2019

Little River Watershed In-Stream Wetland

Project Final Report

Albemarle Resource Conservation & Development Council

1/15/2019

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The Albemarle Resource Conservation and Development Council (ARC&D) gratefully acknowledges the **EPA Section 319 Grant** for the Little River Watershed In-Stream Wetland Project. The grant was a catalyst for strengthening our partnership to restore and protect water quality in the watershed.

The ARC&D gratefully acknowledges the support of the project's partners:

Wade Boyce, Participating Farmer
Steve Harris, Participating Farmer on the CWMTF/USFWS In-stream Wetland Project
Nina Needham, Participating Farmer on EPA 319 Little River Watershed In-Stream Wetland Phase II
Dwane Hinson, Water Management Consultant
Albemarle Commission
Perquimans Soil and Water Conservation District
Pasquotank Soil and Water Conservation District
Perquimans County
Pasquotank County
Frank Heath, Perquimans County Manager
Rodney Bunch, Pasquotank County Manager, Retired
Sparty Hammett, Pasquotank County Manager
Scott Alons, Perquimans Soil and Water Conservation District Technician, Retired
Dr. Mike Burchell, NC State University Department of Biological and Agricultural Engineering
Brock Kamrath, Ph.D Student, NC State University Department of Biological and Agricultural Engineering
Rodney Saunders, Saunders and Sons Excavating
Rodney Johnson, Albemarle RC&D Council Member and Resident of the Little River Watershed
Green $aves Green Group

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Executive Summary

The Albemarle Resource Conservation and Development Council, Albemarle Commission, Perquimans and Pasquotank Counties, Soil and Water Conservation Districts (SWCD), universities, local community groups, and state and federal agencies are working together to restore the Little River watershed, which includes eight miles of impaired river in Perquimans and Pasquotank Counties. The 86,000 acre Little River watershed was once rich in biodiversity with key anadromous fish and shellfish areas, and swamp forests critical to support native fish and wildlife, mitigate flooding, and protect water quality.

Agricultural operations have opened drainage canals that directly carry sediments and nutrients to the river, and residential and commercial developments have increased pollution from stormwater runoff. Swamp forest buffers have been eliminated or severely degraded in many locations along the river.

Most of the canals that flow into the Little River are on private lands, and constructing in-stream wetlands along these privately owned canals is critical for effectively managing stormwater in the watershed. The 2,000 ft. in-stream wetland on the Wade Boyce farm filters nutrients and sediment from a 600-acre watershed with a direct outlet to the Little River. The in-stream wetland also has helped stabilize the watershed drainage system and make it more resilient to major storm events, such as Hurricane Matthew in late 2016.

The purpose of the EPA 319 – funded in-stream wetland project on the Boyce farm was to help restore the health and integrity of the Little River watershed.

The goals of the project were:

- Develop and demonstrate on privately-owned canals a practical and effective stormwater system for improving water quality at a watershed scale
- Develop practical and useful communication tools for public outreach and education
- Create a practical framework for restoring similar watersheds in eastern North Carolina.

The deliverables of the project were:

- Construct two acres of in-stream wetlands and water control structures on a main drainage canal on privately owned agricultural lands
- Monitor and evaluate water quality improvements
- Communicate the impacts and broad application of the project through field days, publications, project partners, and web sites.

A graduate student in the Department of Biological and Agricultural Engineering at NC State University collected water quality data from the in-stream wetland over an 18-month period. The study was conducted in three phases, a concentration analysis pre-vegetation establishment, a concentration analysis post-vegetation establishment, and a load analysis with established vegetation. From these results, it was observed that TN was exported, while TP and TSS were removed from the water column by the ISW, albeit at lower percent reductions (-3%, 15%, 47%, respectively) than those observed in the concentration analysis. The magnitude of TN export by the ISW was 1.7-kg or 0.02-kg/day of TN. When broken down by nitrogen species, NO3-N was removed through the system (1.8-kg or 32%), but this removal was offset by discharges of ON and NH4-N. It should be noted that the N concentrations and the loads delivered to the ISW were lower than is often observed in the Middle coastal Plain. The magnitude of TP removal was 3.4-kg or 0.04-kg/day of TP and the magnitude of TSS removal was 2750-kg or 30-kg/day during the 13-week load analysis. Removal estimates of nutrient and sediment pollution from the ISW was based primarily on the load reductions during relatively short period (13-weeks during Fall 2017) after only 2 growing seasons post-construction.

The project's lessons learned include:

- Substantial planning and staff time are required from project concept to construction
- In-stream wetland projects are a component of improving whole-farm water management
- Water quality improvement should be implemented at a watershed scale
- Water quality monitoring should be longer than two years to effectively measure the impact of in-stream wetlands under natural conditions.

The Boyce in-stream wetland, and two other in-stream wetlands in the upper watershed are creating a critical mass of Best Management Practices, which are needed to effectively manage stormwater above and along the impaired section of the Little River. The projects also demonstrate how the same stormwater system may be used on privately-owned canals throughout the watershed that flow into the Little River. The impact of agriculture on water quality of the Little River watershed is typical to watersheds in eastern NC, and the in-stream wetland system could be replicated throughout the region.

Project Background

The Albemarle Resource Conservation and Development Council (ARCD), Albemarle Commission, Perquimans and Pasquotank Counties, Soil and Water Conservation Districts (SWCD), universities, local community groups, and state and federal agencies are working together to restore the Little River watershed (Pasquotank River Basin, HU-10), which includes eight miles of impaired river (2012, 2014, 2016, 303d list) in Perquimans and Pasquotank Counties. The 86,000 acre Little River watershed was once rich in biodiversity with key anadromous fish and shellfish areas, and swamp forests critical to support native fish and wildlife, mitigate flooding, and protect water quality. Unique characteristics of the watershed as defined by the *NC Biodiversity Wildlife Habitat Assessment* and other sources include:

- Approximately 5,300 acres of Strategic Habitat Area.
- Approximately 2,500 acres and 17,000 acres of Exceptional and Substantial wetlands, respectively.
- Approximately 7.5 square miles of Critical anadromous fish spawning areas.
- Submerged Aquatic Vegetation along the Albemarle Sound (433 acres Patchy and 107 acres Dense)
- Nine animal, plant and natural communities identified by the NC Natural Heritage Program.
- Shortnose and Atlantic Sturgeon on the Endangered Species list, Grassleaf Arrowhead on the Federal Species of Concern list, and Bald Eagles under the Bald and Golden Eagle Protection Act.

The unique characteristics of the watershed are mapped in **Figure 1**.

Agricultural operations and residential and commercial development have significantly impacted water quality and fisheries in the Little River watershed. Agricultural operations have opened drainage canals that directly carry sediments and nutrients to the river, and residential and commercial developments have increased pollution from stormwater runoff. Swamp forest buffers have been eliminated or severely degraded in many locations along the river. As a result, the upper and lower sections of the Little River have been included at different times on the 303(d) list of impaired waters, beginning in 1998 with the upper section of the river from its source to Halls Creek (12 mi.) for low Dissolved Oxygen (DO). In 2012 and 2014, a section of the Little River from SR 1225 to Halls Creek (approx. 8 miles), was listed as impaired in the aquatic life category. Over the course of a five-year assessment period, nearly 11 percent of samples were above the water quality standard for Chlorophyll *a* indicating nutrient enrichment in this segment of the river. The same 8-mile section of river is on the 2016 list of impaired waters.

Most of the canals that flow into the Little River are on private lands, and constructing in-stream wetlands along these privately owned canals is critical for effectively managing stormwater in the watershed. In 2016, the ARCD, Pasquotank County, and Pasquotank SWCD used grants from the Clean Water Management Trust Fund (CWMTF) and US Fish and Wildlife Service (USFWS) to construct 4,800 ft. of instream wetland on a privately-owned canal in the upper part of the watershed. At the same time, the ARCD, Perquimans County, and Perquimans SWCD used this EPA 319 grant to construct 2,000 ft. of in-stream wetland on the Wade Boyce farm, which is just above the impaired section of the Little River. A second EPA 319-funded in-stream wetland was constructed in 2018 along 2,000 ft. of privately-owned canal that drains approximately 3,200 acres of agricultural land and solar farms on the Pasquotank County side of the watershed.

The 2,000 ft. in-stream wetland on the Boyce farm filters nutrients and sediment from a 600-acre watershed with a direct outlet to the Little River (**Figure 2**). Design and construction included the following components:

- Reconfiguration and improvement of the ditch channel
- Stabilization of the side banks
- Installation of rock weirs to hold water for native wetland plants
- Installation of J-hooks at curves to prevent soil erosion
- Fine grading adjacent cropland
- Installation of rock drop structures to funnel stormwater from adjacent cropland
- Installation of controlled drainage tile systems
- Establishment of 50 ft. grass buffers on each side of the in-stream wetland.

The construction designs and specifications are included as an attachment to this report. The in-stream wetland has helped stabilize the watershed drainage system and make it more resilient to major storm events, such as Hurricane Matthew in late 2016.

These in-stream wetland projects are creating a critical mass of Best Management Practices (BMP), which are needed to effectively manage stormwater above and along the impaired section of the Little River (**Figure 3**). The projects also demonstrate how the same stormwater system may be used on privately-owned canals throughout the watershed that flow into the Little River (**Figure 4**). The impact of agriculture on water quality of the Little River watershed is typical to watersheds in eastern NC, and the in-stream wetland system could be replicated throughout the region.

Photos of EPA 319 Boyce farm pre-and post-in-stream wetland project are provided in **Figures 5-8**. Photos of the CWMTF-USFWS in-stream wetland project on the Steve Harris tract are provided in **Figure 9.** Pre-and post-construction photos of the EPA 319 Phase II in-stream wetland on the Nina Needham tract are provided in **Figures 10-11**.

The in-stream wetlands are a component of a broader effort to restore the Little River watershed following state and local recommendations, and public participation. With a grant from Clean Water Act 205j program, the Albemarle Commission and ARC&D collaborated in 2014 and 2015 with Perquimans and Pasquotank Counties, universities, local community groups, and state and federal agencies to develop a long-range watershed restoration plan. Key activities identified in the plan include the construction of in-stream wetlands, establishment of riparian buffers, access improvements, and public education and awareness.

Purpose, goals, and objectives

The purpose of the EPA 319 – funded in-stream wetland project on the Boyce farm was to help restore the health and integrity of the Little River watershed.
The goals of the project were:

- Develop and demonstrate on privately-owned canals a practical and effective stormwater system for improving water quality at a watershed scale
- Develop practical and useful communication tools for public outreach and education
- Create a practical framework for restoring similar watersheds in eastern North Carolina.

The objectives of the project were:

- Construct two acres of in-stream wetlands and water control structures on a main drainage canal on privately owned agricultural lands
- Monitor and evaluate water quality improvements
- Communicate the impacts and broad application of the project through field days, publications, project partners, and web sites.

Project Successes

In-stream wetlands are one component of improving farm water management.
The project developed a model for working with private landowners to construct in-stream wetlands on main agricultural drainage canals in the Little River watershed. The landowner on this project, Wade Boyce, was concerned about how much cropland he was going to have to set aside for the project including the in-stream wetland and buffers on each side. The project design included improvements to drainage and water management on his adjacent cropland, which helped convince him that he was going to get better crop production even though he had to give up some cropland for the project. The instream wetland became an integral component of his overall effort to improve drainage and water management on his cropland. The in-stream wetland design and photos of construction are attached to this report.

Straightforward conservation agreement. The project helped develop a model conservation agreement that does not overburden landowners with technical and legal language, but that does provide enough structure to ensure the terms of agreement are legally binding. The agreement, between Wade Boyce and the Perquimans SWCD, includes a 10-year conservation period for the wetland and buffer. The SWCD manages the conservation agreement and the project is included it in its Spot Check program. The same conservation agreement was used on two other in-stream wetland projects in the Little River watershed. The signed conservation agreement between Perquimans SWCD and Wade Boyce is attached to this final report.

Increased public awareness for conservation professionals and the general public. The project held a field day April 26th, 2017 for 26 conservation professionals and farmers. Dwane Hinson gave an overview of the Little River watershed and the EPA 319 and CWMTF-USFWS in-stream wetland projects before heading to the field. Stops included the instream wetland on the Wade Boyce farm, and the CWMTF/USFWS in-stream wetland on the Steve Harris farm. Mike Burchell of NCSU provided information on water quality monitoring. Information on the field day was included in the 7th project report. The signage developed for public awareness is attached to this report

Dr. Mike Burchell and Brock Kamrath, MS student in the NCSU Department of Biological and Agricultural Engineering presented preliminary water quality monitoring results from the Boyce and Harris in-stream wetlands at the WRRI conference in March 2018. Their PowerPoint presentation was included in the 11th project report.

The ARC&D worked with volunteers in the Green $aves Green group to organize the first Green $aves Green Expo at the Museum of the Albemarle in Elizabeth City in March, 2018. Approximately 1,600 people attended the event with 60 sponsors and vendors. Mark Powell had a table with information about the EPA 319 in-stream wetland project, and the partnership to protect and improve water quality in the Little River watershed. The poster display is attached to this report. Three van tours carried 80 people to see the Amazon Wind Farm, and the in-stream wetland projects in the watershed. Mark Powell gave each tour group a summary of how the in-stream wetlands are helping protect and improve water quality in the watershed. Participants had many questions about how poor water quality is related to the algal blooms that have returned to Albemarle waters after an absence of 30-35 years. The extensive and persistent algal blooms in the Little River and Dance's Bay in 2017 were the first blooms that long-time residents had ever experienced.

Increased public awareness of water quality issues in the Little River watershed, including the link to algal blooms, helped stimulate a group of local residents to begin a citizen scientist initiative to monitor water quality. In the summer of 2018, the citizen scientists collected monthly water samples from seven locations on the Little River from the top of the watershed to Dance's Bay in the lower part of the watershed. The group sent the samples to the NCDA lab for analysis of Organic N and Total P, which per DEQ data collected at its river monitoring station on old US17, have been increasing over the past 20 and 35 years, respectively. The objective of this work is to help identify where these nutrients are coming into the river, and then work back to help identify and address the sources. This work is funded through the CWMTF/USFWS in-stream wetland project, and was reported as match on this project. A detailed description of the Little River monitoring plan was included in the 12th project report.

Developed strong local partnerships and support for watershed projects. The project developed strong partnerships with Pasquotank and Perquimans county managers and commissioners, and SWCD supervisors. Dwane Hinson and Mark Powell provided regular updates on the in-stream wetland project in particular, and water quality issues in the Little River watershed, in general. As a result, the counties have increased money each year for water quality activities in the watershed.

Strong partnerships also were developed with progressive farmers Wade Boyce on this project, and Steve Harris on the CWMTF/USFWS funded in-stream wetland project. As a result of these projects, Nina Needham, a landowner on the Pasquotank side of the Little River, contacted Dwane Hinson about constructing an in-stream wetland on a main drainage canal on a property that was previously used to graze cattle. A 2,000 ft. in-stream wetland was constructed in 2018 with funding from EPA 319 and matching funds from the Pasquotank SWCD.

The project also re-established the ARC&D, SWCD and NCSU partnership that collaborated for many years on stormwater wetland projects in northeast N.C., including the Town of Edenton's EPA-Funded wetland on Filbert's Creek, and the stormwater wetlands at Edenton airport and Chowan Golf Club. A map of stormwater wetlands in northeast NC funded by EPA grants, and other grants, is included in **Figure 12**.

On August 25th, 2018 Mark Powell gave a presentation to sixty people in Edenton on the regional partnership to protect and improve water quality including the effort to identify the causes of the algal blooms that have returned to Albemarle waters after an absence of 30-35 years. The presentation also included a description of regional stormwater management projects including the EPA-funded in-stream wetland projects in the Little River watershed. The PowerPoint presentation was included in the 12th project report.

Project Failures

Natural disasters delayed project activities. The heavy rains from the remnants of tropical storm Julia and Hurricane Matthew in the fall of 2016 caused significant erosion along the north bank of the in-stream wetland close to Chapanoke Road. Many wetland plants planted in May 2016 also were washed away. In 2017, a contractor repaired and reinforced with stone the eroded section of side bank. In the spring of 2017, the entire in-stream wetland was replanted. Under normal circumstances, the wetland plants should have been well established by the summer of 2017. However, due to the historic rain events, good stocking of wetland plants was not achieved until the summer of 2018.

The historic rain events in 2016 also impacted NCSU's water quality monitoring program. As a result of the damage to the in-stream wetland, NCSU had to move its monitoring stations at the head and outlet of the wetland. The delay in establishment of wetland plants until the summer of 2018 limited NCSU's time frame for measuring water quality improvements during a period when the in-stream wetland had optimal stocking of wetland plants.

Project Lessons Learned

Substantial planning is required from project concept to construction. In-stream wetland projects on private lands require substantial planning and meetings with landowners. The **first step** is to identify a drainage canal with potential to construct an in-stream wetland. The **second step** is to talk with the landowner about developing such a project. If the landowner is receptive, then the **third step** is to conduct field work to determine the scale and cost of the project. This includes determining the project's construction footprint, activities, and buffer areas. This information is then presented to the landowner for review and comments. Changes may be made to the design based on feedback from the landowner. If the landowner wishes to proceed with the project, the **fourth step** is to look for grant opportunities and matching funds. Substantial ARC&D and SWCD staff time is required to move a project from concept to design and construction.

In-stream wetland projects are a component of whole-farm water management. Landowners are naturally concerned about how much cropland they will have to give up to construct in-stream wetlands. This was the case with Wade Boyce. Dwane Hinson designed his in-stream wetland to improve water quality, and at the same time, to improve drainage and water management on the adjacent cropland. Wade was more receptive to the project, and less concerned about giving up cropland, when he saw that he would be able to increase crop production by improving drainage and water management, and decreasing soil erosion. This same process was used with Steve Harris on his CWMTF/USFWS funded in-stream wetland project, and Nina Needham on her EPA-funded in-stream wetland project.

Water quality improvement should be implemented at a watershed scale.
Most of the canals that flow into the Little River are on private lands, and constructing in-stream wetlands along these privately owned canals is critical for effectively managing stormwater in the watershed. The Wade Boyce, Steve Harris and Nina Needham in-stream wetlands are creating a critical mass of BMPs, which are needed to effectively manage stormwater above and along the impaired section of the Little River. The projects also demonstrate how the same stormwater system may be used on privately-owned canals that flow into the Little River throughout the watershed. The

impact of agriculture on water quality of the Little River watershed is typical to watersheds in eastern NC, and the in-stream wetland system could be replicated throughout the region.

The nine-element restoration plan for the Little River watershed also identified the conservation of swamp forest buffers as a key activity for improving and protecting water quality. Swamp forests in the watershed are critical for storing and filtering stormwater, and providing key habitat for fish and wildlife. These forests are slow growing and there is a lack of information on how recent, large clearcuts of swamp forests with little or no buffers are impacting water temperature and nutrient release into the Little River. In 2016, the ARC&D, Perquimans and Pasquotank SWCD, and Perquimans and Pasquotank county managers and commissioners worked together to develop a program whereby landowners may enroll a minimum 300 ft. buffer of swamp forest in a voluntary conservation agreement. In exchange, landowners receive a grant incentive based on the tax value of the enrolled acreage. Wade Boyce enrolled 20 acres of swamp forest in the conservation program.

Water quality monitoring should be longer than two years to effectively measure the impact of in-stream wetlands. Brock Kamrath monitored wetland performance for approximately 18 months for his MS thesis, and a summary of his research is attached to this report. As mentioned previously, the historic rain events in the fall of 2016 damaged some sections of the in-stream wetland, and as a result, Brock had to move his monitoring stations at the head and outlet of the in-stream wetland.

Many wetland plants planted in May 2016 also were washed away by Hurricane Matthew. In the spring of 2017, most of the wetland was replanted. Under normal circumstances, the wetland plants should have been well established by the summer of 2017. However, good stocking of wetland plants was not achieved until the summer of 2018. The delay in establishment of wetland plants until the summer of 2018 limited NCSU's time frame for measuring water quality improvements during a period when the wetland had optimal stocking of wetland plants. As a result, caution should be used when interpreting the water quality benefits of the wetland based on Brock's study. A longer period of monitoring is needed--four to five years--to effectively measure the water quality benefits of this instream wetland under natural conditions.

Load reduction data

The monitoring report from NC State University Department of Biological and Agricultural Engineering is attached to this report. The study's conclusions are included below.

Conclusions

To remediate the impairment of the Little River, the Albemarle Resource Conservation and Development (RC&D) Council developed a watershed plan to implement multiple linear in-stream wetlands within low order streams and agricultural ditches. This study was then conducted as a pilot study on the first linear wetland constructed. The study was conducted in three phases, a concentration analysis pre-vegetation establishment, a concentration analysis post-vegetation establishment, and a load analysis with established vegetation.

From these results, it was observed that TN was exported, while TP and TSS were removed from the water column by the ISW, albeit at lower percent reductions (-3%, 15%, 47%, respectively) than those observed in the concentration analysis. The magnitude of TN export by the ISW was 1.7-kg or 0.02-kg/day of TN. When broken down by nitrogen species, NO_3-N was removed through the system (1.8-kg or 32%), but this removal was offset by discharges of ON and NH_4-N. It should be noted that the N concentrations and the loads delivered to the ISW were lower than is often observed in the Middle coastal Plain. The magnitude of TP removal was 3.4-kg or 0.04-kg/day of TP and the magnitude of TSS removal was 2750-kg or 30-kg/day during the 13-week load analysis. Removal estimates of nutrient and sediment pollution from the ISW was based primarily on the load reductions during relatively short period (13-weeks during Fall 2017) after only 2 growing seasons post-construction. Additionally. the load analysis possibly underestimated the treatment ability due to a small amount of additional water inputs that were unaccounted for; however, the use of base flow conditions in the load analysis likely also overestimated the actual treatment ability of the ISW when using total flow conditions. Therefore, the estimated treatment ability presented was a fair representation of the overall treatment ability of the ISW at its current age.

Analysis of the data indicated some nutrient and sediment retention, but the treatment abilities of the relatively young linear wetland were limited. Vegetation establishment was likely slowed due to Hurricane Matthew in October of 2016 that required some replanting by ARC&D. In addition to age, several design factors including a high wetland to watershed ratio, low hydraulic retention time, low upstream N concentrations, and additional surface & subsurface drainage water entering the wetland reach reduced its treatment efficiency. Ideally, a linear wetland of the same size built to maximize nutrient removal would have a smaller contributing watershed, nearly complete wetland vegetative coverage, and limited lateral contributions of nutrients along the reach. The ISW should also ideally contain some additional water level control along the length of the ISW and at the outlet to hold retain water at a deeper depth for longer periods, while slowly releasing it downstream following rainfall events.

Monitoring of this linear wetland has provided enough data to indicate that the ISW can provide some level of nutrient and sediment removal, but the magnitude of the removal is still somewhat unclear. The inability of the ISW to remove pollutants to treatment goals proposed by the Albemarle RC&D in their nine-element restoration plan (2015) does not mean that linear wetlands should not be used as part of an overall watershed management plan. ISWs integrated into that plan has both pros and cons that should be considered.

Potential benefits of linear wetlands include:

- Simple to design and construct
- Relatively small footprint constructed mainly in existing ditch infrastructure.
- Increased drainage capacity (wider cross section area of drainage canals)
- Improved bank stability
- Reduced ditch maintenance, saving farmers time and money
- Removal of N, P, and TSS (however the removal efficiency will be variable as a function of incoming load, hydraulic retention time (HRT) and watershed location)
- Since the main channel is mostly left undisturbed during construction, the practice maintains existing and enhances ecological function in the ditch or canal.

Potential disadvantages of linear wetlands include:

- Loss of farmable land (1-3 acres/mi of ditch)
- Increased initial costs associated with earthmoving ($5-20 per ft), but less than stream restoration) and subsurface and surface drainage retrofits in adjacent fields
- Depending on local soil properties, banks may still slump
- If water control is included in the design, farmers may not accept or maintain structures
- Because so few have been built and monitored, they remain unproven. Actual nutrient and sediment retention in these practices are still unclear.

As documented in this report, many questions about ISWs remain, including the range of expected load reductions and what load reductions are needed to justify more widespread use of this practice to improve water quality in the Little River. To answer these questions continued study at this site as it ages, and at other future sites is recommended. If a future project is funded, it should be located and designed with monitoring in mind and include the following elements:

- A control section (i.e., unimproved canal) and a linear wetland section to measure and document head-to head treatment improvements
- Few drainage discharges along canal length, with no discharges being ideal
- Designed with permanent stable cross sections for more accurate flow monitoring, and adjustable weirs to control flow and depth
- Monitoring of lateral and subsurface contributions of water and pollutants.
- Enough funding to monitor the site as it develops (not just year 1).

Further studies will be needed to answer these questions, but based on this study linear wetlands have potential to be an additional tool to improve water quality, particularly in eastern NC.

Final Budget

The final Section 319 project expenses were $85,598. The final non-federal match was $222,967. The final percent of total budget for Section 319 and non-federal match was 28% and 72%, respectively.

Contract Budget								
Budget Categories (itemize all categories)	Section 319			Non-Federal Match *			Contract Total	**Final Expenses Grant & Match**
	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3		
Personnel/Salary	$ 1,000	$ 1,500	$ 500	$ 8,000	$ 4,000	$ -	$ 15,000	**$ 15,000**
Fringe Benefits	$ 250	$ 375	$ 125	$ 2,000	$ 1,000	$ -	$ 3,750	**$ 3,750**
Supplies	$ 1,000	$ 1,000	$ 500	$ -	$ -	$ -	$ 2,500	**$ 1,477**
Equipment	$ 1,500	$ 1,000	$ 500	$ -	$ -	$ -	$ 3,000	**$ 26,235**
Travel	$ -	$ -		$ -	$ -	$ -	$ -	
Contractual	$ 55,000	$ 10,000	$ 8,000	$ -	$ -	$ -	$ 73,000	**$ 73,190**
Other	$ -	$ -	$ -	$ 100,000	$ 76,678	$ -	$ 176,678	**$ 181,317**
Total Direct	$ 58,750	$ 13,875	$ 9,625	$ 110,000	$ 81,678	$ -	$ 273,928	**$ 300,969**
Indirect (max. 10% of direct costs, per 40 CFR 35.268)	$ 5,875	$ 1,388	$ 963	$ -	$ -	$ -	$ 8,225	**$ 7,605**
Annual Totals	$ 64,625	$ 15,263	$ 10,588	$ 110,000	$ 81,678	$ -	$ 282,153	
Grand Total	$ 90,475			$ 191,678			$ 282,153	**$ 308,574**
% of Total Budget	32%			68%			100%	
FINAL GRAND TOTAL	**$ 85,598**			**$ 222,967**				
% OF TOTAL BUDGET	**28%**			**72%**			**100%**	
*Note: Non-Federal match must be a minimum of 40% of the total project budget								

Figure 1. Unique Features of the Little River Watershed.

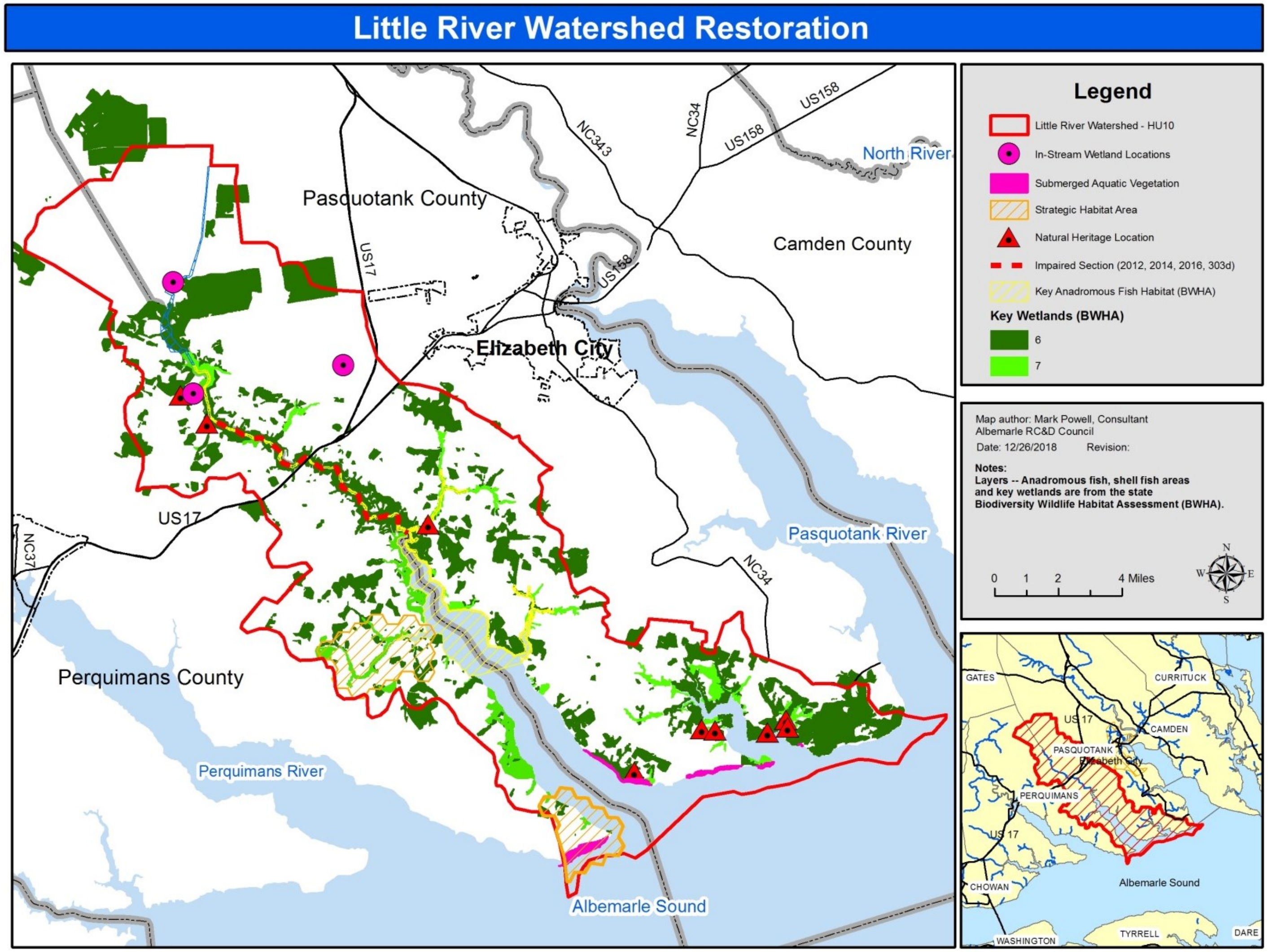

Figure 2. 2,000 ft. In-Stream Wetland on the Wade Boyce Farm.

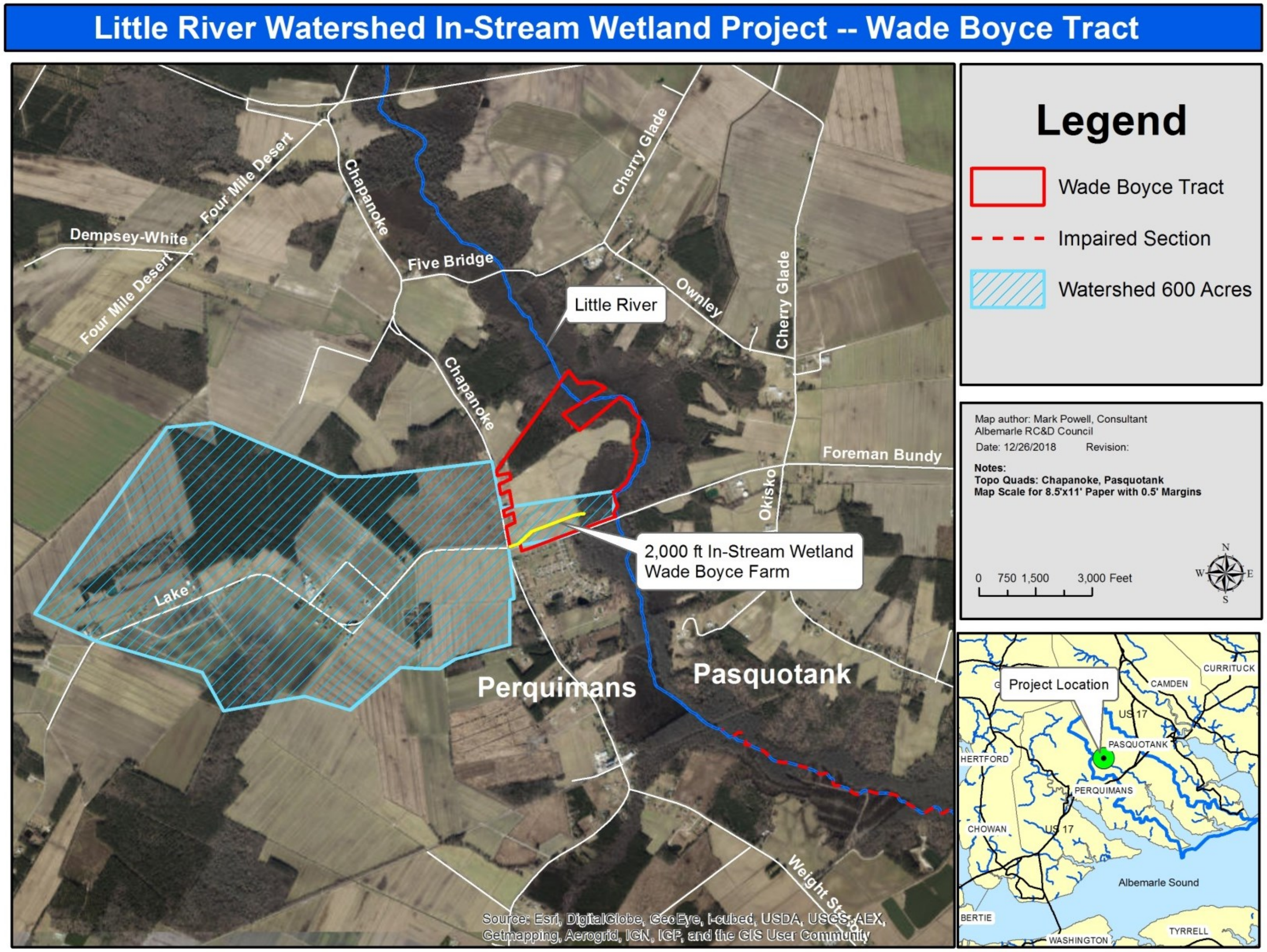

Figure 3. Existing and Proposed In-Stream Wetland Projects in the Upper Little River Watershed.

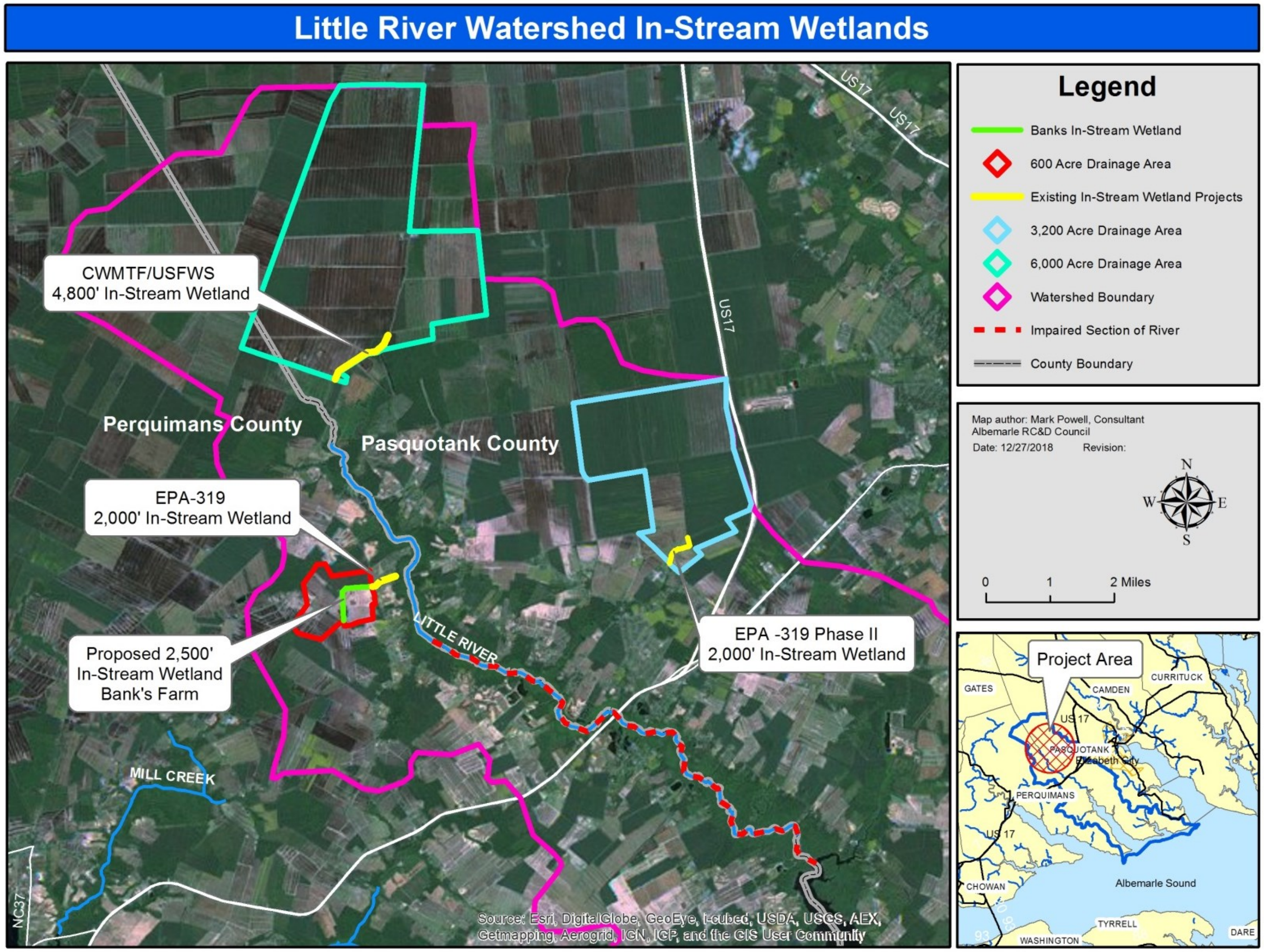

Figure 4. Privately-Owned Canals in the Little River Watershed.

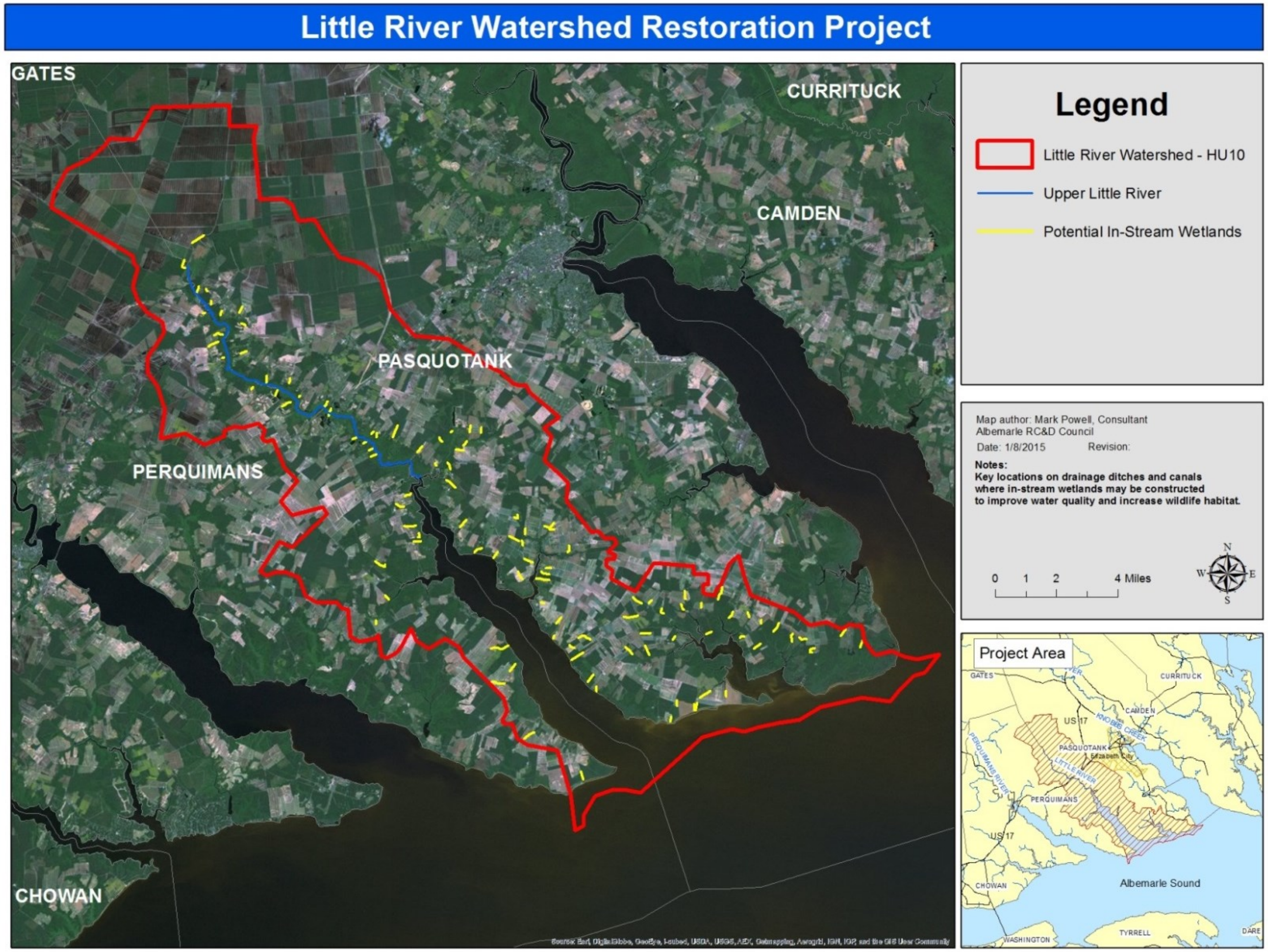

Figure 5. Boyce Tract Drainage Canal Before Project.

The drainage canal before the project had very little buffer and stormwater from cropland drained directly to the canal.

Drainage canal was a major source of sediment and nutrients entering the Little River above the impaired section.

Boyce farm drainage canal 2014 pre-construction. Note the lack of buffers.

Figure 6. Boyce Tract after In-stream Wetland Construction.

Boyce farm in-stream wetland 2017. Note the buffers and rock drop structures, which funnel stormwater from cropland and help prevent side-bank erosion. A rock weir at each rock drop structure stages water for wetland plants.

Boyce farm in-stream wetland after construction in 2016.
Drone image taken by NCSU.

Figure 7. Boyce Farm In-stream Wetland 2016-2017.

Rock weirs were installed along wetland to stage water for native wetland plants.

Stormwater flows from cropland to rock drop structures, and rock weirs stage water for wetland plants.

Wetland plants were planted May 2016, and replanted in May 2017 due to damage from Hurricane Matthew.

Tile lines and water control boxes help the farmer better manage subsurface water on adjacent farmland.

Informational signage at the head of the in-stream wetland

J-hooks were installed at curves of in-stream wetland to prevent erosion of the side banks.

Figure 8. Boyce Farm In-stream Wetland 2017-2018.

Upper in-stream wetland and
50 ft. grass buffers.

Upper in-stream wetland and
50 ft. grass buffers.

Repaired bank at head of in-stream
wetland, damaged by Hurricane Matthew.

Wetland plants were well established by
late 2017.

Lower in-stream wetland with NCSU
monitoring station.

Lower in-stream wetland and
50 ft. grass buffers.

Figure 9. Photos of 4,800 ft. In-stream Wetland on the Steve Harris Farm in the Upper Watershed in Pasquotank County funded by CWMTF and USFWS.

Wetland pockets where drainage ditches run from field into the wetland.

Wetland along 4,800' of main drainage canal with seeded bank and wetland plants along shelf. View looking northeast.

In-stream wetland, view looking northeast.

Informational signage at the head of the in-stream wetland.

Figure 10. Needham Tract Drainage Canal Prior to Construction of In-stream Wetland in 2018 with EPA 319 Grant.

The head of the canal was highly eroded where stormwater enters from cropland.

Drainage canal carries stormwater to the Little River from approximately 3,000 acres of cropland and solar farm.

V-ditches from adjacent farmland carry stormwater directly to the drainage canal.

Stormwater from the adjacent solar flows to the drainage canal.

Figure 11. Needham Tract Drainage Canal after Construction of 2,000 ft. In-stream Wetland in 2018 with EPA 319 Grant.

Side banks have been stabilized. The in-stream wetland bottom elevation is the same as the Little River. Wetland plants will be planted in the Spring of 2019.

Adjacent land was graded to rock drop structures along the in-stream wetland to prevent side bank erosion.

Canal side banks have been stabilized. The in-stream wetland bottom elevation is the same as the Little River.

The in-stream wetland will help filter sediment from cropland above the wetland.

Rock structures help filter sediment from adjacent cropland.

Side banks have been stabilized. The in-stream wetland bottom elevation is the same as the Little River.

Figure 12. Constructed Wetlands in Northeast N.C.