, 2008. Thank you for your commitment.

10). One comment - A limitation of 9% built upon area represents the strictest land use control measure DWQ has ever proposed in NC. This limitation imposed on twelve subwatersheds of upper Swift Creek will have profound repercussions on existing local land use plans, existing zoning ordinances, and land development patterns.
Response: Impervious cover is a surrogate measure in this TMDL. DWQ is not proposing to limit land use to 9% built-upon area. Rather, disconnecting 'hot spots' and

installing bioretention structures (see TMDL Implementation section in the report) are expected to mitigate adverse stormwater impacts and move the stream closer to the water quality standard. This is expected to be more effective than documenting the current and future extent of impervious cover.

11). One comment - It is not clear why Williams Creek is listed in Category 5 of the draft 2008 303(d) List due to impaired biological integrity.
Response: The commenter correctly notes that the Williams Creek was originally based on 1989 monitoring and that subsequent monitoring yielded a Not Rated bioclassification. In August 2001 DWQ began rating small streams as Not Impaired if they would be given at least a Good-Fair bioclassification using the criteria derived for larger streams, and Not Rated if they would be given a Fair or Poor bioclassification. Williams Creek has not yet achieved a Not Impaired bioclassification; therefore, it cannot be removed from the 303(d) list.

12). One comment - The TMDL document essentially establishes a water quality standard for impervious cover and is an invitation to third-party challenges of local approval of any development project in a TMDL watershed.
Response: TMDLs do not establish water quality standards (WQS). TMDLs are designed to establish approaches to meet existing WQS. The applicable water quality standard for this TMDL is the narrative for Class C waters (see TMDL report page 4). In this TMDL, impervious cover is simply a surrogate measure. This TMDL's WLA will be implemented through NPDES Stormwater permits. These permits contain additional requirements for development of recovery plans associated with areas having approved TMDLs. Compliance with these permits and the plans developed will constitute compliance with the TMDL. The TMDL states that it is expected that the process to meet the targets will be iterative and possibly lengthy.

13). One comment – suggested adding text that explicitly describes the wasteload allocation for NPDES permittees.
Response: The text has been revised for clarification.

14). Two comments - The TMDL uses a target of 10% impervious cover and is not associated with a numeric water quality standard as provided in 15A NCAC .02B.
Response: The applicable water quality standard for this TMDL is the narrative for Class C waters (see TMDL report page 4). 40 CFR §130.7 (c)(1) states "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards..." Since the impairment cannot be attributed to a specific pollutant, impervious cover (IC) was used as a surrogate measure of the complex array of stressors associated with stormwater that impact aquatic life.

15). One comment - The TMDL should contain a Wasteload Allocation (WLA) for permitted stormwater.
Response: The TMDL does contain a WLA for permitted stormwater. The text has been revised for clarification.

16). One comment - The TMDL as it is currently written will not be adaptable to the NPDES Stormwater Permit TMDL language in its current form. The permit will have to be reworded to include the requirements of this TMDL.
Response: The DWQ Stormwater Permitting Unit will work with permittees to assess the need for any potential modifications or clarifications in the permit language.

17). One comment - Page 15, 2nd paragraph. The TMDL must include an explicit description of the compliance point, both spatially and in terms of measurement endpoint. The TMDL document states the following: "Since implementation is expected to meet TMDL requirements at compliance points (benthic macroinvertebrate sites), an ongoing biological monitoring program...." However, the TMDL document never provides an actual compliance point.
Response: The document has been revised for clarification.

18). One comment - NCDWQ has ignored North Carolina studies by NC State University and NCDWQ staff that indicate percent imperviousness is not a good predictor of the NC IBI.
Response: The NCEEP Local Watershed Plan for Upper Swift Creek (2005) concludes that imperviousness and associated runoff are the primary sources of degradation in this particular watershed. The study the commenter refers to has not been published; however, the data were forwarded to EPA for use in their report (USEPA 2005); see response to comment #6. Preliminary analysis of study results from the NC Piedmont ecoregion presented at the 2006 WRRI conference suggest that impacts can occur at IC levels less than 10%; however, 90% of sites with less than 10% IC were not degraded. The unpublished study concluded that there is no evidence for a "safe zone" of no impact at low imperviousness. Substantial impacts can occur even at low levels of urbanization. The analysis did not show a breakpoint below which there was no degradation; however, the graphs presented did show a higher rate of degradation with increased IC. This is consistent with other research.

19). One comment - DWQ establishes a 1% Margin of Safety (MOS) through the following sentence on p. 12: "1 % IC Margin of Safety (MOS) was subtracted from the TMDL target to account for uncertainty in the analysis, resulting in a combined WLA and LA target of 9%." The commenter requests that more information be provided regarding the 1% IC MOS.
Response: All TMDLs have to include an implicit or explicit MOS, (EPA Guidance, May 2002). There are numerous TMDLs for NC with an explicit MOS.

20). One comment - Implementation would include retrofitting existing impervious areas to reduce the impacts of stormwater runoff. This would involve the purchasing of private land and installing and maintaining engineered BMPs. This would be an undue burden. We would like to know what authority we have that would allow us to do this for retrofitting purposes.
Response: We recognize that any approach to water quality improvement that requires management changes in existing areas creates implementation challenges. That is why the TMDL document notes the need for an iterative process that may take a long period

of time for implementation. The Division's approach in this process will be to allow entities to develop a recovery plan that is effective and that is also reasonable. Over time we anticipate that management alternatives in these areas will increase/improve and we anticipate that implementing agencies will effectively adapt their management strategies to utilize the most effective approaches. While the TMDL confers no additional authority to local entities for implementation, we do believe that there are authorities available that allow local entities to select and prioritize stormwater management practices today that can begin this process. This could include identifying public lands for stormwater controls, looking at stormwater provisions for redevelopment, or utilizing innovative approaches to reuse or otherwise reduce stormwater runoff.

21). One comment - Some of the compliance points chosen for the TMDL incorporate more than one MS4 jurisdiction. We would be relying on another entity to show compliance at points within our jurisdiction.
Response: It is true that the compliance points for the TMDL are not entirely within a single MS4's jurisdiction. All MS4 permits include a requirement to implement an approved TMDL. We strongly encourage adjoining jurisdictions to work together in this process. We also realize that individual entities will be interested in their specific compliance and the Division anticipates that for each permittee adherence to their final recovery plan will establish their compliance

22). One comment - Swift Creek has been on the 303(d) since 1998. The 1998 303(d) List reports *sediment* as the cause of impairment. Establishing a TMDL based upon sediment may provide a more scientific basis than the existing IC method.
Response: Studies conducted since 1998 by the NC Watershed Assessment and Restoration Program (2001) and NC Ecosystems Enhancement Program (2005) on the Upper Swift Creek watershed indicate that stormwater runoff is the primary stressor.

23). One comment - Page 5. The TMDL should include additional text regarding the use of biological integrity as a suitable basis for TMDL development.
Response: More information can be found in the 'Pollutant Source Assessment' section of the report.

24). One comment - This TMDL could require the commenter to acquire an excessive amount of right-of-way area to comply with the 9% built upon area waste load allocation.
Response: The Division appreciates the challenges that go along with stormwater management initiatives in existing areas. The TMDL language and permitting approach attempt to recognize that there may be multiple ways for entities to meet the intent of the TMDL, not just one single approach as noted in the comment. Through the development of your plan required by your stormwater permit, you will have the opportunity to work with the Division to target the most appropriate approach for your jurisdictional area.

25). One comment - Revise the statement reading "...no single pollutant or group of specific pollutants have been identified as the cause of impairment in the watershed." The 2004 Integrated Report (NCDWQ 2006) states the following regarding Upper Swift Creek: "Toxic impacts, scour, habitat degradation due to limited microhabitat,

hydromodification due to impoundments, and organic/nutrient enrichment are all considered to be stressors that cumulatively cause impairment of biological integrity."
Response: We did not find the quoted statement in the 2004 Integrated Report; however, that information appears to be from the WARP study referenced in this TMDL. DWQ used the findings from the WARP Upper Swift Creek (2001) study and the NCEEP Swift Creek Local Watershed Plan (2005) to develop this TMDL. Multiple stressors have been identified in these studies; however, the primary mechanism causing the impairments is stormwater runoff, not a pollutant. See the 'Stressor Identification' section in the TMDL.

26). One comment - DWQ does not provide the technical basis in the TMDL report for why 12 TMDLs are required to restore the biological integrity of the upper Swift Creek watershed. Consideration should be given to one TMDL, with its compliance point set at the reoccurring basin wide monitoring site at SR 1142 on Swift Creek.
Response: We elected to present the more detailed information on current estimated impervious cover rather than combining that information. If presented as one overall reduction for the watershed, we would have to use the highest percent reduction of 77.5%.

27). Four comments - Revise the Swift Creek TMDL to replace the land management TMDL target with an instream TMDL target.
Response: The TMDL target is a surrogate for the instream TMDL bioclassification goal. This is consistent with 40 CFR §130.2-(i) ("TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.") and 40 CFR §130.7 (c)(1)(i) ("TMDLs may be established using a pollutant-by-pollutant or biomonitoring approach").

28). One comment - Encouraged the NC DWQ to follow through with the efforts to restore this water body to a level which removes it from the NC 303(d) list of impaired waters. The data that has already been collected appears to be sufficient to warrant the beginning of implementing management practices designed to mitigate the effects of stormwater runoff.
Response: Thank you for your support.

29). One comment - The TMDL states that the implementation of such a target would be accomplished through NPDES Phase I & II permits utilizing various stormwater management activities to mitigate the effects of stormwater runoff on receiving waters. As stated in the document, the correlation between land use within the watershed (the hydrology and geology), the instream habitat structure (the biology), and the chemical water quality of the site specific surface water in question (the chemistry), and the resulting quality of the biological community is exceedingly complex and variable. Targeting only impervious cover to address biological integrity is limiting at best.
Response: The goal of the TMDL is to mitigate the effects of stormwater runoff through stormwater management, not documenting the current or future extent of impervious cover. The studies done in this particular watershed clearly indicate that stormwater runoff from impervious areas is having an adverse impact on the biological community.

30). One comment - Expressed support for the biological performance standard approach utilized in the draft Swift Creek TMDL. The commenter also supports the use of impervious cover as a surrogate measure in instances like this where urban runoff is the suspected source. Utilizing a performance standard based on biotic indices closely linked to the impairment determination is a great way to both allow the TMDL parties flexibility in addressing the impairment while verifying the effectiveness of the TMDL over time. With a stressor as complex and varied as urban stormwater runoff, this approach will prove more efficient, more achievable, and ultimately more effective in redressing the impacts on water quality wrought by development. The Swift Creek TMDL for biological integrity is a big step in the right direction.
Response: Thank you for your support.

31). One comment – One commenter requests that DWQ explain the criteria for assigning NCDOT the label of significant contributor of pollutants. Appendix 2 identifies that NCDOT land area comprises 5% of the watershed.
Response: The NCDOT's largely impervious MS4 area extends throughout the watershed and intersects Williams and Swift Creek multiple times; therefore, it must be considered a significant contributor. NCDOT provided the information in Appendix 2 after reviewing an early draft, and asked for it to be used in the TMDL document.

32). One comment - The Swift Creek TMDL does not address instream toxicity.
Response: This TMDL does not address toxicity because the watershed is not impaired for any toxics and no specific toxic substances have been identified as agents causing biological impairment. The NC Ecosystems Enhancement Program's '2005 Swift Creek Detailed Assessment and Targeting of Management Report' states (page 1-5), "The preliminary analyses provided the necessary information needed to identify the primary sources of functional loss within the watershed. Nonpoint source pollution and urbanization/imperviousness appear to be the primary sources of functional loss..."

33). One comment - The use of a surrogate target such as impervious cover could be, in our opinion, completely transferable across watersheds with little or no modification. The precedent this sets for all urbanized communities throughout the state where the vast majority of waters are biologically impaired is alarming.
Response: This approach and target would not necessarily be used in every urbanized community across the state. The surrogate target was based on work done in the Piedmont of NC. We would be willing to consider other targets, surrogate targets, and non-TMDL approaches in other watersheds.

34). Three comments - The 10% Impervious Cover TMDL target is not sufficiently justified.
Response: The relationship between impervious cover and degraded benthic community is well established. See Center for Watershed Protection (2003). According to 'Estimating and Projecting Impervious Cover in the Southeastern United States' (USEPA 2005), degraded benthic community sites are evident as impervious area increases. Specifically, for sites in North Carolina with a total impervious area greater than 10%,

62% were degraded. In contrast, 90% of sites with less than 10% IC were not degraded. The TMDL has been revised for clarification.

35). Two comments – One commenter questions the use of 1999 land use data as the basis for the surrogate target calculation.
Response: Wake County parcel coverage was also obtained in January 2005 to determine parcels that had been developed since 1998. See existing land use section in the TMDL.

36). One comment - Add text that reflects "states have the authority to create more achievable standards for nonsupporting streams within the regulatory framework of the Clean Water Act."
Response: We do not have evidence that a use attainability analysis is appropriate for this watershed. We believe aquatic life uses can be supported.

37). One comment - Further monitoring of the waters of Swift Creek, while providing continued data on the biological condition of the creek, will not put an end to the problem.
Response: The TMDL WLA will be implemented through the NPDES Stormwater Phase I and II permits. DWQ's continued monitoring will ensure that permit requirements contribute to attainment of the water quality standard.

38). One comment - We modified our stormwater ordinance in 2006. These changes were adopted to specifically address stream degradation issues.
Response: We applaud your efforts. We have modified the implementation portion in the TMDL document to reflect your efforts.

39). One comment - The "TMDL Surrogate Targets" do not provide NPDES permittees with a mechanism to measure individual compliance with their WLA. The Swift Creek TMDL report does not provide any "Surrogate WLAs" or any methodologies for calculating an alternative to the 9% impervious cover WLA. Rather, DWQ seems to advocate that the 70-77.5% change between existing and future target imperious cover could be *accomplished by improved stormwater management.* DWQ provides no quantitative association between *improved stormwater management* and percent change in impervious cover. Therefore, even if an NPDES permittee was seeking an alternative to their 9% impervious cover WLA, the permittee would have no means of crediting their improved stormwater management measures implemented.
Response: The intent of the TMDL and Division permitting process for Swift Creek is to recognize the ultimate goal of reaching the Good-Fair or better bioclassification. The Division intends that multiple approaches may be used by affected entities to get to this point. We have attempted to clarify language in the document to address this issue.

40). One comment - The TMDL document must provide a spatial description of the compliance point that justifies the extent of the proposed TMDL.
Response: The TMDL has been revised for clarification.

41). Two comments - NCDWQ should revise the TMDL and TMDL target to reflect site-specific conditions.
Response: The TMDL report contains a great deal of site-specific information, including impervious cover estimates. Implementation of the TMDL will be based on site-specific information as well. The TMDL target is a surrogate measure that will not be used to evaluate TMDL success. It was based on NC Piedmont bioassessments (see response to comment #6). The commenters did not suggest an alternative, more site-specific TMDL target.

42). One comment - Supports and encourages the use of the Impervious Cover Method, and commends staff for their efforts in developing these TMDLs.
Response: Thank you for your support.

43). One comment - Throughout the TMDL report, DWQ implies that an optional alternative to the 9% impervious cover is available in the form of a "TMDL Surrogate Target." Additionally, the upper range surrogate target value of 75% for subwatersheds WC-1, CB-1, CB-2, AB-1, RB-1, SC-2, LY 1, and SB 1 is not consistent with the formula on p. 13. The value based on the formula on page 13 should be 70%.
Response: The percent reduction is not intended to be an optional alternative to the 9% impervious cover surrogate, but is rather a calculation of the difference between the current impervious cover and the surrogate IC target. Percent reductions are a common component of TMDLs. We have corrected and revised text in the TMDL.

44). One comment – The TMDL is not expressed in terms of a maximum daily load. EPA issued guidance regarding the 2006 District of Columbia Circuit Court of Appeals decision requiring all TMDLs include daily limits so as to be consistent with the TMDL provisions of the Clean Water Act. The guidance and the judicial interpretation of the TMDL provisions make it more difficult to use the surrogate limit of impervious surface as has been done in this TMDL.
Response: Percent impervious cover serves as a surrogate measure of the complex mixture of pollutants transported by stormwater. The expression of percent impervious cover as a surrogate TMDL target, as well as the TMDL goal bioclassifcation of Good-Fair or better, are useful for stormwater-impaired waters because they are applicable at all times, whether the time step is instantaneous, hourly, daily, weekly, monthly, seasonally or annually.

45). One comment - Figure 1 in the TMDL report illustrates the locations of benthic monitoring sites and identifies them as the TMDL compliance points. Compliance monitoring points should align with the 12 TMDL subwatersheds.
Response: Estimated current impervious cover information was only available by these 12 subwatersheds. Because the benthic macroinvertebrate sites were used to identify impairment they must also be used to identify improvement.

46). One comment - The Swift Creek TMDL does not properly apply the November 2002 USEPA memorandum cited on page 3 and inappropriately applies a single WLA and load

allocation (LA) to the watershed. DWQ has not established separate WLAs to NPDES-regulated stormwater dischargers in the upper Swift Creek watershed.
Response: We have correctly interpreted EPA's 2002 memo. EPA recommends expressing the wasteload allocation in the TMDL as either a single number for all NPDES-regulated storm water discharges, or when information allows, as different WLAs for different identifiable categories. In this case, information was not available to establish separate WLA numbers. EPA Region 4 and Headquarters (Washington D.C.) concur with our interpretation.

47). One comment - The Swift Creek TMDL extends beyond the impaired segment of upper Swift Creek to include Supporting or Not Rated sub-watersheds draining directly to Lake Wheeler.
Response: This TMDL does not include subwatersheds that drain directly to Lake Wheeler. The TMDL is meant to address the watershed draining to and including AU # 27-43-(1)a, 27-43-(1)b and 27-43-2. This TMDL watershed is depicted in Figure 1 in the TMDL.

48). Two comments - NCDWQ should reconcile the use of an impervious cover TMDL target with the multiple presentations provided for the Universal Stormwater Management Program that discourage the use of percent impervious cover as a management tool.
Response: Percent impervious cover is not a management tool for this TMDL but rather a surrogate measure of the complex array of stressors associated with stormwater that impact aquatic life. The TMDL is focused toward actions that will restore the waters as well as protect for future impacts. The Universal Stormwater Management Program (USMP) addresses only new development and does not include components for existing development areas so it isn't accurate to compare the intended results of the two approaches. It is true that the USMP places clear focus on stormwater management for all new development, regardless of impervious level.

49). One comment - The document should contain an Executive Summary.
Response: The document is brief. We don't believe an Executive Summary is needed.

50). One comment - The NCDWQ web site should contain a link to the WARP and LWP studies for quick reference.
Response: These will be added to the DWQ website.

Several comments were received regarding reorganization of material in the document. Several comments were received concerning punctuation, spelling, and grammar. Errors were corrected.