

**Total Maximum Daily Load Response Plan for Fecal Coliform
Bacteria in Northeast Creek (Cape Fear River Basin),
Durham, North Carolina**



**Prepared by the Public Works Department,
Stormwater & GIS Services Division**

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The City of Durham's Stormwater Quality Group in the Division of Stormwater & GIS Services and the Department of Public Works developed this TMDL Response Plan for the City of Durham. The City would like to acknowledge contributions to this TMDL Response Plan from staff in several City and County government departments and divisions.

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Table of Contents

1. Acronyms and Abbreviations	4
2. Executive Summary	5
3. TMDL Response Plan Objective	6
4. Introduction and Background	6
4.1. Watershed Information	10
4.2. Jurisdictional Responsibility	12
5. Pollutant Sources	13
5.1. Human Sources	14
5.2. Livestock and Domestic Animal Sources	15
5.3. Wildlife Sources	15
5.4. MS4 and In-stream Sources	15
6. Pollution Prevention and Mitigation Measures Currently Being Implemented	16
6.1. Response Plan Measure Definitions	16
7. Newly Proposed Pollution Prevention and Mitigation Measures	19
7.1. Measures to Reduce Human Sources of Fecal Coliform Bacteria	19
7.2. Measures to Reduce Domestic Animal Sources of Fecal Coliform Bacteria	21
7.3. Measures to Reduce Wildlife Sources of Fecal Coliform Bacteria	21
7.4. Measures to Reduce Multiple Sources of Fecal Coliform Bacteria	21
7.5. Measures to Identify Sources of Fecal Coliform Bacteria	22
8. Prioritized Measures Applicable to the NPDES Six Minimum Measures	24
8.1. Implementation of Measures to the Maximum Extent Practicable	24
8.2. Public Education and Outreach	24
8.3. Public Participation and Involvement	24
8.4. Illicit Discharge Detection and Elimination	25
8.5. Construction Site Stormwater Runoff Control	25
8.6. Post-Construction Stormwater Management	25
8.7. Pollution Prevention/Good Housekeeping for Municipal Operations	25
9. Watershed Planning	25
10. Water Quality Assessment and Monitoring	26
10.1. Water Quality Monitoring	26
10.2. Bacterial Source Tracking	29
11. Water Quality Co-Benefits of TMDL Response Plan Implementation	30
11.1. Value Added for Removing Nutrients and Metals	30
11.2. Benefits to Aquatic Life	31
12. Steps Towards TMDL Response Plan Implementation	32
12.1. Response Plan Schedule by Agency	32

12.2.	Tracking and Data Collection	34
12.3.	Re-evaluation of Response Plan.....	34
13.	References.....	34
14.	Appendix A: Summary Table of All Proposed Measures (Priority and Non-Priority).....	36
15.	Appendix B: Summary Table of Measures Not Included in the TMDL Response Plan	38
16.	Appendix C: Measures of Incremental Progress.....	40

List of Tables

Table 1.	Approved TMDL for the Northeast Creek Watershed	9
Table 2.	Measures currently implemented in the Northeast Creek watershed	18
Table 3.	Prioritized Measures in the Northeast Creek watershed.....	23
Table 4.	Pollutants of concern found in untreated domestic wastewater and untreated septage, not including bacteria concentration data.	30
Table 5.	NCDEQ 2016 Final 303(d) List (NCDEQ, 2016) and 2018 Draft 303(d) List (NCDEQ, 2018), Category 5 Assessments for Third Fork Creek. Listings for turbidity were not included on the 2016 303(d) List but added to the Draft 2018 303(d) List.	30
Table 6.	Priority and non-priority measures proposed for the Northeast Creek TMDL Response Plan	36
Table 7.	Measures considered and not currently feasible for implementation in the Northeast Creek TMDL Response Plan.....	38
Table 8.	Preliminary list of incremental progress.....	40

List of Figures

Figure 1.	Map of the Northeast Creek Watershed in Durham County, Wake County, and Chatham County with the impaired segment shown in red.....	8
Figure 2.	Northeast Creek Watershed 2018 Existing Land Use in Durham County	11
Figure 3.	Fecal coliform bacteria pathway conceptual model.....	13
Figure 4.	Percent contribution of the fecal coliform bacteria isolates that were identified in stream water samples collected from April to July 2004 in Northeast Creek at Sedwick Rd. in Durham County (MapTech, 2005).	14
Figure 5.	City of Durham, UCFRBA, and DWR ambient stream monitoring sites in the Northeast Creek watershed.	28
Figure 6.	Fecal coliform bacteria concentrations with proportional source contributions indicated for Northeast Creek at Sedwick Rd. (MapTech, 2005).....	29

1. Acronyms and Abbreviations

- BST – Bacterial Source Tracking
- cfu – colony forming units
- CWEP – Clean Water Education Partnership
- DWR – Division of Water Resources
- EPA – Environmental Protection Agency
- FOG – fats, oils & grease
- IDDE – Illicit Discharge Detection and Elimination

- LA – load allocation
- NCAC – North Carolina Administrative Code
- NCDENR – North Carolina Department of Environment and Natural Resources
- NCDEQ – North Carolina Department of Environmental Quality
- NPDES – National Pollutant Discharge Elimination System
- MEP – maximum extent practicable
- MPN – most probable number
- MST – microbial source tracking
- MS4 – Municipal Separate Storm Sewer System
- OWTS – on-site wastewater treatment system
- RTP – Research Triangle Park
- SCM – Stormwater Control Measure
- TMDL – Total Maximum Daily Load
- UCFRBA – Upper Cape Fear River Basin Association
- USGS – United States Geological Society
- UV - ultraviolet
- WIP – Watershed Improvement Plan
- WLA – waste load allocation

2. Executive Summary

The City of Durham’s Stormwater Quality Group in the Department of Public Works and Division of Stormwater & GIS Services developed this Total Maximum Daily Load (TMDL) Response Plan to address water quality impairments in Northeast Creek due to elevated levels of fecal coliform bacteria. The fecal coliform bacteria TMDL for Northeast Creek was issued in 2003 by the North Carolina Department of Environmental Quality (NCDEQ) and approved by the U.S. Environmental Protection Agency (EPA). A TMDL establishes the allowable pollutant loads for a waterbody so that actions may be taken to reduce point and nonpoint source pollution in order to meet State water quality standards (USEPA, 1991).

The Northeast Creek watershed lies in the southeastern portion of the City of Durham (the City) and includes large portions of unincorporated Durham County (the County) and Research Triangle Park (RTP). The watershed also extends into Wake and Chatham Counties, encompassing an area of approximately 50.2 square miles. Approximately 40% of the watershed is within the City limits. An 8.4-mile segment of Northeast Creek beginning in the City of Durham is listed as impaired for fecal coliform bacteria. Fecal coliform bacteria, a subset of total coliform bacteria, live within the digestive system of warm-blooded animals, which is an indicator bacteria that can be monitored to identify surface water impairments due to the presence of human or animal waste. Fecal coliform bacteria can come from humans, livestock, urban and rural wildlife, waterfowl and other birds, and pets.

This response plan is the product of several brainstorming and planning meetings in 2018 involving input from multiple City and County Departments. This response plan outlines the prevention and mitigation measures that City and County staff will implement to achieve reductions of fecal coliform bacteria concentrations in Northeast Creek. A prevention measure inhibits releases of pollutants from happening while a mitigation measure removes pollutants from the creek after they have been released. The actions described in this plan focus on ways to reduce fecal coliform bacteria from human sources (sanitary sewer

system and septic system discharges), domestic animal sources (dog waste), and wildlife sources (Canada Geese waste).

The recommended prioritized actions that address human sources include a community survey to identify failing septic systems, replacing failing septic systems with a new connection to the City or County sanitary sewer system, and various Illicit Discharge Detection & Elimination (IDDE) techniques such as routine stream walks to identify sewage discharges. The prioritized actions that target domestic animal waste (primarily from dogs) include education and outreach about proper disposal of dog waste, requiring pet waste receptacles for new development projects, and identifying all of the private dog parks and dog kennel facilities in the watershed. The prioritized action to target wildlife sources involves the management of Canada Geese populations near stormwater control measures (SCMs) and neighborhood ponds or lakes. Other prioritized actions that address multiple sources include a media campaign, the exploration of ultraviolet (UV) light treatment devices in the City's stormwater system, and prioritizing the construction of SCMs identified in the Northeast Creek Watershed Improvement Plan (WIP) that remove fecal coliform bacteria.

The majority of the actions described in this response plan are anticipated to be implemented within the first 5 years of the current permit cycle (2018-2023); however, there are four actions that may be implemented within 5-10 years (2018-2028), and one action is estimated to be implemented within 10-15 years (2018-2033). The City's Public Works Department will be responsible for communicating with the appropriate departments, divisions, and workgroups to identify the metrics and data needed to track the progress of measures outlined in this response plan. As resources allow, the City's Public Works Department will re-evaluate the measures outlined in this response plan on a five-year basis and will continue to provide progress updates on an annual basis as part of the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit annual reporting cycle.

3. TMDL Response Plan Objective

The objective of this TMDL Response Plan is to identify and implement measures that will reduce the levels of fecal coliform bacteria in Northeast Creek within the City and County limits of Durham, North Carolina. This TMDL Response plan addresses the City of Durham's assigned municipal separate storm sewer system (MS4) waste load allocation (WLA) documented in the 2003 EPA-approved TMDL for Northeast Creek. In addition, this TMDL Response Plan is required under Section J of the City of Durham's NPDES Municipal Stormwater Permit (No. NCS00249). This response plan incorporates ideas from multiple stakeholders that have a vested interest in complying with state and federal regulations as well as reducing the TMDL pollutant of concern and improving overall water quality in the Northeast Creek watershed. The proposed prevention and mitigation measures aim to reduce fecal coliform bacteria levels using a variety of tools that address the multiple sources and transport pathways of the pollutant of concern. The variety of tools used in this plan is leveraged by the stakeholder groups' diverse regulatory authority and capabilities. As a result, the stakeholders included in this response plan have the ability to implement some but not all of the proposed prevention and mitigation measures. No one entity, including the City of Durham Public Works Department, has the ability to remedy fecal coliform bacteria levels individually, given the nature of the issue.

4. Introduction and Background

The City of Durham is subject to an approved TMDL with waste load allocations in the Northeast Creek watershed, in the Cape Fear River Basin. In 2002, the North Carolina Department of Environmental Quality (NCDEQ, formerly North Carolina Division of Environmental and Natural Resources, NCDENR) identified an 8.4-mile segment of Northeast Creek as impaired by fecal coliform bacteria (NCDENR, 2003b). Figure 1 shows the impaired segment of Northeast Creek highlighted in red. A fecal coliform bacteria TMDL for

Northeast Creek was approved in 2003 (Table 1). The pollutant reduction for this TMDL is expressed as a load of colonies and as a percent load reduction. A Waste Load Allocation (WLA) of 6.68×10^{10} colonies per day was assigned to the City of Durham MS4 area and a Load Allocation (LA) of 2.40×10^{10} colonies per day was assigned to nonpoint source in the Northeast Creek watershed. These values represent 92% and 91% reductions in point source and nonpoint source loading of fecal coliform bacteria from the baseline load (1997-2001), respectively. Both point and nonpoint sources were considered included in the load reduction with WLAs and LAs included in the TMDL. The final EPA-approved TMDL document can be found on the NCDEQ website at the link below:

https://files.nc.gov/ncdeq/Water%20Quality/Planning/TMDL/FINAL%20TMDLS/Cape%20Fear/Northeast_Creek_TMDL_Final.pdf

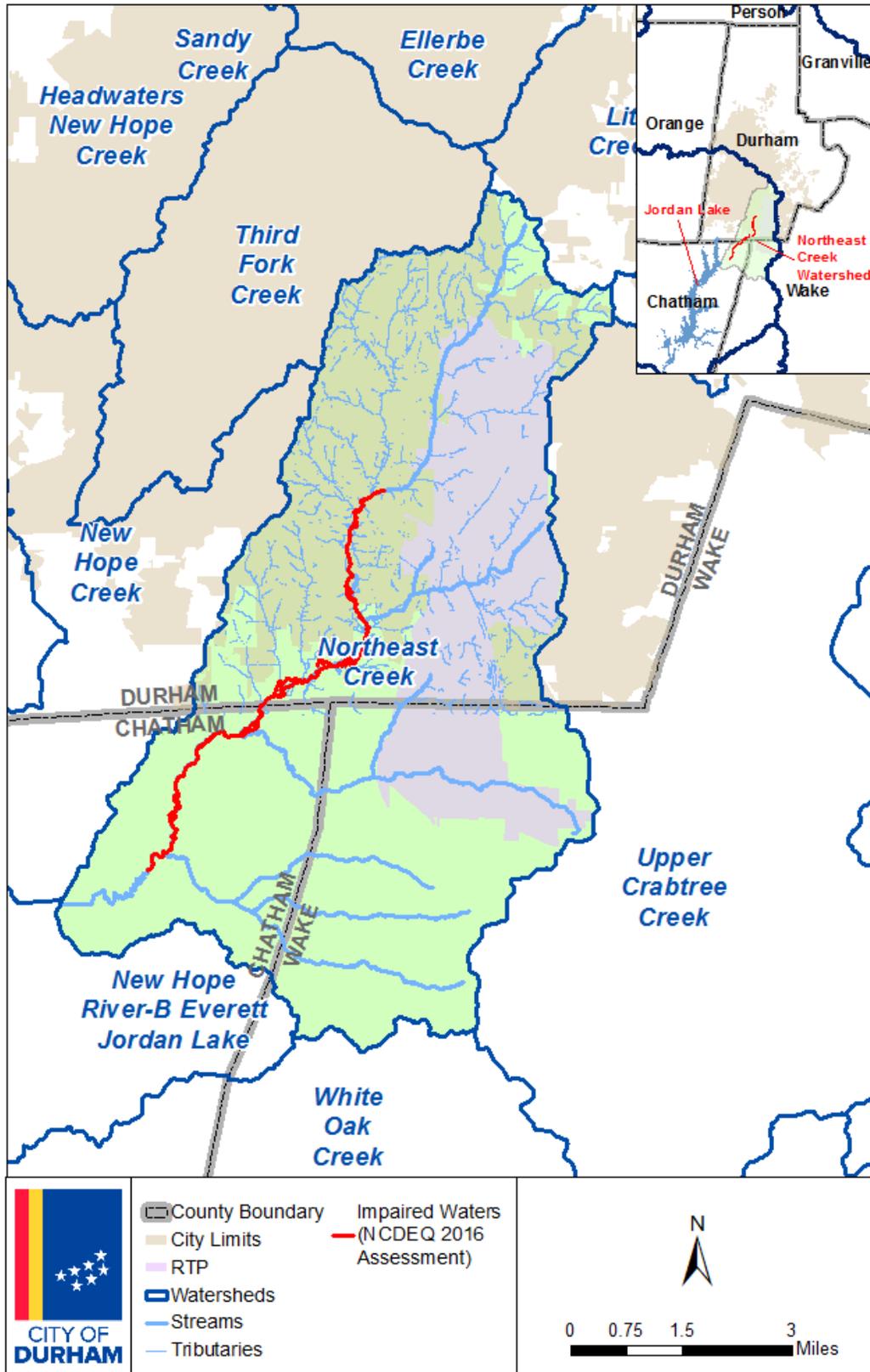


Figure 1. Map of the Northeast Creek Watershed in Durham County, Wake County, and Chatham County with the impaired segment shown in red.

Table 1. Approved TMDL for the Northeast Creek Watershed

Description of area	DWQ Assessment Unit(s)	Stream Classification(s)	TMDL Parameter	TMDL	EPA Approval Date
Northeast Creek from NC Highway 55 to a point 0.5 miles downstream of Panther Creek	16-41-1-17-(0.7)a 16-41-1-17-(0.7)b2	WS-IV NSW. Potable water supply, Nutrient Sensitive Water	Fecal coliform bacteria	1.12x10 ¹¹ colonies per day	September 12, 2003

NSW. Nutrient Sensitive Water
WS. Water Supply classification

The fecal coliform bacteria TMDL for Northeast Creek was developed because stream monitoring data exceeded the Fresh Surface Water Quality Standards for Class C Waters under Title 15A, Subchapter 2B of the North Carolina Administrative Code (NCAC). Under 15A NCAC 02B .0211(7), the water quality standard for fecal coliform bacteria is stated as follows:

Fecal coliform shall not exceed a geometric mean of 200/100ml (MF count) based upon at least five consecutive samples examined during any 30 day period, nor exceed 400/100ml in more than 20 percent of the samples examined during such period. Violations of the fecal coliform standard are expected during rainfall events and, in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution. All coliform concentrations shall be analyzed using the membrane filter technique, unless high turbidity or other adverse conditions necessitate the tube dilution method. In case of controversy over results, the MPN 5-tube dilution technique shall be used as the reference method.

The water quality standard for fecal coliform bacteria listed above is the target that will be used to evaluate the effectiveness of the measures in this TMDL Response Plan which are aimed at reducing fecal coliform bacteria loads in Northeast Creek. Annual updates on progress toward improving fecal coliform bacteria concentrations in Northeast Creek are provided in the City of Durham NPDES Municipal Stormwater Permit Annual Report.

Northeast Creek is also within the B Everett Jordan Lake watershed. A chlorophyll a TMDL for Jordan Lake was approved in 2007. The pollutant reductions for this TMDL are expressed as 336,079 pounds per year of total nitrogen and 23,106 pounds per year of total phosphorus. Target reductions are not expressed specifically for Northeast Creek but are expressed as loads to the Upper New Hope Arm of Jordan Lake.

Full implementation of the measures enclosed in this TMDL Response Plan will be enabled as resources allow. Potential barriers to full implementation include budget constraints, staffing levels, and employee turnover in departments designated for executing the response plan measures. Some measures presented in this TMDL Response Plan require significant monetary resources and are highly dependent on the city budget conditions. All tables with cost-estimate ranges for response plan measures are only associated with the costs to City or County government departments. The ability to secure support and approval for proposed measures from City Council and management could potentially influence project schedules. Implementation of this response plan also depends on coordination and effective partnership with organizations outside of the City of Durham.

The City will implement response plan measures to the maximum extent practicable (MEP) with the goal of reducing the levels of fecal coliform bacteria in Northeast Creek. While the elimination of all fecal coliform bacteria point and nonpoint sources may reduce concentrations below water quality standards, it is recognized that this may not be feasible due to technical, economic, logistic or social factors. Therefore, the City will pursue fecal coliform bacteria reductions to the MEP based on Clean Water Act and MS4 NPDES requirements. Section 402(p)(3)(B) of the Clean Water Act requires municipal MS4 permittees, to the extent allowable under State or local law, to prohibit non-stormwater discharges into the MS4 and implement controls and management measures to reduce the discharge of pollutants to the maximum extent

practicable. Section J(1)(b) of the City's MS4 NPDES permit also requires that the City utilize BMPs (commonly referred to as SCMs) pertaining to the six minimum measures and the TMDL Response Plan to meet the approved TMDL WLA to the MEP. Additionally, Section J(1)(c) of the City's MS4 NPDES also states that the City is not responsible for attaining State water quality standards as this requires pollutant reductions from all point and nonpoint sources identified in the approved TMDL. Therefore, City and County staff will coordinate to implement the measures outlined in this TMDL Response Plan to the MEP.

4.1. Watershed Information

The Northeast Creek watershed lies in the southeastern portion of the City of Durham and includes large portions of unincorporated Durham County and Research Triangle Park. The downstream portions of the watershed are located in Wake and Chatham Counties, with the entire watershed encompassing an area of approximately 50.2 square miles. While a majority of the watershed is in Durham County (70%), approximately 40% of the watershed lies within the City limits (Brown and Caldwell, 2013). Interstate 40 passes east to west through the middle of the watershed and NC-55 runs north to south through the watershed within the city limits. The eastern border of the watershed is defined closely by Miami Boulevard while Barbee Road wraps around the western boundary. The downstream end of the watershed (southern end) is bounded by Jordan Lake. The area upstream of the intersection of O-Kelly Chapel Road and Northeast Creek is approximately 17 percent impervious. A map of the watershed and the impaired section of Northeast Creek is provided in Figure 1 and a map of existing land use types in the Northeast Creek watershed is shown in Figure 2. Within Durham County, the Northeast Creek watershed contains several different land use classifications. This includes industrial, office park, and commercial land uses, mainly in the eastern portion of the watershed, and single and multi-family residential, mainly in the western portion of the watershed. Undeveloped open space does exist throughout the watershed.

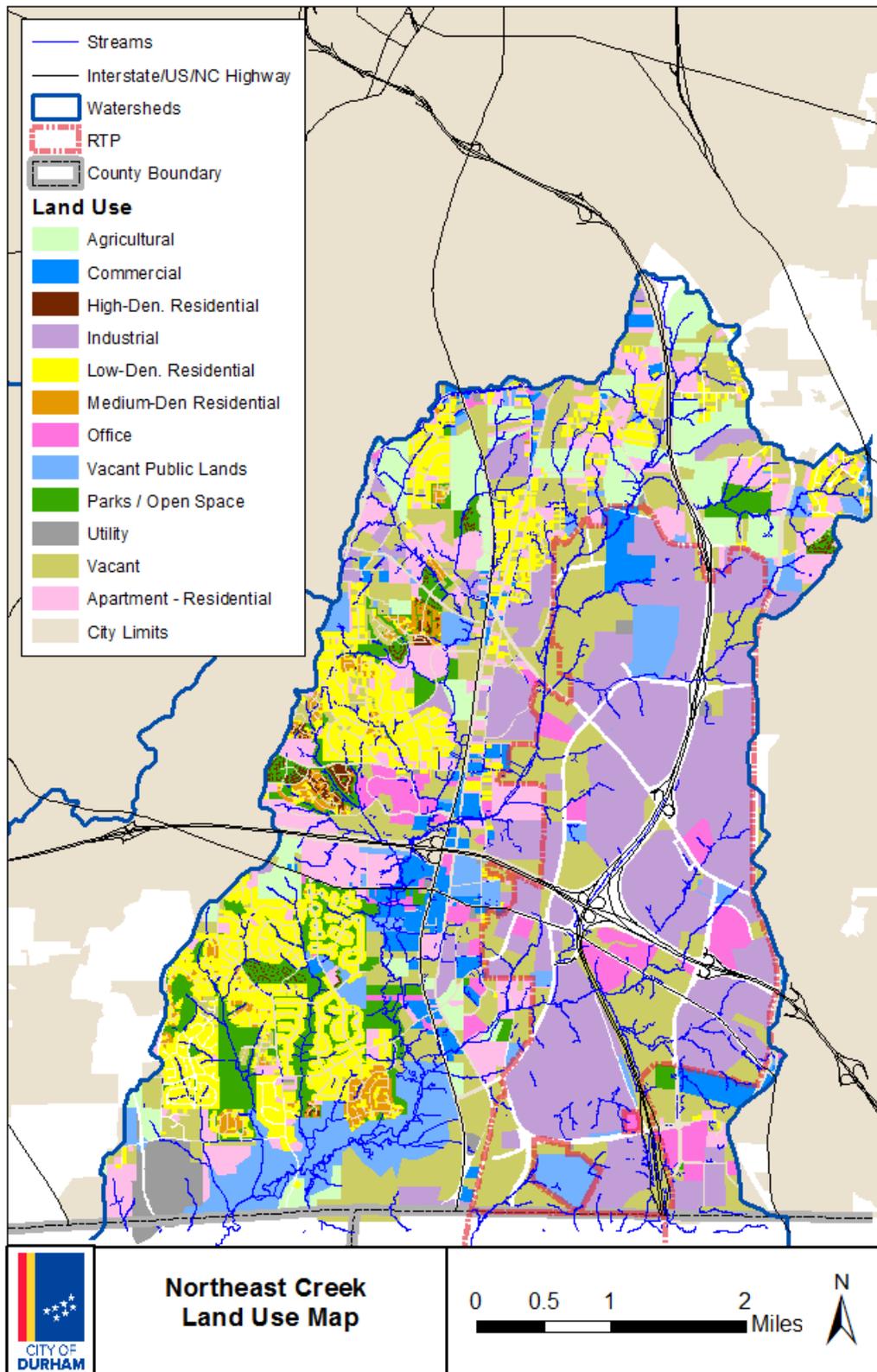


Figure 2. Northeast Creek Watershed 2018 Existing Land Use in Durham County

4.2. Jurisdictional Responsibility

The City of Durham, Durham County, and North Carolina State government have regulatory authority for controlling the various pathways fecal coliform bacteria can enter the environment. These agencies have responsibilities for implementing different prevention and mitigation measures described in this TMDL Response Plan.

City of Durham Departments

Within the Public Works Department are the Stormwater & GIS Services Division, the Engineering Services Division, and the Operations Division. The Stormwater & GIS Services Division is responsible for managing the following NPDES permit programs: Pollution Prevention & Good Housekeeping, Illicit Discharge Detection and Elimination, Public Education & Outreach, Public Participation & Involvement, and Post-Construction Stormwater Management. Stormwater Infrastructure and Watershed Planning are also included in this division. The Engineering Services Division is responsible for reviewing development plans and permitting private connections to the City sanitary sewer system. The Operations Division is responsible for the City's street sweeping program and maintaining the City's streets and storm drainage system.

The Water Management Department's Water and Sewer Maintenance Division is responsible for inspecting the sanitary sewer system for leaks, stopping sanitary sewer overflows, repairing sanitary sewer lines, and cleaning up sewer spills from pipes, manholes, and pump stations. The Industrial Pretreatment Program is responsible for educating the public about proper disposal of Fats, Oils & Grease (FOG) and nonwoven products, and inspecting grease interceptors at food service establishments, assisted living centers, and hotels.

Durham County Departments

The Public Health Department's Environmental Health Division is responsible for inspection of on-site wastewater systems (septic systems) and enforcement of regulations for failing septic systems.

The Engineering and Environmental Services Department's Utilities Division is responsible for controlling sewer leaks, overflows and spills that come from the sanitary sewer system located in the County outside the City limits. The Utilities Division is also responsible for operating the Triangle Wastewater Treatment Plant on NC Hwy 55 which discharges treated effluent into Northeast Creek.

The Durham County Sheriff's Office enforces the Canine Waste Removal Ordinance (<https://www.dconc.gov/environment/canine-waste-ordinance>) which prohibits dog owners from leaving dog waste on any public property, public right-of-way or private property without the permission of a private property owner.

Durham City-County Departments

The Planning Department's Zoning Enforcement Division inspects many properties for code violations and notifies the City's Stormwater & GIS Services Division when failing private sewer lines are found during field investigations. The Unified Development Ordinance (UDO) group is responsible for amending the City-County UDO and ensuring compliance with the UDO.

North Carolina State Government Departments

The Department of Environmental Quality's Division of Water Resources is responsible for inspecting private sewer pump stations, investigating sewer spills and fish kills in surface waters, and enforcing State regulations related to sewage discharges. The Department of Environmental Quality's Division of Energy, Mineral and Land Resources is responsible for issuing NPDES MS4 permits, which provide regulatory guidance for developing and implementing TMDL response plans.

5. Pollutant Sources

Fecal coliform bacteria live within the digestive system of warm-blooded animals and are found in their feces. Fecal coliform bacteria can come from humans, livestock, urban and rural wildlife, waterfowl and other birds, and pets. Fecal coliform bacteria are transported from point sources (e.g., wastewater treatment plants) and nonpoint sources (e.g., animal waste in stormwater runoff, failing septic systems, and leaking sewer lines) to the stormwater drainage system and surface waters. A simple conceptual model illustrates the multiple sources of fecal coliform bacteria that can reach surface waters and result in unsanitary conditions (Figure 3). The results of a 2004 Bacterial Source Tracking (BST) Study for stream samples collected in Northeast Creek at Sedwick Road are shown in Figure 4. The 2004 BST study results show a mixture of wildlife, domestic, and human sources of fecal coliform bacteria in the watershed. Sections 5.1 to 5.4 briefly describe the known and potential sources of fecal coliform bacteria in the Northeast Creek watershed. While land-application of biosolids may be a potential source of fecal coliform bacteria within the Northeast Creek watershed, the City of Durham Water Management Department does not land-apply solids within the watershed or Durham County limits.

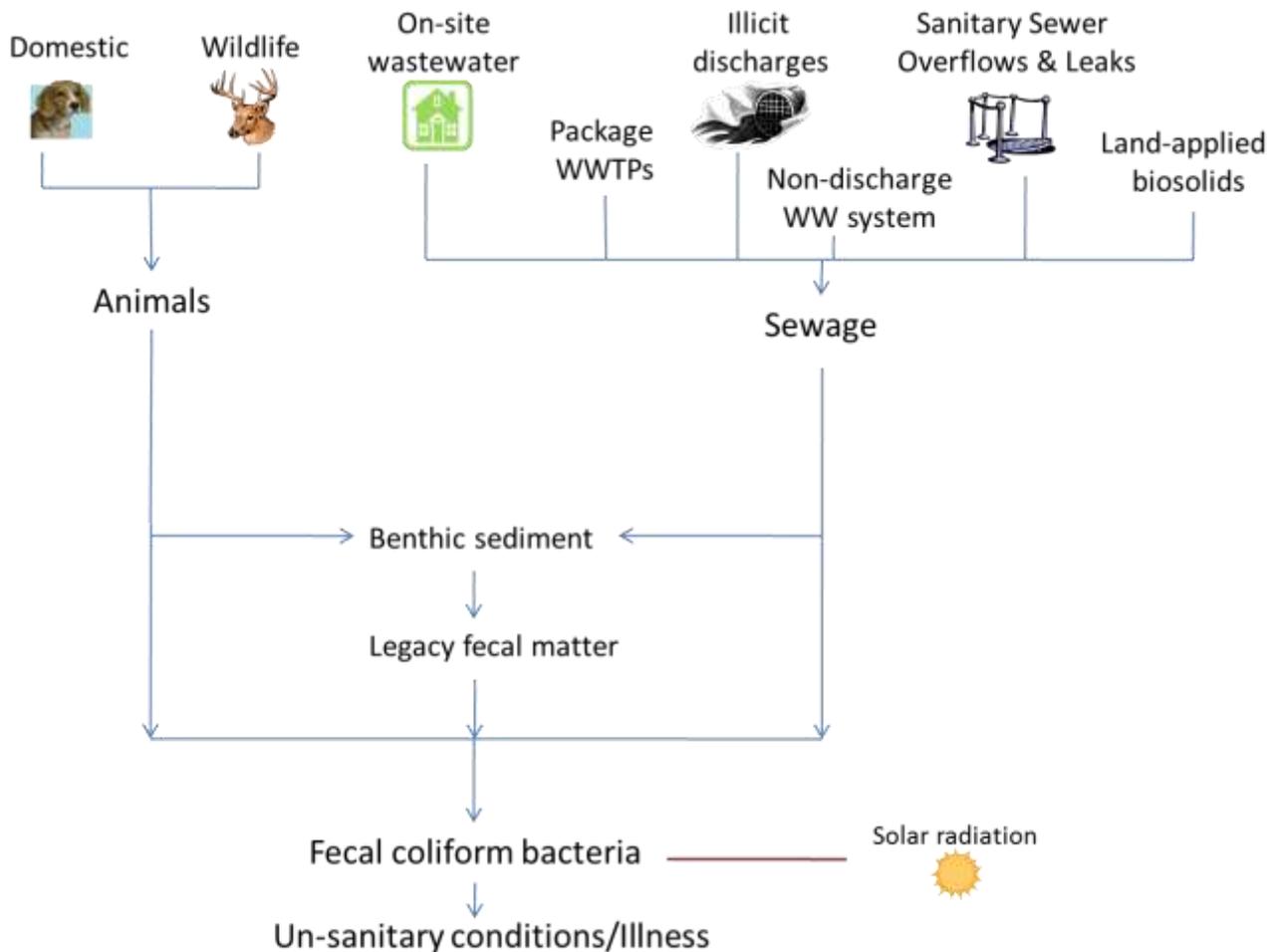


Figure 3. Fecal coliform bacteria pathway conceptual model.

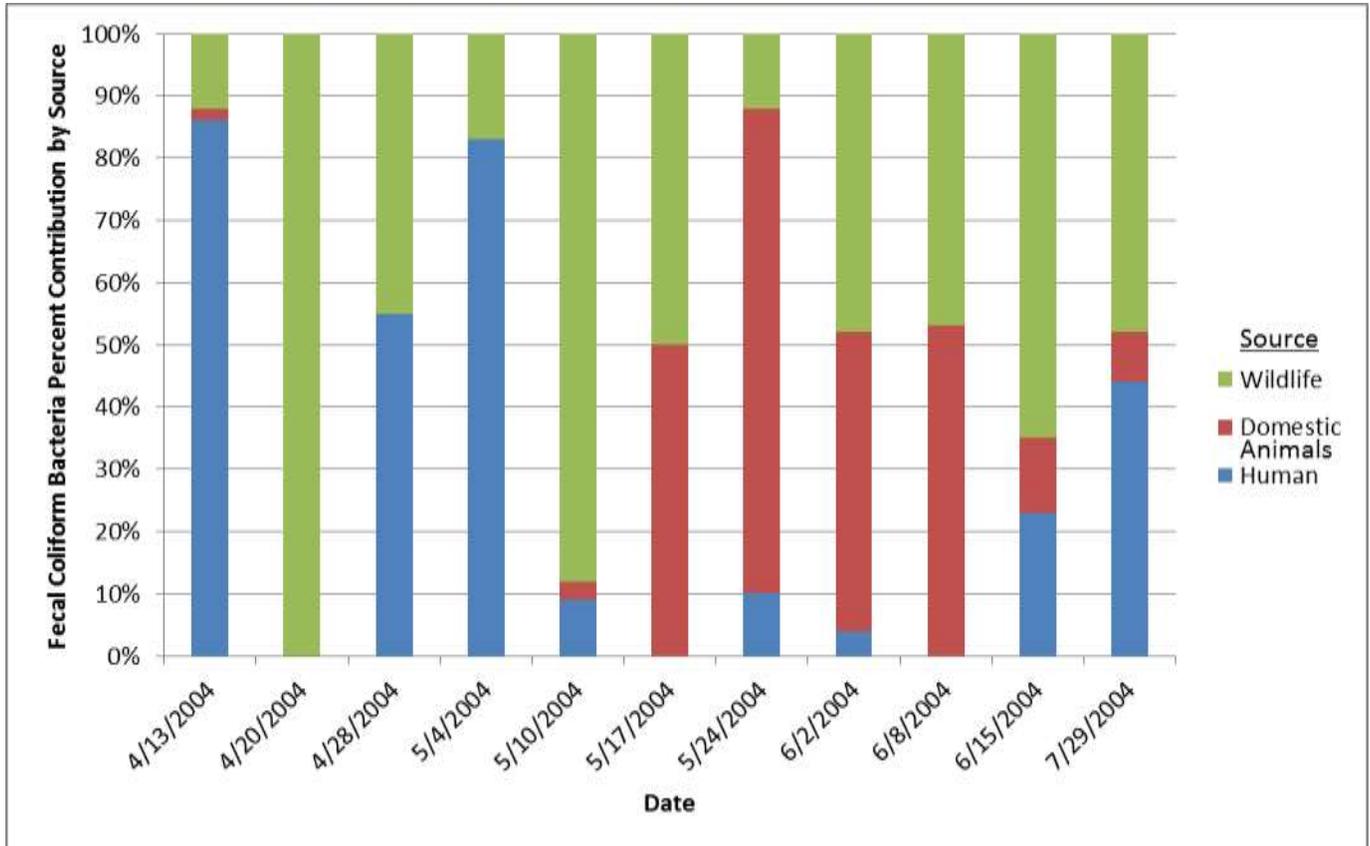


Figure 4. Percent contribution of the fecal coliform bacteria isolates that were identified in stream water samples collected from April to July 2004 in Northeast Creek at Sedwick Rd. in Durham County (MapTech, 2005).

5.1. Human Sources

Fecal coliform bacteria from human waste are typically transported to surface waters when sanitary sewer manholes overflow, sewer mains and laterals leak or break, sewer pump stations fail and overflow, and septic and sand filter systems leak or fail. Other sources of human waste can come from illicit connections of sanitary sewer lines to the stormwater system and from homeless camps. According to Tchobanoglous and Burton (1991), the concentration of fecal coliform bacteria typically found in untreated domestic wastewater ranges from 10^6 to 10^7 (1,000,000 to 10,000,000) colonies per 100mL.

As on-site wastewater treatment systems (OWTS) like septic systems age or are poorly maintained, they can fail and cause untreated sewage to discharge to nearby surface waters during dry weather and wet weather conditions. In properly performing septic systems, fecal coliform bacteria concentrations can range from 10^3 to 10^6 (1,000 to 1,000,000) MPN/100mL in septic tanks and from 0 to 100 MPN/100mL at 1.0 to 3.0 feet below the bottom of the leachfield trench (Tchobanoglous and Burton, 1991). Schueler (2000) reported that the failure rate of septic systems can range from 5% to over 30%, with an average of about 10%. The Durham County Environmental Health Division has estimated there are 141 residential properties with on-site wastewater treatment and 53 of the properties are within 50 feet of a public sanitary sewer line. Although OWTS are inspected by Durham County Environmental Health, the current number of failing OWTS in the Northeast Creek watershed is unknown. One of the proposed measures in this response plan is to identify the properties with failing OWTS and prioritize which properties must connect to the City or County sanitary sewer system.

The Triangle Wastewater Treatment Plant (WWTP) is located in southern Durham County along NC Hwy 55 and discharges treated effluent into Northeast Creek. The Durham County Utilities Division reported that

during the 2017-2018 fiscal year the effluent annual average for fecal coliform bacteria was 1.4 cfu/100mL, which was in compliance with the Triangle WWTP's permit limit monthly average of 200 cfu/100mL (Durham County, 2018). The 2017-2018 average fecal coliform bacteria concentration was also lower than the annual averages reported for 2000, 2001, and 2002 in the 2003 TMDL Northeast Creek Study, which were 56 cfu/100mL, 62 cfu/100mL, and 52 cfu/100mL, respectively (NCDENR, 2003a).

5.2. Livestock and Domestic Animal Sources

During the nonpoint source assessment phase for the 2003 Northeast Creek TMDL Study, NCDEQ (with assistance from Durham County staff) determined that there were 80 cows and 175 horses in the Northeast Creek watershed, although none were observed to be grazing near the stream channel (NCDENR, 2003a). The loading rates for livestock in the Northeast Creek watershed were estimated to be 3000 to 7000 colonies per 100 ml (NCDENR, 2003a). This livestock and domesticated animal survey has not been replicated since the 2003 effort.

In the Northeast Creek TMDL Study, NCDEQ used data from the Durham County Animal Control database to estimate that there were 37,396 dogs and 19,230 cats in Durham County (NCDENR, 2003a). NCDEQ also cited a United States Geological Survey (USGS) study by Hyer et. al. (2001) which found that pet waste accounted for approximately 10% of the fecal coliform bacteria contributions of three creeks in Virginia with varying land uses (NCDENR, 2003a). There are no City-owned dog parks in the Northeast Creek watershed; however, the City Stormwater Quality Group plans to identify how many neighborhood dog parks, apartment complex dog parks, and dog kennels are located in the watershed to aid in the City's public education and outreach efforts to reduce sources of fecal coliform bacteria.

Although dogs and cats are the primary domestic animals in the watershed, domestic chickens (aka backyard chickens) have become more popular within the City limits. The City of Durham has supported the keeping of domesticated chickens on single-family residential lots by allowing up to 10 female chickens per lot. More detailed regulations for keeping domesticated chickens are explained in Section 5.4.12 of the City-County UDO. The Public Works Department has not researched how many domestic chickens are kept in the Northeast Creek watershed. The City-County Planning Department issues Limited Agriculture Permits for keeping domestic chickens and may be able to provide more data on the number of chickens on residential lots in Northeast Creek.

5.3. Wildlife Sources

In the Northeast Creek TMDL study, the primary wildlife fecal contribution was attributed to the deer population because estimates of other animals were not known or available. Using estimates from the North Carolina Wildlife Commission, the NCDEQ used the upper limit of 30 deer per square mile in Northeast Creek and assigned a fecal coliform bacteria loading rate of 50 to 100 cfu/mL (NCDENR, 2003a). Canada Geese and other waterfowl are also contributors of fecal coliform bacteria in urban areas because they can be found at neighborhood lakes and stormwater ponds. Hyer and Moyer (2003) reported that geese were identified as the second highest contributor of fecal coliform bacteria in stream water samples collected in an urban watershed (Accotink Creek) in Virginia.

5.4. MS4 and In-stream Sources

There is a wide range of fecal coliform bacteria concentrations in stormwater runoff which may be due to seasonal variation and factors in urban settings, such as pet waste, sanitary sewer overflows, and illicit sewer connections. For example, Geldreich and Kenner (1969) reported that average fecal coliform bacteria concentrations in stormwater runoff from various geographic regions ranged from 2,700 cfu/100mL in rural areas to 13,000 cfu/100mL in urban business districts. In a USGS study of three Virginia streams by Hyer and Moyer (2003), in-stream fecal coliform bacteria concentrations were lowest during base flow conditions (200 – 2,000 cfu/100mL) and increased during storm events to as high as 700,000 cfu/100mL.

Another potential source of fecal coliform bacteria may be the transport of sediment from the City's stormwater drainage system and resuspension of stream bottom sediments. Some research has shown that fecal coliform bacteria can survive and grow in storm drains and stream sediments (Burton et al., 1987; Marino and Gannon, 1991). High concentrations of fecal coliform bacteria can persist and grow in storm drain sediments during warm, dry weather periods of up to 6 days (Marino and Gannon, 1991). Biofilms located in storm drains and streams also provides a safe environment for fecal coliform bacteria to persist, colonize, and subsequently detach back into the water column (Urban Water Resources Research Council, 2014). Fecal coliform bacteria can survive for weeks and possibly for several months in stream sediments and with bacteria concentrations many times higher than the overlying water (Burton et. al., 1987). A study by Characklis et. al. (2008) comparing storm event microbial concentrations and particle concentrations at wet ponds and stream sites in the Northeast Creek watershed found that average storm concentrations were almost two orders of magnitude higher than background concentrations for bacterial indicators.

6. Pollution Prevention and Mitigation Measures Currently Being Implemented

6.1. Response Plan Measure Definitions

The measures described in this TMDL Response Plan fall into two main categories: Prevention and Mitigation. The definitions below apply to this plan and may be reviewed and modified in future revisions of this plan.

A prevention measure is defined as a management practice, procedure, requirement or other action that can stop a release of pollution from happening. For Northeast Creek, prevention measures are designed to target fecal coliform bacteria at its source by preventing the bacteria from reaching the storm drainage system and surface waters. Prevention measures prioritized in Northeast Creek include:

- Conducting media campaigns to motivate the public to take specific actions that reduce sources of fecal coliform bacteria
- Managing backyard pet waste
- Managing Canada Geese near ponds and SCMs
- Installing pet waste receptacles for residential development

A mitigation measure is defined as a practice, control measure, technology, requirement, or other action that can remove pollution once it has been released, reaches the storm drainage system, or reaches surface waters. For Northeast Creek, mitigation measures are designed to remove or inactivate fecal coliform bacteria. Mitigation measures prioritized in Northeast Creek include:

- Identifying failing septic systems with the potential to connect to the sanitary sewer system
- Conduct stream walks paired with Illicit Discharge Detection and Elimination procedures
- Investigate the feasibility of and install UV treatment devices in culverts and catch basins
- Design and construct SCMs that treat or remove fecal coliform bacteria
- Conduct bacterial source tracking studies to identify sources and their relative contribution to fecal coliform bacteria present in Northeast Creek.

In addition to identifying new mitigation and prevention measures, the 2018 brainstorming sessions held by the City Stormwater & GIS Services Division identified measures that are currently being implemented by City and County departments and may not have been reported in the previous NPDES annual reports. Table 2 below shows the list of nine measures that were discussed during the brainstorming sessions and are currently implemented in the Northeast Creek watershed. The next step is to communicate with each

responsible department about the best method for collecting and reporting the data in the TMDL Response Plan updates.

Table 2. Measures currently implemented in the Northeast Creek watershed

Measures Currently Implemented	NPDES Minimum Measure Category	Estimated Impact on Reducing Fecal Coliform Bacteria	Group(s) Responsible for Implementation	Jurisdiction
Distribute educational mailings on proper maintenance of septic systems to homeowners with septic systems.	Public Education and Outreach	Medium	Environmental Health	County
Distribute educational material on proper maintenance of private sewer laterals to encourage homeowners to take care of laterals.	Public Education and Outreach	Medium	Water Management – Water & Sewer Maintenance; Stormwater Quality - IDDE	City
Education campaign for the proper disposal of nonwoven products (also called flushable wipes) and FOG (fats, oils, and grease).	Public Education and Outreach	Medium	Water Management - Pretreatment	City
Target the Northeast Creek watershed during weekend enforcement patrols.	Illicit Discharge Detection and Elimination	Low-Medium	Public Works – Stormwater Quality - IDDE	City
Inspect sewer lines and pump stations to identify and respond to sewage releases in early stage.	Illicit Discharge Detection and Elimination	Medium	Water Management – Water & Sewer Maintenance	City
Identify and inspect all private sewer pump stations (permitted and non-permitted) and conduct enforcement actions for discharges to the storm drainage system.	Illicit Discharge Detection and Elimination	High	Department of Environmental Quality – Water Resources; Public Works – Stormwater Quality – IDDE	State (inspection & enforcement); City (enforcement)
Routine inspection and maintenance of stormwater catch basins.	Pollution Prevention/Good Housekeeping for Municipal Operations	Low	Public Works – Operations; Stormwater Infrastructure	City
All development which is located in an area that is subject to a TMDL for fecal coliform bacteria shall be required to have at least one SCM for each stormwater discharge that is rated as medium or high for its ability to remove bacteria from stormwater (City code 70-741(d)).	Post-Construction Stormwater Management	Low-Medium	Public Works – Stormwater Development Review	City
Identify sewer rehabilitation areas based on routine inspection and prioritize sewer lines to be repaired.	N/A	Low	Water Management – Water & Sewer Maintenance	City

7. Newly Proposed Pollution Prevention and Mitigation Measures

In 2018, the City's Water Quality Group met with workgroups in several City and County departments to discuss the TMDL Response Plan measures that were specific to their area of responsibility. There were several factors discussed during these meetings to decide whether or not a measure could be implemented in the Northeast Creek watershed. Some of the factors that were discussed and evaluated during the prioritization process include:

- the estimated impact that the measure would have on reducing the number of fecal coliform bacteria reaching Northeast Creek and its tributaries;
- the group(s) that would be responsible for implementing the measure;
- the barriers to implementing the measure;
- the implementation steps;
- the amount of time (in years) it would take to implement the measure;
- an approximate order-of-magnitude cost estimation;
- the NPDES minimum measure category assigned to the measure, if any; and
- whether or not the responsible group thought the measure should be included in the TMDL Response Plan

The priority measures shown in Table 3 are discussed in this section and in Section 8 (grouped by the six minimum measures of the NPDES program). A table of all the priority and non-priority measures proposed for this TMDL Response Plan is found in Appendix A. The low-priority measures will not be implemented as part of this TMDL Response Plan, but they may be revisited and implemented as part of future revisions to this TMDL Response Plan. Appendix B lists all of the measures that were not included in the TMDL Response Plan due to factors such as the estimated high costs (>\$500,000) for implementation, multiple barriers that could hinder implementation, the estimated low impact on reducing fecal coliform bacteria, and the responsible group's willingness to include the measure in the response plan.

A general measure that addresses all bacterial pollution sources is a media campaign to motivate the public to take specific actions that reduce sources of fecal coliform bacteria. This media campaign would include outlets such as the City website, online videos (e.g., YouTube), social media accounts, the Waterways newsletter, partnering with the Clean Water Education Partnership, and other methods. Staff members from Public Education and Pollution Prevention will collaborate on a media campaign. Outcome measures for the media campaign may be quantified using attendance numbers for in-person outreach events; metrics tracking views, likes, and shares of educational material posted on social media; and possibly surveying methods to gauge resident awareness of fecal coliform bacteria issues in Northeast Creek.

7.1. Measures to Reduce Human Sources of Fecal Coliform Bacteria

Human waste can enter the environment through sanitary sewer overflows, failing private sanitary sewer laterals, failing septic tanks, failing septic/sand filter systems, and by direct discharge. The measures in this section are intended to identify and eliminate these sources.

Measures for single- or multi-family, on-site wastewater systems. These measures will be implemented by Durham County Environmental Health unless otherwise noted.

- *Conduct a community survey to identify failing subsurface systems.* Durham County Environmental Health will conduct a door-to-door survey of residences using single-family, on-site systems to locate any systems that may be failing. There are an estimated 141 single- or multi-family residences using

on-site treatment in the Northeast Creek watershed, including those that are located within the city limits.

- *Notify NCDEQ of all existing, unpermitted septic and sand filter discharge systems.* Discharging residences are required to have an NPDES permit. Only a portion of the known septic and sand filter discharge systems are actually permitted, leading to uncertainty regarding the impact of this source of fecal coliform bacteria.
- *Repair or replace existing septic systems within city limits that are failing or leaking.* Once a residential, on-site wastewater system has been deemed in violation by Durham County Environmental Health, the homeowner(s) are required to make repairs to the existing system or to connect to City sanitary sewer. The ease of implementation will vary based on the locations of existing sanitary sewers, required plumbing serves to connect to the sanitary sewer system, cost, and personal preference.
- *Provide a cost-share option as an incentive to connect to the City's sanitary sewer system.* Repairing septic systems and connecting to the City sanitary sewer system can be expensive. The City will explore and potentially implement a cost-share program to provide an incentive to connect to City sewer. The cost-share program would relieve a portion of the financial burden on homeowners and residents within the City limits. This measure will require collaboration between multiple City and County departments, including County Environmental Health, City Stormwater & GIS Services, City Engineering Services, and City Water Management.

Measures for sanitary sewer overflows. These measures will be implemented by the City of Durham Public Works Department unless otherwise noted.

- *Routine stream-walk program to target main stem and tributaries with historically higher incidences of illicit discharges, and inspect major outfalls (greater than 36" diameter pipe) for sources of fecal coliform bacteria.* The City will establish a schedule and procedures for walking along sections of Northeast Creek and its tributaries to identify illicit discharges of sewage from the City's sanitary sewer system and private sanitary sewer laterals. Stream-walk teams will also inspect major outfalls that discharge to Northeast Creek and its tributaries. The City's Stormwater Quality Group will perform the routine stream walks and communicate with the Water Management Department, private property owners, and NCDEQ's Division of Water Resources depending on the type and extent of sewage discharge detected. The Stormwater Quality Group will also require private property owners to stop and clean up sewage discharges through enforcement of the Stormwater Management and Pollution Control Ordinance. The City's Water Management Department repairs or replaces aging and failing sections of the public sanitary sewer lines throughout the City. Water Management staff may be consulted to determine which sewer lines in the Northeast Creek watershed have not been repaired or replaced. Stormwater Quality staff may plan stream-walks in areas of the watershed where sewer rehabilitation has not recently occurred.
- *Conduct cross-training for the Zoning Enforcement and Stormwater Quality Illicit Discharge Detection & Elimination groups to improve communication between departments on sanitary sewer and septic system issues observed in the field.* These groups will schedule cross-training events to educate their staff on multiple code violation subjects, including illicit discharges of sewage from overflowing private sewer laterals or failing septic systems. Zoning Enforcement staff will become familiar with the best methods for reporting sewage discharges to Stormwater Quality IDDE staff.

7.2. Measures to Reduce Domestic Animal Sources of Fecal Coliform Bacteria

Domestic animal waste can enter the environment when pet owners do not pick up after their pets and do not properly dispose of the waste. The measures in this section are intended to identify and prevent sources of dog waste.

- *Require developers to include pet waste receptacles in new residential development.* This requirement would be a part of residential development site plans. The City-County Planning Department will investigate if an amendment to the Unified Development Ordinance is feasible. The City Council and County Board of Commissioners would need to approve this ordinance change.
- *Identify the number and location of private dog parks (neighborhood, apartment, HOA) and dog kennel facilities in the Northeast Creek watershed.* This measure will identify potential hotspots of fecal coliform bacteria from dog waste. Targeted mailings or in-person outreach can also be used to reach residents that visit private dog parks and commercial dog kennels in the watershed. Provide educational materials on pet waste management. The City's Stormwater Quality Group and public outreach staff will conduct online searches and field surveys to complete this measure.

7.3. Measures to Reduce Wildlife Sources of Fecal Coliform Bacteria

Wildlife can excrete fecal material in forested, wetland, and herbaceous areas. Wildlife can also deposit fecal material directly into waterbodies, such as lakes, ponds, and streams. The measure in this section targets Canada Geese that nest or gather near SCMs, ponds, and lakes.

- *Management program for Canada Geese to control population and proximity to water, which may include non-SCM lakes and ponds.* This measure is meant to reduce the presence of Canada Geese in and around neighborhood ponds and lakes, and SCMs, such as wet ponds. The City's Stormwater Development Review Group and the Stormwater Quality Group will research state and federal laws and successful methods of geese management programs in other towns, cities, and states. Surveys may be performed to determine which SCMs, ponds, and small lakes have problems with geese and geese waste. The Stormwater Development Review, Stormwater Quality, and public outreach staff will develop guidance material for a Canada Geese management program that may be implemented by the City, neighborhood communities, and homeowners associations.

7.4. Measures to Reduce Multiple Sources of Fecal Coliform Bacteria

The measures in this section are structural treatment and control devices that can capture or treat fecal coliform bacteria in stormwater runoff. The following measures will be implemented by the City of Durham Public Works Department.

- *Explore UV light treatment devices in culverts or stormwater catch basins to reduce fecal coliform bacteria.* UV light is used to disinfect drinking water and wastewater but is not as commonly used to treat urban stormwater runoff. The City's Stormwater Quality Group will research types of UV treatment devices that can be installed in line with the stormwater system. The City will select and hire contractors to install one or more UV treatment devices in the City's stormwater drainage system.
- *Review the Northeast Creek Watershed Improvement Plan (WIP) and implement the construction of SCMs identified in the WIP that address fecal coliform bacteria.* The City's Watershed Planning Group and Stormwater Quality Group will be responsible for reviewing the WIP and prioritizing SCMs that will be built, assuming available land, funding, and public support. The Watershed Planning Group will be responsible for coordinating public communication, land acquisition, and contract management for the construction of the SCMs.

7.5. Measures to Identify Sources of Fecal Coliform Bacteria

Microbial source tracking (MST) is a useful tool for identifying the various sources of fecal bacteria in impaired surface waters. MST technology analyzes fecal coliform bacteria in stream water samples and identifies differences among the fecal coliform bacteria found in the feces of humans and animals. The following measure will be implemented by the City of Durham Public Works Department.

- *Conduct a microbial source tracking (MST) study and compare results to the City's 2004 bacterial source tracking study.* The City's Stormwater Quality Group will be responsible for hiring a contractor and managing the MST study. The results of the MST study will be used to focus resources on response plan measures that reduce fecal coliform bacteria in the most economical way.

Table 3. Prioritized Measures in the Northeast Creek watershed

Proposed Measure	Type of Measure	NPDES Minimum Measure	Estimated Impact on Reducing Fecal Coliform Bacteria	Group(s) Responsible for Measure Implementation	Estimated Cost to Implement Measure*	Measure Funding Source	Implementation Timeline (years)
Management program for Canada Geese to control population and proximity to water, which may include non-SCM lakes and ponds.	Prevention	N/A	High	Public Works Stormwater Development Review and Stormwater Quality	\$\$	-	5-10
Explore UV treatment devices in culverts or stormwater catch basins to reduce fecal coliform bacteria in baseflow or low turbidity water.	Mitigation	N/A	High	Public Works Stormwater Quality and Infrastructure	\$\$	City Stormwater Utility Fund	5-10
Conduct a community survey to identify failing subsurface systems	Mitigation	N/A	High	County Environmental Health	\$	-	0-5
Conduct a second microbial source tracking (MST) study and compare results to the first BST study completed for Northeast Creek	Mitigation	N/A	Medium	Public Works Stormwater Quality	\$ - \$\$	-	5-10
Notify NCDEQ of all existing, unpermitted discharge systems (septic and sand filter systems)	Prevention	N/A	Medium	County Environmental Health	\$	-	0-5
Repair or replace existing septic systems located within city limits that are failing or leaking. Provide a cost-share option as an incentive to connect to the City's sanitary sewer system.	Mitigation	Illicit Discharge Detection and Elimination	Medium	County Environmental Health, Public Works Engineering Services, Water Management	\$	City Stormwater Utility Fund	0-5
Require developers to include pet waste receptacles in new residential development.	Prevention	Post-Construction Stormwater Management	Medium	City-County Planning	\$	-	5-10
Review the Northeast Creek Watershed Improvement Plan (WIP) and implement the construction of SCMs identified in the WIP that address fecal coliform bacteria.	Mitigation	N/A	Low-Medium	Public Works Watershed Planning and Stormwater Quality	\$\$\$	-	5-15
Conduct a media campaign to motivate the public to take specific actions that reduce sources of fecal coliform bacteria through the City's website, online videos (e.g. YouTube), social media accounts, Waterways newsletter, Clean Water Education Partnership (CWEP) handouts, and other methods.	Prevention	Public Education and Outreach	Low-Medium	Public Works Stormwater Quality and Watershed Planning, CWEP Contractor	\$	City Stormwater Utility Fund	0-5
Routine stream-walk program to target the main stem and tributaries with historically higher incidences of illicit discharges. Also, inspect major outfalls (greater than 36" diameter pipe) for sources of fecal coliform bacteria.	Mitigation	Illicit Discharge Detection and Elimination	Medium	Public Works Stormwater Quality	\$\$	-	0-5
Conduct cross-training for the Zoning Enforcement and Water Quality IDDE groups to improve communication between departments on sanitary sewer and septic system issues observed in the field.	Prevention	Illicit Discharge Detection and Elimination	Low	Public Works Stormwater Quality, City-County Planning	\$	-	0-5
Identify the number and location of private dog parks (neighborhood, apartment, HOA) and dog kennel facilities in the Northeast Creek watershed. Provide educational materials on pet waste management.	Prevention	Public Education and Outreach	Low	Public Works Stormwater Quality	\$	-	0-5

*Estimated Costs: \$\$\$ > \$500,000, \$\$ = \$50,000 to \$500,000, \$ < \$50,000. Estimated costs consider only the projected costs to the City and County departments.

8. Prioritized Measures Applicable to the NPDES Six Minimum Measures

This section highlights the prioritized response plan measures that fall under the six minimum control measures for the EPA’s Stormwater Phase II Final Rule. The prioritized measures in this response plan address Public Education and Outreach, IDDE, and Post-Construction Stormwater Management. There were no measures identified to address Public Participation and Involvement, and Construction Site Stormwater Runoff Control.

8.1. Implementation of Measures to the Maximum Extent Practicable

The City will implement response plan measures to the maximum extent practicable (MEP) with the goal of reducing the levels of fecal coliform bacteria in Northeast Creek. While the elimination of all fecal coliform bacteria point and nonpoint sources may reduce concentrations below water quality standards, it is recognized that this may not be feasible due to technical, economic, logistic or social factors. Therefore, the City will pursue fecal coliform bacteria reductions to the MEP based on Clean Water Act and MS4 NPDES requirements. Section 402(p)(3)(B) of the Clean Water Act requires municipal MS4 permittees, to the extent allowable under State or local law, to prohibit non-stormwater discharges into the MS4 and implement controls and management measures to reduce the discharge of pollutants to the maximum extent practicable. Section J(1)(b) of the City’s MS4 NPDES permit also requires that the City utilize BMPs (commonly referred to as SCMs) pertaining to the six minimum measures and the TMDL Response Plan to meet the approved TMDL WLA to the MEP. Additionally, Section J(1)(c) of the City’s MS4 NPDES also states that the City is not responsible for attaining State water quality standards as this requires pollutant reductions from all point and nonpoint sources identified in the approved TMDL.

8.2. Public Education and Outreach

City of Durham, Public Works Department, Stormwater & GIS Services Division	
<u>Measure</u>	<u>Timeline</u>
<ul style="list-style-type: none"> ▪ Conduct a media campaign to motivate the public to take specific actions that reduce sources of fecal coliform bacteria through the City’s website, online videos (e.g. YouTube), social media accounts, Waterways newsletter, Clean Water Education Partnership (CWEP) handouts, and other methods. 	0 to 5 years
<ul style="list-style-type: none"> ▪ Identify the number and location of private dog parks (neighborhood, apartment, HOA) and dog kennel facilities in the Northeast Creek watershed Provide educational materials on pet waste management. 	0 to 5 years

8.3. Public Participation and Involvement

There were no response plan measures proposed for this NPDES minimum measure.

8.4. Illicit Discharge Detection and Elimination

City of Durham, Public Works Department, Stormwater & GIS Services Division	
<u>Measure</u>	<u>Timeline</u>
<ul style="list-style-type: none"> ▪ Repair or replace existing septic systems located within city limits that are failing or leaking. Provide a cost-share option as an incentive to connect to the City's sanitary sewer system. 	0 to 5 years
<ul style="list-style-type: none"> ▪ Routine stream-walk program to target main stem and tributaries with historically higher incidences of illicit discharges. Also inspect major outfalls (greater than 36" diameter pipe) for sources of fecal coliform bacteria. 	0 to 5 years

8.5. Construction Site Stormwater Runoff Control

There were no response plan measures proposed for this NPDES minimum measure.

8.6. Post-Construction Stormwater Management

Durham City-County Planning Department	
<u>Measure</u>	<u>Timeline</u>
<ul style="list-style-type: none"> ▪ Require developers to include pet waste receptacles with new residential development projects. 	5 to 10 years

8.7. Pollution Prevention/Good Housekeeping for Municipal Operations

There were no response plan measures proposed for this NPDES minimum measure.

9. Watershed Planning

Watershed planning is an additional measure that the City of Durham has incorporated into the Stormwater program. Although this is not one of the Phase II minimum measures, this program does provide information and direction regarding practices implemented in the Northeast Creek watershed.

In 2007 the City began the process of developing Watershed Improvement Plans for watersheds across the City. As of December 2018, watershed improvement plans have been completed for Ellerbe Creek, Northeast Creek, Crooked Creek, Third Fork Creek, Little Lick Creek and Eno River. Each plan identifies new opportunities for stormwater control measures, as well as opportunities to upgrade existing measures (i.e., retrofit existing measures). Extensive field work is conducted in the watershed planning process to verify on-the-ground conditions prior to carrying a project concept forward. Stream restorations are also evaluated as

potential control measures to pollution that can arise from the stream bank (e.g., sediment/turbidity). Each plan provides a recommended list of ranked new stormwater control measures, opportunities for retrofitting measures, and stream restoration. Cost estimates are provided for each measure or restoration opportunity.

The City finalized the Northeast and Crooked Creek Watershed Improvement Plan (WIP) in 2013. The completed plan made the following recommendation to support the reduction of fecal coliform bacteria in the creek:

- Work with the City's Department of Water Management sanitary sewer rehabilitation and replacement program. Support efforts to continue the ongoing sanitary sewer line inspections, with rehabilitation and replacements as necessary. Work to ensure that Durham County Environmental Health Division and NCDNER continue to inspect sand filters and septic systems and require actions to be taken to address leaking or failing systems.
- The City recorded 54 sanitary sewer overflows (SSOs) between 1999 and 2011 in the Northeast and Crooked Creek watersheds, which includes both manhole overflows and leaking sewer pipes and septic systems. The highest-priority recommendation to decrease fecal coliform bacteria loads within the watersheds is to complete the on-going sanitary sewer rehabilitation and replacement program to reduce the SSOs and eliminate illicit connections. Approximately 90 percent of the SSOs and illicit connections could be removed through the City's on-going sanitary sewer rehabilitation and replacement program at an estimated cost of \$3.3 million

The WIP also included areas in Durham County, Chatham County, and Wake County. Some recommendations were also made about fecal coliform bacteria in these jurisdictions.

As described in the WIP, the most cost-effective action to reduce fecal coliform bacteria in Northeast Creek relates to sanitary sewage, including the collection system and single-family, on-site treatment systems (i.e., septic and discharging sand filter systems). New SCMs and SCM retrofits were evaluated for the ability to treat fecal coliform bacteria, thus additional benefits will be realized by these new projects.

10. Water Quality Assessment and Monitoring

10.1. Water Quality Monitoring

The City of Durham has a routine ambient stream monitoring program to generate data that describe the condition of streams in the City and County limits. The City's Stormwater Management Program Plan states that the ambient stream monitoring program supports the following assessment goals (City of Durham, 2017):

- to identify pollution problem areas within the City of Durham;
- to assess compliance with state water quality programs, including TMDLs and nutrient management strategies;
- to determine pollution removal credits;
- to identify overall water quality trends; and
- to evaluate the water quality impacts of urban stormwater runoff on area streams

The monitoring program includes water chemistry, biological monitoring (benthic macroinvertebrates and habitat assessment), and hydrologic monitoring. The ambient water chemistry program focuses on surface water conditions. Special studies are conducted on an infrequent basis to assess stream sediment chemistry. City monitoring staff follow procedures outlined in the Ambient Water Chemistry Monitoring Program Quality Assurance Project Plan and collect grab samples monthly at scheduled monitoring sites. Samples are collected at all monitoring sites in a given basin on the same day. The City uses a rotating

stream basin approach to monitor sites in each basin every two years; however, monitoring sites are evaluated at the end of each year and site locations are adjusted to meet the City's water quality assessment needs. There are three sites in the Northeast Creek basin that are monitored during even-numbered years. The City's stream monitoring sites in Northeast Creek are located on the main channel at NC Hwy 54 (NE1.2NE) and Sedwick Rd. (NE0.0NE), and on the North Prong tributary at Meridian Parkway (NE2.2NP). The Northeast Creek ambient stream monitoring sites for the City, Upper Cape Fear River Basin (UCFRBA), and State Division of Water Resources (DWR) are shown below in Figure 5.

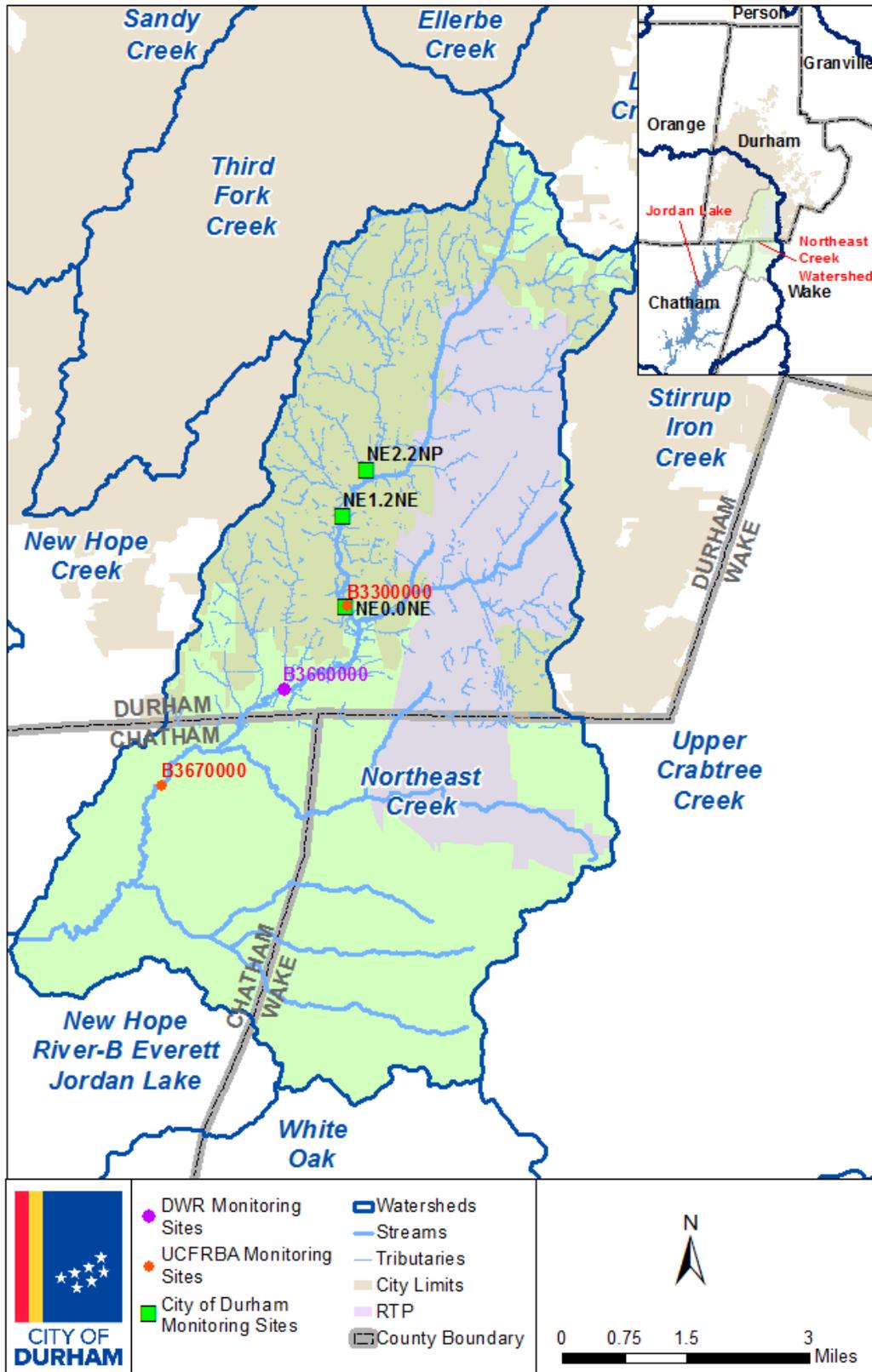


Figure 5. City of Durham, UCFRBA, and DWR ambient stream monitoring sites in the Northeast Creek watershed.

Instream assessments of fecal coliform bacteria have been performed primarily at the point where Northeast Creek crosses Sedwick Road, far upstream of the compliance point that is located 0.5 miles downstream of Panther Creek in Chatham County. Sedwick Road offers a convenient location to evaluate City of Durham and Durham County progress, without interference from other counties or the Triangle WWTP. Sedwick Road is a current monitoring location for the City of Durham (NEO.0NE) and a former monitoring location for the UCFRBA at B3300000. Future comparisons may be made downstream at the compliance point, assuming state data is readily available for the same time frame. However, this is not the best location to track the impact that City actions have on fecal coliform bacteria levels in Northeast Creek since city boundaries do not extend south of Sedwick Road more than approximately 3,000 feet.

The City and State water quality monitoring programs include sample collection and analysis once monthly. The fecal coliform bacteria standard is written for five samples collected within 30 days. Thus, the monitoring methods do not exactly match the water quality standard. The City will screen for compliance by comparing monthly fecal coliform bacteria monitoring data to the state water quality standard to determine if compliance is likely. Data collected during storm events are not removed from this comparison.

Consistent with the NPDES permit, an analysis of changes over time will be performed. This may be a graphical analysis, a linear regression, a Seasonal Kendall test, or another type of time series analysis.

10.2. Bacterial Source Tracking

In 2004, the City of Durham conducted a BST study in coordination with NCDEQ (formerly NCDENR) and private consultants to identify sources of *E. coli* and relative percent contributions from target source groups. The study analyzed antibiotic resistance characteristics of more than 60 scat samples (domestic, wildlife, and human sources) collected from the Northeast Creek watershed and compared them to fecal coliform bacteria concentrations at two stream monitoring sites to identify bacteria sources (City of Durham, 2017). The results from the Sedwick Rd. monitoring site (NEO.0NE) indicated that wildlife sources were more prevalent than domestic and human sources (Figure 6; MapTech, 2005). Figure 6 presents fecal coliform bacteria concentrations with proportional source contributions for NEO.0NE.

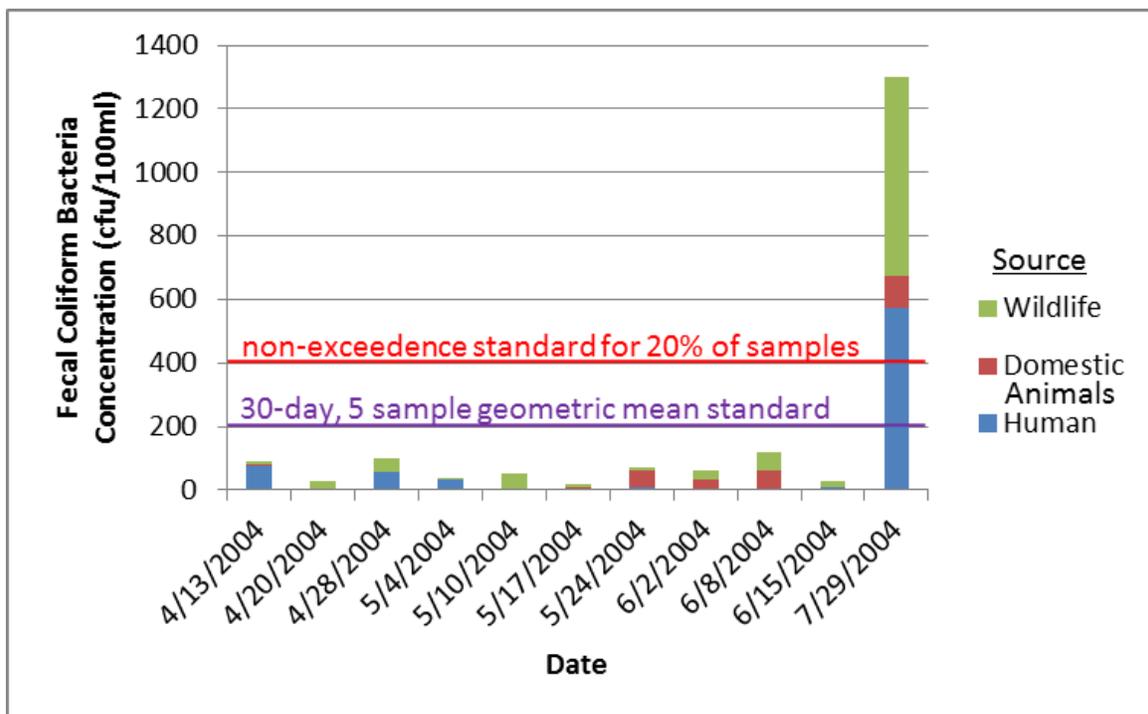


Figure 6. Fecal coliform bacteria concentrations with proportional source contributions indicated for Northeast Creek at Sedwick Rd. (MapTech, 2005).

11. Water Quality Co-Benefits of TMDL Response Plan Implementation

In addition to reducing fecal coliform bacteria, the actions implemented in this TMDL response plan may reduce other contaminants of concern that affect water quality in Northeast Creek. For example, reducing and eliminating discharges of untreated domestic wastewater and untreated septage will prevent high concentrations of total suspended solids, biochemical oxygen demand, total organic carbon, nitrogen, phosphorus, metals, pathogens, and other contaminants. Typical concentrations of specific contaminants in untreated domestic wastewater and untreated septage are shown below in Table 4 (Tchobanoglous and Burton 1991).

Table 4. Pollutants of concern found in untreated domestic wastewater and untreated septage, not including bacteria concentration data.

		Untreated Domestic Wastewater Concentration ¹			Septage Concentration ¹	
Contaminant	Unit	Weak	Medium	Strong	Range	Typical
Suspended Solids	mg/L	100	220	350	4,000 – 100,000	15,000
BOD	mg/L	110	220	400	2,000 – 30,000	6,000
TOC	mg/L	80	160	290	-	-
Total Nitrogen	mg/L	20	40	85	-	-
Total Kjeldahl Nitrogen as N	mg/L	-	-	-	100 – 1,600	700
Ammonia as N	mg/L	-	-	-	100 – 800	400
Total Phosphorus	mg/L	4	8	15	50 – 800	250
Heavy Metals ²	mg/L				100 – 1,000	300

¹ Adapted from Tchobanoglous and Burton (1991).

² Primarily iron (Fe), zinc (Zn), and aluminum (Al).

11.1. Value Added for Removing Nutrients and Metals

The NCDEQ's 2016 Final 303(d) List reports that specific sections of Northeast Creek are impaired for copper and zinc because samples have exceeded the State water quality standards of 7 µg/L and 50 µg/L, respectively. The NCDEQ's 2018 Draft 303(d) List also includes a listing of impairment for turbidity. All 303(d) List Category 5 Assessments are shown in Table 5. Northeast Creek drains to a recreational and drinking water lake (B. Everett Jordan Lake) which is impaired for nitrogen and phosphorus.

Table 5. NCDEQ 2016 Final 303(d) List (NCDEQ, 2016) and 2018 Draft 303(d) List (NCDEQ, 2018), Category 5 Assessments for Third Fork Creek. Listings for turbidity were not included on the 2016 303(d) List but added to the Draft 2018 303(d) List.

Description of stream segment	DWQ Assessment Unit(s)	Impaired segment length (miles)	Assessment Criteria Status	Reason for Rating	Parameter of Interest	IR Category
From US Hwy 55 to Durham Triangle WWTP	16-41-1-17-(0.7)a	3.3	Exceeding Criteria	> 10% and >90% conf > 10% and >90% conf	Copper (7 ug/L) Turbidity (50 NTU; 2018 Draft Listing)	5 5
From Durham Triangle WWTP to Kit Creek	16-41-1-17-(0.7)b1	3.3	Exceeding Criteria	> 10% and >90% conf	Zinc (50 ug/L)	5
From Kit Creek to a	16-41-1-17-	3.2	Exceeding	> 10% and > 90% conf	Zinc (50 ug/L)	5

point 0.5 miles downstream of Panther Creek	(0.7)b2		Criteria	>10% and < 90% conf -	Copper (7 ug/L) Turbidity (50 NTU; 2018 Draft Listing)	5e 5
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The implementation of measures that target human sources of fecal coliform bacteria have an added value of reducing nutrients and metals; measures that target wildlife and domestic animal sources of fecal coliform bacteria can also reduce nutrient pollution. In addition, the installation of SCMs that target fecal coliform bacteria can also reduce metals, nutrients, and sediment transported in urban stormwater runoff. Implementing the prioritized measures in this response plan may result in the reduction of nutrient and dissolved metals pollution in Northeast Creek and Jordan Lake, and in turn, could help the City and County meet State water quality standards and the Jordan Lake Rules.

11.2. Benefits to Aquatic Life

The reduction of overflows and leaks from the City and County sanitary sewer systems and replacement of failing private septic systems will also benefit the aquatic life community (fish, benthic macroinvertebrates, amphibians, etc.) in Northeast Creek. Sanitary sewer overflows can cause fish kills in streams due to toxic effects of high ammonia and BOD concentrations, and low dissolved oxygen concentrations. Reduction in illicit discharges and the number of cross-connected pipes to the City’s MS4 system could reduce metals loading, which, has been shown to affect the health of instream benthic macroinvertebrates (e.g., Hickey and Clements, 1998). Reduced suspended sediment concentrations in Northeast Creek could facilitate healthier instream fauna communities (Henley et al., 2000) and could be facilitated by the installation of SCMs. Increased water clarity could also enable sunlight to penetrate deeper into the water column to inactivate fecal coliform bacteria (Urban Water Resources Research Council, 2014).

12. Steps Towards TMDL Response Plan Implementation

The Northeast Creek TMDL Response Plan will be implemented by workgroups in Durham City and County government. This implementation process is not necessarily a direct prescriptive process – depending on the level of change that implemented response measures are having on fecal coliform bacteria loads in Northeast Creek. Adapting and modifying the response plan will be informed through an ongoing analysis of programmatic data collected to quantify progress.

12.1. Response Plan Schedule by Agency

This section organizes the prioritized response plan measures by the departments that are responsible for implementing them. The prioritized measures in this response plan will be implemented in partnership between the City of Durham Public Works Department (Stormwater and GIS Services Division and Engineering Services Division), the Durham County Public Health Department (Environmental Services Division), and the Durham City-County Planning Department. The timeline for implementation of the prioritized response plan measures is between five and fifteen years.

City of Durham, Public Works Department, Stormwater & GIS Services Division	
<u>Measure</u>	<u>Timeline</u>
<ul style="list-style-type: none"> ▪ Conduct a media campaign to motivate the public to take specific actions that reduce sources of fecal coliform bacteria through the City’s website, online videos (e.g. YouTube), social media accounts, Waterways newsletter, Clean Water Education Partnership (CWEP) handouts, and other methods. 	0 to 5 years
<ul style="list-style-type: none"> ▪ Routine stream-walk program to target main stem and tributaries with historically higher incidences of illicit discharges. Also inspect major outfalls (greater than 36" diameter pipe) for sources of fecal coliform bacteria. 	0 to 5 years
<ul style="list-style-type: none"> ▪ Identify the number and location of private dog parks (neighborhood, apartment, HOA) and dog kennel facilities in the Northeast Creek watershed. Provide educational materials on pet waste management. 	0 to 5 years
<ul style="list-style-type: none"> ▪ Conduct cross-training for the Zoning Enforcement and Water Quality IDDE groups to improve communication between departments on sanitary sewer and septic system issues observed in the field. 	0 to 5 years <i>(in coordination with the City-County Planning Dept.)</i>
<ul style="list-style-type: none"> ▪ Management program for Canada Geese to control population and proximity to water, which may include non-SCM lakes and ponds. 	5 to 10 years
<ul style="list-style-type: none"> ▪ Explore UV treatment devices in culverts or stormwater catch basins to reduce fecal coliform bacteria in baseflow or low turbidity water. 	5 to 10 years
<ul style="list-style-type: none"> ▪ Conduct a second bacterial source tracking (BST) study and compare results to the first BST study completed for Northeast Creek. 	5 to 10 years
<ul style="list-style-type: none"> ▪ Review the Northeast Creek Watershed Improvement Plan (WIP) and implement the construction of SCMs identified in the WIP that address fecal coliform bacteria. 	10 to 15 years

Durham County, Public Health Department, Environmental Health Division	
<u>Measure</u>	<u>Timeline</u>
<ul style="list-style-type: none"> ▪ Conduct a community survey to identify failing subsurface systems 	0 to 5 years
<ul style="list-style-type: none"> ▪ Notify NCDEQ of all existing, unpermitted discharge systems (septic and sand filter systems) 	0 to 5 years
<ul style="list-style-type: none"> ▪ Repair or replace existing septic systems located within city limits that are failing or leaking. Provide a cost-share option as an incentive to connect to the City's sanitary sewer system. 	0 to 5 years <i>(in coordination with City Stormwater Services, Engineering Services, and Water Management)</i>

Durham City-County Planning Department	
<u>Measure</u>	<u>Timeline</u>
<ul style="list-style-type: none"> ▪ Require developers to include pet waste receptacles with new residential development projects. 	5 to 10 years

12.2. Tracking and Data Collection

The City's Public Works Department will communicate with the appropriate departments, divisions, and workgroups to identify the metrics and data needed to track the progress of measures outlined in this Response Plan. A preliminary list of metrics that may be used to track incremental progress for this Response Plan is shown in Appendix C.

12.3. Re-evaluation of Response Plan

The City's Public Works Department will re-evaluate the measures outlined in this TMDL Response Plan on a five-year basis, as resources allow. Modifications to the response plan will depend on reductions in fecal coliform bacteria concentrations, the feasibility of implementing measures, stakeholder needs, and new measures identified. The City will continue to provide progress updates on an annual basis as part of the NPDES Municipal Stormwater Permit annual reporting cycle.

13. References

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14. Appendix A: Summary Table of All Proposed Measures (Priority and Non-Priority)

Table 6. Priority and non-priority measures proposed for the Northeast Creek TMDL Response Plan

Proposed Measure	Type of Measure	NPDES Minimum Measure	Estimated Impact on Reducing Fecal Coliform Bacteria	Group(s) Responsible for Measure Implementation	Estimated Cost to Implement Measure	Implementation Timeline (years)	Priority
Notify NCDEQ of all existing, unpermitted discharge systems (septic and sand filter systems).	Prevention	N/A	Medium	County Environmental Health	\$	0-5	Yes
Conduct a community survey to identify failing subsurface systems.	Mitigation	Illicit Discharge Detection and Elimination	High	County Environmental Health	\$	0-5	Yes
Repair or replace existing septic systems located within city limits that are failing or leaking. Provide a cost-share option as an incentive to connect to the City's sanitary sewer system.	Mitigation	Illicit Discharge Detection and Elimination	Medium	County Environmental Health, City Engineering Services, City Stormwater Quality	\$	0-5	Yes
Routine stream-walk program to target the main stem and tributaries with historically higher incidences of illicit discharges. Also, inspect major outfalls (greater than 36" diameter pipe) for sources of fecal coliform bacteria.	Mitigation	Illicit Discharge Detection and Elimination	Medium	Public Works Stormwater Quality	\$\$	0-5	Yes
Conduct cross-training for the Zoning Enforcement and Water Quality IDDE groups to improve communication between departments on sanitary sewer and septic system issues observed in the field.	Prevention	Illicit Discharge Detection and Elimination	Low	Public Works Stormwater Quality, City-County Planning	\$	0-5	Yes
Identify the number and location of private dog parks (neighborhood, apartment, HOA) and dog kennel facilities in the Northeast Creek watershed. Provide educational materials on pet waste management.	Prevention	Public Education and Outreach	Low	Public Works Stormwater Quality and Watershed Planning	\$	0-5	Yes
Management program for Canada Geese to control population and proximity to water, which may include non-SCM lakes and ponds.	Prevention	N/A	High	Public Works Stormwater Development Review, Stormwater Quality, Watershed Planning; Durham County Sheriff's Office Animal Services; N.C. Wildlife Resources Commission	\$\$	5-10	Yes
Conduct a microbial source tracking (MST) study and compare results to the BST study completed for Northeast Creek.	Mitigation	N/A	Medium	Public Works Stormwater Quality	\$\$\$	5-10	Yes
Explore UV treatment devices in culverts or stormwater catch basins to reduce fecal coliform bacteria in baseflow or low turbidity water.	Mitigation	N/A	High	Public Works Stormwater Quality and Stormwater Infrastructure	\$\$	5-10	Yes
Review the Northeast Creek Watershed Improvement Plan (WIP) and implement the construction of SCMs identified in the WIP that address fecal coliform bacteria.	Mitigation	N/A	Low-Medium	Public Works Watershed Planning and Stormwater Quality	\$\$\$	5-15	Yes
Require developers to include pet waste receptacles in new residential development.	Prevention	Post-Construction Stormwater Management	Medium	City-County Planning	\$	5-10	Yes

Proposed Measure	Type of Measure	NPDES Minimum Measure	Estimated Impact on Reducing Fecal Coliform Bacteria	Group(s) Responsible for Measure Implementation	Estimated Cost to Implement Measure	Implementation Timeline (years)	Priority
Conduct a media campaign to motivate the public to take specific actions that reduce sources of fecal coliform bacteria through the City's website, online videos (e.g. YouTube), social media accounts, Waterways newsletter, Clean Water Education Partnership (CWEP) handouts, and other methods.	Prevention	Public Education and Outreach	Low-Medium	Public Works Stormwater Quality and Watershed Planning	\$	0-5	Yes
Increase education for backyard dog waste and County-wide dog waste ordinance.	Prevention	Public Education and Outreach	Medium	Public Works Stormwater Quality and Watershed Planning, Durham County Sheriff	\$ - \$\$\$	0-5	No
Expand the nonwoven products (flushable wipes) public education campaign.	Prevention	Public Education and Outreach	Low	Water Management - Pretreatment	\$	0-5	No
Query information from sanitary sewer inspection reports on CityWorks using keywords for bacteria issues. Stormwater & GIS Services can use search results to investigate sources of fecal coliform bacteria.	Mitigation	Illicit Discharge Detection and Elimination	Low	Public Works Stormwater Quality	\$	0-5	No
Hire a contractor to pilot drones or a helicopter equipped with infrared camera equipment to spot discharges based on changes in temperature.	Mitigation	Illicit Discharge Detection and Elimination	Low	Public Works Stormwater Quality	\$\$\$	5-10	No
Targeted stormwater outfall program in Northeast Creek watershed. Selected hot spot (<15) outfalls are checked annually. These hot spot outfalls are ones where previous contamination issues have been observed.	Mitigation	Illicit Discharge Detection and Elimination	Low	Public Works Stormwater Quality	\$	0-5	No
Develop a pilot program for conducting proactive investigations during weekdays. Inspect outfalls, business corridors, and apartment complexes during baseflow conditions. Quickly assess field conditions and identify illicit discharges in priority catchments.	Mitigation	Illicit Discharge Detection and Elimination	Low	Public Works Stormwater Quality	\$	0-5	No
Add, update, and maintain dog waste stations at City parks and add signs for reporting violations of the County dog waste ordinance.	Prevention	Pollution Prevention/Good Housekeeping for Municipal Operations	Low-Medium	Public Works Stormwater Quality and Watershed Planning, Parks & Recreation	\$	0-5	No
Increase street sweeping frequency in the City.	Mitigation	Pollution Prevention/Good Housekeeping for Municipal Operations	Low-Medium	Public Works Operations Division	\$\$\$\$\$	5-15	No
Educate apartment complexes about proper dog waste protocols.	Prevention	Public Education and Outreach	Low	Public Works Stormwater Quality	\$	0-5	No
Incentivize the installation of dog poop digesters and other uses for dog waste on residential properties.	Prevention	Public Participation and Involvement	Low	To be determined	\$\$	5-15	No
Develop a cost-share program to plant tall grass buffers and wetland plants around lakes to keep geese and their waste out of the lakes. Evaluate other solutions such as planting wildflowers.	Prevention	Public Participation and Involvement	Low	City Stormwater Development Review, County Soil & Water	\$\$	5-10	No
Encourage Stormwater Star Businesses to install and maintain dog waste stations.	Prevention	Public Participation and Involvement	Low	Public Works Stormwater Quality	\$	0-5	No

*Estimated Costs: \$\$\$\$ > \$500,000, \$\$\$ = \$50,000 to \$500,000, \$ < \$50,000. Estimated costs consider only the projected costs to the City and County departments.

15. Appendix B: Summary Table of Measures Not Included in the TMDL Response Plan

Table 7. Measures considered and not currently feasible for implementation in the Northeast Creek TMDL Response Plan

Proposed Measure	Type of Measure	NPDES Minimum Measure	Estimated Impact on Reducing Fecal Coliform Bacteria	Group(s) Responsible for Measure Implementation	Estimated Cost to Implement Measure	Implementation Timeline (years)
Coordinate sanitary sewer high priority line inspection schedule with outfall screening to optimize surveys. Reduce overlapping surveys and space out the timing of inspections.	Mitigation	Illicit Discharge Detection and Elimination	Low	Public Works Stormwater Quality, Water Management - Water & Sewer	\$	0-5
Identify and inspect all private sewer pump stations (permitted and non-permitted) and conduct enforcement for discharges.	Mitigation	Illicit Discharge Detection and Elimination	High	Water Management -Water & Sewer, NCDWR, Public Works Stormwater Quality	\$	5-10
Create a weekend answering service for the Stormwater Pollution Hotline (560-SWIM), or designate staff to be on-call to answer or check the Stormwater Pollution Hotline.	Mitigation	Illicit Discharge Detection and Elimination	Low-Medium	Public Works Stormwater Quality	\$\$	0-5
Identify sewer rehabilitation priority areas based on routine inspection and fix failing sewer lines.	Mitigation	N/A	Low	Water Management -Water & Sewer	\$\$\$	5-10
Implement a voluntary cost-share program for septic pump-outs to keep systems maintained and prevent discharges.	Prevention	N/A	Low	County Environmental Health	\$\$\$	0-5
Require inspection of private septic systems at the time of property sale or transfer. Require connection to the sewer system when one or more conditions are triggered.	Prevention	N/A	Medium	County Environmental Health	\$	5-10
Install infiltration or biofilter swales along roadside ditches for fecal coliform bacteria removal.	Mitigation	N/A	Medium	NCDOT, Public Works Operations Division, Public Works Stormwater Development Review	\$\$ - \$\$\$	5-10
Keep materials on every Water Management truck to prevent sewage from entering the City's stormwater drainage system.	Prevention	Pollution Prevention/Good Housekeeping for Municipal Operations	Low	Water Management - Water & Sewer	\$	0-5
Increase the use of SCMs that allow natural UV disinfection for new and existing development [i.e., wetlands].	Mitigation	Post-Construction Stormwater Management	Medium	Public Works Stormwater Development Review	\$\$-\$\$\$	5-10
Require Dog Park specifications for SCMs or other bacteria reduction measures to address fecal coliform bacteria issues.	Mitigation	Post-Construction Stormwater Management	Medium-High	City-County Planning, Public Works Stormwater Development Review, Parks & Recreation	\$\$	0-5
Place kiosks at vets and pet stores for dog waste education with a focus on how to handle backyard dog waste.	Prevention	Public Education and Outreach	Low	Public Works Stormwater Quality	\$	0-5

Table 7. Measures considered and not currently feasible for implementation in the Northeast Creek TMDL Response Plan

Proposed Measure	Type of Measure	NPDES Minimum Measure	Estimated Impact on Reducing Fecal Coliform Bacteria	Group(s) Responsible for Measure Implementation	Estimated Cost to Implement Measure	Implementation Timeline (years)
Add a section to the City's reporting App for dog waste issues in City parks.	Prevention	Public Education and Outreach	Low	Public Works Stormwater Quality, Durham OneCall, Parks & Recreation	\$	0-5
Place signs along trails (near creeks and sewer lines) to raise public awareness about reporting sewage discharges and other sources of fecal coliform bacteria.	Mitigation	Public Education and Outreach	Low-Medium	Public Works Watershed Planning, Trail Advisory Group, Water Management	\$	0-5
Develop a Dog Park Poop Patrol program with volunteers from the Durham community.	Prevention	Public Participation and Involvement	Low-Medium	Public Works Stormwater Quality and Watershed Planning, Parks & Recreation	\$	5-10

*Estimated Costs: \$\$\$ > \$500,000, \$\$ = \$50,000 to \$500,000, \$ < \$50,000. Estimated costs consider only the projected costs to the City and County departments.

16. Appendix C: Measures of Incremental Progress

Implementation of any one measure may not directly impact concentrations of fecal coliform bacteria in Northeast Creek. Implementing a combination of measures may reduce fecal coliform bacteria levels much more. The following table lists the incremental progress that will be tracked for this TMDL Response Plan. This tracking is in addition to any tracking performed through the monitoring program.

Table 8 Preliminary list of incremental progress

TMDL Response Plan Metric	Metric Reporting	Reporting Frequency
<u>Human Sources</u>		
Single-family on-site wastewater systems inspected	Count	Annually
Multi-family on-site wastewater systems inspected	Count	Annually
Number of family on-site wastewater systems referred to DWR	Count	Annually
Number of failed wastewater systems identified (septic or sand filter)	Count	Annually
Number of new connections to sanitary sewer	Count	Annually
Number of property owners seeking funding assistance to connect to city sewer	Count	Annually
Number of sanitary sewer overflows, sanitary sewer breaks, or sewer lateral discharges	One Count/all three (reported in NPDES annual report)	Annually
Volume of sewage discharged from public sanitary sewer overflows	Count	Annually
<u>Domestic Animal Waste</u>		
Number of private dog parks.	Count	Every three-five years
Number of dog kennels	Count	Every three-five years
Requirement for pet waste receptacles implemented in Comprehensive Plan or UDO	Yes/No	N/A
Number of Limited Agriculture Permits issued to residents keeping domestic chickens located within Northeast Creek	Count	Every three-five years
<u>Wild Animal Waste</u>		
Guidance for managing Canada Geese at ponds and on grounds	Count of guidance materials distributed to HOAs	Annually
Other	To be determined	To be determined
<u>Educational Material Tracking</u>		
To be determined based on outreach programs that are developed	To be determined	To be determined