# CATEGORY 4B DEMONSTRATION PLAN TO ADDRESS BIOLOGICAL IMPAIRMENT IN LITTLE ALAMANCE CREEK, NC


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| | |
|---|---|
| µg/L | micrograms per Liter |
| BMP | best management practice |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| cfu | colony-forming unit |
| COC | certificate of coverage |
| DEMLR | Division of Energy, Mineral and Land Resources |
| DWQ | Division of Water Quality (name changed to DWR in 2013) |
| DWR | Division of Water Resources |
| EMC | Environmental Management Commission |
| EPA | Environmental Protection Agency |
| FY | fiscal year |
| GI | green infrastructure |
| GIS | geographic information systems |
| GREEN | Guided Reduction of Excess Environmental Nutrients |
| HUC | Hydrologic Unit Code |
| I&I | infiltration and inflow |
| IDDE | Illicit Discharge Detection and Elimination |
| LATT | Little Alamance Creek, Travis Creek, and Tickle Creek |
| LID | low impact development |
| mg/L | milligrams per liter |
| MS4 | municipal separate storm sewer systems |
| NC | North Carolina |
| NCAC | North Carolina Administrative Code |
| NCDENR | North Carolina Department of Environment and Natural Resources |
| NCDMAC | North Carolina Drought Management Advisory Council |
| NCDOT | North Carolina Department of Transportation |
| NCEEP | North Carolina Ecosystem Enhancement Program |
| $NO_3$ | nitrate |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | Natural Resources Conservation Service |
| NSW | Nutrient Sensitive Waters |
| PCSP | Post-Construction Stormwater Program |
| PTCOG | Piedmont-Triad Council of Governments |
| PTRC | Piedmont-Triad Regional Council |
| ROW | right-of-way |
| SCMS | Stormwater Control Management System |
| SMART | Stormwater Management and Recovery of the Triad |
| SR | State Route |
| SWPPP | Stormwater Pollution Prevention Plan |
| TKN | total Kjeldahl nitrogen |
| TMDL | total maximum daily load |
| USFWS | US Fish and Wildlife Service |
| USGS | United States Geological Survey |
| WWTP | wastewater treatment plant |

# Executive Summary

The Little Alamance Creek watershed is located in Alamance County, North Carolina, within the upper Cape Fear River Basin. The watershed is approximately 15.9 square miles in size and includes portions of the cities of Burlington and Graham. Little Alamance Creek flows southeast into Big Alamance Creek, approximately three miles upstream of its confluence with the Haw River.

In 2000, Little Alamance Creek was identified as impaired and included on the North Carolina 303(d) List of Impaired Waters based on a “Poor” bioclassification rating due to the results of benthic macroinvertebrate (benthos) sampling. Impairment for biological integrity is based on a narrative standard that pertains to the aquatic life use designation. Biological integrity has been defined as "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). In streams and rivers, biological integrity is often evaluated using quantitative and qualitative assessments of benthic macroinvertebrate and other aquatic community assemblages. The health of these aquatic communities is determined by water quality and habitat conditions as well as the interactions of complex physical, chemical, and biological processes that shape these stream conditions.

Since 2000, water quality monitoring has confirmed the “Poor” benthos rating but has failed to identify a specific pollutant(s) causing the impairment. A review of available water quality data concluded that data on Little Alamance Creek are not sufficient to draw definitive conclusions on the source of biological impairment or support the development of a total maximum daily load (TMDL) (URS, 2014). The existing watershed reports attributed impairment to those factors that are typical of the complex condition found in many urban watersheds, including hydro-modification, insufficient riparian buffer, streambank erosion, pollutants in stormwater runoff, and degradation of instream habitat.

As described in section 2 of this report, most, if not all, of the stressors thought to be present in the Little Alamance Creek watershed today may have been present long before its impaired status was determined in 2000. Over the past three centuries, land and water resources in Alamance County have been impacted by a multitude of wide-ranging human activities that have resulted in dramatic long-term alterations to the natural hydrology and water quality of the streams in the watershed. Agricultural and industrial activities, such as straightening and channelizing streams, and construction of dams for gristmills, sawmills, cotton mills, and textile mills were common in the watershed and are well documented. For many years the Little Alamance Creek was the receptor of industrial waste and raw sewage. While the impacts of these pollutants cannot be quantified, it is likely that the effects of any such legacy pollutants have had a lasting impact on the water quality in the watershed.

During the summer of 2012, representatives from the North Carolina Department of Transportation (NCDOT) and the cities of Burlington and Graham (hereafter “project partners”) committed to supporting a Category 4b Demonstration process in Little Alamance Creek watershed. As part of this commitment, the project partners have prepared a Category 4b Demonstration Plan (this document) describing management actions that, when implemented, will contribute to the overall goal of restoring water quality and achieving a benthic macroinvertebrate community bioclassification of “Not Impaired”, “Good-Fair”, or better.

Restoring biological integrity and aquatic life use in Little Alamance Creek will depend on the implementation of pollution controls, management practices, and other strategies and activities designed to mitigate known stressors. Collectively referred to as best management practices (BMPs), these activities function to reduce or avoid pollutant inputs to receiving waters in order to achieve water quality protection goals and restore and maintain the physical, chemical, and biological integrity of the receiving waterbodies. BMPs provide this function through control of discharges that could alter natural hydrology, reduction of pollutant loads that are delivered to a waterbody, and mitigation of other stressors that might contribute to impairment. Section 6.0 of this document describes the specific BMPs that the project partners will implement in Little Alamance Creek watershed and the schedule under which those BMPs will be implemented. The project partners all share responsibility in implementing their individual pollution controls for municipal operation and industrial activities being performed within the boundaries of their municipal separate storm sewer system (MS4s) as well as at owned and operated facilities. The proposed approach will enable each of the project partners to implement those BMPs for which they are best suited.

BMPs and conditions in Little Alamance Creek will be reported through a dashboard approach described in section 7. Four dashboard groups, "Streamside Enhancement", "Public Involvement and Outreach", "Pollution Prevention and Reduction", and "Stream Health" will be used to document implementation activities designed to achieve water quality standards and track the effectiveness of those pollution controls. Section 7 describes the dashboard groups along with the proposed BMPs and associated reporting metrics.

It is anticipated that achieving the goal of "Not Impaired", "Good-Fair", or better benthos bioclassification will require significant time and effort on the part of the project partners as well as participation with other stakeholders within the watershed. As described in section 8, the toolbox items will be implemented within an adaptive management framework. This framework for Little Alamance Creek is built upon the overview of the historical and current state of the watershed (Sections 1–4) and the assessment of appropriate pollution controls (Section 5–6). The adaptive management process begins with the implementation of the toolbox items. Pollution controls and monitoring activities performed by the project partners across the Little Alamance Creek watershed will then be tracked, and efforts by the project partners will be assessed against available water quality data collected by North Carolina Department of Environment and Natural Resources (NCDENR) and the project partners. Results of this analysis will be used to adjust future actions performed by the project partners. A summary of the information gathered during the adaptive management process will be distributed through a proposed public website. In addition to reporting on watershed activities, the dashboard will serve the project partners in communicating with and encouraging the general public to participate in opportunities that help to restore biological health in Little Alamance Creek.

# 1.0 Introduction

The Little Alamance Creek watershed is located in Alamance County, North Carolina, within the upper Cape Fear River Basin (Figure 1-1). The watershed is approximately 15.9 square miles in size and corresponds with the United States Geological Survey (USGS) 12-digit hydrologic unit code (HUC-12) 030300020309 boundary. The watershed is located within the Southern Outer Piedmont ecoregion (level IV), a subset of the larger Piedmont ecoregion (level III).

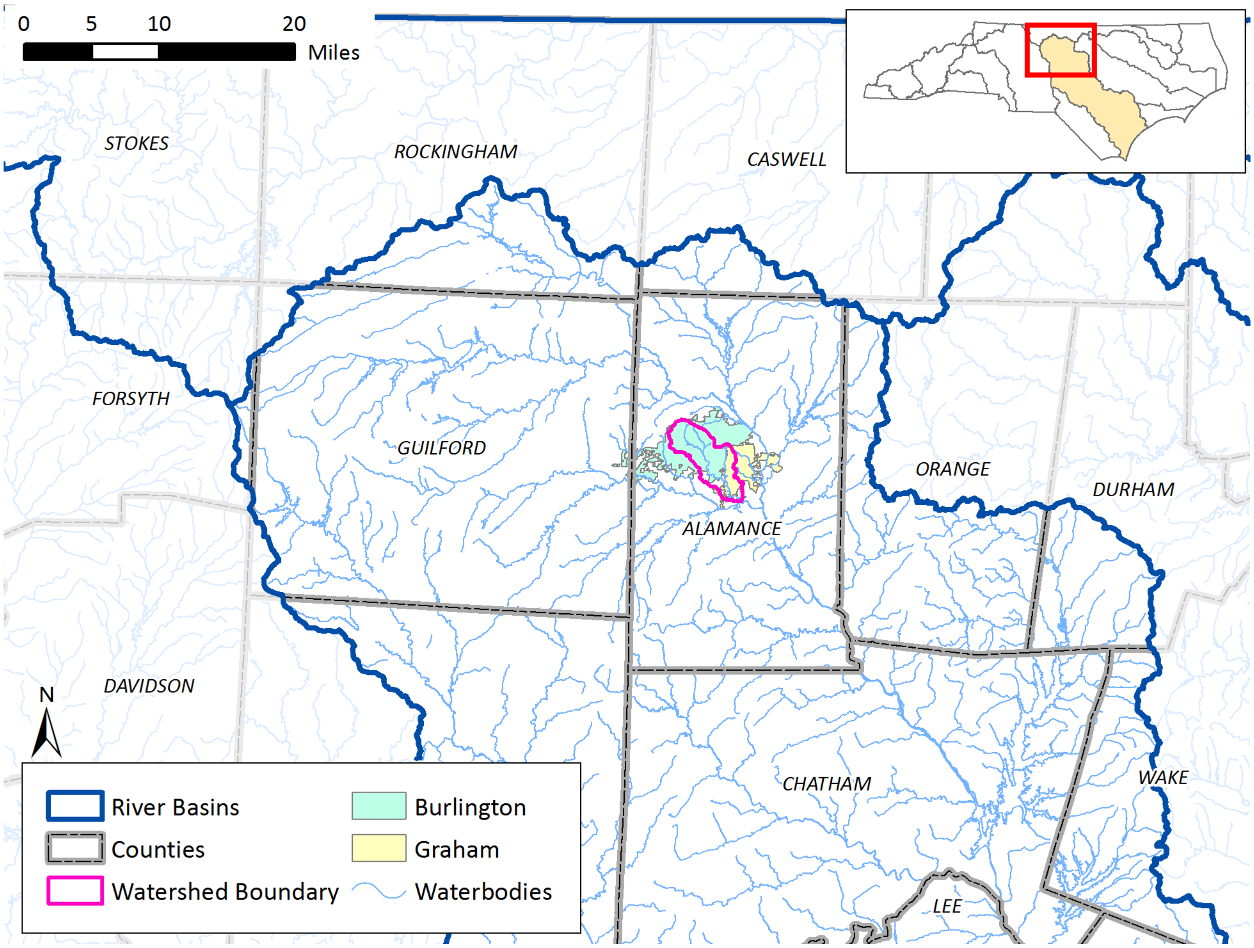


**Figure 1-1. Little Alamance Creek watershed and surrounding region**

The Little Alamance Creek watershed includes portions of the cities of Burlington and Graham, and is drained by Little Alamance Creek and its tributaries: Coble Branch, Brown Branch (also referred to as Willowbrook Creek), Dye Branch, and Bowden Branch (also known as Boyd Creek). The creek flows southeast into Big Alamance Creek, approximately three miles upstream of its confluence with the Haw River. Little Alamance Creek and four tributaries have been assigned an assessment unit ID by the North Carolina Division of Water Resources (DWR) (Figure 1-2).

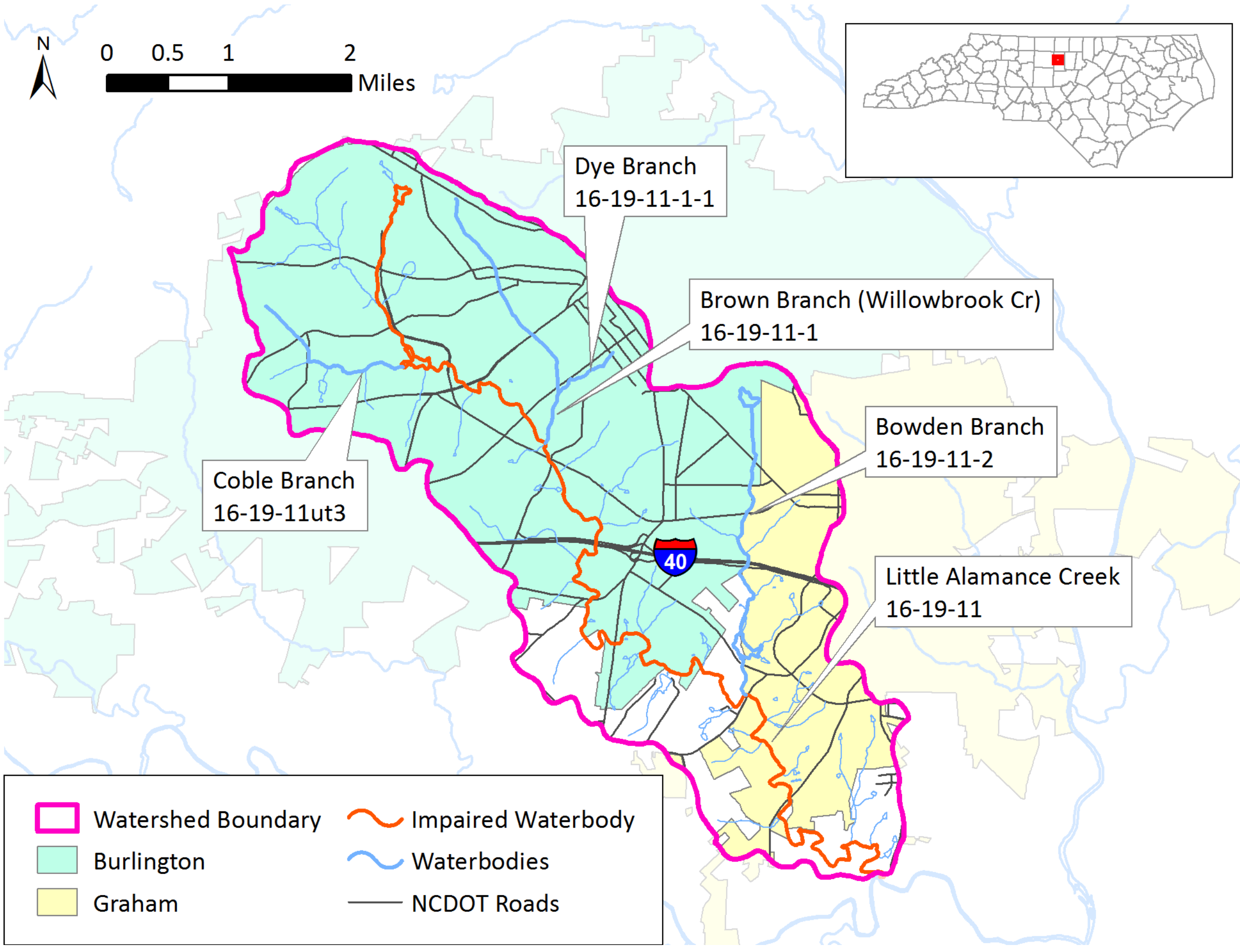


**Figure 1-2. Little Alamance Creek, tributaries, and neighboring cities**

DWR (formerly Division of Water Quality, DWQ) regularly assesses waters throughout the state to determine whether they are meeting the water quality criteria specified for their designated surface water classification, as described in the North Carolina Administrative Code (NCAC) Title 15A NCAC 02B. The results of these assessments are listed in the State's biennial Integrated Report (DWQ, 2012a) to the EPA, in fulfillment of the Clean Water Act (CWA). Each waterbody within the Integrated Report is assigned a category based on its assessment results. Categories range from 1 to 5, with Categories 1 and 2 indicating no impairment, Category 3 indicating inconclusive data, and Categories 4 and 5 denoting impairment from one or more parameters. Subcategories are denoted using letters.

Three named tributaries of Little Alamance Creek have not yet been assessed by DWR (Table 1-1). Coble Branch was listed as a Category 3a due to inconclusive assessment results. In 2000, Little Alamance Creek was listed as impaired (Category 5) by DWR due to a "Poor" bioclassification rating of the benthic macroinvertebrate community (benthos). In 2013, Little Alamance Creek was assigned a "Good-Fair" bioclassification for fish, but remained listed as Category 5 on the Impaired Waters List due to a benthos bioclassification of "Poor". Category 5 waterbodies not meeting defined water quality standards, i.e., waterbodies that are biologically or otherwise impaired and require a TMDL, are recorded in the State's 303(d) list of impaired waters, which is incorporated into the North Carolina biennial Integrated Report.

**Table 1-1. Summary of streams within the Little Alamance watershed (DWQ, 2012b)**

| Reach Name | Reach Description | Assessment Unit | Waterbody Classifications* | 2012 Integrated Report Category† | Rating | Length (miles) |
|---|---|---|---|---|---|---|
| Little Alamance Creek | From source to Big Alamance Creek | 16-19-11 | WS-V; NSW | 5<br><br>1 | Poor bioclassification (benthos, 2006)‡<br>Good-Fair bioclassificiation (fish, 2013) | 12.6 |
| Unnamed Tributary (UT) to Little Alamance Creek (Coble Branch) | From source to Little Alamance Creek at Mays Lake | 16-19-11ut3 | — | 3a | Not Rated | 1.5 |
| Brown Branch (Willowbrook Creek) | From source to Little Alamance Creek | 16-19-11-1 | WS-V; NSW | — | — | 2.3 |
| Dye Branch | From source to Brown Branch | 16-19-11-1-1 | WS-V; NSW | — | — | 0.6 |
| Bowden Branch (Boyd Creek) | From source to Little Alamance Creek | 16-19-11-2 | WS-V; NSW | — | — | 3.8 |
| Other UTs | — | — | — | — | — | >30.5 |

Notes:
* "WS-V" is Water Supply V. "NSW" is Nutrient Sensitive Waters.
† Categories range from 1 to 5, with letters used for subcategories. Categories 1 and 2 indicate no impairment; Category 3a indicates inconclusive data; Category 3c indicates no data; Categories 4 and 5 denote impairment. The 2012 Integrated Report lists overall ratings of "5" for assessment unit 16-19-11 and "3" for assessment unit 16-19-11ut3.
‡ Assessment unit 16-19-11 was first listed as impaired for poor bioclassification (benthos) on the 2000 303(d) List.

Impairment for biological integrity is based on a narrative standard that pertains to the aquatic life use designation. Biological integrity has been defined as "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). In streams and rivers, biological integrity is often evaluated using quantitative and qualitative assessments of benthic macroinvertebrate and other aquatic community assemblages. The health of these aquatic communities is determined by water quality and habitat conditions as well as the interactions of complex physical, chemical, and biological processes that shape these stream conditions.

In contrast to some water quality impairment listings that indicate a specific pollutant of concern, biological impairments simply indicate that an impaired condition exists. Biological assessments do not provide a cause of impairment nor do they necessarily indicate what management approaches are best suited to effectively address the impairment. Despite these limitations, the strength of biological evaluations is that they provide the best indication of overall aquatic health because they reflect both short and long-term stream conditions and reflect any impacts of stressors and pollutants that may not be detected using episodic water quality chemistry measurements. In watersheds where no water quality standard violations have been identified, biological impairments may indicate the presence of infrequent stresses, pollutants, or activities for which current water quality standards or criteria do not exist or are inadequate in detecting.

## 1.1 Options for Addressing Biological Impairment

The goal of the CWA is "to restore and maintain the physical, chemical, and biological integrity of the Nation's waters" (33 U.S.C §1251(a)). Under Section 303(d) of the CWA, states are required to biennially prepare and submit to the United States Environmental Protection Agency (EPA) a report that identifies waters that do not meet or are not expected to meet surface water quality standards after implementation of technology-based effluent limitations or other required controls. Impaired waterbodies must be addressed through the preparation of total maximum daily loads (TMDLs), or other appropriate management action, including technology-based effluent limitations, more stringent effluent limitations, or other pollution control requirements (e.g., best management practices) that are stringent enough to achieve water quality standards (see 40 CFR 130.7(b)(1)) within a reasonable period of time. The list of impaired waters awaiting the development of a TMDL is referred to as the "303(d) List".

As its name implies, a TMDL is intended to improve water quality by defining the maximum loading allowable for a given pollutant. When a waterbody is impaired for a known pollutant with identifiable pollutant sources, TMDLs provide an effective tool for defining the existing and allowable pollutant load and support activities that restore a waterbodies' intended uses. However, in watersheds where the pollutant or sources of impairment are unknown, existing and allowable loads cannot be calculated and other management approaches are needed to assess existing conditions, stressors, or sources contributing to impairment, and potential implementation activities or approaches. In densely populated or urbanized watersheds, water quality and biological health may be compromised as a result of multiple physical, chemical, and biological stressors rather than a single pollutant or source.

In 2001-2003, the North Carolina Department of Environment and Natural Resources (NCDENR) Watershed Assessment and Restoration Program (WARP) performed intensive water quality and watershed studies in eleven biologically-impaired streams to identify the most likely causes of impairment, determine the major watershed activities and pollution sources contributing to those causes, and define watershed strategies for restoration activities and best management practices (BMPs) (NCDENR, 2014). In all eleven watersheds evaluated, the WARP reports concluded that biological impairment was caused by multiple stressors and sources and that restoration activities should include a wide range of management actions. Examples of management actions cited in the WARP studies include restoring stream channels in conjunction with stormwater retrofit BMPs, restoring riparian vegetation and aquatic habitat, implementing actions to reduce organic debris and nutrient loading, mitigating hydrological effects from existing development, addressing toxicological sources, improving sediment and erosion control practices, implementing BMPs to prevent the delivery of pesticides to the stream, implementing education programs, and collecting additional data. These recommendations, along with similar conclusions from other urban watershed studies, suggest that biological impairment is complex, and that a broad range of management actions are generally needed to understand and address these types of impairment.

## 1.2 Description of the Category 4b Demonstration Approach

The EPA encourages the use of alternative approaches, in addition to TMDLs, to achieve the water quality goals of the State (EPA, 2013a). One listed alternative is known as the "Category 4b Demonstration". An impaired waterbody listed as Category 5 may be re-categorized as Category 4b when the management strategy that is expected to address the identified impairment(s) is deemed adequate by EPA. The process of approving a Category 4b Demonstration occurs through EPA's formal approval of the 303(d) List.

The objective of a Category 4b Demonstration is to "promote implementation activities designed to achieve water quality standards in a reasonable period of time" (DWQ, 2011). To achieve this objective, the EPA has identified six elements that should be addressed within a Category 4b Demonstration (Table 1-2). These six elements are also referenced within NCDENR's Category 4b guidance (DWQ, 2011). Specifically, a Category 4b Demonstration should clearly identify the Category 5 waterbody and its impairment, describe the water quality standard and the pollution controls to be implemented in order to reach said target, estimate the time upon which the specific water quality standard will be met, provide a schedule for implementation of various pollution controls, specify a monitoring plan, and provide a commitment to revising the Category 4b Demonstration, as necessary, toward meeting the stated water quality target. As presented in Table 1-2, each EPA element has been included in this Category 4b Demonstration for Little Alamance Creek.

**Table 1-2. EPA/DWR-required elements for a Category 4b Demonstration (EPA, 2006a; DWQ, 2011)**

| | Category 4b Demonstration Six Required Elements | Corresponding Report Sections |
|---|---|---|
| 1 | Identification of waterbody assessment unit number(s) and statement of the problem causing the impairment | Sections 1.0, 3.0, and 4.0 |
| 2 | Description of pollution controls and how they will achieve water quality standards (WQS) | Section 5.0 |
| 3 | Estimation or projection of the time when WQS will be met | Section 8.0 |
| 4 | Schedule for implementing pollution controls | Section 6.0 |
| 5 | Monitoring plan to track effectiveness of pollution controls | Section 7.0 |
| 6 | Commitment to revise pollution controls, as necessary | Section 7.1 |

## 1.3 Project Partners

In 2011 and 2012, representatives from NCDENR, NCDOT, the Cities of Burlington and Graham, and other municipalities participated in meetings to discuss biologically-impaired waterbodies and strategies for addressing impairment when the pollutant(s) causing impairment is unknown. During the course of these meetings, the Category 4b Demonstration, along with other options, was discussed as an alternative to a TMDL. After investigating these options, NCDOT, the Cities of Burlington and Graham (hereafter referred to as the "project partners") voluntarily committed to supporting a Category 4b Demonstration process to address impairment in Little Alamance Creek. As part of this commitment, the project partners have evaluated watershed data and information and jointly prepared a Category 4b Demonstration report (this document) describing management actions that, when implemented, will contribute to the overall goal of improving water quality and achieving a benthic macroinvertebrate community bioclassification of "Not Impaired", "Good-Fair", or better. Formal letters of those commitments, along with DWR's agreement to support a Category 4b Demonstration process in the Little Alamance Creek watershed, are presented in appendix A.

# 2.0 Historical Background

Prior to European settlement of the area, the Little Alamance Creek watershed was likely a predominately forested watershed interspersed with piedmont prairie maintained by fire and large grazing animals such as bison and elk. Native American populations are known to have inhabited the area and likely maintained or created open areas in the forest to raise crops and enhance hunting opportunities of wild game. It is assumed that Native Americans did not have a major impact on water quality and that Little Alamance Creek had abundant aquatic life and a stable hydrologic regime. Beginning with the arrival of Europeans in the early 1700s, the land and water resources in Alamance County have sustained the impacts of a multitude of wide-ranging human activities that have resulted in dramatic long-term alterations to the natural hydrology and water quality of the streams in the watershed.

Like many urban streams in the Piedmont of North Carolina, Little Alamance Creek has followed an evolution from a pristine resource to an agrarian utility to an industrial engine to a waste conveyance to the impaired urban drainages we see today. Likewise, the level of public concern and subsequent governmental regulations regarding water resources have evolved over the years from non-existent to driven by hygiene and sanitation, then water supply protection, and now reestablishing aquatic life and biodiversity. The various industrial enterprises and lack of regulations likely resulted in the discharge of pollutants to Little Alamance Creek and its tributaries. The effects of any such legacy pollutants may have had a lasting impact on the water quality in the watershed.

The present-day condition of Little Alamance Creek is best understood in the context of these historical activities as well as more recent efforts to restore and protect water resources. This section provides a high-level overview of significant land use practices and activities affecting Little Alamance Creek since the eighteenth century and also highlights key water quality protection measures. Major events that affected water quality in and around the Little Alamance Creek watershed, as well as major state and federal water quality regulations, are presented in Figure 2-2. As water quality regulations are typically enacted to address existing concerns, there is often a temporal lag between watershed events and water quality regulations. A more detailed historical commentary for the watershed is provided in appendix B.

## 2.1 Eighteenth and Nineteenth Centuries

### 2.1.1 Land Use Changes

European settlement of the area began in the early eighteenth century. Quakers, Scots-Irish Presbyterians, and German Lutherans from Pennsylvania were among early immigrants who established numerous settlements in Alamance County (Vacca and Briggs, n.d.). Industrialization and urbanization during this time influenced how water resources were altered and used during this and successive periods.

#### 2.1.1.1 Agricultural Impacts

Agriculture and silviculture were significant land uses in both the eighteenth and nineteenth centuries. Timber was harvested and sawmills were constructed to supply lumber to build settlements and eventually towns. The earliest farming was for subsistence and included growing fruits and vegetables and raising cattle and hogs. Later in the eighteenth century, cotton, corn, wheat, oats and rye, flax, and tobacco were grown as commercial crops. Many streams were straightened and channelized to maximize efficient use of arable land and enhance drainage. Dams were also constructed, as the streams provided the channel slope and flow needed for mill races and water wheels. Numerous gristmills were built along the Haw River and its tributaries to produce corn meal and flour. By 1890, there were also a number of sawmills in Alamance County. Figure 2-1 indicates six hydro-powered mills located along Little Alamance Creek in 1893.

#### 2.1.1.2 Industrial Impacts

During the Industrial Revolution some early mill sites became the location for textile mills. Most textile mills provided water power for spinning machines and looms; some mills were later converted to steam power. By the late 1830s, there were 41 gristmills in Alamance County (Vacca and Briggs, n.d.). In 1879, there were 40 gristmills and 24 sawmills. Over half of these mills were built during the previous 20 years (Lounsbury, 1980). As late as 1928 there were still 30 mills, mill dams, or mill sites located in Alamance County.

The first cotton mill in Alamance County was built on the Haw River in 1832, and by 1890, there were 17 cotton mills in the county. At least three late nineteenth century cotton mills were built near the headwaters of several Little Alamance Creek tributaries.

Colorfast indigo dye was used to produce the first colored cotton goods in the South (Vincent, 2009). The production and use of indigo dye was a potential source of water pollution. In addition to the reactants normally used in the production of the dye, caustic lye (sodium hydroxide) and slaked lime (calcium hydroxide) were sometimes added during the dyeing process. The process also used a mordant agent to help set the dye on the fabric. Mordant agents were often metal oxides and included, at various times, tannic acid, alum, urine, chrome alum (chromium potassium sulfate), sodium chloride, and certain salts of aluminum, chromium, copper, iron, iodine, potassium, sodium, and tin . Chemical byproducts from the dyeing process had the opportunity to enter the environment at three stages of production: during the manufacturing of the dye, during the application of the dye to the yarn or cloth, and during the disposal of industrial wastes.


**Figure 2-1. Historic map of Alamance County indicating six mills located along Little Alamance Creek in 1893 (Spoon, 1893)**

## 2.1.2 Water Quality Regulation and Legislation

In the 1700s, the primary interest in public water supply was focused on fire protection (Howells, 1989). By the 1800s, there was a growing concern for hygiene and sanitation, and a greater awareness of the connection between waste management and illness. The late 1800s saw a series of state legislative actions that constituted the first steps toward managing and protecting water resources. In 1877, the North Carolina General Assembly created the North Carolina Board of Health, which was primarily concerned with water quality in terms of sanitation. Before long, public concern grew to include aquatic life and nuisance conditions, and the State passed an Act prohibiting the use of poisons to catch or kill fish in waters of the state (Howells, 1990). In the 1890s, the North Carolina Board of Health was given authority over all inland waters, including protection of watersheds for domestic water supplies. Before the end of the century, all municipal water supplies in North Carolina were required to be inspected and have chemical and bacteriological analyses. At the federal level, the first legislation to address water pollution was the 1899 Refuse Act, which had the primary purpose of preventing discharge of refuse into navigable waters.

## 2.2 Twentieth and Twenty-First Centuries

### 2.2.1 Land Use Changes

In the late nineteenth century, the first hosiery mills in Alamance County began operation. In the 1920s, many cotton mills were converted to produce rayon and other fabrics. Byproducts of rayon production included carbon disulfide, hydrogen sulfide, and zinc. By 1934, Burlington Mills was the largest producer of rayon in the United States (Vacca and Briggs, n.d.).

### 2.2.2 Water Quality Regulation and Legislation

#### 2.2.2.1 1900–1970

As the timeline in Figure 2-2 illustrates, the twentieth century saw a rapid expansion in efforts to control degradation of water resources. In the early 1900s, water purification standards were adopted and bacteriological analyses using coliform indicator bacteria came into practice. Soon after, legislation was enacted to prevent stream pollution from the disposal of mining waste (Howells, 1990). A Fisheries Commission Board was created to oversee commercial fishing and to enforce discharges of substances harmful to fish.

## Little Alamance Creek History Timeline

| Watershed and Vicinity Events | Year | Water Quality Regulations |
|---|---|---|
| Beginning of European Settlement | 1700s | |
| Land Clearing for Agriculture and Silviculture | Early 1700s | |
| First Cotton Mill Built on the Haw River | 1832 | |
| 41 Gristmills Located in Alamance County | Late 1830s | |
| First Use of Indigo Dye to Color Cotton Yarn | 1853 | |
| Construction of Company Shops | 1855 | |
| 6 Cotton Mills Located in Alamance County | 1877 | |
| 3 Cotton Mills Built near Little Alamance Creek | 1880s | |
| 17 Cotton Mills Located in Alamance County | 1890 | |
| 6 Hydro-Powered Mills on Little Alamance Creek | Prior to 1893 | |
| | 1907 | First Use of Coliform Indicator Bacteria |
| | 1927 | Stream Sanitation Committee Formed |
| | 1948 | Federal Water Pollution Control Act |
| Complaints of Sewage Discharge to Creek | 1950 | |
| | 1953 | First State Stream Classifications and Standards |
| | 1955 | Law to Prohibit Sewage Discharge to Haw River |
| | 1956 | Federal Water Pollution Control Act Amended |
| Wastewater Treatment Plant (WWTP) near the Current Location of South Graham Park Began Operation | 1952 | |
| | 1961 | Federal Water Pollution Control Act Amended |

**Figure 2-2. Timeline of watershed events near Little Alamance Creek watershed, and state and federal water quality regulations**

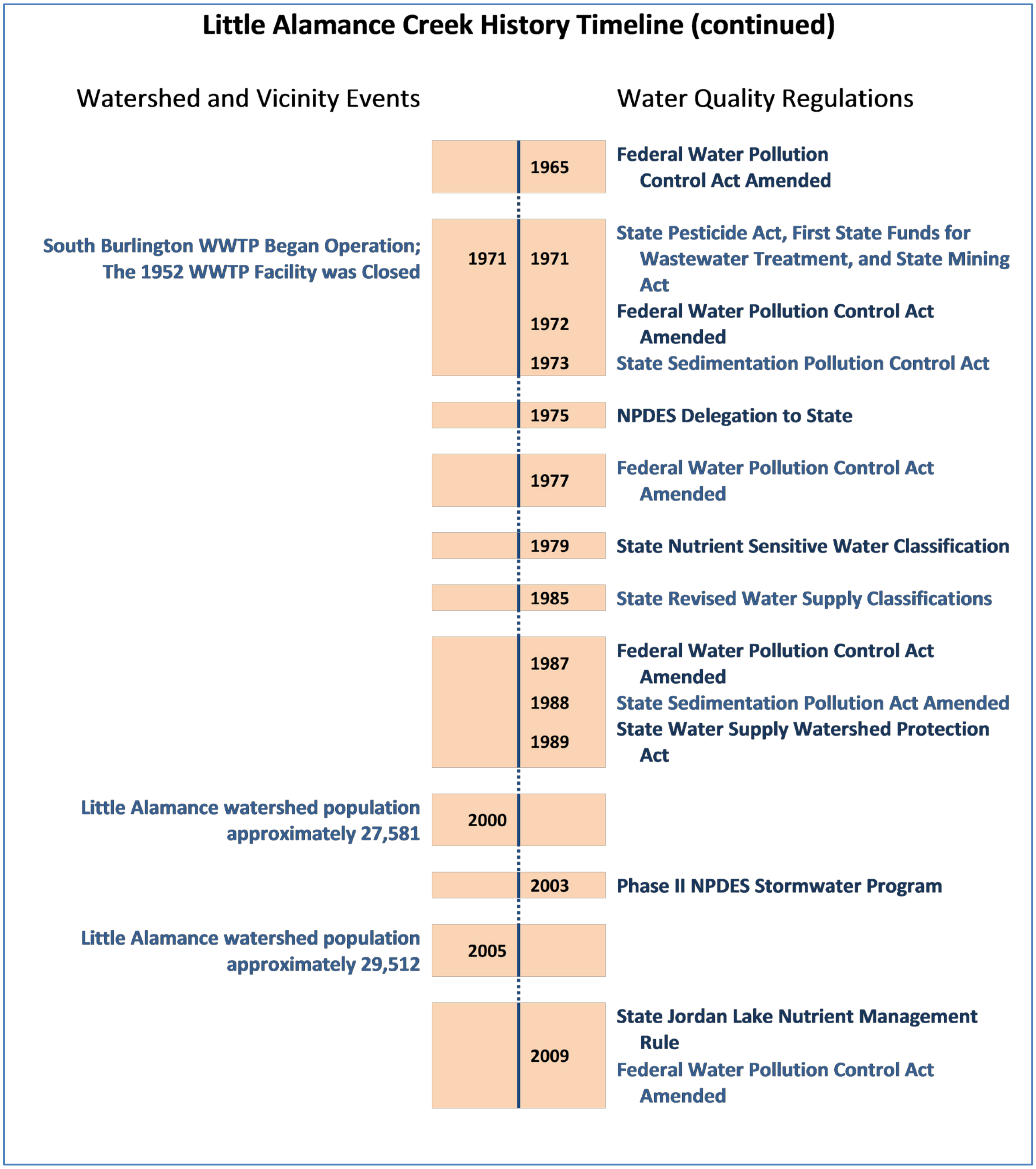


**Figure 2-2. Timeline of watershed events near Little Alamance Creek watershed, and state and federal water quality regulations (continued)**

The most significant piece of legislation at the federal level was the Federal Water Pollution Control Act, enacted by the United States Congress in 1948. It was the beginning of federal–state cooperative water pollution control programs that continue today. In 1951, the North Carolina General Assembly enacted the State Stream Sanitation Act which established the State Stream Sanitation Committee (Howells, 1989). The law authorized a comprehensive stream pollution control program determined by stream classifications based upon best usage categories of the waterway. In 1955, acts were adopted to prohibit discharges of raw sewage, industrial waste, and other substances into the Haw River and the Northeast

Cape Fear River. Pollution of these waters was defined as conditions not meeting their best usage classification or violation of applicable water quality standards (Howells, 1990). The Federal Water Pollution Control Act was amended in 1956, 1961, and 1965, offering additional protections to streams by enhancing wastewater treatment efforts and establishing water quality standards.

*Municipal Sewage Discharge*: Prior to the 1950s, there was no effective statewide law to control discharges to waters of the state (DeVane, n.d.). Discharge of raw sewage directly to streams was common. In the 1930s, the North Carolina Board of Health frequently cited stream pollution as one of the State's greatest problems. Like many communities at that time, the City of Burlington did not have a wastewater treatment plant (WWTP), and sewage was discharged directly into Little Alamance Creek. In 1950, numerous complaints against the City of Burlington were filed with the North Carolina State Board of Health by citizens living along Little Alamance Creek. In 1951, a claim in the amount of $20,000 was filed against the City of Burlington by two residents of Graham for alleged damages arising from the City's discharge of sewage into Little Alamance Creek (The Burlington Daily Times-News, 1951).

In fact, more complaints had been filed against the City of Burlington than any other city in the state, so the State Board of Health urged the City to construct a sewage disposal plant to avoid multiple law suits (The Burlington Daily Times-News, 1950). In 1952, a WWTP located near what is now South Graham Park began operations. Several years later, a major interceptor sewage line and a WWTP for the Little Alamance Creek drainage area was built near the confluence of Big Alamance Creek and the Haw River and the previous WWTP was closed. Currently, wastewater from within the watershed is treated by either the South Burlington WWTP or the City of Graham WWTP. Both WWTPs discharge to surface waters outside of the Little Alamance Creek watershed.

#### 2.2.2.2 1970s–Early 2000s

*Industrial Wastewater*: By 1970, sewage management had improved substantially, but industrial wastewater discharges were still a major source of degradation in receiving streams. In 1970, regulations were adopted requiring cities receiving industrial wastes to adopt sewer use ordinances, which were used to reimburse cities for the cost of treating industrial waste. The Federal Water Pollution Control Act was again amended in 1972, requiring that all industrial discharges be permitted under the National Pollution Discharge Elimination System (NPDES). Permitting was also required for sanitary waste discharges. In 1975, the EPA delegated responsibility to North Carolina for the administration of NPDES permits. With the 1972 amendments, the original focus on protection of public water supplies was broadened to include protection of all water uses. Section 401 of the legislation authorized states including North Carolina to require water quality certifications for federally permitted or licensed activities that could result in a discharge of pollutants into waters of the United States.

*Nonpoint Source Pollution*: Throughout the 1970s, several other regulations were passed, including the Sedimentation Pollution Control Act, which regulated construction sites and land-disturbing activities.

In 1989, the State reported that 30% of North Carolina's streams were degraded, and nonpoint source pollution was cited as the primary source of degradation (Howells, 1990). In order of importance, agriculture, urban runoff, and construction with sediment were identified as the most widespread cause of degradation. In response, the State created agriculture and forestry cost-share programs to match funds for BMPs, and a water supply watershed protection program. State legislation and/or rules followed for mandatory nonpoint source pollution control in water supply watersheds, undisturbed buffer zones along trout waters, BMPs for silviculture, increased funding for agriculture, nonpoint source protection for High Quality Waters, expansion of nonpoint-related groundwater programs, watershed management programs, waste reduction and recycling, and wetland protection.

In 1989, the State began planning for the development and adoption of a statewide stormwater management plan, and also adopted legislation to enhance protection of water supply watersheds. In the same year, NCDENR was created to consolidate all environmental, environmental health, and natural resource programs into a single state agency (Howells, 1990).

*Nutrient Management*: In 1979, a supplemental usage classification was approved for Nutrient Sensitive Waters for surface waters experiencing excessive algal or other aquatic plant growth. Following an extensive fish kill in the Neuse River in 1995, NCDENR began focusing on reducing nitrogen in several of the state's rivers through the use of buffer rules. In 1997, buffer rules were adopted in the Neuse River Basin. Subsequently, buffer rules were adopted in the Randleman Lake Water Supply Watershed in 1999, in the Tar-Pamlico River basin in 2000, in the Catawba River basin in 2004, in the Goose Creek Water Supply Watershed in 2009, and in the Jordan Lake Water Supply Watershed in 2009.

In 2009, the Environmental Management Commission adopted the Jordan Lake Nutrient Management Strategy rules. The Little Alamance Creek watershed, as well as the entirety of the cities of Burlington and Graham, is within the Jordan Lake watershed and subject to the Jordan Lake Nutrient Strategy rules. The strategy is intended to restore and maintain the lake's classified uses. The rules require stormwater management plans for new development, public education, inventory of municipal separate storm sewer system systems (MS4s), removal of illicit discharges, retrofit opportunities for existing development, and BMP maintenance for local communities within the Jordan Lake Watershed. The rules also include options to offset nutrient loads by purchasing reduction credits from other sellers. Diffuse flow into 50-foot wide riparian buffers is required for all intermittent and perennial streams, lakes, ponds, and reservoirs. Nitrogen and phosphorus waste load allocations (WLA) are required for existing wastewater treatment facilities. Nutrient reduction goals are required for agricultural operations as well (NCDENR, n.d.-a).

*NPDES Stormwater Program*: In 1990, Phase I of the NPDES stormwater program was established and required permit coverage for municipalities with populations of 100,000 people or more. Requirements included public education, illicit discharge detection and elimination, construction and post-construction programs, pollution prevention and good housekeeping, storm sewer system inventory and mapping, and water quality monitoring (NCDENR, 2007). Phase II of the NPDES stormwater program began in 2003. The federal rules required certain smaller MS4 operators to meet similar Phase I requirements for larger municipalities (EPA, 2005).

In 1997, the Environmental Management Commission adopted goals to improve nutrient-impaired waters and developed management plans to reduce nutrient inputs from point sources and nonpoint sources. In 2005, rules were established to implement nutrient management strategies to protect drinking water supply reservoirs including TMDL limits when necessary (NCDENR, n.d.-b).

Additional content on the history of both the Little Alamance Creek watershed and North Carolina water quality regulations are located in appendix B.

# 3.0 Present Day Little Alamance Creek and its Watershed

## 3.1 General Watershed Conditions

### 3.1.1 Topography

The Little Alamance Creek watershed is located in the Piedmont physiographic province of North Carolina. The 15.9 square mile watershed ranges in elevation from approximately 450 feet at the confluence with Big Alamance Creek to 700 feet in the headwaters. The Little Alamance Creek watershed is located entirely within one the Southern Outer Piedmont (Level IV) Ecoregion. This ecoregion has lower elevations, less relief, and less precipitation than its neighboring ecoregions. The landform class is mostly dissected irregular with some rounded hills and ridges.

### 3.1.2 Geology and Soils

The Little Alamance Creek watershed lies in the Carolina Slate Belt. The watershed is composed mainly of three geological types: metamorphosed granitic rock in the northern headwaters of the watershed, and metamorphosed gabbro and diorite, and mafic metavolcanic rock in the middle and lower portions of the watershed. Gneiss, schist, and granite are typical rock types, and the rocks are more intensely deformed and metamorphosed than the geologic materials in neighboring ecoregions. The rocks are covered with deep saprolite and mostly red, clayey subsoils.

An insignificant amount of soil in the watershed is classified as hydrologic soil group (HSG) A (sandy; low runoff potential), with the remaining identified soil portion composed of types B, C, and D soils (Table 3-1). The predominant soil association in the Little Alamance Creek watershed is Mecklenburg-Enon-Cecil, comprising almost the entire watershed south of US Highway 70 (US 70). The Vance-Appling-Enon-Cecil association is found north of US 70 and encompasses the majority of the hydric soils found in the watershed. Hydric soils can be found throughout the watershed within the floodplain, but most predominantly along the Little Alamance Creek streambeds and surrounding area north of US 70.

**Table 3-1. Hydrologic soil groups within the Little Alamance Creek watershed**

| Soil Group† | Soil Texture | Runoff Potential | Percentage of Watershed Area |
|---|---|---|---|
| A | Sandy | Low | 0.3 |
| B | Loamy Sand | Moderately Low | 25.0 |
| C | Sandy Clay Loam | Moderately High | 38.0 |
| D | Clayey | High | 12.0 |
| N/A* | — | — | 24.0 |
| Open Water | — | — | 0.6 |

† Soil data downloaded from http://datagateway.nrcs.usda.gov/GDGOrder.aspx
* Soil group data was not available for highly urban areas

### 3.1.3 Climate

Alamance County has a mild year-round climate with four seasonal changes. The annual normal mean temperature is 59.2 °F, with the annual normal minimum and maximum temperatures of 47.1 °F and

71.2 °F, respectively. The annual normal rainfall is approximately 45 inches, while the average annual frozen precipitation is 4.0 inches (State Climate Office, 2013, weather station ID 311239).

The Little Alamance Creek watershed has experienced periods of moderate to exceptional drought in recent years. The North Carolina Drought Management Advisory Council has recorded the weekly drought status for each 8-digit HUC since January 2000. Additional precipitation and drought information is presented in section 4.1.2.

## 3.2 Surface Waters and Wetlands

### 3.2.1 Little Alamance Creek and Its Tributaries

The Little Alamance Creek watershed is located in the Upper Cape Fear River Basin, within the Haw River subbasin. Little Alamance Creek flows into Big Alamance Creek approximately three miles upstream of its confluence with the Haw River. There are approximately 50 miles of perennial and intermittent streams in the watershed as determined by the USGS Quadmap. The Little Alamance Creek assessment unit is identified as 16-19-11. The assessment unit includes 12.6 freshwater miles from source to Big Alamance Creek. Little Alamance Creek is designated a Class C water, indicating that it is protected for secondary recreation, fish consumption, biological integrity, agriculture, and other uses suitable for Class C. Little Alamance Creek is also classified as a Water Supply V (WS-V) and Nutrient Sensitive Waters (NSW).

Key tributaries to the Little Alamance Creek include Bowden Branch, also known as Boyd Creek (3.8 miles); Brown Branch also known as Willowbrook Creek (2.3 miles); and Dye Creek (0.6 miles). Bowden Branch originates at Snoffers Lake north of Providence Road and drains to the south to Little Alamance Creek immediately north of Monroe Holt Road in the city of Graham. Bowden Branch divides the cities of Burlington and Graham north of Interstate 85 (I-85). The contributing watershed north of I-85 is primarily urban as evidenced by a lack of naturally-draining tributaries. In the southeast portion of the watershed, south of I-85, the watershed is primarily undeveloped.

Brown Branch drains the older neighborhoods surrounding Burlington to the southwest of the watershed. The headwaters originate near West Webb Avenue and converge with Little Alamance Creek downstream of Pine Hill Cemetery. Much like Bowden Branch, there are very few naturally draining tributaries.

Dye Creek is a tributary to Brown Branch. It originates near downtown Burlington and parallels Mebane Street before it joins Brown Branch downstream of Pine Hill Cemetery. The contributing watershed includes older neighborhoods southwest of downtown Burlington and sporadic industrial and commercial developments.

### 3.2.2 Wetlands and Surface Waters

Wetland and surface waters can play an important role in balancing the hydrology of a watershed and providing instream water quality treatment. Approximately 15.2 acres of freshwater wetlands (emergent, shrub/scrub, and forested) and 66.4 acres of ponds and lakes are within the Little Alamance Creek watershed (USFWS, 2013). Mays Lake is the only significant surface impoundment on Little Alamance Creek. It is approximately eight acres in size and is located at the confluence of Coble Branch and Little Alamance Creek, immediately upstream of US 70.

## 3.3 Riparian Condition

The absence of riparian buffers exacerbates other stream habitat problems including bank failure, severe streambank erosion, embedded channel substrate, loss of riffle-pool sequences, and excessive light penetration which leads to declines in the respective metrics used to assess these habitat features. As part of the habitat assessments for the North Carolina Ecosystem Enhancement Program (NCEEP) Local Watershed Plans, riparian vegetative width was recognized as the second best indicator of low habitat scores. Both Brown Branch sites and the two most upstream Little Alamance Creek locations (Little Alamance Creek at Mebane Street and NC 54) scored below 5 on the scale of 1 to 10 for Riparian Vegetative Zone width. The three downstream sites had higher scores for this metric because they passed through lesser developed areas with intact riparian buffers.

## 3.4 Population and Land Use

### 3.4.1 Land Use

The Little Alamance Creek watershed includes portions of the cities of Burlington and Graham, NCDOT right-of-way (ROW), and non-incorporated area. The cities of Burlington and Graham, and NCDOT areas cover approximately 87% of the Little Alamance Creek watershed (Table 3-2). Approximately two-thirds and one-fifth of Burlington and Graham are located within the watershed, respectively, as are 63.4 miles of NCDOT roads.

**Table 3-2. Summary of Burlington, Graham, and NCDOT areas within the Little Alamance Creek watershed**

| Name | Total Area (sq mi)* | Area within Watershed (sq mi) | Percentage of Watershed Area |
|---|---|---|---|
| Little Alamance Creek Watershed | 15.9 | 15.9 | 100.0 |
| Burlington | 24.8 | 10.1 | 63.8 |
| Graham | 9.2 | 2.9 | 18.3 |
| NCDOT ROW† | — | 0.8 | 4.8 |
| Non-incorporated Areas | — | 2.1 | 13.1 |

* Total areas for the municipalities include the jurisdictional areas outside of Little Alamance Creek watershed. NCDOT area outside of Little Alamance Creek watershed was not estimated for this table.
† Length of NCDOT roads within the watershed is 63.4 miles.

Land use and land cover in the watershed play a substantial role in stream water quality and aquatic habitat. The Little Alamance Creek watershed is mostly urbanized with 89.4% of the area developed. Single family residential housing is the most predominant land use (59.7%), followed by industrial (12.4%) (Table 3-2). Both downtown Graham and Burlington are north of I-40/85 corridor and the residential development radiates out from these urban cores. Industrial and commercial uses are clustered mainly around the I-40/85 corridor and the major thoroughfares (US 70, NC 87, NC 54, NC 49, and NC 100) between the urban cores and major thoroughfare intersections. NCDOT area is estimated to be approximately 4.8% of the watershed. Undeveloped and agricultural land is mostly found south of I-85. There are some areas south of the I-40/85 corridor that are within the watershed and are outside of the corporate limits of Burlington and of Graham. These areas, 13.1% of the watershed, are unincorporated areas within Alamance County.

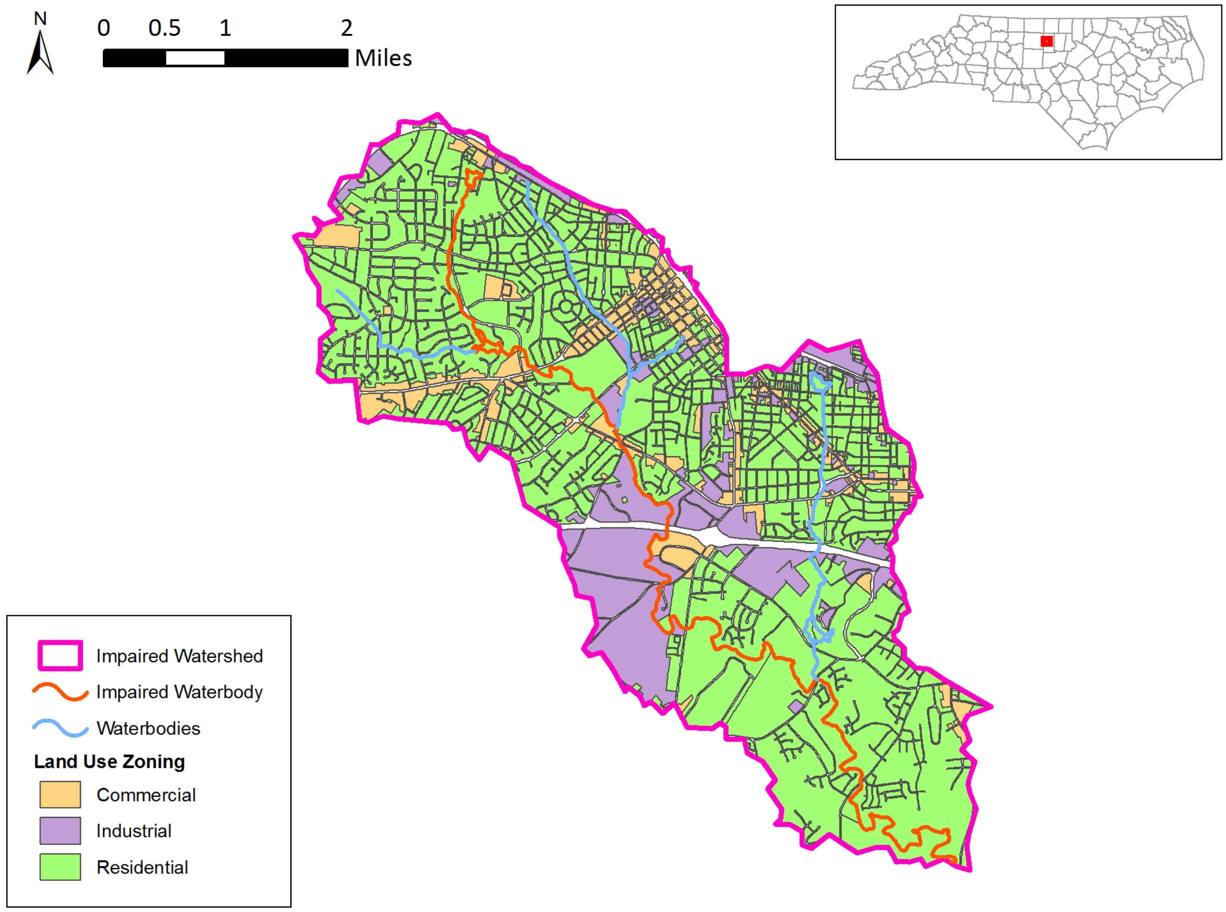


**Figure 3-1. Map of primary zoning categories in the Little Alamance Creek watershed (Trish Patterson, personal communication, Geographic Information Systems [GIS] Specialist for the City of Burlington, July 15, 2014)**

### 3.4.2 Future Development Trends

Future development within the watershed north of the I-40/85 corridor is limited by existing development and topographical features. The primary areas of future development will likely be south of the I-85/40 corridor and appear to be predominately residential development with some limited industrial development potential to the south of Burlington and along the Burlington and Graham boundary.

### 3.4.3 Current Population

An NCEEP (2007) report compiled by the Piedmont-Triad Regional Council (PTRC) (formerly Piedmont-Triad Council of Governments [PTCOG]) listed the Little Alamance Creek watershed population at 27,581, based on 2000 US Census data. The same report also provided a 2005 population estimate of 29,512 based on data from the PTRC Regional Data Center. This equates to an annual population growth rate of 1.3%.

### 3.4.4 Future Population and Trends

Population in Little Alamance Creek is thought to have leveled off since 2012 based on the impact of the recent recession on housing development. While there are small amounts of undeveloped land in the watershed, only a portion of these areas is likely to be developed as residential land use. Exact development patterns in the area south of the I-40/85 corridor have not been identified. Regional growth trends for the area indicate that multi-family development may be a major contributor to overall residential development.

# 4.0 Potential Stressors Causing Biological Impairment

The biological impairment listing for Little Alamance Creek is based on the results of benthic macroinvertebrate (benthos) sampling. Benthic macroinvertebrates have been surveyed 11 times by DWR—five times at one site and one time at six additional sites. The USGS also conducted one benthic survey at one site. Fish communities have been surveyed five times by DWR at one location. Locations of these and other monitored locations within the watershed are shown in Figure 4-1. Since different reports may refer to a single monitoring location using different names, Table 4-1 provides a cross-reference of station IDs for major online databases and reports. Table 4-2 provides sampling dates as well as bioclassifications for Little Alamance Creek watershed monitoring locations.

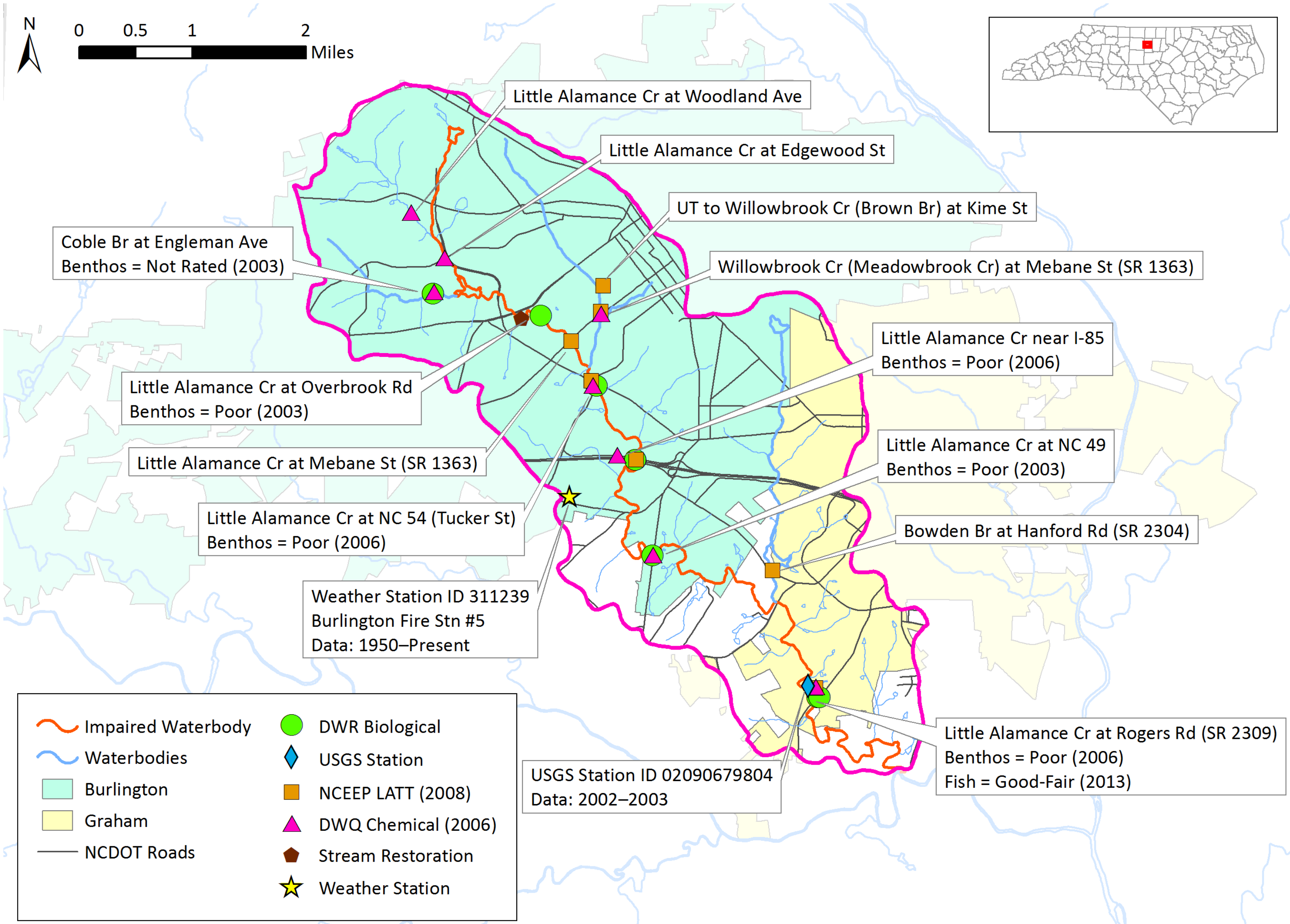


**Figure 4-1. Biological, physicochemical, flow, and climate monitoring locations within the Little Alamance Creek watershed. Most recent DWR bioclassification is noted at applicable sites. "LATT" refers to the NC Ecosystem Enhancement Program's local watershed plan for Little Alamance Creek, Travis Creek, and Tickle Creek.**

**Table 4-1. Monitoring locations cross-referenced by reporting ID from select online databases and reports**

| Monitoring Location | DWQ Biological ID | USGS Station ID | NCEEP (2008) ID | DWQ (2006) ID |
|---|---|---|---|---|
| Little Alamance Cr at Rogers Rd (State Route [SR] 2309) | BB388, B1920000, BF60 | 209679804 | 19 | Little Alamance Cr at Rogers Rd |
| Coble Br at Engleman Ave | BB42 | — | — | Coble Br at Engleman Ave |
| Little Alamance Cr at Edgewood St | — | — | — | Little Alamance Cr at Edgewood St |
| Little Alamance Cr at Woodland Ave | — | — | — | Little Alamance Cr at Woodland Ave |
| Bowden Br at Hanford Rd (SR 2304) | — | — | 20 | — |
| Little Alamance Cr at NC 49 | BB131 | — | — | Little Alamance Cr at NC 49 |
| Little Alamance Cr near I-85 | BB46, BB78 | — | 18 | Little Alamance Cr at Plantation Dr (I-85 Frontage) |
| Little Alamance Cr at NC 54 | BB47 | — | 17 | Little Alamance Cr at NC 54 (Tucker St) |
| Willowbrook Cr (Brown Br) at Mebane St (SR 1363) | — | — | 15 | Meadowbrook Cr at Mebane St |
| UT to Willowbrook (Brown Br) Cr at Kime St | — | — | 14 | — |
| Little Alamance Cr at Mebane St (SR 1363) | — | — | 16 | — |
| Little Alamance Cr at Overbrook Rd | BB193 | — | — | — |

The farthest downstream monitoring site in the watershed and the site with the most data, Little Alamance Creek at Rogers Road (SR 2309), has samples dating to 1985. All benthos samples received a bioclassification rating of “Fair” or “Poor” for each sampling event. This site received a “Not Rated” score in 2008 due to low streamflow as a result of drought, but would have otherwise rated as “Fair” score if adequate streamflow levels were present at the time of sampling (Figure 4-2). All DWR bioclassifications for Little Alamance Creek watershed monitoring locations are listed in Table 4-2.

**Table 4-2. DWR biological sampling results in the Little Alamance Creek watershed**

| Monitoring Location | STORET ID | Sample Date | Type | DWR Bioclassification |
|---|---|---|---|---|
| Little Alamance Cr at NC-49 | BB131 | 6/23/2003 | Benthos | Poor |
| Little Alamance Cr at Overbrook Rd | BB193 | 6/24/2003 | Benthos | Poor |
| Little Alamance Cr at Rogers Rd (SR 2309) | BB388 | 7/14/2008 | Benthos | Not Rated[1] |
| | | 9/12/2006 | Benthos | Poor |
| | | 6/23/2003 | Benthos | Fair |
| | | 7/10/1998 | Benthos | Poor |
| | | 7/29/1985 | Benthos | Fair |
| Coble Br at Engleman Ave | BB42 | 6/24/2003 | Benthos | Not Rated[2] |
| Little Alamance Cr near I-85 (Frontage Rd) | BB46 | 9/12/2006 | Benthos | Poor |
| Little Alamance Cr at NC 54 | BB47 | 9/12/2006 | Benthos | Poor |
| Little Alamance Cr near I-85 | BB78 | 6/23/2003 | Benthos | Poor |
| Little Alamance Cr at Rogers Rd (SR 2309) | BF60 | 4/24/2013 | Fish | Good-Fair |
| | | 4/16/2009 | Fish | Good |
| | | 4/23/2003 | Fish | Good |
| | | 4/8/1998 | Fish | Fair |
| | | 11/4/1993 | Fish | Good |

[1] "Not Rated" due to low flow conditions
[2] "Not Rated" due to a small catchment area

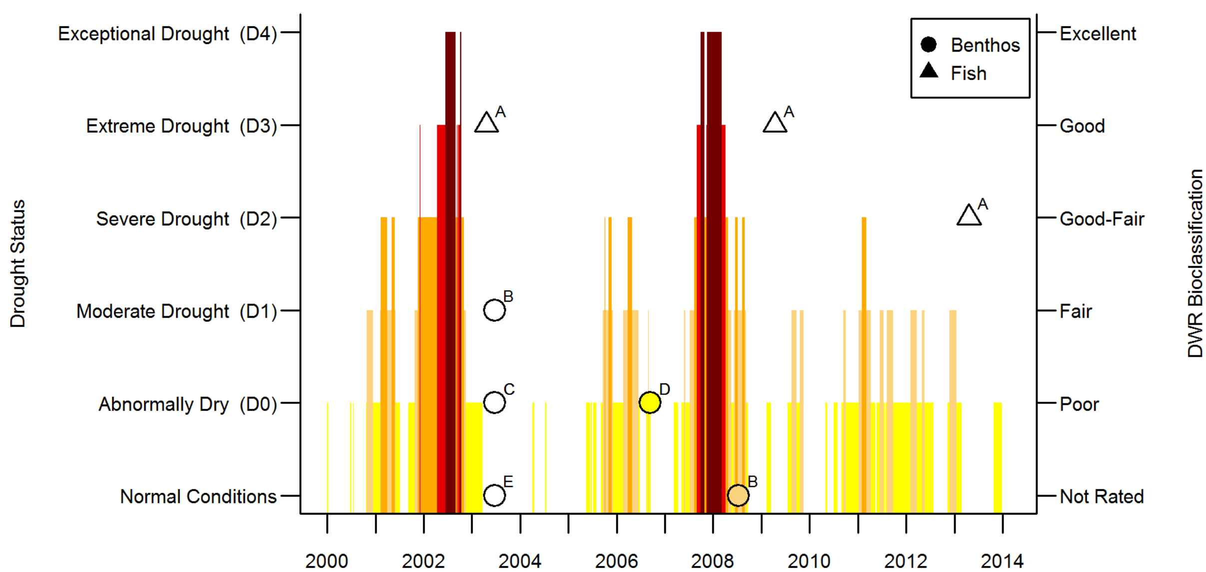


**Figure 4-2. Weekly drought status history for the Haw subbasin (HUC 03030002) which contains the Little Alamance Creek watershed. DWR bioclassification ratings (right axis) for various monitoring sites within the Little Alamance Creek watershed. Color of symbol denotes the drought status of the watershed at the time of sampling. Upper-case letters denote sampled locations (EPA STORET ID): A = BF60; B=BB388; C=BB131, BB78, BB193; D=BB46, BB47, BB388; E=BB42.**

## 4.1 Existing Water Quality Data and Previously Identified Stressors

Prior to identifying potential stressors a literature review and inventory of existing sources of data for the watershed was prepared. This task culminated in a document titled *Little Alamance Creek 4b Demonstration Project Existing Data Inventory* (reprinted in appendix C). The data inventory included a search of online databases, published documents, and personal communication with local officials. The overall conclusion of the inventory was that extensive data on water quality is lacking, and the results have been inconclusive in identifying specific stressors. The available water quality data was the product of short-term targeted studies rather than long-term, continuous monitoring programs. Most of the water quality data have been collected at one location (Little Alamance Creek at Rogers Road [SR 2309]). Table 4-3 summarizes the sources containing water quality data, listed in chronological order by sample date.

**Table 4-3. Summary of reports or online databases describing water quality data in the Little Alamance Creek watershed**

| Data Source | Date Range of Data Collection | Number of Sites Sampled |
|---|---|---|
| EPA STORET data download (EPA, 2013b) | 1968-1975 | 1 |
| Selected Physical, Chemical, and Biological Data for 30 Urbanizing Streams in the North Carolina Piedmont Ecoregion, 2002–2003. (Giddings et al., 2007) | February 2003-July 2003 | 1 |
| TMDL stressor study of Little Alamance Creek, Alamance County, Cape Fear (Memorandum) (DWQ, 2003) | June 2003 | 5 |
| Draft TMDL to Address Impaired Biological Integrity in the Little Alamance Creek Watershed (DWQ, 2010) | June 2003 | 5 |
| Draft Summary of Existing Water Quality Data (DWQ, 2006) | July 2006 | 8 |
| Evaluation of Water Quality, Habitat and Stream Biology in the Little Alamance, Travis, and Tickle Creek Watersheds (DWQ, 2008) | December 2006-August 2007 | 6 |
| Biological Assessments – Cape Fear River Basin (DWQ, 2009) | July 2008 | 1 |

### 4.1.1 Brief History of Water Quality Data Collection

The earliest known water quality sampling occurred from 1968 – 1975, at the SR 2309 location. During this period, a wide variety of parameters were analyzed, but the total number of samples was small. Water quality data for this period are available at the EPA STORET website.

In 2003, USGS conducted sampling on Little Alamance Creek at SR 2309 as part of a National Water Quality Assessment study (Giddings et al., 2007). Continuous stream stage and stream temperature measurements were collected for one year and water chemistry samples were collected twice. Parameters analyzed included basic physiochemical parameters and nutrients as well as pesticides and herbicides. Also in 2003, DWQ conducted a TMDL stressor study that included five sample locations (DWQ, 2003). The study focused on benthic collections, and basic physiochemical data were collected concurrently. In July of 2006, DWQ conducted a one-week study in an attempt to identify areas with water quality problems and developed a plan for additional monitoring (DWQ, 2006). Single measurements of specific conductance were taken at eight bridge crossings across the watershed. Additionally, an automated sampling device was installed at the SR 2309 location for one week, collecting hourly data on temperature, dissolved oxygen, pH, and specific conductance. The largest water quality sampling effort occurred from December 2006 to August 2007, in support of the NCEEP Local Watershed Plans (DWQ, 2008). The results of this study are discussed in section 4.1.2. The dataset available for the SR 2309 location includes one additional physicochemical measurement associated with benthos sampling for the Cape Fear River Basin Biological Assessment in 2008.

### 4.1.2 DWQ Sampling Data (2006–2007)

The most extensive water quality dataset is reported in the Evaluation of Water Quality, Habitat, and Stream Biology in the Little Alamance, Travis, and Tickle Creek Watersheds (DWQ, 2008). The data included sites in two neighboring rural watersheds in addition to the Little Alamance Creek watershed. Of the sources inventoried, this document contained the only dataset with multiple samples taken over a broad spatial and temporal range. DWQ conducted sampling at seven sites in the watershed over a period of nine months (December 2006 – August 2007). A portion of the sampling period coincided with moderate to exceptional drought conditions across the state (Figure 4-3), which may have influenced the results. The analysis included physicochemical parameters, nutrients, metals, and bacteria as well as benthic community samples and habitat assessments. Samples were taken approximately monthly during baseflow, and on three occasions during stormflow. Some key findings are summarized below.

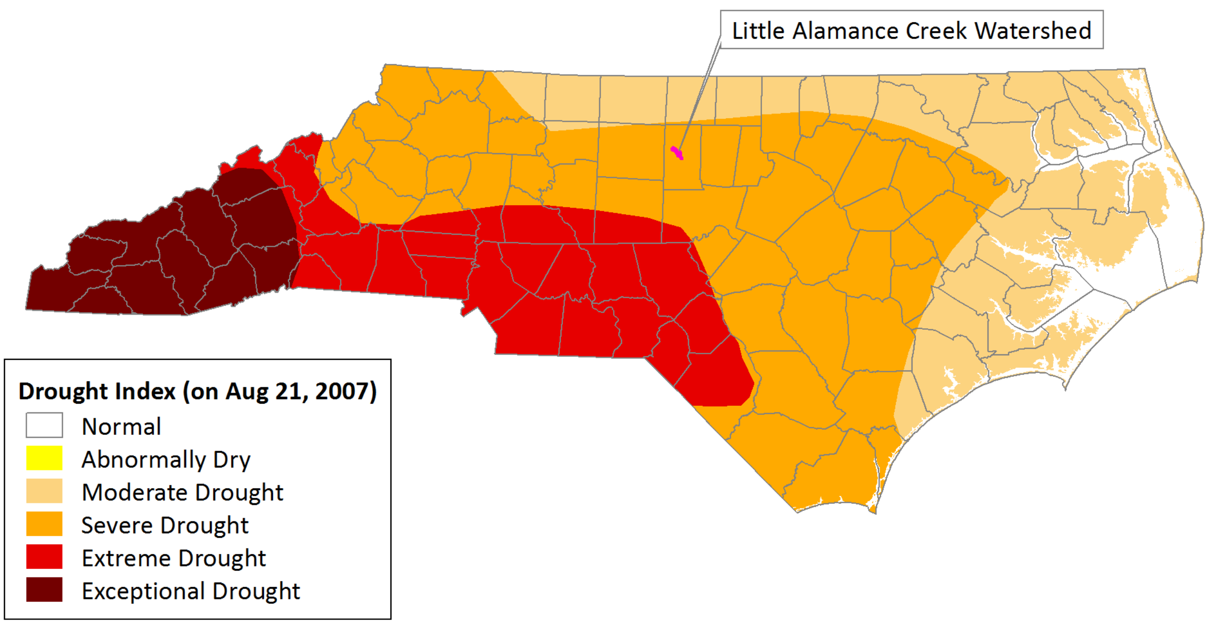


**Figure 4-3. Statewide drought status on August 21, 2007 (North Carolina Drought Management Advisory Council [NCDMAC], http://www.ncdrought.org/archive/index.php)**

*Physicochemical Parameters*. The highest specific conductance measurements occurred in the headwater tributaries of Little Alamance Creek; values decreased at downstream monitoring locations. DWQ concluded that dissolved substances were originating from the urban areas of downtown Burlington and were being diluted further downstream. Brown Branch (referred to as Willowbrook Creek in the DWQ report) samples showed several instances of supersaturated dissolved oxygen concentrations, which were attributed to dense algal blooms noted during sampling. Lower portions of the watershed were found to experience very low levels of dissolved oxygen, falling below the 4.0 mg/L water quality threshold on several occasions. The DWQ report attributed these occurrences to seasonal patterns associated with high air temperatures that were exacerbated by extreme drought conditions and very low flow. Water temperature and pH measurements were within normal ranges.

*Nutrients*. One site, Little Alamance Creek at Mebane Street, was found to have consistently high ammonia concentrations; the site also had the highest Total Kjeldahl Nitrogen (TKN) observed during the study. Willowbrook Creek and an unnamed tributary (UT) to Willowbrook Creek were found to have the highest phosphorus concentrations. The 2008 DWQ report indicated that elevated nutrient concentrations at Little Alamance Creek at Mebane Street and Willowbrook Creek and its UT could be linked to the potential presence of malfunctioning septic or sewage sources. Elevated nutrient loading within the Little Alamance watershed would also be consistent with the watershed's location within the larger, eutrophic Jordan Lake watershed.

*Metals*. Copper, zinc, and lead were found at measureable concentrations within the watershed, predominantly in stormflow samples. Copper was detected in all but two stormflow samples, and most stormflow samples exceeded the 7 µg/L action level. In addition, one baseflow sample taken at Little Alamance Creek at SR 2309 was at the action level of 7 µg/L copper. Lead measurements exceeded the reporting limit only once, in a stormflow sample at Willowbrook Creek. The report stated that this pollutant may have originated from an old city vehicle maintenance facility or possibly from a landfill in the Willowbrook Creek catchment. The Willowbrook Creek site also exceeded the action level for zinc (50 µg/L) in the same stormflow sample, which may also have originated from the same source as the lead. Zinc was measured in five out of seven stormflow samples, and detected in four baseflow samples.

Calcium and magnesium showed slightly elevated baseflow concentrations, possibly due to the abundance of pavement in the urban areas. Both metal concentrations were lower during stormflow samples, indicating dilution during rain events. Sodium concentrations were also elevated, particularly at Willowbrook Creek and Little Alamance Creek at Mebane Street, which is directly downstream of Willowbrook Creek. The report stated that the higher sodium could be an indicator of raw sewage contamination, but could also have originated from other sources.

*Fecal Coliform Bacteria*. Measurements of fecal coliform are used as an indicator of fecal contamination in water. Water contaminated with fecal material may carry *Escherichia coli* (*E. coli*) and other harmful pathogens which can cause food poisoning. Several baseflow samples exceeded the 400 cfu/100 ml reference level (cfu = colony-forming unit) for fecal coliform bacteria: Willowbrook Creek, UT to Willowbrook Creek, and Little Alamance Creek at Mebane Street. One stormflow sample at SR 2309 also exceeded the reference level. High fecal coliform values at these urban sites most likely indicate either sewer line leakage and/or the presence of considerable numbers of domestic pets and/or wildlife.

A display of recent monitoring data events compiled from multiple resources (including the DWQ 2008 report), actual and normal monthly precipitation values, and weekly drought status for Little Alamance Creek watershed is provided in Figure 4-4.

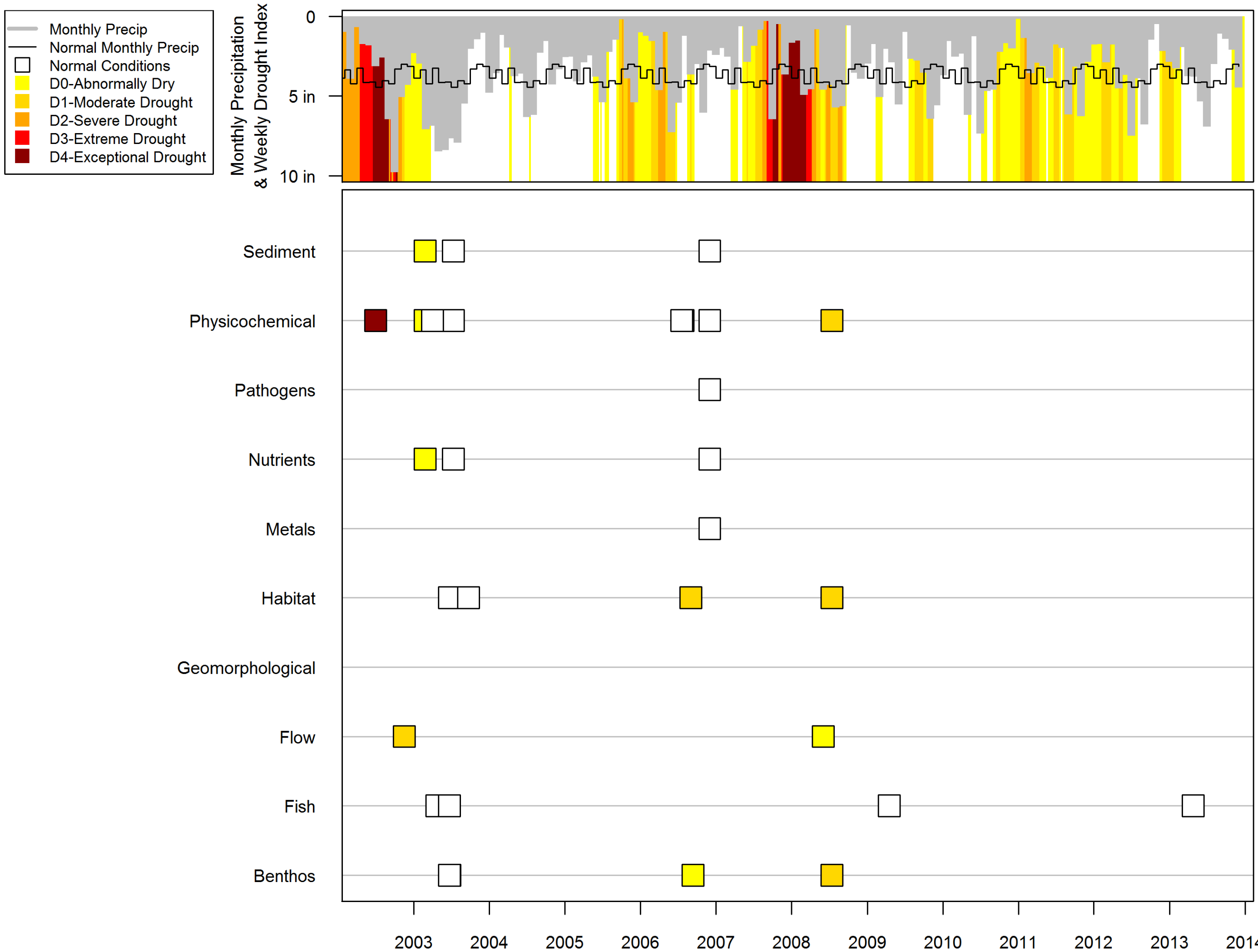


**Figure 4-4. Summary of recent (since 2002) monitoring data for Little Alamance Creek watershed. Data compiled from multiple sources (URS, 2014). Top portion indicates monthly precipitation and normal monthly precipitation from weather station ID 311239 (State Climate Office of North Carolina, http://www.nc-climate.ncsu.edu). Color of square indicates the weekly drought status of Little Alamance Creek watershed at the time of sampling (NCDMAC, http://www.ncdrought.org/archive/index.php).**

*DWR Recommendations*. Recommendations in the 2008 DWQ report included the following:

- Little Alamance Creek, particularly its tributary Willowbrook Creek, would likely benefit from stormwater controls to help moderate the “flashy” hydrology and to reduce sediment and chemical pollutant inputs.
- Restoration is recommended in the Willowbrook Creek subwatershed to improve conditions and to reduce downstream impacts on Little Alamance Creek.
- Particular attention needs to be directed to detecting and correcting the sources of elevated nutrients, heavy metals, and other pollutants in Willowbrook Creek and just downstream of its confluence with Little Alamance Creek.

*Summary.* The available water quality data are not sufficient to draw definitive conclusions about the source of the biological impairment in Little Alamance Creek watershed. The relatively intensive sampling done by DWQ in 2006–2007 did not identify a specific pollutant causing the impairment. Rather, it is likely that the impairment is due to a combination of many complex factors. The existing reports have attributed the impairment to the general conditions typical of an urban watershed, including the following sources:

- Hydro-modification
- Insufficient riparian buffer
- Streambank erosion
- Pollutants in stormwater runoff
- Degradation of instream habitat

## 4.2 Habitat, Riparian Condition, and Channel Geomorphology-Related Stressors

Information on habitat, riparian condition, and channel geomorphology in the watershed is limited. Habitat assessments have been conducted at seven locations throughout the watershed, often concurrent with benthos sampling events. Five sites were evaluated by DWQ during the 2003 TMDL stressor study, and seven sites were evaluated by DWQ in 2006–2007. The habitat assessment scores throughout the watershed have ranged from 53 to 93, out of a maximum possible score of 100. The Little Alamance Creek at SR 2309 site has been assessed three times, with progressively lower scores each time; the scores were 73, 67, and 57 in 2003, 2006, and 2008 respectively. The lowest score was found at Little Alamance Creek at Mebane Street and the highest score was at Bowden Branch at SR 2304. Willowbrook Creek at Mebane Street also had a poor habitat assessment score of 56. As previously noted in section 4.1, this site had multiple water quality issues including elevated levels of phosphorous, lead, zinc, sodium, fecal coliform, and super-saturated dissolved oxygen due to an algal bloom. The reach had been channelized and had no woody riparian buffer. This site would have scored substantially lower if the bank erosion had been active, rather than partially stabilized by herbaceous vegetation and riprap along the bank slopes. Consequently, it is quite likely that bank erosion will become active again and that the habitat total score at this location will decline.

Of the individual metrics that compose the total score, insufficient riffle habitat was the primary contributing factor to low scores. Little Alamance Creek at four different locations (Mebane Street, NC 54, I-85 Frontage Road, and SR 2309) scored below 7 on a scale of 1 to 14 for this metric. The secondary factor contributing to low scores was a lack of riparian buffer. The lack of good riparian buffer zones is a major issue in urban areas where land is at a premium. The absence of riparian buffer exacerbates other stream habitat problems including streambank erosion and subsequent burial of channel substrates, reduced shading, and reduced inputs of woody debris and leaf material.

Another potential stressor is the altered hydrology typical of an urban watershed. The 2008 DWQ study stated that scouring at high flows is a major issue throughout Little Alamance Creek and its tributaries. There are no long-term continuous data on flow, because there are no permanent gauge stations in the watershed. However, stream flow data were collected as part of the USGS study on urbanizing Piedmont streams in 2002 and 2003. Continuous stream stage data were collected hourly for one year, from November 16, 2002 to November 15, 2003. The overall mean discharge for the year was 14.9 cfs.

## 4.3 Stream Geomorphology

There has been no comprehensive assessment of stream geomorphology performed in the Little Alamance Creek watershed. However, three reaches were evaluated for stream restoration. As part of the restoration projects, extensive geomorphological data were collected and documented in the restoration plans for Little Alamance Creek and Brown Branch. Both projects were proposed to be funded by NCEEP. Only one project consisting of the Little Alamance Creek and an unnamed tributary was constructed. Section 5.1.3.1 includes additional information on this restoration project. Table 4-4 summarizes key findings from the pre-restoration geomorphological data.

**Table 4-4. Geomorphological values for select reaches (ARCADIS, 2008)**

| Data Source | Little Alamance Creek (City Park) | UT to Little Alamance Creek (City Park) | Brown Branch (Willowbrook Park) |
|---|---|---|---|
| Drainage Area (sq mi) | 4.2 | 0.1 | 0.8 |
| Gradient (ft/ft) | 0.0024 | 0.0095 | 0.0069 |
| Channel to Depth Ratio | 14.0 | 9.3 | 13.9 |
| Sinuosity | 1.2 | 1.1 | 1.01 |
| D50 (mm) | 2.4 | 3.4 | 8.4 |
| Rosgen Classification | C5/1 and E5/1 | E4/1 | C4/1 and E4/1 |
| NCDENR Stream Classification Score | 47.5 | 33.0 | 35.5 |

Little Alamance Creek at Burlington's City Park in its pre-restoration condition was a pool-dominated system with approximately 65% of the stream length comprised of pools. In the middle section of the project reach, the pools are separated by fairly short and steep bed-rock steps. The C5 stream type is a slightly entrenched, meandering, sand-dominated, riffle/pool channel with a well-developed floodplain (Rosgen, 1997). The E5 stream type is characterized by low to moderate sinuosity, gentle to moderately steep gradients with very low channel width to depth ratios (Rosgen, 1997). The substrate of an E5/1 or C5/1 stream type is comprised mainly of sand with the occurrence of bedrock. The hybrid classification given to Little Alamance Creek reflects the range of channel dimensions found throughout the site.

The upper reach of the UT immediately downstream of Overbrook Road is steeper than the lower reach at the confluence with Little Alamance Creek. The lower reach is located in the relatively flat floodplain of Little Alamance Creek. The E4/1 stream type has gentle to moderately steep gradients with very low width to depth ratios. They are riffle/pool streams and exhibit gravel-size bed material with areas of bedrock. Typically E4/1 channels are meandering streams.

Brown Branch exhibits the aforementioned characteristics of an E4/1 channel but a segment also exhibits C4/1 characteristics. The C4/1 stream type is a slightly entrenched, riffle/pool channel with a well-developed floodplain. The channel substrate is gravel-dominated with areas of bedrock. The C4/1 stream channels have gentle gradients of less than 2%, and display high width/depth ratios. Typically C4/1 channels are meandering but this channel is confined by the limits of Willowbrook Park.

## 4.4 Potential Point Source Stressors

There are generally two types of stressors that impact waterways: nonpoint source pollution and point source pollution. Nonpoint source pollution comes from diffuse sources and includes any source of water pollution that does not meet the legal definition of a “point source” in section 502(14) of the CWA. Point source stressors originate from a readily identifiable source, such as a wastewater discharge pipe from an industrial process or a sewage treatment plant or other discrete conveyance such as a pipe or constructed ditch. EPA also classifies urban stormwater running off of impervious surfaces as a point source pollutant. The NPDES Program regulates point source stormwater discharges from MS4s, construction activities, and industrial activities. There are three MS4 operators in the Little Alamance Creek watershed: City of Burlington, City of Graham, and NCDOT.

### 4.4.1 Critical Areas

There are a number of locations and land uses within Little Alamance Creek that may exhibit the potential to contribute to the degradation of water quality from contributing runoff, non-compliant operations, or past practices. These areas may no longer be contributing pollutants via runoff, spills, or groundwater to Little Alamance Creek or its tributaries but can be categorized as hot spots for future evaluation and monitoring. Typical facilities and land uses that fall into this category include landfills, NPDES discharges, dump sites, and industries no longer operating or now required to perform pretreatment of the wastewater. The Cities of Burlington and Graham have compiled a spatial dataset of these locations for reference in future planning efforts and plan implementation.

### 4.4.2 NPDES-Permitted Stormwater Dischargers

The Cities of Burlington and Graham are both regulated MS4 Phase II NPDES communities (NCS000428 and NCS000408, respectively). They received NPDES permits July 1, 2005, which were renewed in November 2011. NCDOT has an active NPDES permit (NCS000250) originally issued in 1998 and most recently renewed on September 10, 2010. A review of the NCDENR’s Stormwater Permitting Program list (DEMLR, 2013) indicates that there are 14 active general NPDES stormwater permittees in or close to the Little Alamance Creek watershed, three individual NPDES stormwater permittees, and two facilities with No Exposure certifications within the watershed (Figure 4-5 and Table 4-5).

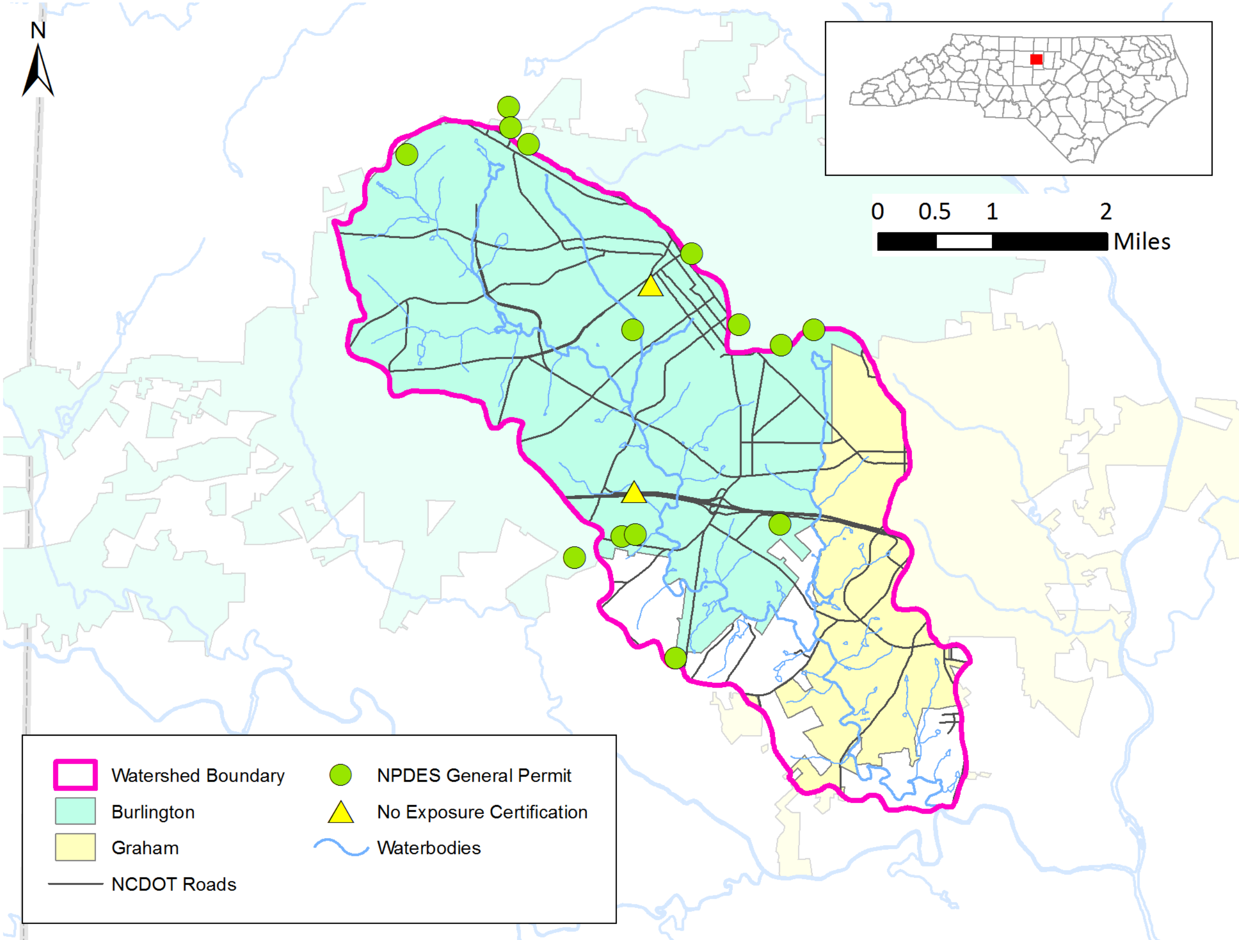


**Figure 4-5. Active NPDES-permitted facilities within approximately 300 yards of Little Alamance Creek watershed (DEMLR, 2013; City of Burlington, personal communication, June 24, 2014)**

**Table 4-5. Permitted facilities in or near the Little Alamance Creek watershed (DEMLR, 2013)**

| Permit Class | Permit Number | Owner Name | Facility Name | Owner Type | Permit Type | Effective Date | Expiration Date | Permit Status |
|---|---|---|---|---|---|---|---|---|
| **Within the Little Alamance Creek watershed:** | | | | | | | | |
| MS4 | NCS000428 | City of Burlington | City of Burlington | Government—Municipal | Stormwater Discharge, Individual (MS4) | 11/11/2011 | 11/10/2016 | Active |
| MS4 | NCS000408 | City of Graham | City of Graham | Government—Municipal | Stormwater Discharge, Individual (MS4) | 11/11/2011 | 11/10/2016 | Active |
| MS4 | NCS000250 | NCDOT - Hydraulics Unit | NCDOT Statewide Stormwater MS4 | Government—State | Stormwater Discharge, Individual (MS4) | 9/10/2010 | 9/9/2015 | Active |
| General | NCG030188 | Sapa Burlington LLC | SAPA Burlington, LLC | Non-Government | Metal Fabrication Stormwater Discharge COC | 12/4/2012 | 10/31/2017 | Active |
| General | NCG080315 | Ernie Koury Jr | The Place | Non-Government | Transportation w/Vehicle Maintenance/Petroleum Bulk/Oil Water Separator Stormwater Discharge COC | 11/1/2012 | 10/31/2017 | Active |
| General | NCG080431 | Carolina Tank Lines Inc | Carolina Tank Lines Incorporated | Non-Government | Transportation w/Vehicle Maintenance/Petroleum Bulk/Oil Water Separator Stormwater Discharge COC | 11/1/2012 | 10/31/2017 | Active |
| General | NCG080706 | City of Burlington | Burlington Equipment Services | Government - Municipal | Transportation w/Vehicle Maintenance/Petroleum Bulk/Oil Water Separator Stormwater Discharge COC | 11/1/2012 | 10/31/2017 | Active |
| General | NCG170202 | Burlington Industries LLC | Burlington Industries-BHP Plant | Non-Government | Textile Mill Products Stormwater Discharge COC | 8/1/2009 | 7/31/2014 | Active |
| General | NCG170228 | Kayser-Roth Corporation | Kayser Roth Corp-Burlington Plant | Non-Government | Textile Mill Products Stormwater Discharge COC | 8/1/2009 | 7/31/2014 | Active |
| No Exposure | NCGNE0091 | Homac Corporation | Lessona/Holt Distribution | Non-Government | Stormwater Discharge, No Exposure Certificate | 5/1/2005 | — | Active |
| No Exposure | NCGNE0831 | BD Diagnostics - Women's Health | BD Diagnostics - Women's Health | Non-Government | Stormwater Discharge, No Exposure Certificate | 1/10/2012 | — | Active |

**Table 4-5. Permitted facilities in or near the Little Alamance Creek watershed (DEMLR, 2013) (continued)**

| Permit Class | Permit Number | Owner Name | Facility Name | Owner Type | Permit Type | Effective Date | Expiration Date | Permit Status |
|---|---|---|---|---|---|---|---|---|
| **Within approximately 300 yards of Little Alamance Creek watershed:** | | | | | | | | |
| General | NCG080316 | Lee Properties SC LLC | Tucker Street Industrial Park | Non-Government | Transportation w/Vehicle Maintenance/Petroleum Bulk/Oil Water Separator Stormwater Discharge COC | 12/12/2012 | 10/31/2017 | Active |
| General | NCG140089 | Chandler Concrete Co., Inc. | Chandler Concrete Co - Burlington Plt #601 | Non-Government | Ready Mix Concrete Stormwater/Wastewater Discharge COC | 7/1/2011 | 6/30/2016 | Active |
| General | NCG170213 | Burlington Technologies | Burlington Manufacturing Services | Non-Government | Textile Mill Products Stormwater Discharge COC | 8/1/2009 | 7/31/2014 | Active |
| General | NCG170241 | Glen Raven Inc | Glen Raven, Inc. Custom Fabrics | Non-Government | Textile Mill Products Stormwater Discharge COC | 8/1/2009 | 7/31/2014 | Active |
| General | NCG170242 | Glen Raven Inc | Glen Raven Inc | Non-Government | Textile Mill Products Stormwater Discharge COC | 8/1/2009 | 7/31/2014 | Active |
| General | NCG200346 | Commercial Metals Company | Commercial Metals Company | Non-Government | Wholesale Trade of Metal Waste and Scrap Stormwater Discharge COC | 1/1/2010 | 12/31/2014 | Active |
| General | NCG200483 | — | OK Recycling | Individual | Wholesale Trade of Metal Waste and Scrap Stormwater Discharge COC | 4/2/2012 | 12/31/2014 | Active |
| General | NCG170250 | National Spinning Company Inc | National Spinning Company - Alamance Dye | Non-Government | Textile Mill Products Stormwater Discharge COC | 8/1/2009 | 7/31/2014 | Active |

Notes:
COC = certificate of coverage

Certain industrial facilities within Burlington and Graham may also have wastewater discharges that would disproportionally impact the sanitary sewer lines or WWTP. For example, oil and grease can obstruct sanitary sewer lines and therefore must be removed from the wastewater before it is discharged into the sanitary sewer system. Industrial facilities that meet certain criteria must obtain a discharge permit from their respective city and pretreat their wastewater to acceptable levels before discharging to the sanitary sewer system.

### 4.4.3 NPDES-Permitted Wastewater Dischargers

There are no active NPDES wastewater discharge permits in the Little Alamance Creek watershed. Previously, the City of Burlington WWTP was located at present-day South Graham City Park, but the facility was closed in the early 1970's.

### 4.4.4 Nonpermitted Point Sources

The sources reviewed for the data inventory did not identify any specific point sources of pollution, though the area around Willowbrook Creek was recommended for further investigation due to several samples with higher fecal coliform, nutrient, and heavy metal concentrations. Some potential point sources to be investigated in this area include leaking sewer lines or septic systems, and a vehicle maintenance facility. There is also an unlined abandoned landfill adjacent to Little Alamance Creek; unlined landfills have the potential to convey contaminants into the stream via groundwater movement.

## 4.5 Potential Nonpoint Source Stressors

There are a multitude of potential nonpoint source stressors in the watershed. Stormwater runoff may contain a complex mixture of contaminants that are accumulated as precipitation flows across surfaces. Some pollutants commonly found in urban stormwater runoff include: pesticides and nutrients from lawns, gardens, and golf courses; oil and other fluids from motor vehicles; heavy metals from roof shingles, gutters, and motor vehicles; road salts; virus, bacteria, and nutrients from pet and wildlife waste and failing septic systems or leaking sewer lines; and sediment from eroding streambanks and construction sites. Thermal pollution can also be an issue, as water temperatures can increase as they flow across dark impervious surfaces such as streets and rooftops or due to a lack of riparian buffer and stream canopy. While these pollutants are common in most urban stormwater, none of these specific stressors have been identified as the main source of impairment for the Little Alamance Creek watershed.

Approximately 30% of the Little Alamance Creek watershed is comprised of impervious surfaces (Elon University, 2010). Growth of impervious surface appears to have leveled off, as percentages for the watershed were 26.0% and 26.2% based on 2001 and 2006 National Land Cover Database (NLCD) GIS data, respectively. There are also private stormwater conveyance systems that are not part of the MS4s. The areas outside of the MS4 stormwater conveyance systems primarily include the riparian areas adjacent to streams and lakes, as well as a small unincorporated area between Burlington and Graham in the central southern portion of the watershed.

## 4.6 Potential Legacy Stressors

In addition to the use of gristmills, cotton factories, and dyeing operations in the late nineteenth and early twentieth centuries alongside Little Alamance Creek (see section 2.0), there are three identified historic wastewater discharge or landfill sites within Little Alamance Creek. There is a historic landfill site located under the Pine Hill Cemetery and the Burlington Public Works facility on Mebane Street between Little Alamance Creek and Brown Branch. The 95-acre landfill was closed and is likely unlined per current standards. At the confluence of Brown Branch and Little Alamance Creek on the other side of Mebane Street is a historic wastewater sludge application site. A second wastewater sludge application site is located where the South Graham Municipal Park is located. These sites are no longer active but could have lasting impacts to the water quality within the watershed.

# 5.0 Pollution Controls

Restoring biological integrity and aquatic life use in Little Alamance Creek will depend on the implementation of pollution controls, management practices, and other strategies and activities designed to mitigate the stressors discussed in section 4.0. Collectively referred to as BMPs, these activities function to reduce or avoid pollutant inputs to receiving waters in order to achieve water quality protection goals and restore and maintain the physical, chemical, and biological integrity of the receiving waterbodies. BMPs provide this function through control of discharges that could alter natural hydrology, reduction of pollutant loads that are delivered to a waterbody, and mitigation of other stressors that might contribute to impairment.

## 5.1 Public Education and Outreach and Public Involvement

Educating and engaging the public on stormwater-related issues can help inform the public about the importance of stormwater quality, reduce pollution at its source, and create a body of support for local stormwater initiatives. Encouraging the proper application of lawn fertilizer and organizing volunteer clean-up activities for roadsides or waterbodies are common examples of directly informing and engaging the watershed's community.

## 5.2 Illicit Discharge Detection and Elimination

An illicit discharge is a discharge that conveys unauthorized substances to the stormwater drainage system. Entry of an illicit discharge into the stormwater system may be performed directly through the spilling or dumping of substances or indirectly through the conveyance of substances overland to inlets or direct connection to underground pipes. The illicit discharge may contain sediment, soap, pet waste, litter, oil, fertilizer, pesticides, or raw sewage, and often times comes from "generating sites." Generating sites are points of pollution that continue over a period and are recurring at regular or irregular intervals.

## 5.3 Erosion and Sediment Control

While erosion and sediment transport are natural processes, the acceleration and frequency of these processes is problematic to receiving waters. Excessive sediment is a water quality pollutant that is detrimental to benthic macroinvertebrates (EPA, 2006b). Land disturbance at construction sites is characterized as a primary source of excessive sediment. Earth-stabilizing protocols, including temporary ground cover, limit erosion processes. Sediment controls, such as silt fences and basins, help prevent sediment from being transported offsite.

## 5.4 Post-Construction Runoff Control Program

The development of the natural landscape into impervious surfaces and managed land results in increased runoff and pollutant loadings (both in amount and frequency of events). As a consequence, qualifying development is required to implement post-construction stormwater controls. These controls are designed to reduce potential pollutant and hydrological impacts to downstream waterbodies. Post-construction stormwater may be addressed with BMPs to treat the runoff, or through site design that employs low impact development (LID) or green infrastructure (GI) principles in order to reduce the volume of runoff.

## 5.5 Pollution Prevention and Good Housekeeping

Employees and contractors of governmental entities have the potential to impact stormwater quality like the rest of the public, but as stewards of stormwater management they must demonstrate and lead by example. Pollution Prevention and Good Housekeeping (PPGH) programs are a collection of internal education initiatives that discuss the importance of stormwater quality, highlight specific ways their work could impact stormwater quality, and review existing ordinances or protocols employees and contractors are required to follow in order to improve stormwater quality. Fertilizer application guidelines and facility-specific pollution prevention plans are two examples of PPGH initiatives.

## 5.6 Collection System Improvements

Older sanitary sewer lines may have significantly high rates of infiltration and inflow (I&I) (water entering the sewer line) and exfiltration (untreated sewage leaching into the soil and groundwater). Excessive I&I can cause the volume of the sewage transported to exceed the design capacity of the system, producing sewer overflows. Untreated sewage may contain water quality pollutants including pathogens, nutrients, oil and grease, metals, and pharmaceuticals. Dissolved oxygen levels in receiving waterbodies may also be reduced due to the high biochemical oxygen demand (BOD) of untreated sewage. Scheduled I&I inspections, sanitary sewer lining, and rehabilitation are some examples of collection system improvements.

## 5.7 Stream Buffers

A stream buffer (riparian buffer) is the vegetated land adjacent to a streambank. Stream buffers stabilize streambanks, provide shade, and supply detritus (e.g., leaves) to many aquatic organisms. These ecological functions reduce streambank erosion, reduce thermal loadings, and support a more diverse food web in the stream's ecosystem. Stream buffers have also been shown to reduce nitrogen levels (Messer et al., 2012). Many stream buffers are further defined into zones measured perpendicular from the streambank. Zone 1 is adjacent to the streambank and consists of undisturbed woody vegetation. Zone 2 is adjacent to Zone 1 and can include managed vegetation (Figure 5-1).

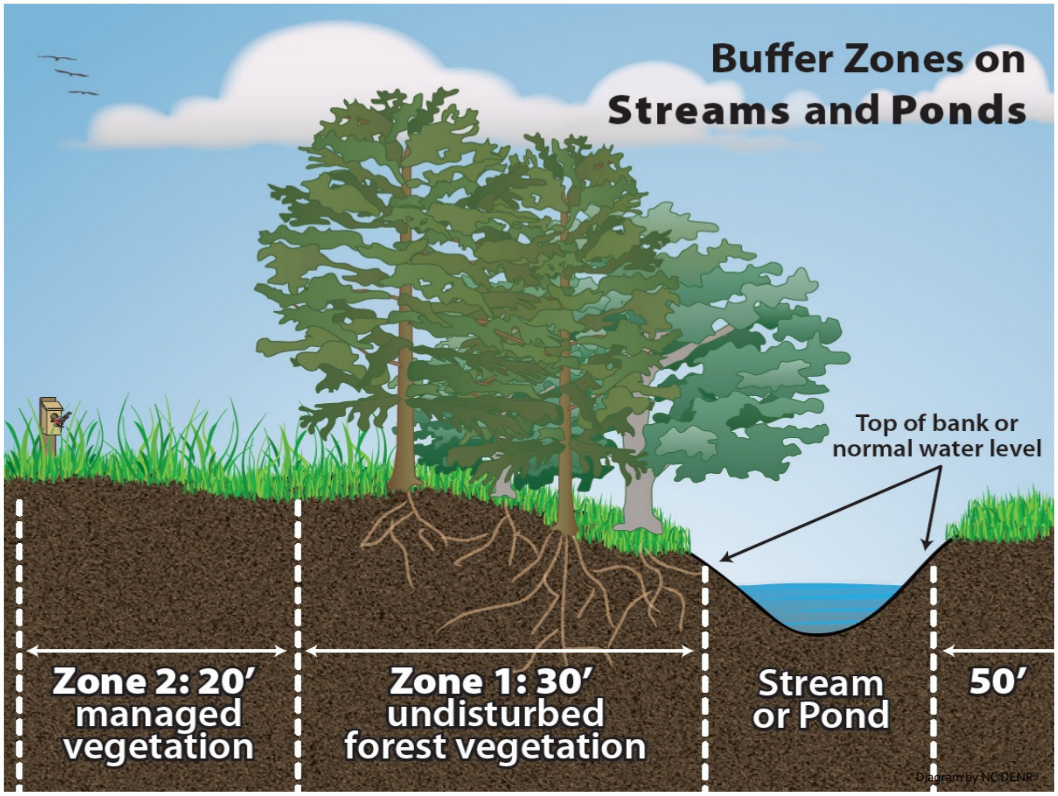


**Figure 5-1. Diagram of stream buffer zones (NCDENR, n.d.-c)**

## 5.8 Stream Restoration and Enhancement

Degraded streams typically lack diversity in aquatic habitat and fauna, and may have increased levels of streambank erosion. Stream degradation may be the product of past channelization, "flashy" hydrology due to decreased levels of infiltration, lack of buffer, or upstream pollution.

Stream restoration is the re-establishment of the general structure, function, and self-sustaining behavior of the stream. Many restoration projects feature aspects of the natural channel design method such as modification of channel dimension, pattern, and profile (Rosgen, 1997). Stream enhancement and stream stabilization are narrower in scope than stream restoration and focus on improving the floodplain and streambank areas, respectively. "Daylighting" projects improve stream habitat by converting a piped segment of the stream to a more natural state such as a vegetated channel.

## 5.9 Stormwater Retrofits

Structural BMPs are used to help control and treat stormwater runoff. A "retrofit" is a BMP that has been installed within a previously developed area that does not have adequate runoff treatment in place. BMPs often include stormwater retention, detention, and treatment devices that mitigate altered hydrologic and pollutant loadings typically associated with land disturbance and development. BMPs can provide hydrologic benefits by reducing runoff volume, increasing groundwater recharge, reducing the peak flow and duration of high stream flows, and reducing stream velocities. While many of these hydrologic benefits can directly enhance water quality, many BMPs provide additional water quality benefits through additional treatment and pollutant removal mechanisms. For most BMPs, the removal mechanism involves sequestering the pollutant within the BMP (typically bound to the soil or within vegetation) or completely removing it from the aquatic environment. For example, sediment-bound phosphorus may be trapped within a forebay BMP and prevented from entering the receiving waterbody, whereas water-soluble nitrate ($NO_3$) may be transformed into nitrogen gas ($N_2$) and enter the atmosphere.

Certain pollutants are more efficiently removed using different mechanisms. Suspended solids can be removed through sedimentation or filtration. Nitrogen loadings may be reduced through plant uptake or be transformed into nitrogen gas ($N_2$) via denitrification. Metals including copper, lead, and zinc are efficiently removed through sorption onto organic matter such as mulch (Davis et al., 2001) or peat (Chen et al., 1990). Hydrocarbons such as oil and grease are efficiently sorbed onto mulch and subsequently biodegraded (i.e., removed from the environment) by microbes (Hong et al., 2006). A reduction in thermal pollution has been documented in filtration BMPs (Jones and Hunt, 2009; DiGennaro, 2008). Variable success has been shown in reducing pathogen loadings with structural BMPs (Sullivan et al., 2007; Hathaway et al., 2009). Because of the variable removal rate, a combination of treatment and source-reduction measures for pathogens is typically recommended. A list of structural BMPs cross-referenced by their pollutant removal mechanisms is presented in Table 5-1.

**Table 5-1. Select structural BMPs and their pollutant removal mechanism (adapted from NCDOT, 2008)**

| Structural BMP | Description | Infiltration | Filtration | Detention | Sedimentation | Sorption | Microbial-mediated transformation* | Biological uptake | Pollution Prevention | Energy dissipation |
|---|---|---|---|---|---|---|---|---|---|---|
| Bioretention Basin | A type of media filter with a shallow basin, engineered media, an underdrain system, and landscaped vegetation. | | X | | | X | X | X | | |
| Dry Detention Basin | A shallow, dry basin with an outlet pipe or orifice near the invert of the basin. | | | X | X | X | | | | |
| Filter Strip | A linear section of land, either grassed or forested, that physically filters and infiltrates stormwater. | X | X | | | X | | X | | |
| Filtration Basin | A type of media filter with a shallow basin, engineered media, and an underdrain system. | | X | | | X | X | X | | |
| Forebay | A small basin located upstream of another BMP. | | | X | X | | | | | |
| Hazardous Spill Basin | A shallow basin with an outlet control structure that can trap all flow that enters the basin. | | | | | | | | X | |
| Infiltration Basin | A shallow basin in permeable soils that detains and infiltrates stormwater runoff. | X | | | | X | | | | |
| Level Spreader | A trough and level lip used to redistribute concentrated stormwater as diffuse flow. Typically combined in a system with a filter strip. | X | | | | | | | | X |
| Riparian Buffers | A defined width of protected or restored land—wooded or not—adjacent to both sides of a streambank. | | X | | | | X | X | | X |
| Preformed Scour Hole | A riprap-lined basin formed at the outlet of a pipe with a diameter less than or equal to 18 inches. | X | | | | | | | | X |
| Stormwater Wetland | An engineered marsh or swamp with dense wetland vegetation. | | | X | X | X | X | X | | |
| Stream Restoration | The re-establishment of the self-sustaining functions of a stream through channel modification and re-alignment. | | | | X | | X | | | X |
| Swale | A broad and shallow channel with dense vegetation. | X | X | | X | | X | | | |
| Wet Detention Basin | A shallow basin that maintains a permanent pool of water by using an elevated outlet control structure. | | | X | X | | X | X | | |

* Certain microbes within the soil matrix are adept at transforming pollutants. For example, certain anaerobic bacteria convert nitrate ($NO_3$) into nitrogen gas ($N_2$).

Selecting the appropriate BMP depends largely on site-specific criteria such as drainage area, topography, soil characteristics, water table elevation, and pollutant(s) of concern. Therefore, identifying and prioritizing locations that are conducive to retrofits is an important part of a retrofit program. After the type of BMP has been selected, the previously mentioned location-specific criteria are used to customize the control measure for the given site. Often, a BMP is actually an assembly of multiple BMPs working in sequence to maximize pollutant reduction. For example, a level spreader may include a forebay, a vegetated buffer, a forested buffer, and a bypass swale, in addition to the actual level spreader component.

## 5.10 Research

The science behind improving stormwater quality has advanced in recent decades. Today, a well-developed stormwater management plan is not satisfied solely through the reduction of peak flow via a large detention basin. New BMPs such as level spreaders and vegetated filter strips allow stormwater agencies to choose from a larger selection of water quality improvement tools. Ongoing research provides information on the pollutant removal effectiveness of various BMPs, as well as recommendations for design, site selection and prioritization, installation techniques for contractors, and frequency of maintenance activities. Research at the state or local level further engages the community by creating partnerships between universities and stormwater agencies.

# 6.0 Implementation Plan

This section describes the various BMPs that the project partners will implement as part of this Category 4b Demonstration Plan. The project partners all share responsibility in implementing their individual pollution controls within the boundaries of their MS4s as well as at owned and operated facilities. This plan will include a wide range of pollution controls, management practices, and other strategies and activities designed to mitigate identified stressors throughout the watershed. The schedule for implementing BMPs will correspond with the North Carolina state fiscal year (FY) calendar (July 1 through June 30). The implementation of the following BMPs will contribute to the overall goal of achieving a benthic macroinvertebrate community bioclassification of “Not Impaired”, “Good-Fair”, or better.

## 6.1 Public Education and Outreach and Public Involvement

The goal of external education is to make the public aware of how their activities and choices can contribute to potential stressors and to provide them the means to mitigate these actions. This goal is achieved mainly by direct and indirect engagement of select audiences, provision of educational materials, demonstration of best practices, and solicitation of feedback and involvement. Extended education efforts in the watershed should not only foster stormwater pollution prevention but also create a culture of environmental stewardship for stormwater mitigation and management. In order to target the necessary audiences, a combination of broad and focused external education efforts will be implemented as pollution controls.

The project partners have been implementing external education efforts over the duration of their NPDES MS4 permits. These efforts, while diverse and numerous, have been focused at a broader level to maximize the extent of awareness and provide straight-forward messaging. As a result, the project partners are confident in asserting that awareness of stormwater pollution and environmental stewardship is at an elevated level compared to a decade ago prior to the promulgation of NPDES MS4 permits. This is generally beneficial to restoration efforts for Little Alamance Creek but for the purposes of this plan, these efforts will need to be tailored for the Little Alamance Creek watershed and its stressors. The project partners will evaluate opportunities to implement specific external education initiatives in the Little Alamance Creek watershed. As part of this Category 4b Demonstration Plan, a list of external education BMPs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-1.

**Table 6-1. External education BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Partner with the Stormwater Management and Recovery of the Triad (SMART) program as a regional, broad-based stormwater education provider | Currently implemented, continue as programmed |
| Partner with Piedmont Triad Water Quality Partnership as a regional, broad-based stormwater education provider | Currently implemented, continue as programmed |

| Pollution Control | Schedule |
|---|---|
| Leverage the quarterly CityWorks newsletter distributed with utility bills to inform the public of the Category 4b Demonstration Plan and their potential involvement in nonpoint source pollution reduction | Currently implemented, continue and adapt as necessary |
| **City of Burlington (continued)** | |
| Document Burlington customer response program, stormwater, and stream-related solicitations in watershed | Currently implemented, continue and adapt as necessary |
| Conduct Annual Stormwater Meeting for public feedback and solicitation | Currently implemented, continue and adapt as necessary |
| Attend festivals/parades/events with stormwater-related staff for public engagement | Currently implemented, continue and adapt as necessary |
| Perform stormwater-related presentations for civic groups | Currently implemented, continue and adapt as necessary |
| Organize and publicize stream clean up in watershed | Adapt current program in FY 2016 |
| Promote proper disposal of E-Waste and collection events in watershed | Adapt current program in FY 2016 |
| Promote water quality programs for Summer Camp performed by the Recreation Department | Currently implemented, continue and adapt as necessary |
| Develop Green Infrastructure Grant Program for targeted areas in the watershed | Implement new program in Year 3 |
| Prioritize 50/50 Cost Share projects in the watershed | Adapt current program in FY 2017 |
| Develop specific watershed content for Stormwater Division's website | Adapt current program in FY 2016 |
| Partner with Alamance County Cooperative Extension on rain garden education and construction in watershed | Adapt current program in FY 2016 |
| **City of Graham** | |
| Partner with Stormwater SMART as a regional, broad-based stormwater education provider | Currently implemented, continue as programmed |
| Partner with Piedmont Triad Water Quality Partnership as a regional, broad-based stormwater education provider | Implement new relationship in FY 2017 |
| Conduct Annual Stormwater Meeting for public feedback and solicitation | Currently implemented, continue and adapt as necessary |
| Attend festivals/parades/events with stormwater-related staff for public engagement | Currently implemented, continue and adapt as necessary |
| Perform stormwater-related presentations for civic groups | Currently implemented, continue and adapt as necessary |
| Prioritize projects identified through the 50/50 Cost Share Program in the watershed | Implement new program in FY 2017 |
| Partner with Alamance County Cooperative Extension on rain garden education and construction in watershed | Implement new relationship in FY 2017 |
| Continue relationship with Stormwater SMART as a regional, broad-based stormwater education provider | Currently implemented, continue as programmed |

| Pollution Control | Schedule |
|---|---|
| **NCDOT** | |
| In cooperation with Burlington and Graham distribute pollution prevention educational materials through NCDOT's Office of Beautification during local fairs/Earth Day celebrations/and other appropriate community events | Implement in FY 2016 and adapt as necessary |
| Promote Category 4b Demonstration Plan and activities through NCDOT social medias (Twitter/Facebook/RSS/ Flickr) and NCDOT Now (YouTube) | Implement in FY 2016 and adapt as necessary |
| Adopt-A-Highway program for NCDOT roads in the watershed | Currently implemented, continue and adapt as necessary |
| Post this watershed plan and other appropriate content on NCDOT's Highway Stormwater Program website | Implement in FY 2016 and adapt as necessary |
| Promote stakeholder group meetings for proposed construction projects in watershed | Currently implemented, continue and adapt as necessary |

## 6.2 Illicit Discharge Detection and Elimination

The goal of illicit discharge detection and elimination pollution controls is to identify and mitigate non-stormwater discharges to the MS4s and illegal dumping of materials indirectly or directly to the MS4. This goal is achieved by routine inspections and monitoring as well as investigation following any observation or complaint, reliance on regulatory measures for abatement and enforcement, and remedial construction of illicit connections where necessary. The project partners all share responsibility in implementing these pollution controls within the boundaries of their MS4s. Both the Cities of Burlington and Graham have regulatory authority through local ordinances to prohibit and eliminate illicit discharges and connections. NCDOT manages the potential for illicit discharges and connections through their Illicit Discharge Detection and Elimination (IDDE) and Encroachment Programs.

The project partners have been implementing and reporting on illicit discharge detection and elimination programs over the tenure of their NPDES MS4 permits. These programs will continue to be used to reduce non-stormwater discharges of toxins, fats, oils, greases, and heavy metals, and to prevent the cross-contamination of wastewater into the MS4 both during wet weather and dry weather conditions. The pollution controls have been focused on the regulatory requirements of inspection, investigation, and enforcement but will continue to be refined and adapted as the sources of stormwater pollution stressors in Little Alamance Creek is understood better. As part of this Category 4b Demonstration Plan, a list of IDDE-related BMPs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-2.

**Table 6-2. IDDE BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Perform dry weather flow stream walks for the intermittent and perennial streams in the watershed within each permit cycle | Currently implemented, continue as programmed |
| Perform annual representative outfall monitoring within the watershed for designated outfalls | Implement new program in FY 2016 |
| Perform illicit discharge detection and elimination program under authority of ordinance | Currently implemented, continue and adapt as necessary |
| Utilize the Burlington customer response program for fielding complaints about illegal dumping | Currently implemented, continue and adapt as necessary |
| Perform annual inspections of 50% of the identified dumpsters for proper function | Implement new program in FY 2016 |
| Perform analytical monitoring of 5 sites in the watershed | Currently implemented, continue and adapt as necessary |
| Perform inspections of locations in the watershed where sanitary sewer cross-contamination may occur. | Implement new program in FY 2016 |
| **City of Graham** | |
| Perform dry weather flow stream walks for the intermittent and perennial streams in the watershed within each permit cycle | Currently implemented, continue as programmed |
| Perform annual representative outfall monitoring within the watershed for outfalls | Implement new program in FY 2020 |
| Perform illicit discharge detection and elimination program under authority of ordinance | Currently implemented, continue and adapt as necessary |
| Illegal dumping hotline | Continue to use the City's primary number and direct calls to appropriate contacts |
| Perform inspections of dumpsters in the watershed for proper use and structural adequacy once per permit cycle. | Implement new program in FY 2017 |
| Perform inspections of sanitary sewer high priority lines within the watershed | Implement new program in FY 2016 |
| **NCDOT** | |
| Perform illicit discharge detection and elimination program | Currently implemented, continue and adapt as necessary |
| Perform illicit discharge detection training for NCDOT and contractor staff in the watershed | Currently implemented, continue and adapt as necessary |

## 6.3 Erosion and Sediment Control

The goal of erosion and sediment pollution controls is to limit the generation and transport of sediments associated with land disturbance for qualifying construction activities. This goal is achieved through the administration of programs that include the dissemination of erosion and sediment control best practices, review of erosion and sediment control plans, implementation of routine inspections, reliance on regulatory measures for abatement and enforcement, and implementation of self-monitoring. The City of Burlington and NCDOT are directly responsible for implementing these pollution controls within the boundaries of their program's authority for qualifying construction activities. The City of Graham relies on NCDENR to administer the program on their behalf. For the Cities of Graham and Burlington, qualifying construction activities are limited to land disturbance of an acre or greater while NCDOT administers NCDOT's program for all land disturbances.

The project partners have been administering or delegating erosion and sediment control programs within the boundaries of their authority since the 1970s. These programs, now in place for over 40 years, have established processes and practices that are well known throughout the development community. Ongoing efforts within the programs include performing maintenance for the duration of the project and evaluating and adapting controls to increase performance. Given the low remaining development potential of the watershed, it is anticipated that these pollution controls will not play a significant role in addressing existing stressors in Little Alamance Creek watershed but will help prevent exacerbating the current level of impairment. With NCDOT's significant involvement in linear construction across the state, NCDOT's ongoing research on the best technologies and methods for controlling erosion and sediment will be deployed in Little Alamance Creek watershed for their construction activities. As part of this Category 4b Demonstration Plan, a list of erosion and sediment control BMPs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-3.

**Table 6-3. Erosion and sediment control BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Implement approved, delegated erosion and sediment control program administered by Engineering Department | Currently implemented, continue and adapt as necessary |
| Perform reviews of site plans and calculations by Engineering Department for proposed erosion and sediment controls | Currently implemented, continue and adapt as necessary |
| Perform on-site inspections by Engineering Department for plan and permit compliance | Currently implemented, continue and adapt as necessary |
| Issue violations for noncompliance under authority of delegated program | Currently implemented, continue and adapt as necessary |
| **City of Graham** | |
| Rely on State erosion and sediment control program administered by NCDENR | Currently implemented, continue and adapt as necessary |
| **NCDOT** | |
| Implement approved, delegated erosion and sediment control program administered by the Construction Program | Currently implemented, continue and adapt as necessary |

## 6.4 Post-Construction Runoff Control Program

The goal of post-construction runoff pollution controls is to limit the generation and transport of pollutants associated with built-upon areas and how they are used. This goal is achieved through the administration of programs that include the regulatory requirement for post-construction runoff BMPs, review of development and redevelopment plans, reliance on regulatory measures for abatement and enforcement, and annual inspection and reporting. For the Cities of Burlington and Graham, qualifying development is limited to land disturbance of an acre or greater. As part of their Post-Construction Stormwater Program, NCDOT implements post-construction BMPs for discharges, controls runoff from new development and redevelopment, and provides training on implementing the NCDOT Stormwater Best Management Practices Toolbox.

The project partners have been managing post-construction runoff over the tenure of their NPDES MS4 permits. Given the remaining development potential of the watershed, it is anticipated that these pollution controls will have minor positive impact going forward in addressing existing stressors in Little Alamance Creek watershed but will help prevent exacerbating the current level of impairment. These pollution controls could play a more significant role in pollutant reduction where redevelopment is significant enough to trigger regulation. As part of this Category 4b Demonstration Plan, a list of post-construction runoff BMPs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-4.

**Table 6-4. Post-construction runoff BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Require conformance to stormwater standards for new development and redevelopment projects by Stormwater Division participation in Technical Review Committee process | Currently implemented, continue and adapt as necessary |
| Receive and evaluate annual inspection reports submitted by owners for permitted structural BMPs in the watershed | Currently implemented, continue and adapt as necessary |
| Within each permit cycle perform inspections of permitted structural BMPs in the watershed by Stormwater Division | Currently implemented, continue and adapt as necessary |
| Adopt by ordinance the standards for the control of nutrients in accordance with the Jordan Lake Rules | Implement new program in accord with legislative implementation schedule |
| Incorporate provisions for LID as part of Unified Development Ordinance revision | Implement new program in FY 2020 |

| Pollution Control | Schedule |
|---|---|
| **City of Graham** | |
| Perform reviews of site plans and calculations for compliance with new development and redevelopment standards | Currently implemented, continue and adapt as necessary |
| Require developments that are greater than 10% of the upstream drainage area to match predevelopment runoff rates | Continued implementations of the City's Storm Drainage Design Manual and reduce the upstream drainage limits within the watershed to 10% from the current 25%. |
| Receive and evaluate annual inspection reports submitted by owners for permitted structural BMPs in the watershed | Currently implemented, continue and adapt as necessary |
| Perform inspection of permitted structural BMPs in the watershed once per NPDES Phase II Permit Cycle | Currently implemented, continue and adapt as necessary |
| Adopt Jordan Lake Rules by ordinance for new and development standards for the control of nutrients in post-construction runoff | Implement new program in accord with legislative implementation |
| **NCDOT** | |
| Implement NCDOT's Post-Construction Stormwater Program (PCSP) controls for roadway and non-roadway projects | Currently implemented, continue and adapt as necessary |
| Perform inspection of BMPs in the watershed utilizing NCDOT Stormwater Control Management System (SCMS) database | Currently implemented, continue and adapt as necessary |
| Maintain the use of the Best Management Practices Toolbox for post-construction runoff control on NCDOT projects | Currently implemented, continue and adapt as necessary |

## 6.5 Pollution Prevention and Good Housekeeping

The goal of this set of pollution controls is to prevent and reduce stormwater pollution from municipal operations and industrial activities. This goal is achieved mainly by the development of directive plans on the proper handling of potential pollutants and deployment of available controls, training and education of staff, and implementation of identified operation and maintenance procedures. The project partners are responsible for implementing their individual pollution controls for municipal operation and industrial activities being performed within the boundaries of their MS4s as well as at owned and operated facilities. NCDOT does not own or operate any permanent facilities within Little Alamance Creek watershed so their responsibility is limited to industrial activities performed within the NCDOT ROW within the watershed.

The project partners have been implementing and reporting on pollution prevention and good housekeeping measures over the tenure of their NPDES MS4 permits. The pollution controls have been focused on typical pollutants generated by project partner facilities and activities but will continue to be refined and adapted, where applicable, as the understanding of the stormwater pollution stressors in Little Alamance Creek increases. As part of this Category 4b Demonstration Plan, a list of PPGH BMPs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-5.

**Table 6-5. PPGH BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Annual inspection of city owned facilities by Stormwater Division for compliance with Stormwater Pollution Prevention Plan (SWPPP) | Currently implemented, continue and adapt as necessary |
| Development of SWPPP for remaining facility | Develop SWPPP in FY 2016 |
| Annual refresher training on good housekeeping and IDDE for targeted City employees | Currently implemented, continue and adapt as necessary |
| New employee training on good housekeeping and IDDE | Currently implemented, continue and adapt as necessary |
| Annual reviews of municipally-owned NPDES stormwater permitted facilities by Stormwater Division | Currently implemented, continue and adapt as necessary |
| Annual sweeping of curb and gutter streets in watershed | Currently implemented, continue and adapt as necessary |
| Provide seasonal leaf and weekly yard waste collection to properties in the watershed | Currently implemented, continue and adapt as necessary |
| Inspect and clean catch basins as necessary to insure proper maintenance of the stormwater system | Currently implemented, continue and adapt as necessary |
| **City of Graham** | |
| Annual inspection of City-owned facilities by Stormwater Consultant for compliance with SWPPP | Currently implemented, continue and adapt as necessary |
| Annual refresher training on good housekeeping and IDDE for targeted City divisions and departments | Currently implemented, continue and adapt as necessary |
| New employee training on good housekeeping and IDDE | Currently implemented, continue and adapt as necessary |
| Annual reviews of City-owned NPDES stormwater permitted facilities by Stormwater Consultant | Currently implemented, continue and adapt as necessary |
| Annual sweeping curb and gutter streets in watershed | Currently implemented, continue and adapt as necessary |
| Inspect and clean catch basins as necessary to insure proper maintenance of the stormwater system | Currently implemented, continue and adapt as necessary |
| **NCDOT** | |
| Provision and update of Industrial and Roadway Maintenance Activities (IRMA) BMP Guidance Manual for activities performed within the ROW | Currently implemented, continue and adapt as necessary |
| Stormwater pollution prevention and spill prevention and response training to NCDOT staff | Currently implemented, continue and adapt as necessary |
| Train NCDOT staff and contractors on fertilizer management and nutrient application decisions | Currently implemented, continue and adapt as necessary |

## 6.6 Collection System Improvements

The goal of collection system improvements as pollution controls is to prevent untreated sanitary sewer discharges from entering the collection system. This goal is achieved primarily through regular inspections, scheduled maintenance, targeted education about the operation of the collection system, and capital construction projects and repairs. The Cities of Burlington and Graham are the primary owners and operators of sanitary sewer collection systems where these pollution controls will be implemented. NCDOT does not own or operate any wastewater collection systems within the watershed.

The Cities of Burlington and Graham have been managing their wastewater collection systems to permit-required conditions since 2002. The Cities are both audited by NCDENR staff approximately every 2 years for compliance and both programs are compliant with their permit conditions. These pollution controls focus on the reduction of incidental discharges of untreated wastewater from the collection system within the Little Alamance Creek watershed, thereby reducing the contribution of a wide range of typical wastewater pollutants to the MS4 and waters of the state. As part of this Category 4b Demonstration Plan, a list of collection system-related BMPs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-6.

**Table 6-6. Collection system improvement BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Identify and prioritize I&I reduction projects for the watershed | Currently implemented, continue and adapt as necessary |
| Clean or asses 10% of non-unique sanitary sewer mains annually | Currently implemented, continue and adapt as necessary |
| Inspect high priority sanitary sewer lines in the watershed semi-annually | Currently implemented, continue and adapt as necessary |
| Perform fats, oils, and grease education distributions annually for the watershed | Currently implemented, continue and adapt as necessary |
| Assess the effectiveness of the pretreatment program and provide recommended improvements to the Water Resources Department | Currently implemented, continue and adapt as necessary |
| **City of Graham** | |
| Identify and prioritize I&I reduction projects for the watershed | Currently implemented, continue and adapt as necessary |
| Maintain sanitary sewer mains via high pressure jetting of 10% of the lines within the entire system on an annual basis | Currently implemented, continue and adapt as necessary |
| Inspect high priority sanitary sewer lines in the watershed semi-annually | Currently implemented, continue and adapt as necessary |
| Perform an annual fats, oils, and grease education program element annually for watershed | Currently implemented, continue and adapt as necessary |
| Inspect one pretreatment facility bi-annually in watershed to ensure proper disposal procedures | Currently implemented, continue and adapt as necessary |

## 6.7 Stream Buffers

The goal of stream buffers as a pollution control is to protect and maintain vegetative systems along streams for the purposes of diffusing and treating stormwater runoff through biological and hydrologic processes. This goal is achieved through the administration of programs that includes the review of development and redevelopment plans for compliance stream buffer standards, routine inspections, and reliance on regulatory measures for abatement and enforcement. For the Cities of Burlington and Graham, language from the State's model ordinance was incorporated into local stormwater management and land use regulation ordinances granting the authority to require these pollution controls along qualifying streams and waterbodies. NCDOT manages these pollution controls within its ROW through its Stormwater Management Program under the overarching Guided Reduction of Excess Environmental Nutrients (GREEN) program.

For the project partners, stream buffer protection and management is being driven recently by the Jordan Lake Rules. For years prior to the adoption of the Jordan Lake Rules, stream buffers and built-upon area setbacks existed through other regulations. Since 2009, NCDOT has been complying with stream buffer standards for new development projects in the Little Alamance Creek watershed. The Cities of Burlington and Graham implemented their stream buffer ordinances in 2011. Given the available development potential of the watershed, it is anticipated that these pollution controls will be limited for new development to those undeveloped portions and sparse redevelopment opportunities. Efforts to publicize the new ordinance throughout the watershed have likely highlighted the role and importance steam buffers provide to the community. The message being delivered through these efforts can be parlayed into support for stream buffer restoration in developed areas of the watershed. Ongoing stream buffer restoration efforts will be directed through education outreach and voluntary adoption. As part of this Category 4b Demonstration Plan, a list of stream buffer BMPs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-7.

**Table 6-7. Stream buffer BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Require conformance to stream buffer standards for new existing developments by Stormwater Division participation in Technical Review Committee process | Currently implemented, continue and adapt as necessary |
| Enforce violations of stream buffer standards under authority of ordinance | Currently implemented, continue and adapt as necessary |
| **City of Graham** | |
| Require conformance to stream buffer standards for new and existing developments | Currently implemented, continue and adapt as necessary |
| Enforce violations of stream buffer standards under authority of ordinance | Currently implemented, continue and adapt as necessary |
| **NCDOT** | |
| Implement GREEN Program for New Development projects in watershed | Currently implemented, continue and adapt as necessary |

## 6.8 Stream Restoration and Enhancement

The goal of stream restoration and enhancement as a pollution control is to mitigate the nonpoint source contribution of sediment and pollutants from streambanks and facilitate sediment transport in a manner conducive to supporting biological habitat. This goal is achieved through planning efforts and facilitating collaborative opportunities between local land owners and funding agencies. Mitigation efforts may originate from the NCEEP; restoration opportunities may originate from the Clean Water Management Trust Fund; and streambank stabilization opportunities may originate from citizen concerns, sanitary sewer or GI in jeopardy, and local government cost-share funding. The Cities of Burlington and Graham will implement this pollution control in their respective communities, where feasible.

There are few completed stream restoration and streambank stabilization projects in Little Alamance Creek. The Burlington City Park Stream Restoration was completed in 2012 and consisted of the restoration and enhancement of 2,600 linear feet of stream. The project was successful in establishing a stream buffer, reducing nonpoint source pollution from eroding banks, attenuating floodwaters, stabilizing stream geomorphology, and enhancing aquatic habitat. The City Park Stream Restoration is a model for future implementation in the watershed as other opportunities materialize. Stream restoration and bank stabilization can provide a direct reduction in nonpoint source pollution while improving aquatic habitat, but the impact can be limited by degraded upland watershed conditions. In addition, willingness for implementation on private property and the cost of watershed-wide application may limit the opportunities to implement this pollution control. As part of this Category 4b Demonstration Plan, a list of stream restoration and enhancement BMPs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-8.

**Table 6-8. Stream restoration and enhancement BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Compile and maintain active list of stream restoration and streambank stabilization opportunities for possible implementation. | Implement new program in FY 2017 |
| Coordinate with funding agencies to identify and evaluate potential projects from list | Implement new program in FY 2018 |
| Amend 50/50 Cost Share program to incorporate the evaluation of streambank stabilization | Implement new program in FY 2019 |
| Identify additional stream restoration and streambank stabilization opportunities through watershed planning process | Implement new program in FY 2020 |

| Pollution Control | Schedule |
|---|---|
| **City of Graham** | |
| Compile and maintain active list of stream restoration and streambank stabilization opportunities for possible implementation. | Implement new program in FY 2016 |
| Coordinate with funding agencies to identify and evaluate potential projects from list | Implement new program in FY 2017 |
| Identify additional stream restoration and streambank stabilization efforts as part of watershed study | Implement new program in FY 2020 |

## 6.9 Stormwater Retrofits

The goal of stormwater retrofits as a pollution control is to reduce the contribution of pollutants from stormwater and mitigate the hydraulic impacts of runoff from developed surfaces. This goal is achieved through planning efforts and facilitating collaborative opportunities with local land owners. The project partners all share responsibility in implementing these pollution controls within the boundaries of their MS4.

There are few completed stormwater retrofit projects in Little Alamance Creek. A bioretention area that treats 2.2 acres of runoff from a multi-recreational use facility was designed and constructed at the Burlington Aquatic Center. The project was successful in leveraging stormwater utility fees to treat and infiltrate stormwater from an eroding ditch and serves as a model and education outpost for future implementation in the watershed as other opportunities materialize. Stormwater retrofits provide direct mitigation of certain stormwater stressors, but willingness for implementation on private property and cost of watershed-wide application may be limiting factors. Therefore retrofits can only be relied upon as a part of the overall strategy. As part of this Category 4b Demonstration Plan, a list of retrofit BMPs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-9.

**Table 6-9. Stormwater retrofit BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Compile and maintain active list of stormwater retrofit opportunities for possible implementation | Implement new program in FY 2016 |
| Prioritize stormwater retrofits within the watershed | Implement new program in FY 2018 |
| Amend 50/50 Cost Share program to incorporate LID projects | Implement new program in FY 2017 |
| Identify additional stormwater retrofits through watershed planning process | Implement new program in FY 2020 |

| Pollution Control | Schedule |
|---|---|
| **City of Graham** | |
| Compile and maintain active list of stormwater retrofit opportunities for possible implementation | Implement new program in FY 2016 |
| Prioritize stormwater retrofit within the watershed | Implement new program in FY 2018 |
| Identify additional stormwater retrofits through watershed planning process | Implement new program in FY 2020 |
| **NCDOT** | |
| Compile and maintain active list of stormwater retrofit opportunities for possible implementation | Implement new program in FY 2016 |
| Design and construct evaluated stormwater retrofits for watershed | Implement new program in FY 2018 |

## 6.10 Research

Stormwater research provides a mechanism to improve the understanding of the pollutants in stormwater, their impacts on receiving streams, and the BMPs that can be used to mitigate or avoid those impacts. This goal is achieved through leveraging research organizations for direct or relevant research projects within the watershed. The City of Burlington will leverage its current membership on North Carolina's Water Resource Research Institute Stormwater Group in order to access opportunities that align with needs of Little Alamance Creek watershed. The City of Burlington will also develop a new research relationship with Elon University, a partner in the community. Under its NPDES stormwater permit, NCDOT maintains a Research and Analysis Program which works closely with state and national experts in the field of stormwater management.

Through the two current research programs, numerous stormwater or water quality-related studies and projects have been conducted since 2001. Both research programs solicit new research ideas through a competitive selection and funding process. Where opportunities materialize, pilot projects or case studies can be directed to Little Alamance Creek watershed, potentially providing site-specific monitoring and implementation of pollution controls. The addition of Elon University as a future research partner enhances the project partner's capability to identify more site-specific research opportunities in the Little Alamance Creek watershed. As part of this Category 4b Demonstration Plan, a list of BMP-related research programs proposed for implementation within the Little Alamance Creek watershed is presented in Table 6-10.

**Table 6-10. Research program BMPs to be implemented within the Little Alamance Creek watershed**

| Pollution Control | Schedule |
|---|---|
| **City of Burlington** | |
| Continue participation in the Stormwater Group through the North Carolina Water Resources Research Institute | Currently implemented, continue and adapt as necessary |
| Develop partnership with Elon University for collaborative research services in watershed | Implement new program in FY 2017 |
| **NCDOT** | |
| Leverage findings from NCDOT's Research and Analysis Program for improvements to design or maintenance of pollution controls in the watershed | Currently implemented, continue and adapt as necessary |
| Evaluate new opportunities to initiate a stormwater research project within watershed | Evaluate in FY 2018 |

# 7.0 Monitoring Plan to Track Effectiveness of Pollution Controls

The overall goal of this Category 4b Demonstration Plan is to achieve a benthic macroinvertebrate community bioclassification of "Not Impaired", "Good-Fair", or better for Little Alamance Creek. Numeric values associated with a bioclassification of Good-Fair or better are determined by DWR, and listed in the current benthic *Standard Operating Procedures for Collection and Analysis of Benthic Macroinvertebrates* (DWR, 2013). For example, a bioclassification of Good-Fair is based on the average of the biotic index and EPT scores = 3 (DWR, 2013). Actual numeric values depend upon stream size, flow regime, season of collection, and collection method. Numeric target levels used to evaluate attainment will be consistent with the SOP in effect at the time of evaluation. It is being presumed that the benthos community will improve once the stressors are removed or mitigated. However, neither an individual nor a group of specific stressors has been conclusively linked to the impairment of the benthos community in Little Alamance Creek (see section 4.0). This is likely due to the cumulative effects of environmental factors (e.g., sediment load, channel substrate condition, and upstream pollutant discharges) that may affect the benthos community. Therefore, an approach that draws from the range of pollution controls outlined in section 6.0 (hereafter "toolbox items") seems prudent in progressing towards the goal.

## 7.1 Dashboard Approach

A dashboard approach has been adopted for use in tracking execution of toolbox item implementation, correlating progress with available data, and communicating efforts to the public. The toolbox items comprise various potential activities as outlined in section 6.0. The dashboard approach allows the project partners to maintain a long-term focus on addressing the various stressors, even as refined effectiveness data on toolbox items becomes available and as project partner's ability to implement or organizational responsibilities evolve. Additionally, the dashboard approach facilitates the communication of technical water quality information to a more public-friendly format in order to communicate progress and encourage public participation in watershed restoration.

The dashboard for the Little Alamance Creek Category 4b Demonstration Plan is presented in Table 7-1. The organization of the four dashboard groups not only provides the high-level framework for addressing stressors but also provides direct linkages from dashboard group to the toolbox items to the metrics. For example, implementation of the Streamside Enhancement dashboard group may include the protection of stream buffers. Implementation of the stream buffer toolbox item could be tracked by measuring the number of square feet of protected or restored stream buffers. Through these linkages the public can more clearly understand why protecting stream buffers is important and that they can contribute to the metrics of the plan. In addition, metric tracking provides common ground for the project partners to work separately but collectively to a consistent goal. The cumulative tracking of these metrics will be used to reinforce the implementation progress being made with respect to analytical monitoring results.

**Table 7-1. Dashboard groups, toolbox items, and examples of associated tracking metrics**

| Dashboard Groups | Toolbox Items (see section 6) | Example Metrics for Tracking Effectiveness |
|---|---|---|
| Streamside Enhancement  | Stream Buffers | Linear feet/sq feet protected; # of potential sites assessed/identified |
| | Stream Restoration | Linear feet of enhancement or restoration; # of potential sites assessed/identified; instream habitat index results; streambank stability index results |
| Public Involvement and Outreach  | Public Education and Outreach and Public Involvement Programs | # of stream clean-up events; # of volunteers; feet of streams cleaned up; # of bags of trash collected; # of events where information was distributed; individual narratives highlighting specific public initiatives |
| | Research | Individual narratives on current collaboration efforts |
| Pollution Prevention & Reduction  | Illicit Discharge Detection and Elimination | # of outfalls screened; # of illicit discharges detected; # of internal training events/participants, related to the IDDE program |
| | Erosion and Sediment Control Program | # of sites inspected; # of internal training events/participants, related to the Erosion and Sediment Control program |
| | Post-Construction Runoff Program | # of sites inspected; # of training events/participants, related to the Post-Construction Runoff Program |
| | Pollution Prevention and Good Housekeeping | # of training events/participants, related to the PPGH program; individual narratives illustrating an improvement or concerted effort in water quality protocols at a municipal maintenance facility |
| | Collection System Improvements | Feet of lines assessed; # of manholes assessed; feet of lines slip-lined/replaced; # of manholes repaired |
| | Retrofits | # of potential sites assessed/identified; # of existing sites; total drainage area of all completed BMPs; nitrogen and phosphorus reduction estimates from implemented BMPs; inspection & maintenance results |
| Stream Health  | Ambient Water Chemistry* | Narrative discussion of physicochemical water quality results |
| | Fish Community* | North Carolina Index of Biotic Integrity (NCIBI) score and rating results† |
| | Benthos* | Bioclassification results† |
| | All monitoring* | Summary of monitoring activities performed |

**Table 7-1. Dashboard groups, toolbox items, and examples of associated tracking metrics (continued)**

* Items listed with the Stream Health dashboard group are not toolbox items, since they do not mitigate pollution.
† Data collected by NCDENR
Table 7-1 Photo Credits: “international tidyman” from public domain; toolbox by http://www.creattor.com/; water drop by http://www.clipartbest.com/; fish by Kim Kraeer & Lucy van Essen-Fishman (http://ian.umces.edu/imagelibrary/); and stream and stonefly by Tracey Saxby (http://ian.umces.edu/imagelibrary/).

The fourth dashboard group, “Stream Health” contains all of the water quality monitoring efforts performed by the project partners and NCDENR. While not explicitly an action to address a potential stressor, the “Stream Health” dashboard group provides the basis for correlating progress towards the goal with the overall efforts of the toolbox items being implemented. “Stream Health” will be compiled from available water quality monitoring sources within and near the watershed where relevant. These sources of water quality monitoring principally include NCDENR ambient monitoring programs, municipal ambient monitoring programs for illicit discharge detection and elimination, and special studies being performed by others in the watershed. NCDENR’s ambient monitoring program includes, but is not limited to, temperature, specific conductance, turbidity, total suspended solids, dissolved oxygen, pH, fecal coliform, nutrients, total hardness, chloride, fluoride, sulfate, oil and grease and dissolved metals. Monitoring data will only be used where it has been collected in a manner consistent with its prescribed quality control and assurance procedures. This is an appropriate approach given the need to rely heavily on non-structural pollution controls and voluntary participation from the public in order to progress towards the goal.

# 8.0 Path Forward

Achieving the goal of "Not Impaired", "Good-Fair", or better benthos bioclassification will require time and effort on the part of the project partners as well as participation with other stakeholders within the watershed. With this understanding, the toolbox items will be implemented within an adaptive management framework, where they will be documented, assessed, and compared to water quality data from Little Alamance Creek. Findings derived through the adaptive management process will be used by the project partners to target future efforts in the watershed, in order to progress to the overall goal. While there is no certain way of knowing when biological integrity will be restored, in consultation with DWR, water quality standards are projected to be achieved by 2030.

## 8.1 Adaptive Management Process

As section 6.0 indicates, the list of BMPs performed by the project partners is extensive. In order to make an informed decision on where to focus available resources, an adaptive management process will be used to revise pollution controls within the watershed. The adaptive management process for this Category 4b Demonstration Plan is built upon the overview of the historical and current state of the watershed (Sections 1–4) and the assessment of appropriate pollution controls (section 5–6). The adaptive management process begins with the **implementation** of the toolbox items (Figure 8-1, box 1). Pollution controls and monitoring activities performed by the project partners across the Little Alamance Creek watershed will be **tracked** (box 2). Efforts by the project partners will be **assessed** against available water quality data collected by NCDENR and the project partners (box 3). Results of this analysis will be used to **adjust** future actions performed by the project partners (box 4). A summary of the information gathered during the adaptive management process will be presented in a website that will be updated on a regular basis.

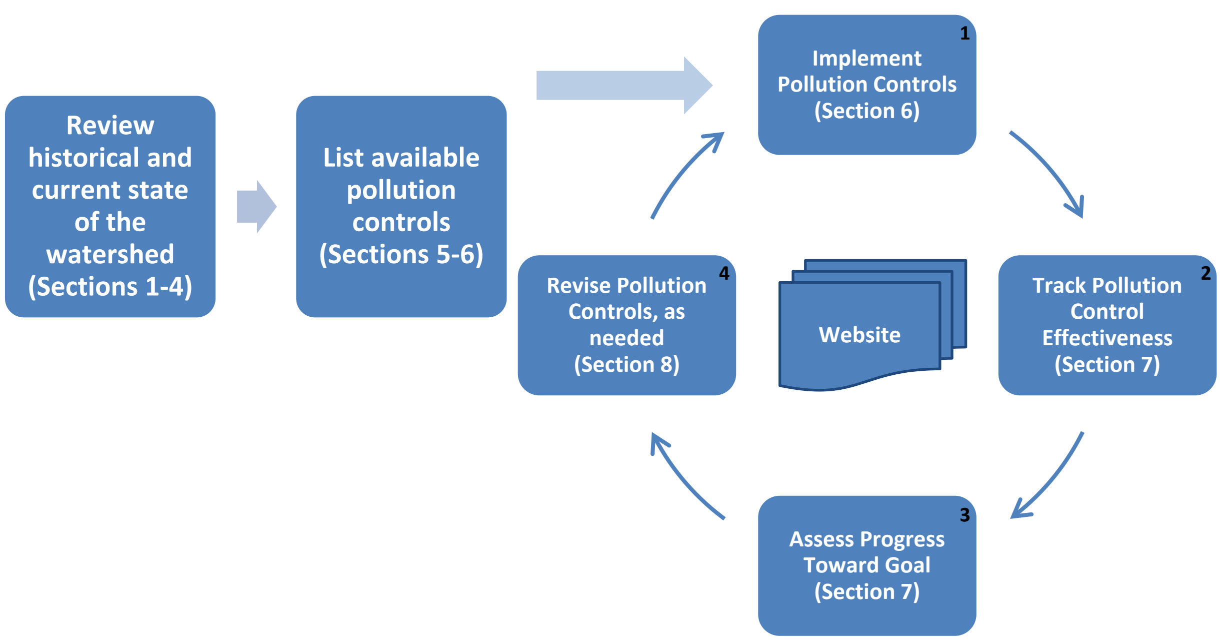


**Figure 8-1. Adaptive management process to address biological integrity in Little Alamance Creek watershed**

## 8.2 Reporting Mechanisms

A summary of the information gathered during the adaptive management process will be distributed through a public website that will be updated on a continuous basis. The use of a website allows for more timely and frequent updates on the efforts of the project partners throughout the watershed. The organization of the website's content into the four dashboard groups combined with an interactive user experience will allow the Little Alamance Creek Category 4b Demonstration website to be accessible to both the general public and water quality specialists. In addition to reporting on watershed activities, the dashboard will serve the project partners in communicating with and encouraging the general public to participate in opportunities that help to restore biological health in Little Alamance Creek.

Creation of the proposed Little Alamance Creek Category 4b Demonstration website would begin after the approval of this Category 4b Demonstration Plan and will be hosted by the City of Burlington. While updating the Little Alamance Creek Category 4b Demonstration website is the preferred reporting mechanism, each project partner may elect to individually submit electronic reports to NCDENR.

# 9.0 Acknowledgements

This Category 4b Plan for Little Alamance Creek describes a partnership between NCDOT and the Cities of Burlington and Graham that is designed to restore the biological integrity of Little Alamance Creek. This Plan represents the combined efforts of staff from the North Carolina Department of Transportation, the Cities of Burlington and Graham, URS Corporation, HDR, and Alley Williams, Carmen and King, Inc. as listed below.

**<u>North Carolina Department of Transportation</u>**

Andrew McDaniel, P.E., North Carolina DOT
S. Craig Deal, P.E., North Carolina DOT
Brian Jacobson, P.H., CFM, URS Corporation*
Mark Fernandez, E.I., URS Corporation*
Melissa Bauguess, URS Corporation*

**<u>City of Burlington</u>**

Michael Layne, City of Burlington
Chester Patterson, City of Burlington
Patrick Blandford, P.E., HDR*

**<u>City of Graham</u>**

Josh Johnson, P.E., Alley, Williams, Carmen, and King, Inc.*

** Consultant for listed agency*

In addition, valuable contributions were received from of the following: Patricia (Trish) Patterson at the City of Burlington provided Burlington and Graham zoning GIS data. Mark H. Chilton, author of *An Historical Atlas of the Haw River,* and Anne M. Cassebaum, author of *Down Along the Haw: The History of a North Carolina River,* both provided insight to historical events.

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NCDENR. n.d.-c Riparian Buffer Rules, Jordan Lake Watershed, Neuse River Basin (including Falls Lake Watershed). Slide deck.

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# Appendix A

# Letters of Commitment to Category 4b Demonstration in Little Alamance Creek

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*August 8, 2012*

Mr. Chuck Wakild
Director
NC Division of Water Quality
1601 Mail Service Center
Raleigh, N.C. 27699-1601

Subject: Category 4b Demonstration as an alternative management approach to the draft impervious cover limitation TMDL for Little Alamance Creek

Dear Mr. Wakild:

The City of Burlington has been investigating pursuing a Category 4b Demonstration for Little Alamance Creek since our December 2, 2011 letter to former NC DWQ Director Coleen Sullins. While the City still has reservations about the appropriateness about TMDLs that use impervious cover as a surrogate for water quality, our investigation has led us to committing to developing a Category 4b Program.

NC DWQ established a deadline for the stakeholders in Little Alamance Creek to commit to the 4b demonstration was established in order to allow the municipalities to budget effectively for program creation. As such the City of Burlington has funds in its current budget to begin development of the Category 4b Program. In keeping with former NC DWQ guidance, specifically the City's original draft NPDES Stormwater Permit about impaired/TMDL waters, the City plans to develop its Category 4b program over the next 24 months from the acceptance of this letter by NC DWQ. Once the program is created the City will submit it to NC DWQ for approval.

We look forward to working with DWQ staff on this important initiative to begin the process of restoring the biological integrity of Little Alamance Creek. If you or your staff have any questions or need any additional information please contact our Stormwater Administrator, Michael Layne, P.E. at (336) 222-5140 or via email at mlayne@ci.burlington.nc.us.

Respectfully Submitted,

Harold Owen, City Manager

Cc: Josh Johnson, P.E. Alley, Williams, Carmen, and King
Michael Layne, P.E. City of Burlington
Andy McDaniel, P.E. NCDOT
Chris Rollins, City Manager City of Graham
Kathy Stecker, NC DWQ Planning Section
Mike Randall, NC DWQ Surface Water Protection Section

City of Graham
P. O. Drawer 357
201 South Main Street
Graham, North Carolina 27253
Tel: (336) 570-6700 / Fax: (336) 570-6703

July 24, 2012

Mr. Chuck Wakild
Director
NC Division of Water Quality
1601 Mail Service Center
Raleigh, N.C. 27699-1601

Subject: Category 4b Demonstration as an alternative management approach to the draft impervious cover limitation TMDL for Little Alamance Creek

Dear Mr. Wakild:

The City of Graham has investigated pursuing a Category 4b Demonstration for Little Alamance Creek since my November 30, 2011 letter to former NC DWQ Director Coleen Sullins. While the City still has reservations about the appropriateness of TMDLs that use impervious cover as a surrogate for water quality, our investigation has led us to commit to developing a Category 4b Program.

The July 2012 deadline in the original letter for the stakeholders in Little Alamance Creek to commit to the 4b demonstration was established to allow the municipalities to budget effectively for program creation. As such the City of Graham has funds in its current budget to begin development of the Category 4b Program and plans to begin development this month. In keeping with former NC DWQ guidance, specifically the City's original draft NPDES Stormwater Permit about impaired/TMDL waters, the City plans to develop its Category 4b program over the next 24 months from the acceptance of this letter by NC DWQ. Once the program is created the City will submit it to NC DWQ for approval.

We look forward to working with DWQ staff on this important initiative to begin the process of restoring the biological integrity of Little Alamance Creek. If you or your staff have any questions or need any additional information please contact our stormwater engineer, Josh Johnson, P.E. at (336) 226-5534 or through email at josh@awck.com.

Respectfully Submitted,

Chris Rollins, City Manager

Cc: Josh Johnson, P.E. Alley, Williams, Carmen, and King
Michael Layne, P.E. City of Burlington
Andy McDaniel, P.E. NCDOT
Kathy Stecker, NC DWQ Planning Section
Mike Randall, NC DWQ Surface Water Protection Section

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STATE OF NORTH CAROLINA

# DEPARTMENT OF TRANSPORTATION

BEVERLY EAVES PERDUE
GOVERNOR

EUGENE A. CONTI, JR.
SECRETARY

July 27, 2012

Mr. Chuck Waklid
Director
NC Division of Water Quality
1601 Mail Service Center
Raleigh, N.C. 27699-1601

Subject: Category 4b Demonstration as an alternative management approach to the draft impervious cover limitation TMDL for Little Alamance Creek

Dear Mr. Waklid:

On October 21, 2011 the NCDOT participated in a meeting to discuss alternative management approaches to restoring the biological integrity of Little Alamance Creek in the Cape Fear River basin. The meeting was attended by representatives from DWQ's Modeling & TMDL Unit, the Stormwater Permitting Unit, along with several local government staff persons from across the state. As a follow-up to this meeting, on November 22, 2011 I sent former Director Coleen Sullins a letter describing NCDOT's commitment to further investigate the feasibility of preparing a Category 4b Demonstration as an alternative to the draft impervious cover limitation TMDL, and as a framework for achieving our common goal of restoring water quality standards in Little Alamance Creek. In this letter NCDOT committed to work with its project partners at DWQ and the cities of Burlington and Graham to reach a final decision on pursuing a Category 4b Demonstration by July 2012.

Upon further investigation of the Category 4b process and in consultation with representatives of Burlington and Graham, NCDOT believes a Category 4b Demonstration is a viable alternative management approach to the draft impervious cover limitation TMDL for Little Alamance Creek. As such, NCDOT commits to a cooperative working partnership with Burlington and Graham to prepare a joint Category 4b Plan designed to restore the biological integrity of Little Alamance Creek. NCDOT and its municipal partners will submit the Plan to DWQ for your review and approval within a time period no longer than twenty four (24) months after receiving written notice-to-proceed from your office.

**MAILING ADDRESS:**
NC DEPARTMENT OF TRANSPORTATION
HYDRAULICS UNIT
1590 MAIL SERVICE CENTER
RALEIGH NC 27699-1590

TELEPHONE: 919-707-6700
FAX: 919-250-4108

*WEBSITE: WWW.NCDOT.ORG/DOH/*

**LOCATION:**
CENTURY CENTER COMPLEX
BUILDING B
1020 BIRCH RIDGE DRIVE
RALEIGH NC

We look forward to working with DWQ staff and our municipal partners to begin the process of restoring the aquatic life support uses of Little Alamance Creek. We hope you concur with our findings that a Category 4b Demonstration is indeed a viable alternative to an impervious cover limitation TMDL and we look forward to receiving your letter of notice-to-proceed so we can begin this important project. If you or your staff have any questions or need any additional information please contact Andy McDaniel, PE of my staff at (919) 707-6737 or through email at amcdaniel@ncdot.gov.

Respectfully Submitted,

David Chang

David Chang, PhD, PE
State Hydraulics Engineer
Hydraulics Unit
NC Department of Transportation

cc: Kathy Stecker (DWQ)
Mike Randall (DWQ)
Mike Mills, PE (NCDOT)
Jerry Parker (NCDOT)
Don Lee, CPESC (NCDOT)
Ken Pace, PE (NCDOT)
Andy McDaniel, PE (NCDOT)
Harold Owen (City of Burlington)
Michael Layne, PE (City of Burlington)
Chris Rollins (City of Graham)
Josh Johnson, PE (Alley, Williams, Carmen, and King)

RECEIVED
AUG 28 2012
DIVISION OF HIGHWAYS
HYDRAULICS UNIT

NCDENR

North Carolina Department of Environment and Natural Resources
Division of Water Quality

Beverly Eaves Perdue, Governor
Charles Wakild, P. E., Director
Dee Freeman, Secretary

August 23, 2012

David Chang, PhD, PE
State Hydraulics Engineer
NC Department of Transportation
1590 MSC
Raleigh, NC 27699

Dear Dr. Chang:

Our Director, Mr. Charles Wakild, asked me to respond to your July 27, 2012 letter regarding a Category 4b demonstration as an alternative management approach for Little Alamance Creek. According to EPA guidance, Category 4b is appropriate for situations where a TMDL is not needed, because other pollution control requirements are expected to result in the attainment of an applicable water quality standard in a reasonable period of time. DWQ concurs that a Category 4b demonstration is a viable alternative to the draft TMDL for Little Alamance Creek.

Please consider this letter to be your requested notice-to-proceed. We understand that within the next 24 months, NCDOT, Burlington, and Graham will submit documentation addressing each of the required six elements of a 4b demonstration. We request that staff assigned to developing the 4b plan arrange to meet with DWQ staff early in the process and then periodically as development proceeds. This will help to ensure that the product is consistent with federal regulations and EPA's recommended structure.

Thank you for your commitment to restoring Little Alamance Creek. Please contact me if you have any questions. My phone number is 919-807-6331, and my email address is kathy.stecker@ncdenr.gov.

Sincerely,

Pam Behm for Kathy Stecker

Kathy Stecker, Supervisor
Modeling and TMDL Unit

cc: Mike Randall
Andy McDaniel, DOT
Michael Layne, Burlington
Josh Johnson, AWCK

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# Appendix B

# Historical Watershed Information

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## Historical Watershed Information

The original native inhabitants of present day Alamance County were referred to as the Shackory Indians by the German explorer Dr. John Lederer in 1670 (Euliss 1984, 5). More commonly known as the Sissipahaw Indians, they were Siouan and had settled between the Eno and Haw Rivers. Numerous village sites have been located along the Haw River and Alamance Creek which indicate that the Sissipahaw raised crops on fertile floodplains and hunted wild game.

Little else is known about the Sissipahaw. Native Americans left the area before the arrival of European settlers perhaps merging with the Catawba Indians, the largest Siouan tribe in the Piedmont. European settlement of the area began in the early 1700s; however, following the Tuscarora Indian Wars (1711–1713) and the English Crown's purchase of the Lords Proprietor's Colony (1729) many more settlers moved into the area (Vacca and Briggs, n.d, under "Colonial History: European Settlement").

The Indian Trading Path linked Indians in east central Virginia with the Catawba Indians west of the Yadkin River in North Carolina. A segment of the Trading Path passed through Alamance County from northwest of Hillsborough toward Mebane crossing the Haw River at the Town of Haw River (Troxler 2000, under "East-west Pattern of the Trading Path Network in Alamance County"). Beyond the Haw River the Path split into a "western Trading Path" and a "lower Trading Path". The western Trading Path continued to Graham and beyond where it crossed both Little Alamance Creek and Great Alamance Creek.

The Trading Path became important for commerce between Virginia traders and the Catawba nation. In 1728 Colonel William Byrd of Virginia described the Trading Path as traversing "…the most fertile high land in this part of the world…" (Euliss 1984, 5). This and other similar descriptions of the area attracted settlers from the middle and northern colonies. Land in the Piedmont region of North Carolina was relatively inexpensive when compared to land in Pennsylvania.

Quakers, Scots-Irish Presbyterians, and German Lutherans and Reformed from Pennsylvania were among early immigrants who established numerous settlements in Alamance County (Vacca and Briggs, n.d., under "Colonial History: Settlement Patterns"). German Lutheran and Reformed settlers located along Alamance Creek and Stinking Quarters Creek. English, German, and Welsh Quakers settled near Snow Camp along Cane Creek. Scots-Irish Presbyterians chose settlements in eastern Alamance County near Hawfields.

### Land Uses and Population

Agriculture and silviculture were significant land uses in both the eighteenth and nineteenth centuries. Timber was harvested and sawmills were constructed to supply lumber to build settlements and later towns. The earliest farming was for subsistence and included growing fruits and vegetables and raising cattle and hogs. Corn, wheat, oats and rye, flax, and tobacco were grown later in the eighteenth century as commercial crops. Numerous gristmills were built along the Haw River and its tributaries to produce corn meal and flour.

Many of these streams were ideal locations to construct dams and provided the channel slope and stream flow needed for mill races and water wheels. During the Industrial Revolution some early mill sites became the location for textile mills. Most textile mills provided water power for spinning machines and looms. Some mills were later converted to steam power. By the late 1830s there were 41 gristmills in Alamance County (Vacca and Briggs, n.d, under "Textile Industry"). In 1879 there were 40 gristmills and 24 sawmills. Over one-half of these mills were built during the previous 20 years (Lounsbury 1980, 68). As late as 1928 there were still 30 mills, mill dams, or mill sites located in the county.

A number of mills were located along Little Alamance Creek. A map of Alamance County shows six hydro-powered mills located along Little Alamance Creek between its confluence with Great (Big) Alamance Creek and present-day Burlington (Figure B-1).


**Figure B-1. Historic map of Alamance County indicating six mills (the Rogers & Curtis Mill, the Harden Mill, Whittsett's Mill, W.F. Jones's Mill, Sellar's Old Saw Mill, and Coble's Mill) located within the Little Alamance Creek watershed (Spoon, 1893)**

In 1832, John Trollinger built the first cotton mill in the county located on the Haw River north of Stony Creek. In 1837, Edwin M. Holt and his brother-in-law William Carrigan founded the Alamance Cotton Factory on Alamance Creek at Alamance.

Carrigan later sold his interest to Holt who also acquired the Granite Cotton Factory at Haw River in 1845. In 1849, Edwin M. Holt built a yarn mill on the Haw River at Saxapahaw. He is considered the most important of the early mill owners in Alamance County. It was largely his vision that led to the growth of the textile industry in Alamance County and North Carolina.

Prior to that time most cotton grown in North Carolina was shipped to northern manufacturers to be converted into yarn. North Carolina mills were in turn paying higher prices for the yarns produced by the northern mills. Holt realized that building cotton mills in Alamance County would take advantage of already having the raw materials nearby, benefit from low freight rates to the mill, utilize established mill sites for water power and have abundant labor.

In 1879 there were six cotton mills in the county. By 1886 the number of mills had grown to 13, and by 1890 there were 17 mills. In 1890 there were also numerous grain and sawmills in the county.

It was also Edwin M. Holt who produced the first colored cotton goods in the South. In 1853, Holt's son, Thomas M. Holt, learned the art of dying cotton yarn. He and his father installed looms in the Alamance Cotton Factory on Alamance Creek specifically for producing woven, dyed cotton cloth. This cloth became known as Alamance Plaids (Stockard 1900, 92).

Holt's mills produced hundreds of yards of cloth used to make Confederate uniforms during the Civil War. In 1883, he built the E.M. Holt Plaid Mills in present-day Burlington. Alamance Plaids were also manufactured at the Plaid Mills (Whitaker 1949, 103) and were very popular in both southern and northern markets. In 1900, the E. M. Holt Plaid Mills converted from the plaid fabric to gingham which it continued to produce until 1931 when it was converted again to manufacture yarn goods.

At least three late nineteenth century cotton mills were built near the headwaters of several Little Alamance Creek tributaries. These were the Plaid Mills (1883) in present-day Burlington, the Oneida Mill (1882), and the Sidney Mill (1885) both in present-day Graham (Dickenson 1987, various pages).

Color-fast indigo dye was used to produce the first Alamance Plaids (Vincent 2009, 76). Indican, a natural blue colorant is found in many plants world-wide. Indigofera plant varieties are generally considered to produce the largest amounts of Indican per plant and were highly desirable as sources for Indigo dye in the nineteenth century.

The production of Indigo dye followed essentially the same process world-wide between the sixteenth and the nineteenth centuries (Sweet, n.d, 1-16). Indican is a water-soluble glucoside which is easily extracted by steeping the plant leaves and stems in water. In the nineteenth century the production of Indigo dye required a series of large vats.

After steeping, the liquid created was allowed to ferment for 10 to 12 hours. During fermentation a natural enzyme known as Indimulsin was added to hydrolyze the Indican and eliminate glucose. The liquid would literally heave and swell and develop a foul odor.

The fermented liquid was then decanted into another vat exposing the Indican to air. The resultant oxidation process transformed the Indican into an insoluble form. Once in the second vat the fermented liquid was beaten or flailed with large paddles for several hours causing a precipitate called Indigotin to form in the bottom of the vat. The precipitate was dried and cut into small blocks of Indigo dye.

To be used as dye these blocks were ground into a powder and mixed in an alkaline (mordant) bath. Mordant agents were often metal oxides and included, at various times, tannic acid, alum, urine, chrome alum, sodium chloride, and certain salts of aluminum, chromium, copper, iron, iodine, potassium, sodium, and tin (Wikipedia 2014, under "Mordant"). They served to make the Indigo soluble again and enhanced the saturation of the yarn or cloth with the dye during the dyeing process. Once dyed the yarn or cloth was exposed to air to dry. The resultant oxidation process once again transformed the Indican into an insoluble form making the dye color-fast.

The production and use of indigo dye resulted in potential sources of surface water pollution. In addition to the reactants normally used in the production of the dye, caustic lye (sodium hydroxide) and slaked lime (calcium hydroxide) were sometimes added during the dyeing process to aid fermentation and to modify color intensity, respectively. Chemical by-products from the dyeing process had the opportunity to enter the environment at three stages: during the manufacturing of the dye, during the application of the dye to the yarn or cloth, and during disposal.

In the late nineteenth century the first hosiery mills in the county began operation. In the 1920s, many cotton mills were converted to produce rayon and other fabrics. By 1934, Burlington Mills was the largest producer of rayon in the United States (Vacca and Briggs, n.d, under "Textile Industry").

**Railroad**

In 1849, the North Carolina General Assembly enacted legislation creating the North Carolina Railroad Company. The action included a charter to construct a railroad to connect western North Carolina with the Goldsboro terminus of the Wilmington and Weldon Railroad (Vincent 2009, 12). Various owners of textile mills in Alamance County were among the chief proponents of the railroad (Euliss 1984, 13).

Construction began in 1851 with the route passing through central Alamance County. The first train traveled the entire route from Goldsboro to Charlotte in January 1856. The advent of the railroad significantly shaped the future of a number of towns and cities including Burlington and Graham.

The route of the railroad greatly influenced area demographics and ensured that late nineteenth century mills and other manufacturing concerns would locate in towns near the railroad (Vincent 2009, 12). Indeed, seven late nineteenth century cotton mills were located adjacent to or in close proximity to the railroad in the present-day cities of Burlington and Graham. The railroad alignment followed the ridgeline that defines the upper watershed boundary of Little Alamance Creek.

A repair station was built midway along the route to service locomotive engines and rolling stock. Construction began in 1855 and was largely complete by 1859. The station was known as Company Shops and attracted engineers, mechanics, and other skilled workers from 10 states and several foreign countries (Vincent 2009, 13).

The rapid population growth and diversity ultimately transformed the railroad town into a community of varied cultural backgrounds. The original railroad directors envisioned a company town characteristic of nineteenth century industrial development (Troxler 2006, under "Company Shops"). To control development they acquired 632 acres, although the railroad shops occupied less than 30 acres.

By 1859, Company Shops included 57 buildings. Within the repair station seven shop structures were built including two machine shops, a blacksmith shop, a foundry, a carpentry shop, an engine shed, and car shed. In addition, a passenger and freight station, a two-story hotel, houses for workers and railway officials, and a company headquarters building were constructed.

Company Shops remained a village until 1863 when company stockholders approved the layout of streets and the sale and lease of lots. The village was incorporated in 1866. In 1871, the railroad was leased to the Richmond & Danville Railroad which was working in concert with the Pennsylvania Railroad to link the Northeast with the South. By 1893 the North Carolina Railroad had become part of the Southern Railway system.

Southern Railway built new shops in Spencer, North Carolina. The acquisition of the railroad and the new shops in Spencer resulted in the transfer of many jobs. Resentment toward the railroad led citizens to seek a change in the town name. In February 1887, the North Carolina General Assembly changed the municipal charter and Company Shops formally became Burlington.

**Sewage Discharge**

In 1950, numerous complaints against the City of Burlington were filed with the North Carolina State Board of Health by citizens living along Little Alamance Creek. At that time the City of Burlington was discharging sewage into Little Alamance Creek. As more complaints had been filed against the City of Burlington than any other city in the state, the State Board of Health urged the City to construct a sewage disposal plant to avoid multiple law suits (The Burlington Daily Times-News, 6 December 1950).

On April 26, 1951, a claim in the amount of $20,000 was filed against the City of Burlington by two residents of Graham for alleged damages arising from the City's discharge of sewage into Little Alamance Creek (The Burlington Daily Times-News, 27 April 1951). On January 10, 1962 the United States Community Facilities Administration approved a $38,235 loan for the preliminary planning of a major interceptor sewage line and waste treatment plant for the Little Alamance Creek drainage area (The Burlington Daily Times-News, 1962a).

The Burlington city council voted unanimously on January 16, 1962 to purchase a 58-acre tract for the construction of a waste treatment plant to be located near the confluence of Big Alamance Creek and the Haw River (The Burlington Daily Times-News, 17 January 1962).

The proximity of various mills and other industrial enterprises to Little Alamance Creek and its tributaries could have resulted in the discharge of potential pollutants dating to the Colonial period.

## History of North Carolina's Water Quality Permitting Programs

Eighteenth century interest in public water supply in antebellum North Carolina was mainly focused on fire protection (Howells 1989, 1). Well into the nineteenth century unsafe water supplies were frequently the cause of illness and death. Mortality figures from the Civil War reveal more deaths from disease than from battle with water-borne illnesses often cited as the cause.

In response to growing concern for hygiene and sanitation, the North Carolina General Assembly created the North Carolina Board of Health in 1877. Early water quality analyses were limited by the incomplete understanding of the connection between water chemistry and disease and by the simplistic analytic technology of the time (Howells 1989, 5). Still, these efforts successfully made the connection in some instances between contaminated groundwater wells and illness.

Public concern for stream sanitation grew to include aquatic life and nuisance conditions. In 1883, the North Carolina General Assembly enacted An Act to Prevent Poisoning Streams of Water in this State. The Act made it illegal to use poisonous substances to catch, kill, or drive fish in waters, creeks, and rivers of the state (Howells 1990, 4).

In 1886, both the City of Durham and the City of Raleigh acted to provide community water systems. By 1888, the North Carolina Board of Health reported 12 communities with public water supply systems although the water quality for each varied. Turbidity was often reported. There was little to no use of the water provided by poorer classes, presumably because of the cost.

These early public water supplies generally received no treatment other than some degree of sedimentation. Whether deep wells or streams, the water sources themselves were not protected and were vulnerable to pollution. For this reason the City of Raleigh sought legislation in 1887 to protect the stream and watershed of Walnut Creek.

Thirty-five North Carolina counties reported cases of Typhoid fever in 1888. In 1889, the North Carolina Board of Health issued several advisories that Cholera and Typhoid fever were commonly caused by polluted drinking water and recommended that drinking water be boiled. This time period also saw the general acceptance of the need to disinfect waste and treat sewage.

Beginning in 1889, the North Carolina General Assembly passed numerous legislative prohibitions against pollution from lumber mill sawdust. Similar legislation was passed for various counties through 1921 (Howells 1990, 9).

In 1893, the North Carolina General Assembly authorized the North Carolina Board of Health to oversee all inland waters and determine their potential as domestic water supplies. This authority extended to the protection of watersheds. One early effect of this authorization was determining that the Little River water supply for the City of Goldsboro was contaminated by streams draining unsanitary areas of the City. The City was advised to abandon the river and obtain public water from deep wells.

In 1897, legislation was introduced in the North Carolina General Assembly that would have extended the police powers of cities and towns to their water supply watersheds and would have required periodic watershed inspections (Howells 1989, 22). Although the legislation was not enacted it prompted the North Carolina Board of Health to order all municipal water supplies inspected and tested chemically and bacteriologically. In 1899, the North Carolina General Assembly adopted legislation that required public water companies to undertake quarterly biological and chemical analyses.

By 1902, the number of North Carolina towns having public water supplies had grown to 27; however, the North Carolina Board of Health continued to express concern with the quality of the water furnished by some of the systems. The quarterly watershed inspections and water quality analyses were generally not being observed (Howells 1989, 35). Treatment was still commonly limited to mechanical filtration at times augmented by coagulation prior to filtration. Water quality analyses had improved to some degree but chemical analysis for chlorine, ammonia, nitrate and nitrite was limited.

Prior to the 1950s, there was no effective statewide law to control discharges to waters of the state (DeVane, n.d.). In 1895, the North Carolina Board of Health reported that raw sewage was discharged to Walnut Creek, the water source for the City of Raleigh. Discharge of raw sewage directly to streams or their tributaries was common. In 1903, the North Carolina General Assembly adopted An Act to Protect

Water Supplies. Under the law, pollution of water sources was considered a misdemeanor offense subject to fines and imprisonment.

In 1905, the City of Durham sued Eno Cotton Mills under the Act alleging their wastewater discharge resulted in pollution of the City's Eno River water supply. The court ruled in favor of Durham, a decision that was subsequently sustained on appeal to the State Supreme Court (Howell 1989, 38).

By 1907, the North Carolina Board of Health had published water purification standards and advocated bacteriological analysis as the most appropriate test for acceptable drinking water. It was during this period that analyses for coliform indicator bacteria were first recommended.

During this time, there were 48 communities with public water supplies but only 25 with sewer systems. Efforts to treat drinking water and protect public water supply watersheds continued. The North Carolina Board of Health first recommended disinfection with compounds of chlorine in 1911.

The same disinfection requirement was not applied to the discharge of sewage. While it was acknowledged by this time that studies of sewage treatment and industrial wastes were needed to determine the assimilative capacity of receiving streams, there appears to have been some debate surrounding the legal rights of municipalities to discharge sewage. As late as 1926, a citizen petitioned the North Carolina Board of Health with concerns about the Town of Warsaw's raw sewage discharge. The Board declined to make specific finding or recommendations citing differences of opinion about the judicial right to discharge raw sewage to a stream.

Similarly the Town of Smithfield petitioned the North Carolina Board of Health over concerns about the City of Raleigh discharge of sewage. The Town alleged health hazards arising from contamination of their Neuse River water supply. Ultimately the Town of Smithfield sued the City of Raleigh in 1934 (DeVane, n.d.). The Superior Court ruled in favor of the Town as did the State Supreme Court on appeal. The City of Raleigh was ordered to build a sewage disposal plant.

In 1911, the North Carolina General Assembly passed the first state legislation to prevent stream pollution from the disposal of tailings waste from mining activities (Howells 1990, 11). In 1915, the North Carolina General Assembly created a Fisheries Commission Board to oversee commercial fishing and authorized it to enforce discharges to state waters of deleterious materials and substances poisonous to fish life. Following this legislation the North Carolina General Assembly adopted An Act to Prevent Pollution of Fishing Stream and Trespass on State Fish Hatchery Property in 1927.

In 1927, a Stream Sanitation and Conservation Committee was formed representing the North Carolina Board of Health and the Conservation Commission. The committee was charged with investigation of stream pollution on the Neuse, Haw, Tar, Catawba and Roanoke Rivers (Howells 1989, 59).

Increasing concern for interstate waters pollution resulted in the North Carolina General Assembly enacting An Act Providing for Administration and Control of Interstate Waters in 1929.

In the 1930s, the North Carolina Board of Health frequently cited stream pollution as one of the State's greatest problems. In 1945, the North Carolina General Assembly established the State Stream Sanitation and Conservation Committee.

At the federal level, the first legislation to address water pollution was the 1899 Refuse Act. While its primary purpose was to prevent discharge of refuse into navigable waters, it was used successfully in the 1960s as an enforcement tool for the discharge of wastewater to navigable waters. The United States Congress enacted Public Law 845, the Federal Water Pollution Control Act in 1948. It was the beginning of the federal-state cooperative water pollution control programs that continue today.

In 1951, the North Carolina General Assembly enacted the State Stream Sanitation Act which established the State Stream Sanitation Committee as an autonomous committee within the North Carolina Board of Health (Howells 1989, 60). The law authorized a comprehensive stream pollution control program determined by stream classification, which was based upon present or contemplated best usage.

The State Stream Sanitation Committee adopted stream classifications and standards in 1953 (DeVane, n.d.). The classifications were A-I: Protected Water Sources, A-II: Water Supply Sources Requiring Full Treatment, B: Body Contact Recreation, C: Fish Life Propagation, D: Agriculture, Fish Survival, Industrial Cooling and Processes, and E: Navigation, Sewage and Industrial Waste and Disposal Short of Nuisance Conditions. For saline waters the classifications were SA: Shellfish Growing, SB: Body Contact Recreation, SC: Fish Propagation, and SD: Navigation Short of Nuisance Conditions.

In 1955, the North Carolina General Assembly adopted acts to prohibit discharges of raw sewage, industrial waste and other noxious and deleterious substances into the Haw River and the Northeast Cape Fear River. Pollution of these waters was defined as conditions not meeting their best usage classification or violation of applicable water quality standards (Howells 1990, 79).

During the 1950s, different committees within the North Carolina Board of Health administered the stream sanitation law and health code. The Division of Water Pollution Control was responsible for sources of pollution to classified waters. The Sanitary Engineering Division was responsible for sources of pollution to unclassified waters. In 1959, the Stream Sanitation Committee along with its Division of Water Pollution Control was transferred to a new Board of Water Resources.

The Federal Water Pollution Control Act was amended in 1956 by enactment of Public Law 660. The amendments authorized federal grants for construction of publicly-owned wastewater treatment plants, increased technical assistance, broadened research, and increased federal enforcement of wastewater discharges to interstate waters. The Act was amended again in 1961 and 1965. The 1965 requirements included standards for all streams in the United States, state-issued water quality standards for interstate waters, and authorization for the Federal Water Pollution Control Administration to set standards where states failed to do so.

The Water and Air Resources Act was enacted in 1967 by the North Carolina General Assembly. The legislation called for pollution and water use surveys, preparation of comprehensive pollution abatement plans and development of surface water classifications based upon best use and associated water quality standards (Howells 1989, 61). The Board of Water Resources became the Board of Water and Air Resources. In 1968, the state’s lowest stream classification (E) was abolished.

Federal Water Pollution Control Administration regulations adopted in 1970 required cities receiving industrial wastes into their sewage systems to adopt sewer use ordinances. The ordinances provided for the collection of user charges sufficient to reimburse the cities for the cost of treating industrial waste. On July 9, 1970, the Federal Water Pollution Control Administration was transferred to the newly created Environmental Protection Agency.

The North Carolina Pesticide Act of 1971 was enacted to address the fate of pesticides and their potential pollution of stream and lakes causing danger to aquatic life. The sale and use of pesticides were regulated and licensure was required for dealers and applicators (Howells 1990, 120).

In 1971, the North Carolina General Assembly authorized the first appropriations to aid the construction of local wastewater treatment plants. Also in that year the North Carolina General Assembly authorized a bond referendum to aid public water supply, strengthened enforcement provisions and pollution control monitoring requirements, and established minimum standards for public water supplies.

In 1971, the North Carolina General Assembly transferred the Department of Water and Air Resources to a new Department of Natural and Economic Resources. The Board of Water and Air Resources became the North Carolina Environmental Management Commission (EMC) along with its Division of Environmental Management on July 1, 1974.

Also in 1971, the North Carolina General Assembly enacted the Mining Act. A major intent of the legislation was to condition the issuance of mining permits on pollution control measures. Permits could be denied if the mining operation would adversely affect freshwater, estuarine, or marine fisheries or violate water quality standards.

The Federal Water Pollution Control Act was again amended in 1972. The amendments increased the maximum federal contribution for matching grants to construct publicly-owned waste treatment plants. The Act also required that all new and existing industrial discharges be permitted under the National Pollutant Discharge Elimination System (NPDES). Permitting was also required for sanitary waste discharges along with point source discharge technology-based standards. In 1975, the Environmental Protection Agency delegated responsibility to North Carolina for the administration of NPDES permits.

With the 1972 amendments to the Federal Water Pollution Control Act the original focus on protection of public water supplies was broadened to include protection of all water uses. Section 401 of the legislation authorized states including North Carolina to require water quality certifications for federally-permitted or licensed activities that could result in a discharge of pollutants into waters of the United States. The certifications required that all state water quality standards, limitations, and restrictions be met and were a condition for issuance of the federal permit or license. Section 401 was applicable to the Clean Water Act Section 404 permits and authorizations, permits issued under Sections 9 and 10 of the Rivers and Harbors Act, licenses for hydroelectric power plants issued under the Federal Power Act, and licenses issued by the Nuclear Regulatory Commission.

In 1973, the North Carolina General Assembly enacted the Sedimentation Pollution Control Act to regulate urban and highway construction land-disturbing activities. The Sedimentation Control Commission and the Division of Land Resources were charged with policy enactment and enforcement. Also in 1973, the North Carolina General Assembly adopted the Oil Pollution Control Act making it unlawful to discharge oil into any waters, tidal flats, beaches, or lands or into any sewer or surface water drain without a permit.

In 1972, Congress passed the Federal Coastal Zone Management Act. To protect estuaries, marine ecosystems and other coastal resources the North Carolina General Assembly enacted the Coastal Area Management Act in 1974. The Act restricted development in environmentally sensitive areas and required local governments in coastal counties to adopt land-use plans that included policies and standards for public and private land and water use (Holm 2000, 22).

The Environmental Management Commission adopted federal effluent limitations in 1976. In 1977, Congress again amended the Federal Water Pollution Control Act. Emphasis was placed upon toxic pollutants and long-term funding for municipal sewage treatment construction grants. As a result, the Environmental Protection Agency listed sixty-five toxic pollutants in 1978 that would serve as the basis for developing effluent standards (Howells 1990, 135).

In 1978, the Division of Environmental Management proposed revisions to the State's water quality standards resulting from the triennial review required by Section 303 of the Federal Clean Water Act. This was the second time the standards were reviewed in their entirety since 1953. Proposed changes involved mixing zones, toxic chemicals, and nutrient standards.

In response to concerns about nitrogen and phosphorus the Environmental Management Commission approved a supplemental Nutrient Sensitive Water Classification in 1979 for surface waters experiencing excessive algal or other aquatic plant growth. Subsequent supplemental classifications were approved for High Quality Waters (1989), Outstanding Resource Waters (1985), and Water Supply Waters (1985).

The North Carolina General Assembly enacted the North Carolina Safe Drinking Water Act in 1979 enabling the State to assume primary jurisdiction over drinking water standards authorized in the Federal Safe Drinking Water Act (Howells 1989, 62).

A comprehensive set of new NPDES regulations was adopted by the Environmental Protection Agency in 1979 and translated to permit regulations in 1980. They reflected best available technology (BAT) and best conventional technology (BCT) effluent limitations adopted by Congress in the 1977 Federal Clean Water Act amendments.

The Environmental Management Commission approved new water supply (WS) classifications in 1985. They were WS-I, WS-II, and WS-III, and were defined by the amount and types of point sources regulated by the state and local government land use efforts to control nonpoint pollution sources.

In 1987, the North Carolina General Assembly authorized a Clean Water Revolving Loan and Grant Fund in response to continued need for State aid for local government water and sewage facilities. Also in 1987, amendments to the Federal Water Pollution Control Act required states to designate at least 50% of federal funds in fiscal year 1989-1990 for revolving loans. Following that period through fiscal year 1994 all federal funds were to be used for the revolving loan program (Howells 1990, 174).

The Division of Environmental Management proposed stormwater controls for development activities in the 20 coastal counties in 1987. They were designed to protect shellfish waters and coastal water quality. The Outstanding Resource Water classification, first adopted in 1985, played a significant role in this approach.

An Act to Establish Penalties for Failure to remove Prohibited Discharges and An Act to Establish Penalties for Prohibited Discharges were enacted in 1987. The former authorized civil penalties for the willful or negligent discharge of hazardous substances, the failure to report an illegal discharge, or the failure to comply with compliance orders. The latter authorized civil penalties for the willful or negligent violation of classifications, standards, or limitations of prohibited discharges of radiological, chemical, or biological warfare agents (Howells 1990, 216).

The North Carolina General Assembly adopted An Act to Establish a Septage Management Program in 1988. Septage could be disposed of only at public or community sewage systems designed and permitted to discharge effluent to surface waters.

In 1988, the Sedimentation Pollution Control Act was amended to strengthen compliance requirements and enforcement provisions. In 1989, the Environmental Management Commission adopted a turbidity standard to be imposed in cases of sedimentation violations.

The Division of Environmental Management reported on nonpoint source pollution assessment and management in 1989 in conformance with the 1987 amendments to the Federal Water Pollution Control Act. Thirty percent of the state's streams were reported as degraded; nonpoint source pollution was cited as the primary source of degradation of freshwater rivers and streams in the state. Pollution sources, in order of importance, were agriculture, urban runoff, and construction with sediment identified as the most widespread cause of degradation (Howells 1990, 181).

About five percent of estuarine waters were degraded with nonpoint sources accounting for 72% of the degradation. Agriculture, septic tanks and urban runoff were the primary sources. Excess nutrients and fecal coliform bacteria were cited as the principal causes of degradation.

In response to these findings, the Division of Environmental Management nonpoint source management plan included agriculture and forestry cost-share programs to match funds for best management practices (BMP), a water supply watershed protection program, regulation under the Sedimentation Pollution Control Act and the Mining Act, and coastal stormwater regulations. The North Carolina Nonpoint Program was approved by the Environmental Protection Agency in 1989.

State legislation and/or rules followed for mandatory nonpoint source pollution control in water supply watersheds, undisturbed buffer zones along trout waters, BMPs for silviculture, increased funding for agriculture, nonpoint source protection for High Quality Waters, expansion of nonpoint-related groundwater programs, watershed management programs, waste reduction and recycling, and wetland protection.

In 1989, the North Carolina General Assembly enacted An Act to Authorize and Direct the Environmental Management Commission to Phase in Stormwater Runoff Rules and Programs. It required the Environmental Management Commission to begin a continuous planning process for the development and adoption of a statewide stormwater management plan including rules and enforcement.

The North Carolina General Assembly also acted in 1989 to ratify the Water Supply Watershed Protection Act, requiring the Environmental Management Commission to adopt new water supply watershed classification rules. Appropriate classifications were required for all water supply watersheds in the state with associated minimum protective standards. Related legislation was passed to provide for a state water supply plan and local water supply plans.

In 1989, the North Carolina General Assembly created the North Carolina Department of Environment, Health, and Natural Resources to consolidate all environmental, environmental health, and natural resource programs into a single state agency (Howells 1990, 224).

The Environmental Management Commission adopted a final set of Water Supply Watershed Protection rules in 1992. The rules restricted development densities, limited land uses, and required stream buffers to treat stormwater runoff and other nonpoint sources of pollution (North Carolina Cooperative

Extension Service, n.d., 1). Point sources of pollution including domestic and industrial wastewater discharges were also addressed. Local governments whose land-use jurisdictions included water supply watersheds were required to implement watershed protection plans and adopt ordinances meeting or exceeding state guidelines. WS-IV and WS-V waterbody classifications were also added.

Following an extensive fish kill in the Neuse River in 1995, the North Carolina General Assembly established a goal of reducing nitrogen in the Neuse River by 30% by 2001. To achieve this goal the Environmental Management Commission adopted the Neuse Buffer Rule in 1997 requiring a 50-foot vegetated riparian buffer along streams and rivers in the Neuse River Basin. Buffer rules were subsequently adopted in the Randleman Lake Water Supply Watershed in 1999, in the Tar-Pamlico River Basin in 2000, in the Catawba River Basin in 2004, in the Goose Creek Water Supply Watershed in 2009, and in the Jordan Lake Water Supply Watershed in 2009.

In 1990, Phase I of the NPDES stormwater program was established and required permit coverage for municipalities with populations of 100,000 residents or more. Requirements included public education, IDDE, construction and post-construction programs, PPGH, storm sewer system inventory and mapping, and water quality monitoring (NCDENR, 2007, 2-2).

Phase II of the NPDES stormwater program began in 2003. The federal rules required certain smaller MS4 operators to meet Phase I requirements for larger municipalities. Operators of construction sites equal to or greater than one acre in area were required to file a Notice of Intent (NOI) prior to beginning construction and develop and implement a SWPPP (EPA, 2005, 3).

In 1997, the North Carolina General Assembly enacted The Clean Water Responsibility Act. It required the Environmental Management Commission to adopt goals to improve nutrient-impaired waters and to develop and implement management plans to reduce nutrient inputs from point sources and nonpoint sources. The North Carolina General Assembly subsequently enacted legislation in 2005 (S.L. 2005-190) directing the Environmental Management Commission to adopt permanent rules to establish and implement nutrient management strategies to protect drinking water supply reservoirs including total maximum daily load (TMDL) load reduction limits when necessary (NCDENR, n.d., 1).

In 2009, the Environmental Management Commission adopted the Jordan Lake Nutrient Management Strategy rules. The strategy is intended to restore and maintain the lake's classified uses and enhance protections currently implemented by local governments in existing water supply watersheds. The North Carolina General Assembly subsequently modified the rules (S.L. 2009-216 and S.L. 2009-484).

The rules require stormwater management plans for new development, public education, inventory of MS4 systems, removal of illicit discharges, retrofit opportunities for existing development, and maintenance of BMPs. The rules also include options to offset nutrient loads by purchasing reduction credit from other sellers. Diffuse flow into 50-foot wide riparian buffers is required for all intermittent and perennial streams, lakes, ponds, and reservoirs. Nitrogen and phosphorus waste load allocations (WLA) are required for existing wastewater treatment facilities. Nutrient reduction goals are required for agricultural operations. Fertilizer application is also addressed (NCDENR, n.d., 1).

In 2011, the Environmental Management Commission adopted the Falls Reservoir Water Supply Nutrient Strategy rules. The rules are similar to the Jordan Lake Nutrient Management Strategy rules implemented in two stages. The first stage goal is to restore water quality in the lower portion of the lake through requirements across the lake's entire watershed. The second stage goal is to restore water quality in the upper portion of the lake with additional requirements for regulated activities in the upper watershed. Stage I goals apply to the entire watershed to ensure that the chlorophyll-a standard is met in the lower lake by 2021. Stage II requires additional reductions in the upper watershed to achieve the chlorophyll-a standard throughout the lake by 2041 (NCDENR, 2010, 3).

# Appendix C

# Little Alamance Creek Existing Data Inventory

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# Little Alamance Creek 4b Demonstration Project

# Existing Data Inventory

Prepared by:
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Hydraulics Unit
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Raleigh, NC 27699-1590
919.250.4100

City of Burlington
Water Resources Department
1103 S. Mebane St.
Burlington, NC 27215
336.222.5145

City of Graham
Public Works Department
105 West Parker Street
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Graham, NC 27253
336.570.6709

Final
January 2014

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## List of Tables



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# List of Acronyms and Abbreviations

| | |
|---|---|
| μg/L | Micrograms per Liter |
| BEHI | Bank Erosion Hazard Index |
| BMP | Best management practice |
| CFS | Cubic feet per second |
| DWQ | Division of Water Quality |
| DWR | Division of Water Resources |
| LATT | Little Alamance, Travis, and Tickle Creeks |
| mg/L | Milligrams per Liter |
| NBS | Near bank stress |
| NC | North Carolina |
| NCDENR | North Carolina Department of Environment and Natural Resources |
| NCDOT | North Carolina Department of Transportation |
| NCEEP | NC Ecosystem Enhancement Program |
| NSW | Nutrient Sensitive Water |
| SPMD | Semipermeable membrane device |
| SR | State Route |
| TKN | Total Kjeldahl Nitrogen |
| TMDL | Total maximum daily load |
| UCFRBA | Upper Cape Fear River Basin Association |
| USGS | United States Geological Survey |

# 1.0 Introduction

This document provides a summary of available watershed information and water quality data for the Little Alamance Creek watershed. This document was prepared for the North Carolina Department of Transportation (NCDOT), the City of Burlington, and the City of Graham under a collaborative project to address impairment in the creek through a Category 4b demonstration. The assessment provided herein will be used to identify data gaps, develop strategies for collecting additional data and implementing stormwater controls, and to prepare the Category 4b demonstration report.

## 1.1 Project Background

Portions of Little Alamance Creek (Cape Fear River Basin) are impaired and included on the 2012 North Carolina 303(d) List of Impaired Waters published by the North Carolina Department of Environment and Natural Resources Division of Water Quality (DWQ) based on a “poor” bioclassification rating. In October 2010, the DWQ prepared a draft total maximum daily load (TMDL) report to address the impairment. The TMDL report identified stormwater runoff and hydromodification as potential contributors to impairment and used impervious cover as a surrogate for biological impairment because no specific pollutants were known or identified. Subsequent to the draft TMDL report, representatives from NCDOT and the cities of Burlington and Graham (hereafter, “project team”) participated in meetings with representatives from the North Carolina Division of Water Resources (DWR) Modeling and TMDL Unit, Stormwater Permitting Unit, and local governments statewide to discuss alternatives to traditional TMDL development in watersheds where the stream is listed as “Category 5” (not meeting designated uses) but the pollutant causing impairment is unknown. During the course of these discussions, the group took steps to investigate the feasibility of preparing a Category 4b demonstration as an alternative to the draft impervious cover limitation TMDL. Category 4b demonstrations are used to address impaired waters where a TMDL is not required because the waterbody is expected to meet standards due to other pollution control requirements.

During the summer of 2012, the project team committed to supporting a Category 4b process in Little Alamance. As part of this commitment, the project team will jointly prepare a Category 4b demonstration describing management actions that, when implemented, will contribute to the overall goal of restoring water quality and achieving a benthic macroinvertebrate community bioclassification of “Not Impaired”, “Good-Fair”, or better. This plan will be submitted to DWR on or before August 23, 2014.

## 1.2 Purpose of this Document

The purpose of this document is to summarize existing water quality and watershed data and information relevant to the impairment in Little Alamance Creek. This document also provides a description of activities performed by the project team to date, a preliminary assessment of data gaps, and recommendations on additional data collection or analysis.

## 1.3 Activities to date

Over the past year the project team has collaborated to develop and prioritize project goals and tasks, participated in a watershed tour, and prepared a report outline. Key project activities and milestones are shown in Table 1.

**Table 1. Key project activities and milestones completed by the project team to date.**

| Date | Project Activity or Milestone |
|---|---|
| September 7, 2012 | Project team kick-off meeting. |
| October 10, 2012 | Project kick-off meeting held with NCDWQ and project team. Project schedule, deliverables, roles responsibilities, and points of contact defined. |
| January 28, 2013 | Category 4b demonstration outline prepared. |
| February 28, 2013 | Project team meeting and watershed tour. Project team member roles/responsibilities in preparing the Category 4b demonstration, desired project outcomes, and opportunities for implementing best management practices (BMP) discussed. The team meeting was followed by a half-day watershed tour during which the project team drove throughout the watershed, walked portions of the stream, discussed pending watershed improvement projects and teaming opportunities, and identified areas that had the potential to support BMP retrofits. |
| May 7, 2013 | Project team coordination meeting with DWQ staff. Project progress, field visit, and report outline discussed. |
| June 28, 2013 | Full project schedule and roles prepared for project team comment. |
| September 3, 2013 | Project progress and coordination meeting with DWR staff. |
| October 22, 2013 | Coordination meeting with United States Environmental Protection Agency and DWR staff. |

### 1.4 Team Members, Roles, Responsibilities

The project team includes NCDOT and representatives from the cities of Burlington and Graham. Team members, along with their associated roles and responsibilities are shown below in Table 2.

**Table 2. Team members, roles, and responsibilities.**

| Name | Organization (Representing) | Roles and Responsibilities |
|---|---|---|
| Josh Johnson | Alley, Williams, Carmen & King, Inc. (City of Graham) | Project management and report preparation |
| Michael Layne | City of Burlington | Project management |
| Patrick Blandford | HDR, Inc. (City of Burlington) | Task management and general support |
| Kenneth Trefzger | HDR, Inc. (City of Burlington) | Task management and general support |
| Andy McDaniel | NCDOT | Project management |
| Craig Deal | NCDOT | Report preparation |
| Brian Jacobson | URS Corp. – North Carolina (NCDOT) | Task management and report preparation |
| Melissa Bauguess | URS Corp. – North Carolina (NCDOT) | Data assessment and report preparation |

## 2.0 Existing Data Inventory

### 2.1 Data Sources

A search for existing data on the Little Alamance Creek watershed consisted of internet research and personal communication with the cities of Burlington and Graham, NC, and also Elon University. Table 3 lists the data sources that were reviewed for information pertaining to Little Alamance Creek. Not all sources reviewed contained data specific to Little Alamance Creek.

**Table 3. Existing documents reviewed for data on the Little Alamance Creek watershed, sorted by document source and publication date. The three documents in bold type contain the majority of available data pertaining to water quality and stream biology.**

| DWQ Documents - Cape Fear River Basin |
|---|
| 1996 Cape Fear River Basinwide Water Quality Plan |
| 2000 Cape Fear River Basinwide Water Quality Plan |
| 2005 Cape Fear River Basinwide Water Quality Plan |
| 2009 DWQ Biological Assessments - Cape Fear |
| 2009 Cape Fear River Basin Basinwide Assessment Report Whole Effluent Toxicity Program, 2004 – 2008 |
| 2009 DWQ Lake and Reservoir Assessments – Cape Fear River Basin |
| 2009 DWQ Cape Fear River Basin - Ambient Monitoring System Report |
| 2009 Upper Cape Fear River Basin Association (UCFRBA) 2009 Annual Report |
| DWQ Documents – Little Alamance Watershed |
| **2006 DWQ Draft Summary of Existing Water Quality Data for Little Alamance, Travis, and Tickle Creek (LATT)** |
| 2007 Evaluation of Water Quality, Habitat, and Stream Biology in the LATT Watersheds, Final Report |
| **2008 Evaluation of Water Quality, Habitat, and Stream Biology in the LATT Watersheds, Draft Final Report** |
| Undated. Prusha, DWQ LATT Benthic Study Review |
| 2010 Total Maximum Daily Load to Address Impaired Biological Integrity in the Little Alamance Creek Watershed |
| NC Ecosystem Enhancement Program (NCEEP) Documents |
| 2007 LATT Watershed Characterization Phase I, Final Report |
| 2008 Little Alamance Creek Stream Restoration Plan (Arcadis) |
| 2008 LATT Local Watershed Plan Phase II |
| 2008 LATT Watersheds Report and Project Atlas, Phase III |
| 2009 LATT Summary of Findings and Recommendations |
| Undated NCEEP LATT Local Watershed Plan Fact Sheet |
| **Elon University Documents** |
| 2010 Elon University Little Alamance Restoration Alliance Meeting - Slide Presentation |
| Little Alamance Land Cover Summary Statistics |
| Haw River Watershed and Little Alamance Watershed Map |
| Little Alamance Watershed Map |
| **Watershed Assessment and Restoration Program (WARP) Reports** |
| 2002 Biological Impairment in Little Troublesome Creek Watershed – Rockingham County |
| 2003 Assessment Report- Biological Impairment in Horsepen Creek Watershed – Guilford County |
| **Other** |
| EPA STORET Database, http://www.epa.gov/storet/ |
| **2007 US Geological Survey (USGS) Data Series 279** |
| State Climate Office of North Carolina, http://www.nc-climate.ncsu.edu/ |
| NC Natural Heritage Program, http://www.ncnhp.org/ |
| USFWS, http://www.fws.gov/ |

## 2.2 Watershed Characteristics

The Little Alamance Creek watershed is located in the upper Cape Fear River Basin, within the Haw River subbasin. Little Alamance Creek flows into Big Alamance Creek approximately three miles upstream of its confluence with the Haw River. This section presents an overview of watershed characteristics, including drainage area, ecoregion, climate, and land use. The following table lists some general identifying information about the Little Alamance Creek watershed.

**Table 4. General watershed characteristics.**

| Characteristic | Description |
|---|---|
| River Basin | Cape Fear River Basin |
| Subbasin | Haw River |
| USGS Hydrologic Unit Code | 03030002040110 |
| NCDWQ Subbasin | 03-06-03 |
| NC stream index number | 16-19-11 |
| NC stream classifications | Class C: Protection of aquatic life and secondary recreation<br>Nutrient Sensitive Water (NSW): a supplemental classification, which carries additional regulatory requirements for agricultural and stormwater management practices. |
| Associated jurisdictions | Alamance County, Burlington, Graham |
| Watershed Area | 16 sq. mi. watershed<br>13 subwatersheds (as delineated for NCEEP Local Watershed Plan) |
| Named Tributaries and Lakes | Boyd Creek (Bowden Branch on USGS topo map), Willowbrook Creek, Mays Lake, May Brook, Walker Brook, Coble Brook, Powell Lake Branch, Gant Brook, Gant Lake, Lamm Brook, Meadowbrook Branch |

### 2.2.1 Ecoregion

The Little Alamance Creek watershed is located in the Piedmont physiographic province of North Carolina. The elevation ranges from approximately 450 feet at the confluence with Big Alamance Creek to 700 feet in the headwater regions. The Little Alamance Creek watershed is located entirely within one Level IV Ecoregion – the Southern Outer Piedmont. This ecoregion has lower elevations, less relief, and less precipitation than its neighboring ecoregions. Gneiss, schist, and granite are typical rock types, and the rocks are more intensely deformed and metamorphosed than the geologic materials in neighboring ecoregions. The rocks are covered with deep saprolite and mostly red, clayey subsoils.

The watershed is composed mainly of three geological types: quartzite in the northern headwaters of the watershed, and metamorphosed gabbro and diorite, and mafic metavolcanic rock in the middle and lower portions of the watershed.

The predominant soil association in the Little Alamance watershed is Mecklenburg-Elon–Cecil, comprising almost the entire watershed south of Route 70. The Vance-Appling–Enon-Cecil association is found north of Route 70 and encompasses the majority of the hydric soils found in the watershed. Hydric soils can be found throughout the watershed within the floodplain, but most predominantly along the Little Alamance Creek stream beds and surrounding area north of Route 70.

### 2.2.2 Climate

Extensive climatic data for the Little Alamance Creek watershed are available through the State Climate Office of North Carolina. Temperature and precipitation records go back over one hundred years. There are multiple weather stations in Alamance County, four of which are currently active. One of these, located in Graham, has collected climatic data from 1902 to present.

Alamance County receives approximately 45 inches of rainfall per year, and another 4 inches per year of frozen precipitation. The greatest one-day precipitation was 6.71 inches in 1954. Recent droughts have impacted data collection efforts in the watershed. A significant drought was occurring in 2007 when DWQ was performing an evaluation of water quality and stream biology. All North Carolina rivers and streams commonly have a maximum flow in late spring, with low flow in fall.

The Normal Monthly Mean Temperature in Alamance County is 59.2 °F; the Normal Monthly Maximum Temperature is 71.2 °F; and the Normal Monthly Minimum Temperature is 47.1 °F. The highest temperature on record was 105°F and the lowest was -6 °F.

### 2.2.3 Land Use

Land use and land cover in the watershed play a substantial role in stream water quality and aquatic habitat. There is relatively good information on these watershed features, as well as information on how these features have changed over time. Elon University conducted an analysis of parcel and census data to determine land use. Approximately 80% of the parcels are residential, and roughly 6.6% of the parcels contain riparian areas; these numbers are based on the number of parcels and not on the total area of land.

Elon University provided a land cover analysis based on aerial photographs from the years 1956, 1984, and 2009. Table 5 shows how road length, forested area, and the number of buildings changed between these years.

**Table 5. Change in land use over time.**

| Year | Total Road Length (miles) | Forested Area (percent of watershed) | Number of Buildings |
|---|---|---|---|
| 1956 | 136 | 37.2 | 5,200 |
| 1984 | 174 | 33.3 | 8,204 |
| 2009 | 195 | 27.4 | 9,637 |

Elon University also estimated the percent of the watershed area that was covered in impervious surfaces for various years. Between 1984 and 2010 the percentage of impervious surface was estimated to increase from 24.6% to 30.0%. This translates to approximately 86 acres of additional impervious surface.

**Table 6. Estimated percent impervious surface over time.**

| Year | Estimated Percent Impervious Surface |
|---|---|
| 1984 | 24.6% |
| 1993 | 27.0% |
| 2001 | 28.6% |
| 2005 | 29.6% |
| 2010 | 30.0% |

The first phase of NCEEP's Local Watershed Plan for Little Alamance, Travis, and Tickle Creeks included an analysis of land use. The results from the analysis are provided in Table 7.

**Table 7. Little Alamance Creek watershed land use (Source: 2007 LATT Watershed Characterization Phase I, Final Report; NCDOT area estimated to be approximately 4.8% of the watershed).**

| Type | Acreage | Percentage |
|---|---|---|
| Agriculture | 318.0 | 3.6% |
| Commercial | 565.5 | 6.6% |
| Industrial | 1,082.1 | 12.4% |
| Institutional | 171.1 | 1.9% |
| Mobile Homes | 2.9 | 0.0% |
| Multifamily | 545.3 | 6.2% |
| Office | 226.6 | 2.6% |
| Open Space/Recreational | 256.9 | 2.9% |
| Single Family | 5,233.0 | 59.7% |
| Vacant | 360.4 | 4.1% |
| Total Acreage in Parcels | 8,761.8 | 100.0% |

In addition to the work done by Elon University and NCEEP, land cover analysis was included in the DWQ report *Evaluation of Water Quality, Habitat, and Stream Biology in the Little Alamance, Tickle, and Travis Creek Watersheds* (2008). During 2006 and 2007, the DWQ conducted monitoring at seven sites in the Little Alamance Creek watershed (Sites 14, 15, 16, 17, 18, 19, and 20). The land use data of the drainage area for each sampling site were obtained from the National Land Cover Database 2001. Table 8 shows the contribution of each category of land use within the drainages of each of the monitoring locations. Most of the drainages are highly developed.

**Table 8. Percent land cover type for the drainage areas of selected monitoring sites across the Little Alamance Creek watershed (National Land Cover Database 2001).**

| Location | Drainage Area (sq. mi.) | High Density Developed | Low Density Developed | Forest | Agriculture | Herbaceous | Water |
|---|---|---|---|---|---|---|---|
| UT to Willowbrook Cr at Kime St. | 0.4 | 61.6 | 38.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Willowbrook Cr at Mebane St (SR 1363) | 1.3 | 21.3 | 78.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| Little Alamance Cr at Mebane St (SR 1363) | 4.4 | 12.7 | 85.8 | 1.3 | 0.1 | 0.1 | 0.1 |
| Little Alamance Cr at NC 54 (Tucker St.) | 6.4 | 37.1 | 53.1 | 8.4 | 1.0 | 0.5 | 0.0 |
| Little Alamance Cr at I-85 Frontage Rd (SR 1398) | 7.7 | 29.6 | 61.6 | 8.4 | 0.2 | 0.1 | 0.0 |
| Little Alamance Cr at Rogers Rd. (SR 2309) | 14.1 | 13.2 | 40.3 | 26.1 | 13.3 | 6.8 | 0.2 |
| Bowden Br at Hanford Rd (SR 2304) | 2.5 | 19.3 | 65.2 | 11.2 | 2.1 | 2 | 0.0 |

## 2.3 Water quality data

Water quality sampling efforts have not been continuous or widespread throughout the watershed. The majority of the water quality data exists for one location, Little Alamance Creek at SR 2309 (Rogers Road). Additional locations throughout the watershed were sampled in support of DWQ's TMDL study and NCEEP's Local Watershed Plan. The following sources for water quality data were identified.

**Table 9. Sources for water quality data in the Little Alamance Creek watershed.**

| Data Source | Date Range of Data Collection | Number of Sites Sampled |
|---|---|---|
| EPA STORET data download | 1968-1975 | 1 |
| 2007 Selected Physical, Chemical, and Biological Data for 30 Urbanizing Streams in the North Carolina Piedmont Ecoregion, 2002–2003. | 2/25/2003-7/11/2003 | 1 |
| USGS Gage Station 0209679804 | | |
| 2010-12 TMDL to Address Impaired Biological Integrity in the Little Alamance Creek Watershed | June 2003 | 5 |
| 2006 DWQ Draft Summary of Existing Water Quality Data | July 2006 | 8 |
| 2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in the Little Alamance, Travis, and Tickle Creek Watersheds | December 2006-August 2007 | 6 |
| 2009 DWQ Biological Assessments – Cape Fear | July 2008 | 1 |

The various data sources collect and report data in different ways, and therefore combining or summarizing the results would be inadvisable. This document focuses more on the extent or completeness of data available, rather than reiterating the results of the various reports. The original data sources (summarized below) contain more detailed information if desired.

The data downloaded from EPA STORET were collected from Little Alamance Creek at SR 2309 between 1968 and 1975. Analytical techniques and quality assurance procedures have improved since that time period.

In 2002-2003 the US Geological Survey (USGS) conducted sampling on Little Alamance Creek at SR 2309 as part of a National Water Quality Assessment study. The purpose of the study was to examine the effects of urbanization on stream ecosystems. Biological, chemical, and physical data were collected on 30 streams across the piedmont of North Carolina. The SR 2309 location is referred to as USGS Gage Station 0209679804 for this USGS study. Continuous stream stage and stream temperature measurements were collected hourly for one year, from November 16, 2002 to November 15, 2003. Standard USGS streamgaging techniques for collection of streamflow data were not used because of the short term of data collection at the sites and limited resources for the project. Instead, a submersible pressure transducer with an internal data logger was used. Water chemistry samples were taken twice, on February 25, 2003 and July 11, 2003. Parameters included basic physiochemical parameters and nutrients as well as pesticides and herbicides.

The DWQ conducted a TMDL stressor study in June 2003 that included five sample locations. The study focused on benthic collections but some physiochemical data were collected at the same time.

In July of 2006, DWQ personnel collected a limited amount of field data to ascertain if any water quality problems could be readily identified, and to aid in the development of a plan for additional monitoring.

In support of the NCEEP Local Watershed Plan, DWQ conducted additional sampling at seven sites in the watershed from December 2006 to August 2007. The sites are identified as 14, 15, 16, 17, 18, 19, and 20 in the *Evaluation of Water Quality, Habitat, and Stream Biology in the Little Alamance, Travis and Tickle Creek Watersheds* (DWQ, 2008). The sampling included water quality data for physical parameters, nutrients, metals, and bacteria. Samples were taken approximately monthly during baseflow, and on three occasions during stormflow. The number of samples for each parameter and site varies.

### 2.3.1 Physicochemical parameters

Physicochemical parameters such as pH, specific conductance, dissolved oxygen, and temperature are the most abundant type of water quality data available for Little Alamance Creek. The historical data from 1968-1975 included these parameters (minus specific conductance) as well as alkalinity and biochemical oxygen demand, two parameters that have not been analyzed since. These data included approximately 18 samples at one location – Little Alamance Creek at SR 2309.

Physicochemical parameters were measured on a limited basis in 2003 by DWQ (one sample at each of five locations) and USGS (two samples at one location). One additional measurement at SR 2309 was taken by DWQ in 2008 with the biological assessment.

The majority of the physicochemical data were collected in 2006 and 2007 by DWQ. In July of 2006, single measurements of specific conductance were measured at eight bridge crossings across the watershed. In addition, duplicate data sondes were installed at Little Alamance Creek at SR 2309 that recorded temperature, pH, specific conductance, dissolved oxygen and the percent saturation of dissolved oxygen. Data were recorded at hourly intervals between July 25 and 31, 2005, for a total of 270 measurements for each parameter. The most widespread sampling effort was from December 2006-2007 when DWQ measured these same parameters at six sites across the watershed, collecting at least 30 observations for each parameter.

**Table 10. Summary of available physicochemical data for the Little Alamance Creek watershed**

| Data Source | Date range of Data Collection | Number of Sites Sampled | Approximate Number of Samples per Site |
|---|---|---|---|
| EPA STORET data download | 1968-1975 | 1 | 18 |
| 2007 USGS Report<br>USGS Gage Station 0209679804 | 2/25/2003-7/11/2003 | 1 | 2 |
| 2010-12 TMDL to Address Biological Integrity in the Little Alamance Creek Watershed | June 2003 | 5 | 1 |
| 2006 DWQ Draft Summary of Existing Water Quality Data | July 2006 | 8 | 270 at SR 2309<br>1 at others |
| 2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in Little Alamance, Travis, and Tickle Creek | December 2006-August 2007 | 6 | 30-34 |
| 2009 DWQ Biological Assessments – Cape Fear | July 2008 | 1 | 1 |

The 2008 DWQ report identified that the highest specific conductance measurements occurred in the headwater tributaries of Little Alamance Creek and that values decreased at downstream monitoring locations. DWQ concluded that dissolved substances were originating from the urban area of downtown Burlington and were being diluted further downstream. Willowbrook Creek samples showed several instances of supersaturated dissolved oxygen concentrations, which were attributed to dense algal blooms noted during sampling. Lower portions of the watershed were found to experience very low levels of dissolved oxygen, falling below the 4.0 mg/L water quality threshold on several occasions. DWQ attributed these occurrences to seasonal patterns associated with high air temperatures that were exacerbated by extreme drought conditions and very low flow. Water temperature and pH measurements were found to be within normal ranges.

### 2.3.2 Nutrients

Data for nutrients is somewhat more limited for the watershed. Three datasets were found containing nutrient data. The historic data from SR 2309 included four nutrient samples in 1971 and 1972. Ammonia, inorganic nitrogen, and Total Kjeldahl Nitrogen (TKN) were sampled once in 1971; in 1972, ammonia, inorganic nitrogen, TKN, and phosphorus were sampled once.

In 2003, USGS measured nutrients in two samples at SR 2309 for the following parameters: TKN, ammonia, nitrate plus nitrate, nitrite, particulate nitrogen, total nitrogen, orthophosphate, and phosphorus.

The most widespread sampling effort was from December 2006-2007 when DWQ measured nutrients at six sites across the watershed, collecting at least 30 samples for each of the following parameters: ammonia, inorganic nitrogen, TKN, total nitrogen, and phosphorus. All parameters had 34 baseflow samples and two stormflow samples.

**Table 11. Summary of available data on nutrients in water quality samples.**

| Data Source | Date range of Data Collection | Number of Sites Sampled | Approximate Number of Samples |
|---|---|---|---|
| EPA STORET data download | 1968-1975 | 1 | 2 |
| 2007 USGS Data Series 279<br>USGS Gage Station 0209679804 | 2/25/2003-7/11/2003 | 1 | 2 |
| 2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT | December 2006-August 2007 | 6 | 30-34 |

The 2008 DWQ report identified a few trends in the nutrient data. One site, Little Alamance Creek at Mebane Street, was found to have consistently high ammonia nitrogen concentrations and the highest TKN observed during the study. Willowbrook Creek and UT to Willowbrook Creek were found to have the highest phosphorus concentrations. Willowbrook Creek and its UT were also high in ammonia and sodium. The 2008 DWQ report indicated that elevated nutrient concentrations at Little Alamance Creek at Mebane Street and Willowbrook Creek and its UT could be linked to the potential presence of malfunctioning septic or sewage sources.

### 2.3.3 Metals

Only one dataset was found in which metal concentrations were reported. DWQ sampled six locations for both toxic and non-toxic metals between December 2006 and August 2007, approximately monthly. Results for several toxic metals (arsenic, cadmium, chromium, mercury, nickel, and silver) were below the detection limit and were not reported. Three other toxic metals (copper, lead, and zinc) were found and reported. Other metals analyzed included aluminum, iron, manganese, calcium, magnesium, potassium, and sodium. Metals were sampled at six sites 10-15 times at low flow and two times during high flow conditions. A summary of the available data on metals in the Little Alamance Creek watershed is shown in Table 12.

**Table 12. Summary of available data on metals in water quality samples.**

| Data Source | Date range of Data Collection | Number of Sites Sampled | Approximate Number of Samples |
|---|---|---|---|
| 2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT | December 2006-August 2007 | 6 | 10-15 |

Copper, zinc, and lead were found at measureable concentrations within the watershed, especially in samples collected under high flow conditions. Copper was detected in all but two high flow samples, and most high flow samples exceeded the 7 µg/L action level. In addition, one low flow sample taken at Little Alamance Creek at SR 2309 was at the action level of 7 µg/L copper. Lead occurred above the reporting limit only once, in a high flow sample at Willowbrook Creek. The report stated that this may have originated from runoff from an old city vehicle maintenance facility or possibly from a landfill in the subwatershed. The Willowbrook Creek Site also exceeded the action level for zinc (50 µg/L) in the same high flow sample, which may also have originated from the same source as the lead. Zinc was measured in all but two high flow samples, and detected in four low flow samples.

Among the other metals, calcium and magnesium were noted as having somewhat elevated low flow concentrations, possibly due to the abundance of pavement in the urban areas. Both were lower during high flow samples, indicating dilution during rain events. Sodium concentrations were also elevated, particularly at Willowbrook Creek and Little Alamance Creek at Mebane Street, which is directly downstream of Willowbrook Creek. The report stated that the higher sodium could be an indicator of raw sewage contamination, but could also have originated from other sources. Because Willowbrook Creek also had higher levels of ammonia, nitrogen, and phosphorous, lead, and zinc, further investigation was recommended in this area.

### 2.3.4 Other Water Quality Data

The USGS study in 2003 included analysis of some additional parameters that have not been included in the other datasets. The study included the total concentration and the quantity of pesticides, fungicides, herbicides, insecticides, and nematicides. In addition, a Pesticide Toxicity Index was calculated for cladocerans (water fleas), benthic macroinvertebrates, and fish.

The USGS study also included several organic constituents: total particulate carbon, particulate inorganic carbon, particulate organic carbon and dissolved organic carbon were measured in the two samples.

USGS also collected data with semipermeable membrane devices (SPMDs) to examine concentrations of hydrophobic organic compounds over time. The SPMDs were placed at each site for a period of approximately 6 weeks during April and May 2003. SPMDs are passive samplers that concentrate trace levels of hydrophobic organic compounds in the water column. They are designed to mimic the bioaccumulation of organic compounds in the fatty tissues of aquatic organisms.

**Table 13. Summary of other available water quality data.**

| Data Source | Date range of Data Collection | Number of Sites Sampled | Approximate Number of Samples |
|---|---|---|---|
| 2007 USGS Data Series 279<br>USGS Gage Station 0209679804 | 2/25/2003-7/11/2003 | 1 | 2 |

## 2.4 Fecal Coliform Bacteria

Two datasets were found containing data on fecal coliform bacteria. The historical data from SR 2309 contained 12 samples from July 1968 to February 1975.

DWQ also measured fecal coliform in water samples at six stations between December 2006 and August 2007. A total of 34 samples were analyzed, ranging from one to nine samples per site. The report indicated that fecal coliform pollution is present at multiple sites. All available data on bacteria are summarized in the table below.

**Table 14. Summary of available bacteria data for the Little Alamance Creek watershed.**

| Data Source | Date range of Data Collection | Number of Sites Sampled | Approximate Number of Samples |
|---|---|---|---|
| EPA STORET data download | 1968-1975 | 1 | 12 |
| 2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT | December 2006-August 2007 | 6 | 34 |

## 2.5 Biological Data

Biological sampling in Little Alamance Creek has been documented since 1985. DWQ assigns each site a "bioclassification" rating according to how many species are present at a sample site and the relative abundances of the species. There are five bioclassifications ratings – Poor, Fair, Good-Fair, Good, and Excellent – indicating how well aquatic life is being supported. Documents containing biological data are shown in Table 15.

**Table 15. Biological data sources for the Little Alamance Creek watershed.**

| Data Source | Survey Date | Number of Sites Surveyed |
|---|---|---|
| 1996 Cape Fear River Basinwide Water Quality Plan | July 1985 | 1 |
| 2000 Cape Fear River Basinwide Water Quality Plan | July 1998 | 1 |
| 2007 Selected Physical, Chemical, and Biological Data for 30 Urbanizing Streams in the North Carolina Piedmont Ecoregion, 2002–2003 | May 2003 | 1 |
| 2005 Cape Fear River Basinwide Water Quality Plan | June 2003 | 5 |
| 2010 TMDL to Address Biological Integrity in the Little Alamance Creek Watershed | June 2003 | 5 |
| 2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT | September 2006 | 3 |
| 2009 DWQ Biological Assessments – Cape Fear | July 2008 | 1 |
| DWQ Little Alamance, Travis, and Tickle Creeks Benthic Study Review – Prusha (undated) | Unknown | 3 |

### 2.5.1 Benthic Macroinvertebrates

Benthic macroinvertebrates have been surveyed at seven locations throughout the Little Alamance Creek watershed. Six of these locations have been surveyed once – five in 2003 and two in 2006.

Little Alamance Creek at SR 2309 has been sampled five times by DWQ between 1985 and 2008. The site received a bioclassification rating of "Fair" or "Poor" each time. The site was Not Rated in 2008 due to low streamflow as a result of drought, but would have otherwise rated as "Fair." The USGS also conducted macroinvertebrate sampling at SR 2309 in 2003. The data were collected for the National Water Quality Assessment Program study, and included a variety of organisms including insects, bivalves, gastropods, and annelids. The survey did not provide a bioclassification to compare with the DWQ rating, but documented 47 species of macroinvertebrates at the site. Benthic macroinvertebrate data are summarized in Table 16.

**Table 16. Benthic macroinvertebrate data summary.**

| Sample Location | Date | DWQ Bioclassification |
|---|---|---|
| Coble Branch at Engleman Ave | 6/24/2003 | Not Rated |
| Little Alamance Cr at Overbrook Rd. | 6/24/2003 | Poor |
| Little Alamance Cr at NC 54 | 9/12/2006 | Poor |
| Little Alamance Cr near I-85 | 6/23/2003 | Poor |
| Little Alamance Cr I-85 Frontage Rd. | 9/12/2006 | Poor |
| Little Alamance Cr at NC 49 | 6/23/2003 | Poor |
| Little Alamance Cr at Rogers Rd (SR 2309) | 7/29/1985 | Fair |
| | 7/10/1998 | Poor |
| | 5/20/2003 | N/A |
| | 6/23/2003 | Fair |
| | 9/12/2006 | Poor |
| | 7/14/2008 | Not Rated |

### 2.5.2 Fish

The fish community has been sampled four times at one site - Little Alamance Creek at SR 2309. Three of the surveys were conducted by DWQ (1993, 1998, and 2003,) and one by USGS (2003). DWQ assigned Bioclassification ratings of Good, Fair, and Good, respectively (see Table 17 below). The USGS does not calculate the same bioclassification rating, but reported a total of 16 fish species. The most abundant species were the bluehead chub (43), crescent shiner (35), and the tessellated darter (33).

**Table 17. Summary of fish sampling data.**

| Sample Location | Date | Bioclassification |
|---|---|---|
| Little Alamance Cr at Rogers Rd (SR 2309) | 1993 | Good |
| Little Alamance Cr at Rogers Rd (SR 2309) | 1998 | Fair |
| Little Alamance Cr at Rogers Rd (SR 2309) | 2003 | Good |
| Little Alamance Cr at Rogers Rd (SR 2309) | June 2003 | N/A |

### 2.5.3 Protected Species

There are no federally protected species in Alamance County. Four aquatic species are listed as Federal Species of Concern. Two vertebrates, the American eel (*Anguilla rostrata*) and the Carolina darter (*Etheostoma collis lepidinion*) have no state status. Two mussel species, the Carolina creekshell (*Villosa vaughaniana*) and the Yellow lampmussel (*Lampsilis cariosa*) are listed as Federal Species of Concern and North Carolina Endangered.

## 2.6 Habitat assessment

Data for habitat assessments were found in three documents, listed below in Table 18. The assessments were generally conducted concurrently with benthic macroinvertebrate sampling.

**Table 18. Habitat assessment data sources for the Little Alamance Creek watershed.**

| Data Source | Survey Date | Number of Sites Surveyed |
|---|---|---|
| 2010-12 TMDL to Address Biological Integrity in the Little Alamance Creek Watershed | June 2003 | 5 |
| 2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT | September 2006-August 2007 | 7 |
| 2009 DWQ Biological Assessments – Cape Fear | July 2008 | 1 |

Habitat assessment scores ranged from 53 to 93, out of a maximum possible score of 100. The Little Alamance Creek at SR 2309 site has been assessed three times, with scores of 73, 67, and 57 in 2003, 2006, and 2008 respectively.

## 2.7 Channel Data

Morhpological data for the Little Alamance Creek watershed is very limited. The TMDL Stressor Study performed by DWQ in 2003 included some basic channel characteristics at each of the five benthic sampling sites. A stream restoration project conducted in Burlington's City Park included more detailed morphological data for the mainstem of Little Alamance Creek and one unnamed tributary.

**Table 18. Morphological data sources for the Little Alamance Creek watershed**

| Data Source | Survey Date | Number of Sites Surveyed |
|---|---|---|
| 2010 TMDL to Address Biological Integrity in the Little Alamance Creek Watershed | June 2003 | 5 |
| 2007 USGS Data Series 279; USGS Gage Station 0209679804 | 2003 | 1 |
| 2008 Little Alamance Creek - Stream Restoration Plan - Arcadis | Unknown | 2 |

### 2.7.1 Stream Morphology

A stream restoration project was conducted by NCEEP on a 2,633-linear-foot section of Little Alamance Creek in City Park in Burlington. The only available morphological data have been obtained from the restoration plan for this project. Prior to restoration activities, this section of Little Alamance Creek was approximately 30 to 60 feet wide at the top of the bank, with banks ranging between 4 and 8 feet high, and bank height ratios between 1.0 and 1.4. An unnamed tributary included in the project was approximately 5 to 10 feet wide at the top of bank, with bank heights of 2 to 4 feet and bank heights ratios between 1.0 and 1.3.

Little Alamance Creek's cross sectional area ranged between 79.3 $ft^2$and 125.0 $ft^2$ with an average of 95.0 $ft^2$. Channel width ranged from 31.8 feet to 42.5 feet with an average of 36.2 feet, and mean depth ranged between 2.2 feet and 2.9 feet, with an average of 2.6 feet. The width to depth ratio ranged between 11.6 and 17.0 with an average of 14.0.

The pattern of the reach was slightly meandering, with a sinuosity of 1.2. The average water surface slope of the section was 0.24 percent. Approximately 65 percent of the stream reach was comprised of pools. In the middle section of the project reach, the existing pools were separated by fairly short and steep bedrock steps.

### 2.7.2 Substrate Composition

The primary information on substrate composition comes from the NCEEP stream restoration plan for the section of Little Alamance Creek in City Park. The streambed in that section was comprised mainly of sand, though there is some occurrence of bedrock. The particle size distribution of Little Alamance Creek's substrate prior to restoration was: $D_{16}$ = 0.2 mm, $D_{35}$ = 0.7 mm, $D_{50}$ = 2.4 mm, $D_{84}$ = 138.0 mm, and $D_{95}$ = 216.0 mm.

Substrate composition was also estimated at the five benthic sampling sites in 2003.

### 2.7.3 Streambank Stability

Quantitative information on streambank stability is available for a portion of Little Alamance Creek in Burlington's City Park. This information was collected as part of a stream restoration project. Bank erosion had caused the stream to become overly wide in some sections and mid-channel bars had developed because the stream did not have the capacity to transport sediment through these reaches.

Prior to restoration, a Bank Erosion Hazard Index (BEHI) analysis was performed on Little Alamance Creek and its unnamed tributary. The ratings ranged from low to extreme on Little Alamance Creek and from low to very high on the unnamed tributary. Contributing to the high, very high, and extreme ratings were high bank heights, shallow rooting depths, and low rooting densities (a function of the lack of woody vegetation). Near bank stress (NBS) ranged from low to extreme on both Little Alamance Creek and the unnamed tributary. Extreme NBS ratings were due to high banks, central bars, and tight meander bends. Based on these ratings, an estimated 694 tons of sediment per year were being contributed by this reach of Little Alamance Creek, and the unnamed tributary was contributing an additional 55 tons of sediment per year.

### 2.7.4 Flow Data

There are no active USGS gages located in the Little Alamance Creek watershed. The nearest active gage station, 02094500, is located on Reedy Fork west of Little Alamance near Gibsonville, NC. The station has data for gage height and discharge for years 1928-present. Another long-term gage station is located to the east of Little Alamance; Station 02096500 is located on the Haw River in the town of Haw River, NC. The station has data for precipitation, gage height, and discharge for years 1928-present.

Three data sources were identified with flow data in the Little Alamance Creek watershed, shown in Table 19.

**Table 19. Sources of flow data for Little Alamance Creek watershed**

| Data Source | Date range of Data Collection | Number of Sites Sampled | Approximate Number of Samples |
|---|---|---|---|
| EPA STORET data download | 1968-1975 | 1 | 8 |
| 2007 USGS Data Series 279<br>USGS Gage Station 0209679804 | 7/15/2002 - 7/14/2003 | 1 | 365 days of hourly mean |
| 2008 Little Alamance Creek - Stream Restoration Plan – Arcadis | Unknown | 1 | |

The data downloaded from EPA's STORET database indicated that stream gage height was measured on Little Alamance Creek at SR 2309 from December 1970 to February 1975. A total of 8 stage heights were reported, ranging from 11.75 feet to 17.8 feet. On four of these dates, a calculated mean flow was also reported, ranging from two to nine cubic feet per second (cfs). However, the stage and discharge are not correlated as expected – the highest stage measurement corresponds with the lowest discharge calculation. The reliability of these historical data is not known.

Stream flow data were collected as part of the USGS study on urbanizing piedmont streams in 2002 and 2003. Continuous stream stage data were collected hourly for one year, from 11/16/2002 to 11/15/2003. Standard USGS stream gaging techniques for collection of streamflow data were not used because of the short term of data collection at the sites and limited resources for the project. Instead, a submersible pressure transducer with an internal data logger was used. Daily mean discharges were computed for the period of record. The overall mean discharge for the year was 14.9 cfs. USGS calculated numerous other statistics, including measures of flashiness and frequency of high and low flow, and duration of high and low flow.

The bankfull discharge was also estimated for the stream restoration project in Burlington's City Park. Little Alamance Creek has a drainage area of 4.2 square miles at this location. The average velocity for the channel was measured at 2.5 feet per second, which was multiplied by the average cross sectional area of the channel, for a calculated discharge of 237.5 cfs at bankfull flow.

## 2.8 NPDES Wastewater Treatment Point Source Discharges

There are no known NPDES-permitted wastewater treatment facilities in the Little Alamance Creek watershed.

## 2.9 Stormwater outfall inventory

The cities of Burlington and Graham have completed field inventories of stormwater infrastructure within their respective municipal boundaries. An inventory of the stormwater infrastructure is currently being conducted by NCDOT.

# 3.0 Summary of Existing Data

While some categories of data are more complete than others, the Little Alamance Creek watershed is lacking comprehensive water quality data to explain the poor benthic community results.

## 3.1 Spatial Distribution

Data for the Little Alamance Creek watershed have been collected from a total of 11 different locations. Various studies and reports sometimes refer to the same location by different identifying codes. Table 20 lists the location of each sampling site and a cross-referencing of the various codes that the location has been sampled under. Figure 1 shows a map of the watershed with the location of each sampling site.

**Table 20. Location and identity code information for all sample sites in the Little Alamance Creek watershed**

| Location | Latitude | Longitude | Watershed Area ($mi^2$) | TMDL ID | Benthic ID | 2008 Eval ID |
|---|---|---|---|---|---|---|
| Coble Branch at Engleman Ave | 36.086111 | -79.469722 | 0.6 | B1 | BB42 | |
| Little Alamance Cr at Overbrook Rd | 36.083333 | -79.452778 | 4.4 | B2 | BB193 | |
| Unnamed Tributary to Willowbrook Cr at Kime St | 36.0872 | -79.4429 | 0.4 | - | | 14 |
| Willowbrook Cr at Mebane St (SR 1363) | 36.0839 | -79.4433 | 1.3 | - | | 15 |
| Little Alamance Cr at Mebane St (SR 1363) | 36.0801 | -79.4479 | 4.4 | - | | 16 |
| Little Alamance Cr at NC 54 (Tucker St) | 36.074444 | -79.443889 | 6.4 | - | BB47 | 17 |
| Little Alamance Cr at I-85 Frontage Rd (SR 1398) | 36.0650 | -79.4376 | 7.7 | B3 | BB46 | 18 |
| Little Alamance Cr near I-85 | 36.065 | -79.437778 | 7.4 | - | BB78 | |
| Bowden Br at Hanford Rd (SR 2304) | 36.0509 | -79.4160 | 2.5 | - | | 20 |
| Little Alamance Cr at NC 49 | 36.052778 | -79.435 | 9.0 | B4 | BB131 | |
| Little Alamance Cr at Rogers Rd (SR 2309)* | 36.0359 | -79.4092 | 14.1 | B5 | BB388 | 19 |

* Little Alamance Creek at SR 2309 is also identified as Site B1920000 in the historical STORET data, and as USGS Gage Station 0209679804.

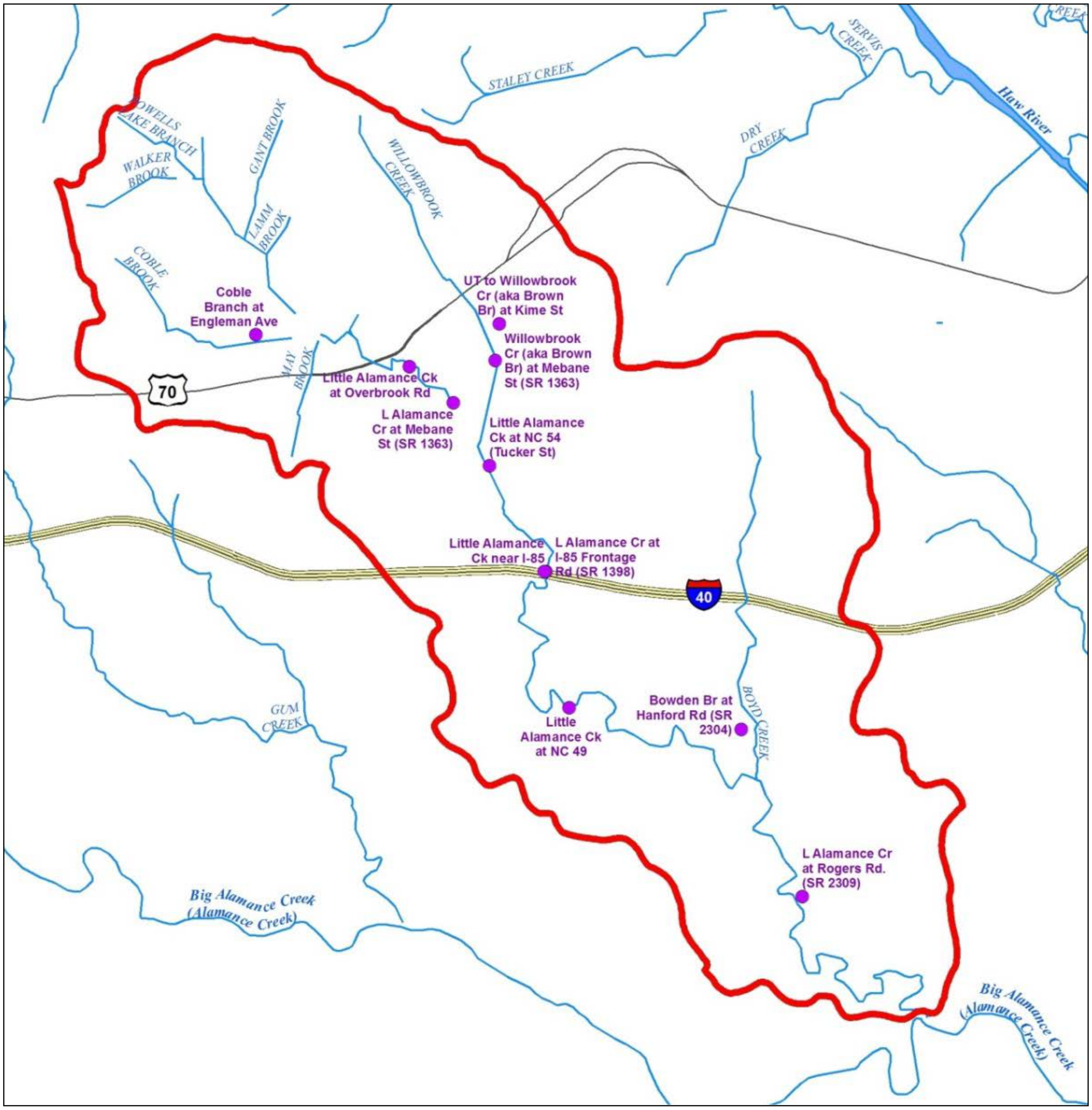


**Figure 1. Little Alamance Creek watershed showing the spatial distribution of the 11 sites where data have been collected**

## 3.2 Temporal Distribution

Water quality sampling efforts in the watershed span almost 40 years. The earliest known samples were taken in July 1968. No data were collected between 1975 and 1985, when limited biological monitoring resumed. More concentrated data collection efforts took place in 2003 and 2007.

## 3.3 Extent of available data

Table 21 presents a qualitative summary of the relative completeness of the various data categories. In an effort to distill and summarize the findings of the data inventory into a single table, each data category was given a qualitative rating of the relative completeness of the available data (Table 21). The ratings are loosely defined as follows:

Inadquate: Very limited data relative to other parameters in the watershed. Data may be limited by total samples or by spatial and temporal variability and additional data collection would be useful.

Moderate: Some data are available and have a greater number of data points or capture some degree of spatial and temporal variability. However, data are not sufficient to draw conclusions or establish baseline conditions.

Adequate: The existing dataset includes much or all available data and there is not a significant need for additional data collection. (Note – this does not necessarily equate to a large quantity of data. For example, NPDES-permitted wastewater discharges do not exist in the watershed, but since the availability of these data are complete, the category was given a rating of Adequate).

**Table 21. Availability of information on Little Alamance Creek watershed**

| Category | Inadequate | Moderate | Adequate |
|---|---|---|---|
| Watershed Characteristics | | | |
| General Information | | | X |
| Ecoregion | | | X |
| Climate | | | X |
| Land Use | | | X |
| Water Quality Data | | | |
| Physicochemical parameters | | X | |
| Nutrients | X | | |
| Metals | X | | |
| Bacteria | X | | |
| Biological Data | | | |
| Benthic macroinvertebrate sampling | | X | |
| Fish sampling | X | | |
| Habitat assessment | | X | |
| Channel Data | | | |
| Stream Morphology | X | | |
| Substrate composition | X | | |
| Streambank stability | X | | |
| Flow Data | | X | |
| NPDES WWTP Point Source Discharges | | | X |
| Stormwater Outfall Inventory | | X | |

General information about the watershed is widely available and complete. Availability of water quality data is sparse, with slightly more complete data for physicochemical parameters. Biological data are generally sparse and are considered inadequate to support most planning and water quality and watershed planning decisions or needs. Benthic macroinvertebrate data collections span over 20 years, and therefore were given a rating of moderate. There is minimal information on channel characteristics and stability. Flow data is somewhat more complete, as data were collected continuously for one year near the bottom of the watershed.

# 4.0 Conclusions

Overall, the available data on Little Alamance Creek are not sufficient to draw definitive conclusions about the source of the biological impairment or support development of a TMDL. The creek is impaired for aquatic life only, and no specific pollutants were identified. The existing reports attributed the impairment to the generally understood conditions of an urban watershed, including the following sources:

- Hydromodification
- Insufficient riparian buffer
- Streambank erosion
- Pollutants in stormwater runoff
- Degradation of in-stream habitat

These conclusions were largely identified through field studies that occurred during a period of drought. Regardless, no known water quality pollutants or pollutant sources have been identified to date.

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