CHAPTER 4: WATER QUALITY

A. Introduction

Most of the water quality related aspects of the Town's stormwater program are driven by State and Federal regulations. The Town has established a number of comprehensive ordinances, sometimes proactively, to address the requirements (See Section 2B). As part of its stormwater program, the Town maintains detailed databases recording citizen concerns and the Town's responses. Most stormwater related concerns reported by citizens are related to flooding or damaged infrastructure. Relatively few of the concerns are directly related to water quality, which can be considered a measure of the effectiveness of the Town's stormwater program related to water quality. Section 4B summarizes infrastructure related issues that affect water quality. State and Federal stormwater regulations are constantly changing, and the Town intends to remain proactive in addressing future stormwater quality needs and requirements. As part of the Stormwater Master Plan, potential future stormwater requirements and regulatory trends anticipated from DWQ and USEPA are examined. A detailed description of these trends is provided in Section 5A with recommended actions by the Town to address or prepare for such requirements. Additionally, a number of potential BMP retrofit sites were identified and evaluated as part of this study and are included in Section 5C, as a part of meeting State and Federal requirements as well as the Town's stormwater quality goals. This Chapter summarizes important aspects of the Town's stormwater quality program.

B. Infrastructure Assessment Related to Water Quality

Water quality related issues discussed in this Section mostly relate to sedimentation and erosion and pollution from illicit discharges. The Town utilizes a GIS database to track citizen questions and concerns regarding stormwater issues. From December 2001 to September 2011, the Town complaint database registered 1,089 reports regarding stormwater infrastructure. Two hundred of those reports, approximately 20%, were related to water quality. These reports are categorized into four main groups: construction work, erosion, stormwater infrastructure, and illicit discharge.

Table 4.1 - Water Quality Reports (2001-2011)

Type	# of Reports
Construction Work	36
Erosion	99
Stormwater Infrastructure	35
Illicit Discharge	30

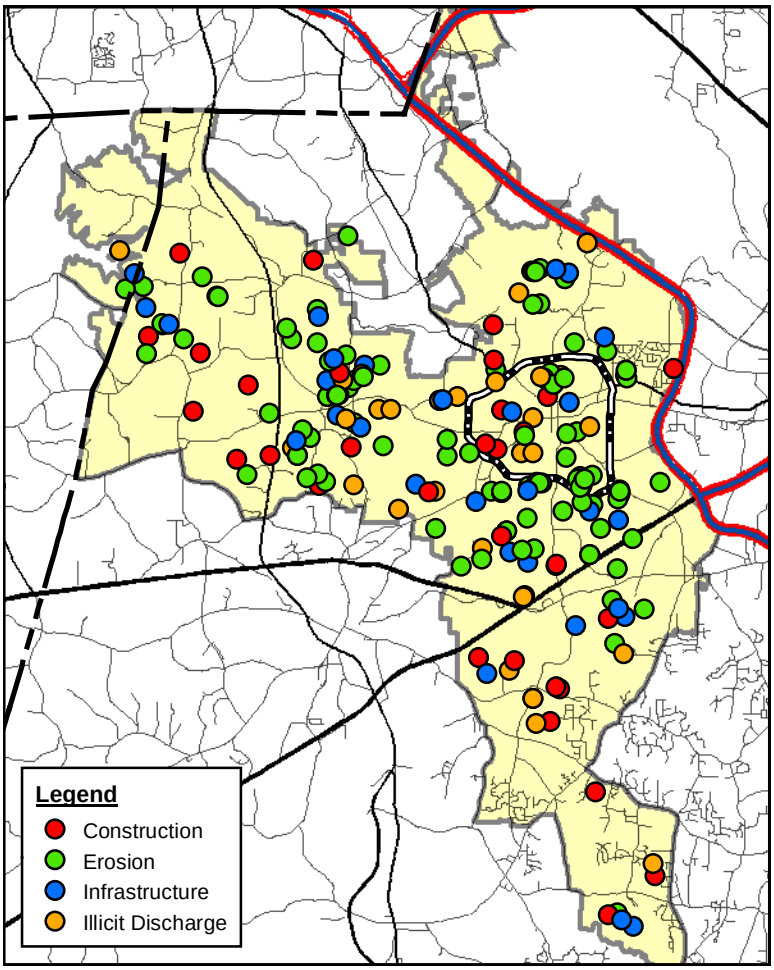


Figure 4.1 - Water Quality Reports(2001-2011)

Roughly half of the 200 reports were related to erosion with the primary contributors being erosion of stream banks.

Approximately one-sixth of the reports were in response to malfunctioning erosion control devices on construction sites. These complaints primarily related to the improper installation or malfunction of silt fence on construction sites.

Reports concerning stormwater infrastructure also contributed to approximately one sixth of the total complaints listed. Those listings include malfunctioning BMPs, stormwater ditches, stormwater outfalls, and riprap bank protection.

Illicit discharges such as oil, fuel, and construction, animal, restaurant and yard waste contributed to roughly one sixth of the complaints listed.

Construction

Water quality reports involving construction work mainly involved poorly functioning erosion control measures at construction sites. Most of the reports were related to the improper installation, malfunction, or lack of silt fence at construction sites. Figure 4.2 shows the locations of where the complaints occurred according to the GIS database. Most of these reports are evenly distributed throughout the Town; however, by nature they are associated with new development or redevelopment. There are relatively few reports, however, which supports the current effectiveness of the Town's erosion and sedimentation control program.

Table 4.2 - Construction Related Reports

Report Type	# of Reports
Malfunctioning Erosion Control Measures	36

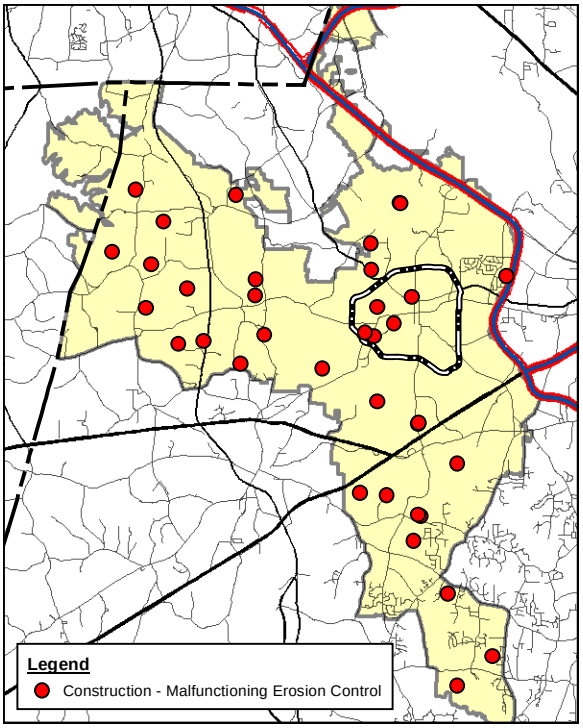


Figure 4.2 - Construction Related Reports

Erosion

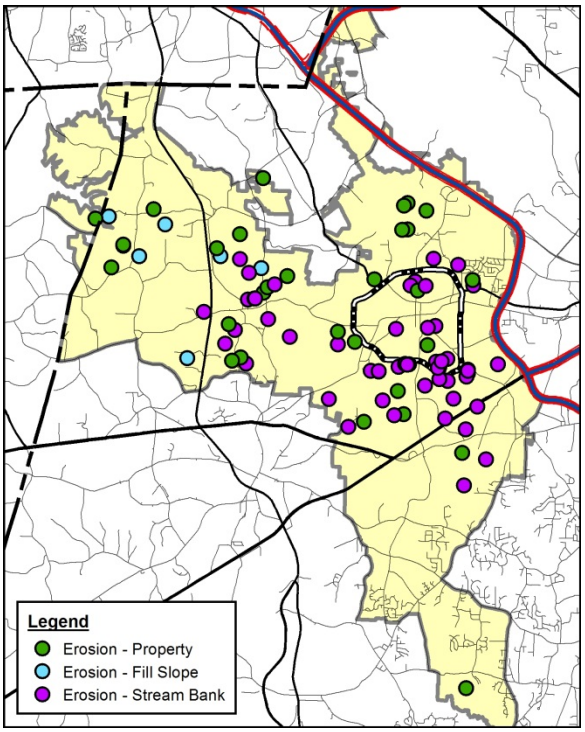


Figure 4-3 - Erosion Related Reports

Half of the water quality related reports related to erosion issues, more specifically stream bank erosion. Other reports that pertained to erosion dealt with general erosion from properties and fill slopes. Stream bank erosion issues appear to be concentrated in the older parts of the Town. The other erosion issues appear to be located in the more recently developed areas and may have occurred during or recently after the development of the properties from which the reports were generated.

Table 4.3 - Erosion Related Reports

Report Type	No. of Reports
Stream bank	60
Fill Slope	6
Property	33

Infrastructure

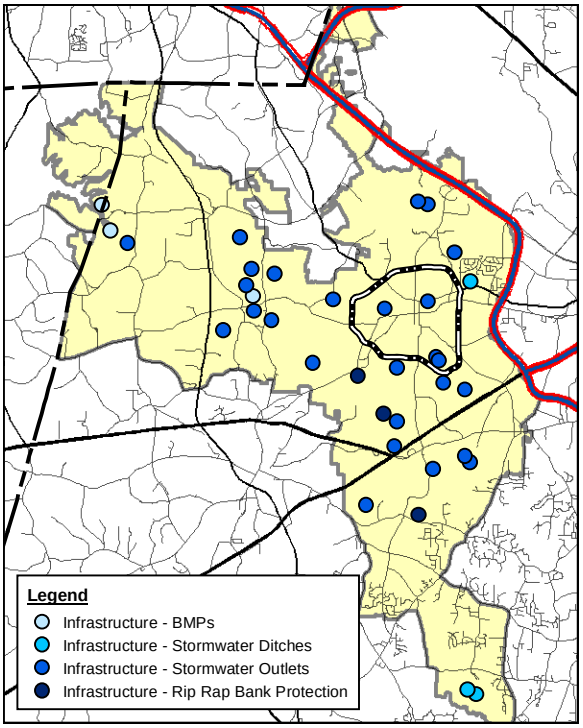


Figure 4.4 - Infrastructure Related Reports

Other erosion issues are related to and associated with conveyance infrastructures such as stormwater outlets and ditches. Outlets with the most reports were pipe outlets where a significant drop in elevation separated the outlet to the receiving stream or ditch. Requiring designers to include drop structures or larger dissipaters at outlets can help reduce such conditions for future BMPs.

Table 4.4 - Infrastructure Related Reports

Report Type	# of Reports
BMPs	3
Stormwater Outlets	26
Riprap Bank Protection	3
Stormwater Ditches	3

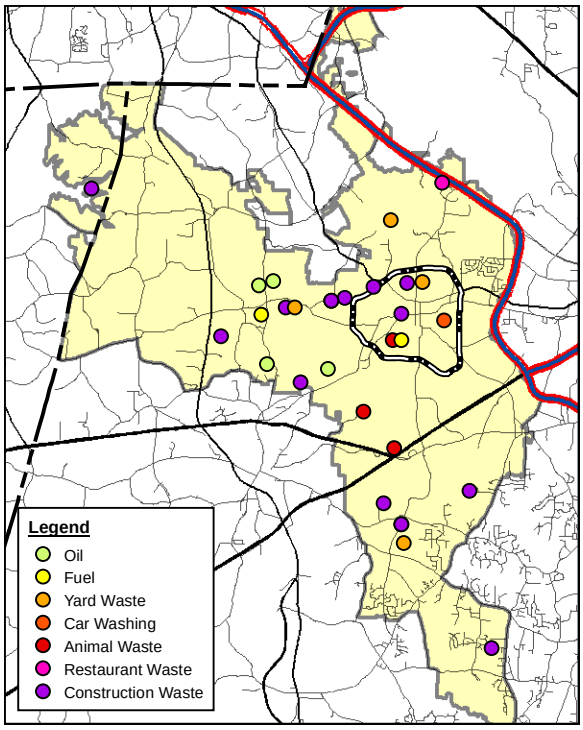
Illicit Discharge

A variety of illicit discharges have been reported. The most common is the improper disposal of construction waste including materials such as paint, concrete, fertilizer, and cleaning chemicals. The complaints are more concentrated in the center part of the Town. The fact that there are only 30 such reports in the last 10 years suggests that the current program is effective.

Table 4.5 - Illicit Discharge Reports

Report Type	No. of Reports
Oil	4
Fuel	2
Yard Waste	4
Car Washing	1
Animal Waste	3
Restaurant Waste	1
Construction Waste	15

Figure 4.5 - Illicit Discharge Report



Recurring Report Locations

There were three (3) locations of reported stream bank erosion that stand out due to multiple complaints stemming from a single location. These locations received complaints of recurring stream bank erosion from July 2002 to September 2009. These streams may eventually require restoration or bank stabilization to prevent any further erosion and excess sediment loads to the receiving waters.

Table 4.6 - Recurring Erosion Reports

Feature	Watershed	# of Reports
UT1 to Lynn Branch	Swift Creek	30
UT2 to Lynn Branch	Swift Creek	60
UT to Turkey Creek	Crabtree Creek	10

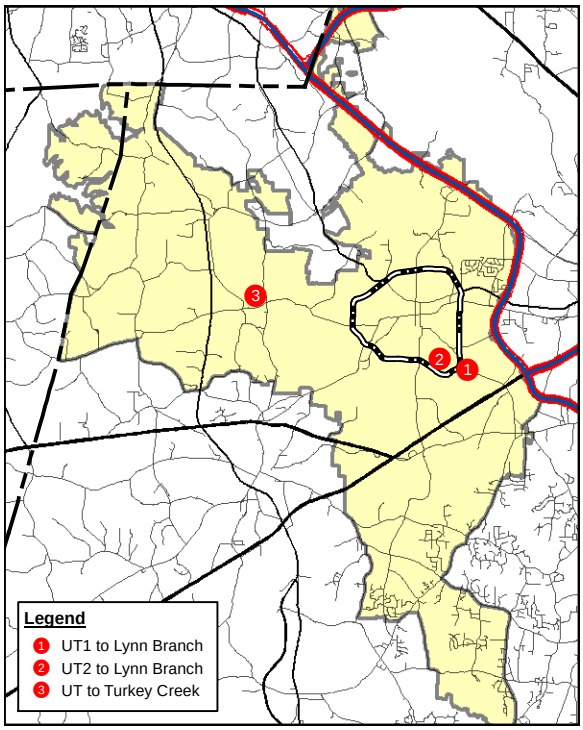


Figure 4-6 - Recurring Erosion Reports

Summary

Over the time period that was analyzed, the Town received approximately 1 to 2 reports per month on average. From the information provided in the database recorded by the Town Engineering Services/Stormwater, it appears that most of the reports were appropriately addressed by the Town. The fact that there were so few reports related to water quality would suggest that the Town's stormwater quality program is effective. As such, no new apparent actions or changes are recommended for improving upon the Town's existing sedimentation and erosion control program or its illicit discharge program. However, it is recommended that the Town continue to repair stream banks or streams using natural channel design techniques on Town-owned streams. This is because all of the recurring reports are related to stream and stream bank erosion. Additionally, educating citizens regarding the negative effects of woody vegetation removal near streams banks and the means of replanting stream banks could be an effective, low-cost method of addressing some stream erosion issues. However, in regards to addressing citizen concerns, the Town's water quality program appears to be effective.

C. BMP Evaluation

The Town of Cary's Engineering Services/Stormwater currently monitors approximately 800 Stormwater BMPs within its jurisdiction. Different BMP types are used throughout the Town to meet the requirements of the Town's stormwater management program. The BMP type selected for use is largely based on the state's regulatory requirements and town ordinances. Each BMP type has different sizing criteria and stormwater treatment benefits; therefore, the type of BMP is implemented on a site-by-site basis. The table below provides the total quantity and percent total for each BMP type within the Town, as well as a brief description of the stormwater treatment capabilities of each BMP.

Table 4.6 - BMP Summary Table

BMP	Quantity in Use	Percent Total	Detention Provided	Water Quality Treatment [1]
Wet Detention Basins	185	23%	Excellent	▪ 85% TSS removal ▪ 25% TN removal
Stormwater Wetlands	157	20%	Excellent	▪ 85% TSS removal ▪ 40% TN removal
Bioretention Areas	133	17%	Moderate	▪ 85% TSS removal ▪ 35% TN removal
Level Spreaders	107	13%	Low to None	▪ 40% TSS removal ▪ 30% TN removal
Dry Detention Basins	85	11%	Excellent	▪ 50% TSS removal ▪ 10% TN removal
Grassed Swales	43	5%	None	▪ 35% TSS removal ▪ 20% TN removal
Sand Filters	39	5%	Low to None	▪ 85% TSS removal ▪ 35% TN removal
Underground Detention	31	4%	Excellent	None
Other BMP's	20	3%	--	--
Total	800	100%		

[1]- According to the NCDWQ Stormwater BMP Manual (2007) TSS = Total Suspended Solids, TN = Total Nitrogen

Historical Use of BMPs within the Town

Wet Detention Basins, Stormwater Wetlands, Bioretention Areas, Level Spreaders, and Dry Detention Basins compromise approximately 84% of the total BMPs in use. These BMPs have been used effectively throughout the Town of Cary stormwater program's history to help meet the goals of the developing program. As the goals of the program have changed, so did the BMP usage trends within the Town. New developments often gravitate to more efficient BMPs that meet these stormwater goals. For this reason, the

BMP usage trends have changed over time due to changes in NCDWQ's regulations, BMP design guideline changes, and land use needs. The following briefly describes the history of Engineering Services/Stormwater regulatory goals and the associated effect on BMP usage trends in the Town of Cary.

- In 1988, the Town adopted an ordinance to provide on-site detention within Water Supply Watersheds. This ordinance began the trend of installing stormwater detention BMPs such as, Wet Detention Basins, Dry Detention Basins, and Underground Detention to control stormwater peak discharges (only) from new developments in the Swift Creek watershed. This change only affected a small portion of the Town at the time, so the installation of these BMPs was not widespread.
- In 1993, the Town adopted the Water Supply Watershed Rules, which required high density developments to treat the first inch of rainfall and 85% average annual TSS removal. These rules affected the Swift Creek and Jordan Lake Watersheds and, therefore, approximately 49% of the Town's jurisdictional area at the time. BMPs that provided both water quality treatment and stormwater detention started to become more favored for implementation. Wet Detention Basins most efficiently met these needs at that time, and were the standard for stormwater control. A greater portion of the Town was impacted by the adoption of this rule resulting in an increase in stormwater BMP implementation.
- The Neuse River Basin Nutrient Sensitive Water Management Strategy was established in 1996 requiring nitrogen treatment of onsite stormwater for all new development and redevelopment and peak flow control of no net increase leaving a site for the 1-year, 24-hour storm event. The Town implemented these requirements in both the Neuse Basin and Cape Fear Basin. This triggered an increased use in BMPs that provided or enhanced nitrogen treatment like Stormwater Wetlands, Bioretention Areas, Level Spreaders, Grass Swales, and Sand Filters. The 1999 North Carolina Division of Water Quality Stormwater Best Management Practices Manual (NCDWQ Stormwater BMP Manual) further established the various BMP types by defining guidelines for design and treatment reductions. Stormwater Wetlands and Bioretention Areas saw the largest increase in trend during this time period because these facilities provided a high level of nitrogen treatment combined with moderate to excellent stormwater detention. Additionally, Wet Detention Basins began to be coupled with Level Spreaders and Grass Swales to help provide the needed reduction in total nitrogen export, which decreased the land efficiency of this BMP type.
- In 2007 the NCDWQ Stormwater BMP Manual (2007) was revised to incorporate new methodologies in BMP design and sizing criteria. This revision led to a modification in the sizing requirements for both Stormwater Wetlands and Bioretention Areas and increased the amount of land needed to site each of these BMPs. These revisions were directly followed by the Town adopting a detention ordinance in 2008 requiring peak flow attenuation for the 2-, 5-, and 10-year, 24-hour rain events. These changes in the stormwater control requirements helped to re-establish the land efficiency of Wet Detention Basins against other BMP options.

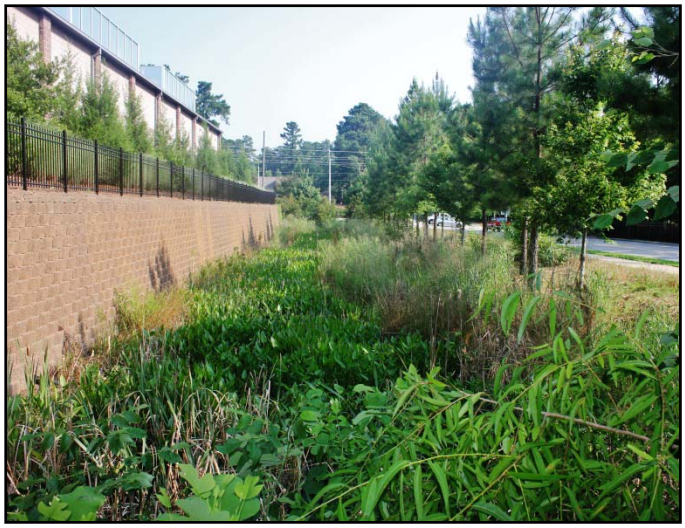
Aesthetic Quality of BMPs and the Effect on Public Perception

The Planning Department regulates site design standards that address the aesthetics of BMPs. The Town recognizes that a BMP's general aesthetic appeal, in addition to its functionality, is important. Public perception and acceptance of stormwater BMPs are often based upon the aesthetic quality. BMPs that are pleasing to the eye, are well maintained, compliment the surrounding landscape, or otherwise are obstructed from view can help improve public opinion of these features. The following photographs and descriptions provide several examples of BMPs within the Town that accomplish the desired aesthetic quality.

Stormwater Wetland at Bishop's Gate Community

The Bishop's Gate stormwater wetland is a good example of utilizing the natural look of a stormwater wetland to blend in with the surrounding landscape. A greenway trail meanders by this stormwater wetland making it a focal point to pedestrians and increasing interaction with the BMP. Additionally, a wall and hedgerow have been utilized as a screening mechanism for the adjacent residential community.

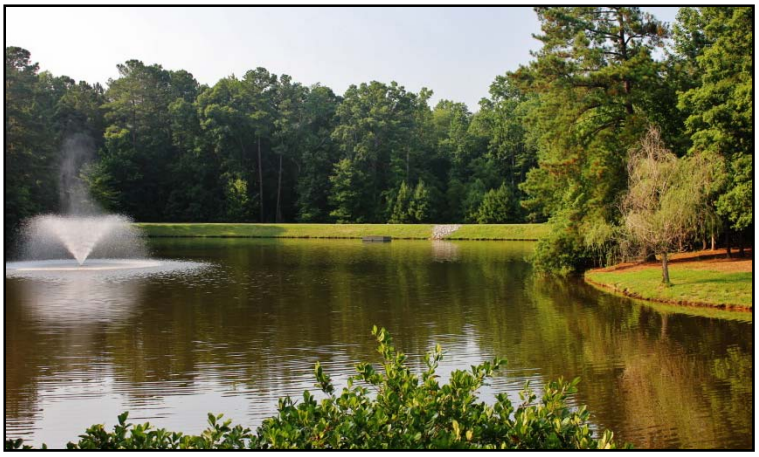
Stormwater Wetland at ALDI Foods



The stormwater wetland located behind the ALDI Foods on Maynard Rd. provides a good example of practicable land management. This stormwater wetland has been placed behind the commercial development reducing the visibility to patrons of the shopping center. The natural look and design of the stormwater wetland provides an attractive buffer between the commercial development and Sudbury Dr., a residential street. Finally, a landscaped buffer along Sudbury Dr. adds to the natural aesthetics of the wetland, and provides natural shade to the wetland.

Wet Detention Basin at Millpond Village

The wet detention basin at Millpond Village shows how a well landscaped and properly maintained stormwater BMP can serve as a visual amenity to a development. The well-manicured wet detention basin creates a water feature amenity for Wake Technical Community College. Additionally, DWQ allows aeration fountains since they reduce stagnation, improving water quality.



Bioretention Area at White Oak Park

This bioretention area has been integrated into a landscape island, and blends in well with the surrounding park environment. Well placed bioretention areas, like the one here, are often hard for the public to recognize as stormwater treatment facilities. An added bonus with bioretention areas is their relative lack of size compared to other BMPs; they can be added to parking islands and other tight areas where a pond or wetland wouldn't fit.

Sand Filter at Kangaroo Gas Station, Harrison Pointe Shopping Center

This underground sand filter at the Kangaroo Gas Station is incorporated into the surrounding landscape. The vegetation provides a visual buffer from the parking lot, and the brick facing matches the surrounding buildings. Additionally, the sand filter is set at grade allowing access for maintenance; however, the closed top serves as a safety feature to the public.

Grass Swale at Bright Beginnings Child Development Center

The grass swale at the Bright Beginnings Child Development Center provides secondary stormwater treatment while its meandering pattern provides an interesting site feature for patrons of the school.

Bioretention Area at Cary Town Hall - South

This bioretention area utilizes a site location normally reserved for only landscaping and replaces it with a multi-function use, landscaping and stormwater treatment. Additionally, the BMP provides a visual buffer between the parking deck and the remainder of the Town Hall development.

Dry Pond at Bishop's Gate Community

The Bishop's Gate dry pond provides an example of how this BMP can be blended into grassed landscape areas. With a good design and proper installation, dry ponds can provide little visual impediments to the public.

Level Spreader at Regency Park

This Level Spreader Regency Park is constructed of concrete with a curb gutter lip. It also has an engineered filter strip to promote infiltration which prevents pollutants from travelling to the downstream waters. Level spreaders are typically located near the buffer and away from public view; however, proper construction and maintenance are essential for these BMPs to be functional.

Future BMPs and Trends

The Town can anticipate that BMP usage trends will continue to be driven by the stormwater regulation and goals set by the program. The next driver of BMP usage trends in the Town of Cary is expected to be the Jordan Lake Nutrient Management Strategy Rules, which will implement more stringent nitrogen export requirements and introduce phosphorus export requirements in the Jordan Lake Watershed. Additionally, the Jordan Lake Management Strategy Rules will provide more allowance for the use of non-traditional BMPs to meet the new stormwater goals. A non-traditional BMP is considered to be a stormwater BMP that is not currently included in the NCDWQ Stormwater BMP Design Manual, but one that can be proven to provide the claimed stormwater treatment.

Along with these regulations the Jordan Lake Nutrient Management Strategy Rules will include the use of the Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool. The Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool modifies the current standard of determining nitrogen and phosphorus treatment through removal efficiencies and replaces this method with site specific effluent concentrations assigned to each BMP type. The new Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool calculates effluent concentrations of nitrogen and phosphorus based on the BMP type and physiographic region selected, and accounts for volume reductions through rainwater harvesting and infiltration (for instance) in the stormwater plan.

As a result, BMP usage trends within the Jordan Lake watershed could result in an increase in the use of a larger variety of BMPs, including rainwater harvesting and infiltration BMPs that help remove stormwater runoff in the post-development condition. This BMP usage trend could eventually encompass all new development in the Town of Cary, if the Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool is eventually required by the Engineering Services/Stormwater to be applied within the Neuse River Basin. Similar requirements are being implemented by other municipalities affected by the Jordan Lake Nutrient Management Rules, such as, the City of Durham. If this calculation method is not required within the Neuse River Basin, then the Town can expect that the BMP usage trends that exist today should continue into the future. However, NCDWQ has expressed a desire for uniform nutrient accounting measures and developers may favor the Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool over the traditional calculation methods due to the flexibility it can provide; therefore, it is highly possible that the Jordan Tool will be expanded to the Neuse Basin (beyond the Falls Lake drainage basin).

The following describes potential BMPs that are not often used within the Town but may become more widely used in the future. Some of these BMPs are also included in Chapter 7, the BMP Toolbox.

Stormwater Irrigation Basins

Charles W. Stanford Middle School, Hillsborough, NC

A Stormwater Irrigation Basin would modify the design of a Dry Detention Basin or Wet Detention Basin to include a volume of stormwater retention for rainwater harvesting. This retained stormwater can then be used as irrigation water onsite. Based on traditional treatment criteria, the retained stormwater volume would be in addition to the permanent pool volume required for water quality treatment when modifying a Wet Detention Basin. The permanent pool should not be required in the Jordan Lake Watershed following the release of the Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool, as this Tool provides greater flexibility for the use of volume reduction to help meet pollutant loading requirements for TN and TP; therefore, the Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool makes Stormwater Irrigation Basins a more viable treatment option in the Jordan Lake Watershed.

Example Use Locations:

- Single family developments, multi-family developments, commercial developments.

Advantages of Use:

- Helps reduce post-construction peak discharge and stormwater volume released to downstream waters.
- Can be used within the Jordan Lake Watershed to reduce nitrogen and phosphorus discharge loading rates through water harvesting methods.
- Reduces the need of potable water for irrigation.
- May reduce fertilizer needs for landscaping through nutrient recycling in the stormwater.
- Can be used to retrofit existing stormwater facilities owned by the Town and other publically owned sites to help reduce cost of irrigation.

Disadvantages of Use:

- Would require a specific maintenance agreement, or other mechanism, with the Owner to regulate irrigation use in order to monitor compliance with the Jordan Lake Watershed Rules.
- BMP Calculations and agreements should account for seasonal use of the retained stormwater volume.
- Requires a separate or specialized distribution system.
- Requires additional documentation by the Owner to comply with Maintenance Agreement.
- Retrofitting irrigation infrastructure may be difficult and costly on densely developed sites.

Stormwater Cisterns

Stormwater Cisterns consist of an above or below ground storage tank intended to retain stormwater for the purpose of rainwater harvesting. Harvested stormwater could be used for irrigation of site landscaping and/or incorporation into a building's toilet facilities. The new Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool provides greater flexibility for the use of volume reductions to help meet pollutant loading requirements for Total Nitrogen and Phosphorus, and makes Stormwater Cisterns a more viable treatment option in the Jordan Lake Watershed. These are only recommended for use at commercial, institutional, or large multi-family developments where a centralized cistern could be established, monitored, and used in a consistent manner.

Prairie Ridge Ecostation, Raleigh, NC

Example Use Locations:

- Single-family residences, businesses, schools

Advantages of Use:

- Helps reduce post-construction peak discharge and stormwater volume released downstream.
- Can be used within the Jordan Lake Watershed to reduce nitrogen and phosphorus discharge loading rates through water harvesting methods.
- Reduces the need of potable water for irrigation and toilet flushing.
- May reduce fertilizer needs for landscaping through nutrient recycling in the stormwater.
- Reduces the surface area requirement of some BMPs such as bio-retention by slower release

Disadvantages of Use:

- Would require a specific maintenance agreement, or other mechanism, with the Owner to regulate irrigation and active use (i.e. toilet flushing) in order to monitor compliance with the Jordan Lake Watershed Rules.
- BMP calculations and agreements must account for seasonal use of the facility when used for irrigation purposes.
- The use of toilet facilities may vary greatly based on tenant occupancy, Owner might need to have a contingency plan in place to account for these scenarios.
- Would require additional documentation by the Owner to comply with Maintenance Agreement.
- Only marginally reduces potable water usage for single family residences unless a very large cistern is installed.
- Would be costly and time-intensive to track usage for single family residences.
- Not currently used today because they do not remove pollutants.

Stormwater Oil-Water Separators

An increase in rainwater harvesting BMPs could create a greater need to provide oil and hydrocarbons pretreatment for stormwater flowing from parking lots and roofs. Water that is heavily polluted with oils and hydrocarbons can damage landscape vegetation and grass. Oil-water separators could be utilized as an inline pretreatment measure in rainwater harvesting BMPs to help reduce the amount of oil and hydrocarbons entering the BMP.

Charles W. Stanford Middle School, Hillsborough, NC

Example Use Locations:

- Gas stations, town vehicle maintenance facilities

Advantages of Use:

- Pre-treatment of the 1-inch rainfall better protects the BMP and the surrounding environment from oil and hydrocarbons.
- Oil and hydrocarbons are directly removed from the system by vacuum truck and disposed of at a waste facility site.
- Helps protect the developments investment in reuse water and landscaping.
- Collects trash and debris in oil-water separator box where it is less visible.
- Helps reduce health risks when irrigation water is applied to athletic fields and public parks.

Disadvantages of Use:

- Would require a specific maintenance agreement, or other mechanism, with the Owner to regulate cleaning and removal of the oil, hydrocarbons and debris from the facility.
- Does not directly achieve regulated water quality or quantity goals of the development.
- Difficult to treat large impervious drainage areas with one structure.
- Cost of structures can be expensive.

Green Roof

Stormwater Green Roofs are specifically designed to retain stormwater on the roof of a building to saturate soil media, irrigate the green roof vegetation, and sustain the process of evapotranspiration. Currently, the NCDWQ Stormwater BMP Manual (2007) does not credit Green Roofs with pollutant removal. Future research could eventually see modification for some pollutant removal; however, Green Roofs can be designed to provide substantial volume reduction in a traditionally unusable space. Green Roofs could be used in the Jordan Lake Watershed to retain stormwater and reduce the impervious area of the development, and essentially providing a net removal of the nitrogen and phosphorus loading from the site.

University of North Carolina Wilmington
Wilmington, NC

Example Use Locations:

- Parking decks, office buildings.

Advantages of Use:

- Retains stormwater through rainwater harvesting helping to reduce nitrogen and phosphorus loading in the Jordan Lake Watershed.
- Creates pervious ground cover on a traditionally impervious area to help reduce the net impervious area of new developments.
- Reduces temperatures on the roof, helping to reduce the urban heat island effect caused by impervious surfaces. Reduced roof temperature also helps reduce energy costs for the building owner, and helps protect downstream waters from temperature spikes.
- Helps conserve space by providing stormwater treatment on the roof.

Disadvantages of Use:

- More difficult to inspect than more traditional ground level BMPs.
- Safety and awareness of the inspector is a concern while on the roof.
- Green Roofs can be expensive, and require additional structural support within the building.
- Small Green Roofs may not retain enough stormwater to be worth the expense.
- Retrofits can be costly, and may not be the best option for publicly owned buildings.
- Town may have the responsibility of roof repairs to maintain the BMP if development becomes vacant.
- Does not remove Total Suspended Solids (TSS).

Onsite Natural Area Restoration

Beaverdam Mitigation Site, Harnett County, NC

Obtaining regulatory credit through implementation of traditional BMPs may not be feasible in every site scenario. Onsite Natural Area Restoration could include restoring function to degraded natural systems like streams, wetlands, and riparian buffers. These natural areas are often negatively impacted by site stormwater runoff resulting from development. Improving or restoring natural function to these systems through new development can provide treatment of stormwater runoff for that site, and remediate degraded natural resources. Additionally, restoring natural areas could be used to generate mitigation credit (see Chapter 6-D). The Town would need to coordinate individual site credit through the North Carolina Division of Water Quality, or alternatively work toward a predetermined system for established regulatory credit for the restored function of these systems.

Example Use Locations:

- Parks, greenways

Advantages of Use:

- Improves existing natural resources which are otherwise often unusable for other purposes due to regulatory constraints.
- Provides mitigation credit for enhancement, restoration, and protection of the Town of Cary's degraded streams, wetlands, and riparian buffers.
- Can provide greater flexibility for stormwater attenuation on constrained sites than do traditional, engineered BMPs.
- May provide an additional stormwater attenuation options for more linear projects like roadways, greenway trails, and sidewalks, which often have too many constraints to site traditional BMPs.
- Larger restoration projects could be utilized as regional BMPs to attenuate peak discharges and reduce flooding, for instance.

Disadvantages of Use:

- A mitigation banking instrument for establishing regulatory credit would need to be negotiated with the NCDWQ and USACE.
- A determination of treatment efficiency and loading rate concentrations may need to be established for TSS, nitrogen, and phosphorus removal of these systems.
- May need to be utilized in conjunction with traditional BMPs like Level Spreaders and Filter Strips to provide better protection of these systems and the necessary stormwater treatment.

Permeable Pavement

Wal-Mart Site, Indian Land, SC

The Division of Water Quality completed a major revision to the NCDWQ Stormwater BMP Design Manual that will provide regulatory credit for 70% or 85% TSS removal and a total nitrogen (10% or 30%) and phosphorous (10% or 60%) removal efficiency for Permeable Pavement meeting the modified design requirements. This revision provides developments greater flexibility and incentive to install permeable pavement onsite and in-lieu of traditional paved parking lots. It also includes design parameters based on water quality or detention only. Additionally, the Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool provides nitrogen and phosphorus effluent concentrations for Permeable Pavement implementation. These revisions make Permeable Pavement a more viable stormwater quality and quantity solution that can be used in appropriate settings throughout the Town of Cary.

Example Use Locations:

- Parking lots, driveways, sidewalks that only receive runoff from impervious surfaces

Advantages of Use:

- Reduces nitrogen and phosphorus effluent concentrations in the Neuse and Jordan Lake watersheds.
- Implementation in accordance with the new design guidelines in the NCDWQ BMP Stormwater Manual provides pollutant reduction.
- Can provide volume and peak discharge reduction.
- Creates pervious ground surface on a traditionally impervious area to help reduce the net impervious area of new developments.
- Helps conserve space by providing stormwater treatment in parking areas.
- Can receive runoff from adjacent impervious cover.

Disadvantages of Use:

- Not applicable for all sites based on existing site soils, the seasonal high water level, or non-impervious tributary areas.
- Regular maintenance is required to maintain function, which includes street sweeping truck.

Post-Construction Soil Remediation

Topsoil existing onsite prior to development often provide important functions pertaining to stormwater management which include, but are not limited to, water infiltration, nutrient and sediment adsorption, and pollutant decomposition. When the site is graded for development, these functions are mostly lost when the development strips away the topsoil and replaces it with compacted soils and a minimal sod layer. Stormwater runoff from these mass graded sites can mimic impervious surfaces in quantity and pollutant load. Post-Construction Soil Remediation can be incorporated into the onsite pervious open space as a non-traditional BMP. The Engineering Services/Stormwater can set design guidelines for Post-Construction Soil Remediation that promote re-establishment of onsite topsoil to the pre-existing conditions, or better.

Example Use Locations:

- Managed turf, landscape areas

Advantages of Use:

- Eliminates or reduces stormwater runoff rate increases from pervious areas following construction.
- Could be established to improve soil conditions following construction greater than the pre-existing conditions. Post-Construction Soil Remediation established in this manner could be considered a non-traditional BMP and provide regulatory credit.
- Improved soil conditions can help establish mature site vegetation more quickly following construction, improving temperature, soil retention, and aesthetics of the site.
- Utilizes an existing site feature that traditionally contributes to stormwater pollution as an onsite BMP.
- Could provide a BMP alternative for smaller and constrained sites.

Disadvantages of Use:

- Not currently approved by NCDWQ to meet water quality requirements.
- Town guidelines will be required for design and monitoring of Post-Construction Soil Remediation.
- May be more costly to implement and maintain on larger sites than traditional BMPs.
- Is not applicable for highly impervious urban sites.

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D. BMP Inspection Program

The Town established its BMP Inspection Program in response to regulatory requirements instituted by DWQ and the USEPA (see Section 2B). Sufficient oversight, tracking, and enforcement of maintenance requirements are necessary to ensure adequate maintenance of BMPs. The Town of Cary's BMP Inspection Program provides for all of the above. As a result of its intensive inspection program, the Town remains in compliance with State and Federal requirements (such as NPDES Phase II), and both the private and public stormwater BMPs within the Town maintain their required functions. For Town citizens, this translates to improved water quality and functional BMPs that are orderly in their appearance.

> *"…no matter how well they are designed and constructed, BMPs will not function correctly nor look attractive unless they are properly maintained. Most maintenance problems with BMPs are less costly to correct when they are caught early—as the old adage goes, 'an ounce of prevention is worth a pound of cure'." (DWQ Stormwater Best Management Practices Manual, July 2007)*

To appreciate the success of the Town's BMP Inspection Program, it is important to understand the process and how that process supports the Town stormwater program's goal of well-maintained BMPs. The process features several layers of protection and assurances, resulting in a program that ensures the BMPs perform as designed. Currently, staff from the Town Engineering Department manage the program.

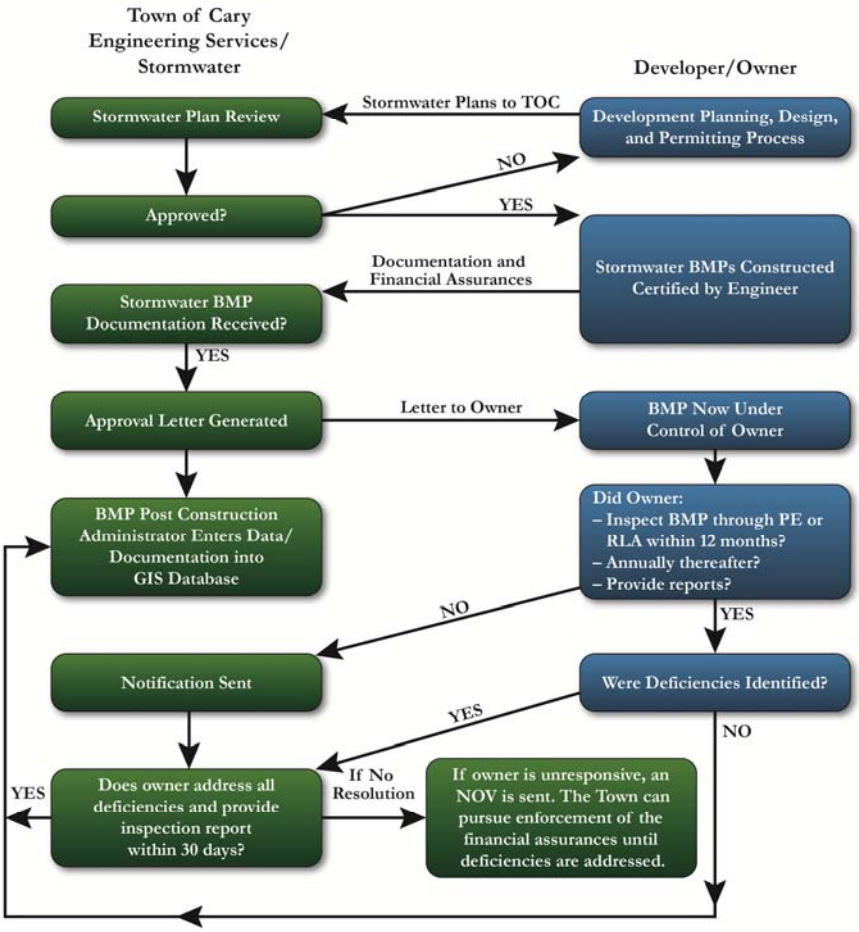
Prior to being accepted into the BMP Inspection Program, the property owner (that includes the BMP) must receive a letter from the Town that the constructed BMP has been approved and that the long-term disposition of the BMP has been established. This letter is required for the issuance of a Certificate of Occupancy. Once this letter has been issued, the BMP becomes part of the Post Construction Program and enters the BMP Inspection Program cycle. The following are the basic requirements for the initial approval of the BMP by the Town Engineering Department:

1. An approved Operation and Maintenance Manual;
2. A maintenance agreement with the owner;
3. A maintenance easement for access recorded in agreement with plans;
4. A letter sealed by a Professional Engineer or Landscape Architect that the BMP was constructed according to the plans and Town requirements (this must be provided within 30 days after completion of construction);
5. As-built drawings of the BMP;
6. A letter of credit or other financial assurance; and
7. Record access agreement and easement.

The physical file containing these components then is sent to the BMP Inspection Program manager; the BMP is located and added to a GIS mapping-based database; and relevant documentation is established in an electronic geodatabase. The geodatabase not only locates the BMP, but also provides links to data tables and databases that include all of the required documentation. The program soon will include photos of the BMP.

The inspection report is due on the one-year anniversary of the issuance of the Town's BMP approval letter, and reports are due annually thereafter. The inspection forms are updated annually to ensure that the most relevant information is recorded. The owner is required to retain a private, independent inspection company to inspect the BMP and provide the report. Under this inspection system, there is incentive for these companies to accurately identify and address issues with the BMPs such as lack of grass cover, leaking or damaged structures, and unhealthy wetland and screening vegetation. Since the majority of existing BMPs are wet detention ponds, stormwater wetlands, or bioretention areas, there is a strong understanding of the function and maintenance of these systems among the various companies that provide inspection services. Refer to Section 4C for a detailed review of the types of BMPs commonly used in the Town.

Figure 4-7 - Stormwater BMP Inspection Program Flow Chart



If an inspection report identifies a deficiency, the owner has 30 days to address the deficiency. Since the inspection process requires that identified issues with a BMP be addressed through maintenance, repair, or replacement, the service life of the BMP is extended indefinitely. If the owner refuses to make required repairs, the Town has enforcement mechanisms and the required financial assurances to ensure the BMP is maintained. Owners are given a choice of the financial assurances they can provide: cash or an "ever-green" letter of credit. At this point, these mechanisms have not been needed, which speaks to the success of the Inspection Program in meeting its goal of maintained BMPs.

The NPDES Phase II Stormwater Permit issued in November 2011 includes a requirement that Town staff visit each BMP at least once in the five-year permit cycle. The Town currently has an informal program in which Engineering/Stormwater Services staff visit approximately 80% of the BMPs annually. This program now must be implemented formally.

The Town's BMP Inspection Program is well established, efficient, and has a successful track record of ensuring that stormwater BMPs within the Town are maintained. As of February 2012, there are over 750 BMPs (both private and public) tracked in the database.

The following section compares the Town's stormwater BMP inspection program to the programs of five other North Carolina municipalities in the Piedmont region.

Comparison to Other Local BMP Inspection Programs

Table 4-7 provides a summary of the BMP inspection programs of five municipalities to that of the Town's. Cary, Durham, Apex and Raleigh all require professional certification of as-built conditions of the BMPs as well as qualified inspector requirements. The City of Greensboro is considering to do the same. Additionally, Durham has its own BMP Certifying Engineer Program (BCE) as well as a BMP Maintenance Certifier Program (BMC) as well.

In regards to unique approaches, the City of Raleigh requires that developers contribute 24% of a BMP's construction cost to a City-held general maintenance fund (required special legislative approval). The Town could investigate whether or not this would be easier than accepting letters of credit or tracking individual financial assurances; however, under the Town's current system, it has never had to call in a letter of credit.

Table 4.7 - Comparison of Other Local BMP Inspection Programs

Municipality	As-Built Certification	Reporting Cycle	Owner Agreement	Financial Assurances	Compliance, Enforcement, and Tracking
Town of Cary	Yes	Annual	Yes	Letter of credit/cash payment	▪ **Compliance for Deficiencies**: 30 days to address identified issues with extensions available ▪ **Enforcement Procedures**: Planning can directly impose fines for non-compliance ▪ **Tracking Method**: All information, including inspections, available through GIS geodatabase ▪ **Planned Improvements**: 1) Consider establishment of general maintenance fund for developers to pay into 2) Hyperlinked photos of BMPs added to geodatabase.
Town of Apex	Yes	Annual	Yes	125% Performance and 25% Maintenance Guarantee	▪ **Compliance for Deficiencies**: If a deficiency is noted by a private inspector (PE, LS, LA), then the owner has 60 days to address issues and submit a "passing" report. ▪ **Enforcement Procedures**: Town will issue an NOV with a compliance deadline. Penalties can be up to $100 per day. ▪ **Tracking Method**: Spreadsheet ▪ **Planned Improvements**: Considering using CityWorks software.
City of Durham	Yes	Annual	Yes	Bonding	▪ **Compliance for Deficiencies**: Conditional certification with a scope of work and 90 days to implement for minor issues. Engineering Modification Report required for extensive repairs ▪ **Enforcement Procedures**: Typically enforcement is sought indirectly through the Planning Dept. ▪ **Tracking Method**: Spreadsheet with locations in GIS database ▪ **Planned Improvements**: 1) Proposed ordinance to improve enforcement 2) Improve GIS tracking program.
City of Raleigh	Yes	Annual	Yes	24% BMP cost	▪ **Compliance for Deficiencies**: Deficiencies to be addressed prior to submitting report. ▪ **Enforcement Procedures**: Typically done through a Notice of Non-Compliance. Fines can be imposed beyond that (updated 2008) ▪ **Tracking Method**: Microsoft Access Database ▪ **Planned Improvements**: As of January 2011, developers must contribute 24% of the BMPs cost to a City-held general maintenance fund
City of Greensboro	Yes	Annual	Yes Recorded on plat	Bond/Letter of Credit during construction	▪ **Compliance for Deficiencies**: If the City inspector identifies a deficiency the owner has 90 days to address them. ▪ **Enforcement Procedures**: After 90 days, if deficiencies are not addressed the City sends an NOV with 30 days to address. If not addressed another NOV is sent allowing 14 days. If still not addressed, enforcement procedures are triggered. ▪ **Tracking Method**: Sequel Server, a Microsoft program that is internet based. ▪ **Planned Improvements**: Altering program to have a Certification program like Durham's. Require maintenance bonds.
City of Charlotte & Mecklenburg County	Yes	Annual	Yes	Escrow Account	▪ **Compliance for Deficiencies**: A Corrective Action Plan must be sent in 30 days. Once the repairs are completed, it will be re-inspected by the appropriate Town. The Town inspector works outs the repair time line. All actions are logged and progress tracked in the CityWorks database. ▪ **Enforcements Procedures**: Call in the escrow account. ▪ **Tracking Method**: BMPs are tracked and managed as if they were City assets using the CityWorks database. ▪ **Planned Improvements**: They are considering additional inspections during construction phase for LID devices.

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E. Watershed Impairment Criteria and Evaluation

The State is required under Section 303(d) of the Federal Clean Water Act of 1972 to identify and establish a priority ranking system to meet and maintain water quality standards for surface waterbodies. Waterbodies are ranked by parameter using Integrated Reporting Categories (IRC) based on observed water quality data. Descriptions of the IRCs are provided in Table 4.8 below:

Table 4.8 - Integrated Reporting Category Descriptions

Category	Use Rating	Description
Category 1	n/a	All uses are monitored and supporting (Not used in NC due to statewide Mercury Impairment)
Category 2	n/a	All monitored uses are supporting or not rated and there are no impaired assessments in the AU (used in NC instead of overall Category 1).
Category 3	n/a	Monitored uses are not rated and there are no impaired assessments.
	Impaired	Parameter assessment is Not Rated due to insufficient or inconclusive data.
	Impaired	Parameter assessment is Not Rated due to insufficient or inconclusive data and there is a management strategy in place to address exceedances of the parameter.
	Impaired	Not rated for Chlorophyll *a*. Exceeds the evaluation level but there are less than 10 samples.
	Impaired	Parameter is Not Rated in the AU and there is an approved TMDL for the parameter.
	n/a	No data available to make any water quality assessments.
Category 4	n/a	There is at least one impaired assessment but TMDLs are not required to address the impairments.
	Impaired	Parameter assessment is impaired and there is a management strategy in place to address exceedances of the parameter.
	Impaired	Parameter assessment is impaired and there is a dam upstream of downstream that is causing exceedances of the parameter.
	Impaired	Assessment is impaired due to loss of use buy there are no data collected *used for Swimming Advisories only).
	Impaired	Ecological/biological integrity is Impaired and there is separate Category 5 assessment for another aquatic life parameter.
	Impaired	Parameter assessment is impaired and there is an approved TMDL for the parameter.
Category 5	n/a	There is at least one impaired assessment that requires development of a TMDL (s).
	Impaired	Parameter assessment is impaired and TMDL development is required for the parameter.
	Impaired	Parameter assessment is impaired and there is restoration activity to address the standards violations of this parameter.

Assessment Units (AUs) that receive an IRC 5 are classified as Impaired, which requires the state to establish a Total Maximum Daily Load (TMDL) for pollutants that are identified as causing the impairment. Typically, TMDLs are administered to the entire watershed of the AU to address water quality issues. AUs can vary in length and area and are typically subdivided based on waterbody characteristics, observed similarities in water quality, and/or landmarks.

North Carolina Administrative Code 15A NCAC 2B .0200 specifies that water quality standards are based on waterbody classifications. Freshwater classifications of waters within the Town Planning Limit (TPL) include:

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.
B	Freshwaters protected for primary recreation which includes swimming on a frequent or organized basis and all Class C uses.
WS-III	Waters protected as water supplies which are generally in low to moderately developed watersheds. Point source discharges of treated wastewater are permitted pursuant to Rules 15A NCAC 2B .0104 and .0211. Local programs to control nonpoint sources and stormwater discharges of pollution shall be required. Suitable for all Class C uses.
WS-IV	Waters protected as water supplies which are generally in moderately to highly developed watersheds. Point source discharges of treated wastewater are permitted pursuant to Rules 15A NCAC 2B .0104 and .0211. Local programs to control nonpoint sources and stormwater discharges of pollution shall be required. Suitable for all Class C uses.
WS-V	Waters protected as water supplies which are generally upstream of and draining to Class WS-IV waters. No categorical restrictions on watershed development or treated wastewater discharges shall be required. However, the Commission or its designee may apply appropriate management requirements as deemed necessary for the protection of downstream receiving waters suitable for all Class C uses (15A NCAC 2B .0203).
NSW	Nutrient Sensitive Waters subject to growths of microscopic or macroscopic vegetation requiring limitations on nutrient inputs.

Waters located within the TPL are either classified as: C, B, WS-III, WS-IV, or WS-V and all waters carry the supplemental NSW classification. Waters located within the Swift Creek watershed are WS-III while waters located within the Jordan Lake watershed are WS-IV or WS-V. Tributaries to Middle Creek (including Camp Branch and Bells Lake) and Crabtree Creek (including Black Creek, Richlands Creek, Reedy Creek, Brier Creek, Little Brier Creek, Turkey Creek, Coles Branch and South Fork Coles Branch) do not carry water supply classifications and are either Class C or B waters. The Class B waters potentially affected by

activities within Town planning limits include, Jordan Lake, Silver Lake, Lake Johnson, Lake Raleigh and Lake Crabtree (from backwaters of Crabtree Lake to mouth of Richlands Creek).

Water quality assessments for Class C and B AUs are evaluated on three Use Support Categories: aquatic life, recreation, and fish consumption. WSI-V AUs are subject to an additional water supply set of standards. Each use support category has specific assessment methodologies and standards as described below.

Aquatic Life Assessment Methodology and Standards

Numerical Water Quality Standards

Parameters for numerical water quality standards are considered to be impaired if 10% of the collected samples exceed the standard level. Water bodies are considered Supporting if less than 10% of the zero aquatic life numerical water quality samples exceed the standard. There must be a minimum of 10 samples taken per parameter for an AU to be a Category 5 Impaired. If there are less than 10 samples, but more than 10% of the samples exceed the standard limit, then the AU is classified as Category 3 Not Rated and flagged for further sampling. For a complete list of standards per classification, refer to North Carolina Administrative Code 15A NCAC 2B .0200. Common standards criteria are:

- Dissolved Oxygen (DO): Daily average not less than 5.0 mg/l with minimum instantaneous value of not less than 4.0 mg/l.
- pH: Between 6.0 and 9.0
- Temperature: Not to exceed 5.04º F above natural water temperature and in no case exceed 89.6º F.
- Chlorophyll *a*: Not greater than 40 µg/l in waters to include dam backwaters, lakes, and reservoirs.
- Toxic Substances:
    - Arsenic: 50 µg/l
    - Beryllium: 6.5 µg/l
    - Cadmium: 2.0 µg/l
    - Chlorine, total residual: 17 µg/l
    - Cyanide: 5.0 µg/l
    - Fluorides: 1.8 mg/l
    - Lead, total recoverable: 25 µg/l
    - Nickel: 88 µg/l
    - Chlorides: 230 mg/l (action level standard)
- Action Level Metals: These metals are used for permitting purposes and generally exceedances outside the standard levels do not result in a Category 5 listing. DWQ reviews Copper and Zinc assessments to determine if a Category 5 listing is necessary.

  - Copper: 7 µg/l
  - Silver: 0.06 µg/l
  - Zinc: 50 µg/l

- Turbidity: Not to exceed 50 Nephelometric Turbidity Units (NTU) for streams and 25 NTU for lakes and reservoirs.

Ecological/Biological Integrity

A narrative standard is assessed using a bioclassification criterion for aquatic life. If an AU receives a macroinvertebrate or fish community bioclassification of Severe, Poor, or Fair and there are no other aquatic life standard violations, then the AU is classified as Category 5 Impaired. If the AU bioclassification is Severe, Poor, or Fair and another aquatic life standard violation occurs, then the AU is classified as Category 4.

Recreation Assessment Methodology and Standards

Recreation standards are based on fecal coliform colony data collected at Division of Water quality (DWQ) stations. In addition to bacteria standards, Division of Environmental Health (DEH) advisory postings are used when assessing recreation. Standards for pathogens are as follows:

- Fecal Coliform: Not to exceed a geometric mean of 200 colonies / 100 ml based on at least 5 consecutive samples during any 30-day period and not to exceed 400 colonies / 100 ml in more than 20 percent of the samples during the sampling period.
- Enterococcus: Not to exceed a geometric mean of 35 enterococci / 100 ml based on a minimum of five samples within any consecutive 30 days.

An AU is classified as Category 3 Not Rated if the standards are exceeded, but the samples were not collected within the same 30-day period. An AU is classified as Category 4cr Impaired if a DEH swimming advisory is posted for greater than 61 days in any 6 year period; this listing does not require a TMDL.

Fish Consumption Assessment Methodology and Standards

Fish consumption assessment is based on NC Department of Health and Human Services (DHSS) consumption advisories. These advisories are developed through site-specific fish tissue data analyses. Parameters assessed are: polychlorinated biphenyls (PCBs), dioxin, and mercury. Since North Carolina is under a statewide advisory for mercury, all AUs are considered Category 5 Impaired for mercury fish consumption.

Water Supply Assessment Methodology and Standards

Parameters for numerical water quality standards are considered to be impaired if 10% of the collected samples exceed the standard level. There must be a minimum of 10 samples taken per parameter for an AU to be a Category 5 Impaired. If there are less than 10 samples, but more than 10% of the samples exceed the standard limit, then the AU is classified as Category 3 Not Rated and flagged for further sampling. For a complete list of standards per classification, refer to North Carolina Administrative Code 15A NCAC 2B .0200. Common standards criteria are:

- Barium: 1.0 mg/l
- Chloride: 250 mg/l
- Nickel: 25 µg/l
- Nitrate Nitrogen: 10.0 mg/l
- 2,4-D: 100 µg/l
- 2,4,5-TP (Silvex): 10 µg/l
- Sulfates: 250 mg/l

Assessment Period

The 2012 Section 303(d) list is based on data collected during the calendar years 2006 through 2010. Since monitoring and sampling is cost restrictive, some AUs may have data that was collected in earlier reporting periods, but not resampled for this reporting window. Sources of data collection include the NC Department of Natural Resources (NCDENR) Division of Water Quality (DWQ), NCDENR Division of Environmental Health (DEH), the United State Geological Survey (USGS), local government, environmental groups, universities, and any entity that procures data that includes an approved Quality Assurance Project Plan (QAPP) to ensure all samples were collected consistent with EPA protocol.

F. Town of Cary Impaired Watersheds

The Town of Cary is divided by a ridgeline approximately parallel to NC 55 into the Neuse River Basin and Cape Fear River Basin. Approximately 71% of the TPL and the entire TCAP area lie in the Neuse River Basin while 29% of the TPL is located in the Cape Fear River Basin. Approximately 97% of the TPL is located within a watershed that drains to a Section 303(d) listed stream. Figure 4.8, below, shows that 56% of the Town is in a watershed that is under a TMDL or is rated as a Category 4b.

Figure 4-8 - Current TMDL/Category 4b Impaired Watersheds

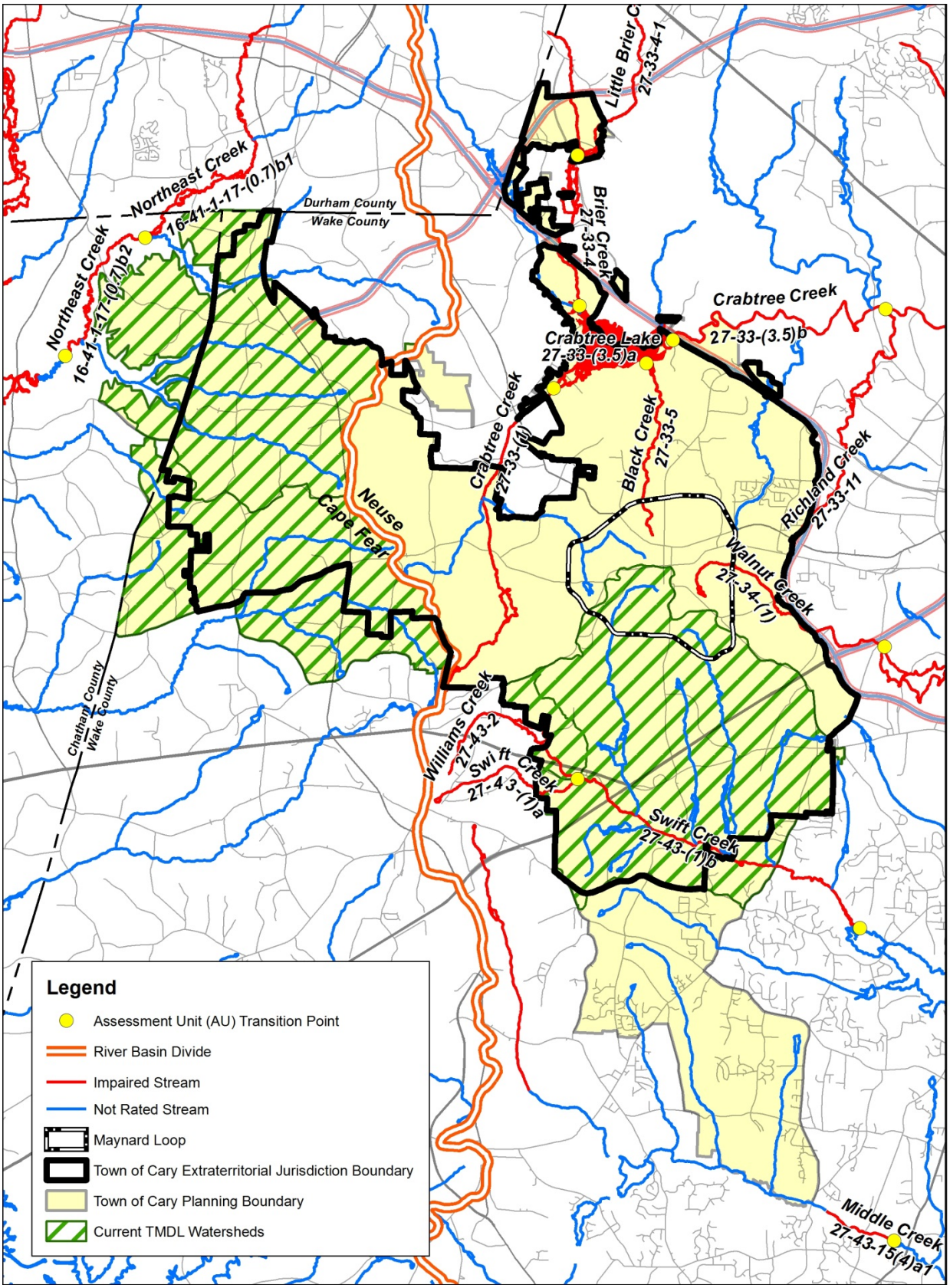

Table 4.9 - Town of Cary Impaired Streams

River Basin	Name	Assessment Unit (AU)	IRC	Parameter	303(d) List Year
Neuse	Black Creek	27-33-5	5	Eco/Bio Integrity	1998
Neuse	Brier Creek	27-33-4	5	PCB	2008
Neuse	Crabtree Creek	27-33-(1)	5	Eco/Bio Integrity	1998
Neuse	Crabtree Lake	27-33-(3.5)a	4s	Eco/Bio Integrity	--
			5	Turbidity	2008
			5	PCB	2008
Neuse	Crabtree Creek	27-33-(3.5)b	5	Turbidity	1998
			5	PCB	1998
Neuse	Little Brier Creek	27-33-4-1	5	PCB	2008
Neuse	Richlands Creek	27-33-11	5	Eco/Bio Integrity	2004
Neuse	Swift Creek	27-43-(1)a	4t	Eco/Bio Integrity	1998
Neuse	Swift Creek	27-43-(1)b	4t	Eco/Bio Integrity	1998
Neuse	Walnut Creek	27-34-(1)	5	PCB	2010
Neuse	Williams Creek	27-43-2	4t	Eco/Bio Integrity	1998
Neuse	Middle Creek	27-43-15-(4)a1	4b	Zinc	--
			5	Turbidity	2010
Cape Fear	Jordan Lake	--	--	Chlorophyll a/pH	--
Cape Fear	Northeast Creek	16-41-1-17-(0.7)b1	5	Zinc	2008
Cape Fear	Northeast Creek	16-41-1-17-(0.7)b2	5	Copper	2008
			5	Zinc	2008
			5	Turbidity	2008
			4t	Fecal Coliform (recreation)	1998

303(d) Streams

Neuse River Basin

- Black Creek [AU# 27-33-5; C; NSW] from source to Crabtree Lake (Crabtree Creek): Is impaired for (lack of) biological integrity. Species present indicate impairment due to toxicity and sediment from urban runoff. The non-profit organization, Watershed Education for Communities and Officials (WECO), and the Black Creek Watershed Association have partnered with the Town to plan monitoring and restoration of Black Creek. Strategies of the WECO Black Creek Watershed Management Plan include: public education and outreach, identification of areas of natural interest for preservation and recreational opportunities, control of sedimentation and erosion from construction sites, management of invasive species management, and retrofit of BMPs.

  Black Creek Watershed Association – with WECO - Goals and Accomplishments:

  1. Public outreach and education
     - Four watershed "Clean-ups" by over 102 volunteers
     - Black Creek Stream Walk – taught stream assessment and then had participants walk the creek and assess specific reaches.
     - Educational Booths at "WaterFest" events at Lake Crabtree County Park
     - Bi – Annual newsletter "Black Creek Watershed Wire".
     - NCSU students obtained funding and collected water assessment data in a geodatabase.
     - Middle and High school students in Cary designed logo, participated in meetings, and some High school students monitored a rain gage.
     - Established goal of surveying ecological perception held by Cary residents.
     - Have begun developing educational workshop and marketing material for neighborhoods (less rain down the drain).

  2. Identification of areas of natural interest for preservation and rec opportunities
     - Maintenance and improvement of current recreational areas was strategized, but new ones have not been pushed forward.
  3. Control of sedimentation and erosion from construction sites
     - Brainstormed effective strategies
     - Pollution Source Survey (2008) instructions describe how to identify pollution stemming from construction site erosion, but no data is compiled and available.
  4. Management of invasive species
     - Brainstormed effective strategies
  5. Retrofit of BMPs
     - Brainstormed effective strategies
     - Constructed pilot Rain-garden project at West Cary Middle School with NCSU and EPA.
     - Established Goal: Identify areas on Public Property for BMP retrofits
     - Seek BMP funding to incorporate with Greenways.

- Brier Creek [AU# 27-33-4; C; NSW] from source to Crabtree Lake (Crabtree Creek): Brier Creek is impaired for fish consumption due to the Department of Health and Human Services (DHHS) advisory for polychlorinated biphenyls (PCBs). DWQ reported that the stream was not assessed for any other water quality parameters during the plan assessment period; however, DWQ believes urbanization has contributed to erosion, increased stream velocities, excess nutrients, and toxicity.
- Crabtree Creek [AU# 27-33-(1); C; NSW] from source to backwaters of Crabtree Creek (Lake Crabtree): This reach is impaired due to a benthic community bioclassification of Poor. Bioclassification richness is an index that describes the number of different species and number of individuals of each species. This richness index has decreased by 50% since the 2000 sampling, indicating further water quality degradation.
- Crabtree Creek (Lake Crabtree) [AU# 27-33-(3.5)a; B; NSW] from the backwaters of Crabtree Creek to Cary WWTP: This reach is impaired for aquatic life due to turbidity standard violations. Low dissolved oxygen and high conductivity were also observed during sampling. Lake Crabtree is under a fish consumption advisory warning for PCBs.
- Crabtree Creek (Lake Crabtree) [AU# 27-33-(3.5)b; B: NSW] from the Cary WWTP to the mouth of Richlands Creek: This reach is impaired for aquatic life due to turbidity standard violations. Conductivity and nutrient levels were elevated during sampling. Dissolved oxygen was within tolerances during sampling; therefore, this reach was removed from the 303(d) list for low dissolved oxygen. This section of Crabtree Creek is under a fish consumption advisory warning for PCBs.
- Little Brier Creek [AU# 27-33-4-1; C; NSW] from the source to Brier Creek: Little Brier Creek is under a fish consumption advisory warning for PCBs.
- Richlands Creek [AU# 27-33-11; C; NSW] from source to Crabtree Creek: Richlands Creek was not sampled during the latest basin plan assessment period. It is impaired for aquatic life due to a Fair bioclassification.
- Swift Creek [AU# 27-43-(1)a, WS-III, NSW] from source to the confluence with Williams Creek: This reach of Swift Creek was not assessed during the latest sample period, but it was added to the 303(d) list for impaired biological integrity in 2001 and will remain on the list going forward.
- Swift Creek [AU# 27-43-(1)b; WS-III; NSW] from confluence with Williams Creek to backwaters of Lake Wheeler: This reach of Swift Creek is impaired due to a Fair benthic bioclassification. Sampling indicates low DO, high fecal coliform bacteria levels, high turbidity, and elevated conductivity. A Watershed Assessment and Restoration Project (WARP) through DWQ was conducted in 2001 to address biological impairment and outlines restoration activities and BMPs. A TMDL based on impervious cover was approved by EPA in March 2009 for the Headwaters of the Swift Creek Watershed. The purpose of the TMDL is to address aquatic life impairments through implementation of BMPs. The four primary stressors, which were identified in the WARP study and are listed in the TMDL, include:
    - Hydromodification and scour due to increased stream velocities.

- Toxicity from urban stormwater runoff
- Hydromodification from dams and reduced connectivity
- Organic and nutrient enrichment.

- The Town has submitted a draft Water Quality Recovery Program as required by the TMDL for the Swift Creek basin which is still under review by DWQ as of the publication of this report.
- Walnut Creek [AU# 27-34-(1); C; NSW] from source to dam at Lake Johnson: This reach of Walnut Creek was added to the 2010 Section 303(d) list for fish consumption advisory warning for PCBs. A biological TMDL is planned for the Walnut Creek watershed by 2013. Like the Swift Creek TMDL, this will likely be based on an impervious cover load allocation.
- Williams Creek [AU# 27-43-2; WS-III; NSW] from source to Swift Creek: This reach is impaired for aquatic life. Williams Creek is a tributary to Swift Creek and lies within the Headwaters of the Swift Creek Watershed TMDL.
- Middle Creek [AU# 27-43-15-(4)a1; C; NSW] from dam at Sunset Lake to small impoundment upstream of US 401: This reach is impaired for aquatic life due to turbidity standards violation. The reach has an Excellent rating for fish communities and a Good-Fair rating for macroinvertebrates. The reach is rated 4b for zinc.

Cape Fear River Basin:

- Jordan Lake [WS-IV; CA; NSW] (includes index numbers of all feeder streams/rivers): The Jordan Lake TMDL was developed to satisfy both DWQ's NSW requirements and an EPA required TMDL. The TMDL resulted in the implementation of the "Jordan Rules" which apply to the entire watershed draining to the Lake and are intended to reduce nitrogen and phosphorus inputs. These nutrients are thought to be the cause of the multiple chlorophyll a and pH standards violations. Jordan Lake is the primary water supply source for the Town of Cary. The Jordan Rules are discussed in more detail in Section 2B – Current Regulatory Environment.
- Northeast Creek [AU# 16-41-1-17-(0.7)b1; WS-IV; NS] from Durham Triangle WWTP to Kit Creek: This reach of Northeast Creek is impaired due to zinc standard exceedances.
- Northeast Creek [AU# 16-41-1-17-(0.7)b2; WS-IV; NS] from Kit Creek to a point 0.5 miles downstream of Panther Creek: Aquatic life in this reach of Northeast Creek is impaired due to turbidity, copper, and zinc. A TMDL has been developed for fecal coliform in this reach and so it appears in section 4t of the §303(d) list.

Conclusion

The Town's stormwater program already includes a number or ordinances and other programs in place to address water quality of the Town's streams. These ordinances and programs are discussed in more detail throughout the Master Plan. Part of the intent of such ordinances and programs is to improve water quality or prevent further degradation of the Town's streams. The Town's primary water supply is from Jordan Lake which most of the Town's streams west of Highway 55 drain. Since streams are the conduit that conveys stormwater to its water supply, the Town has an interest in having good water quality in its streams.

Continuing to implement the Town's stormwater program should help to address the existing water quality issues noted above. Beyond that, there are future goals and objectives described in Chapters 5 and 6 that, if implemented, will further address water quality. DWQ and the USEPA may also play a role in addressing water quality by establishing TMDLs or Category 4b WQRP-type plans in impaired watersheds for targeted water quality management. Assisting in the expansion of watershed associations similar to the BCWA may help proactively address impaired systems prior to DWQ or the USEPA implementing TMDLs.

The Town already has a robust stormwater quality program. By continuing down its current path and possibly implementing the future goals and opportunities identified in this Master Plan, the Town can make strides in addressing the condition of its impaired streams.