The Cape Fear Water Fund:
A Partnership for Watershed Conservation

Proposal Submitted to the Cape Fear Public Utility Authority
Submitted by The Nature Conservancy

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The Nature Conservancy
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Summary and Goal of Proposal

The Nature Conservancy (TNC) has been working over the past year to develop a water fund partnership to help improve the water quality in the Cape Fear River for the benefit of people and nature. This water fund would be a long term financial partnership to protect the valuable waters of the Cape Fear, focusing first and foremost on the lower portion of the river particularly in the vicinity of Lock and Dams 1 and 2. This area was selected because of its importance to recreation, fisheries, and drinking water. Unfortunately this stretch of the river has also been recently subjected to harmful algae blooms that threaten the sustainability of this resource. TNC is hoping to launch this partnership in collaboration with the Cape Fear Public Utility Authority (CFPUA), Brunswick County Public Utilities, and Pender County Utilities, with the aim of growing the partnership over time. It is anticipated that the water fund will officially launch in 2014.

Included in this proposal is a summary of the achievements TNC has made to date in modelling and understanding the Cape Fear River Watershed, as well as budget proposals for how the partnership can form and move forward together productively. The three budget proposals are examples. As the budgets indicate, TNC's foremost priority is to develop a more precise and refined understanding of the watershed, as this will enable us to develop the most robust and cost effective investments for the water fund partnership to fund in Year 2 and beyond.

TNC's goal over the last year has been to provide a watershed model to help understand the sources of nutrients in the river and narrow the focus of future studies (both geographically and what types of analyses need to be completed). We used a model called InVEST (Integrated Valuation of Environmental Services and Tradeoffs) to generate an understanding of how the watershed functions relative to non-point source nutrient pollutants (specifically nitrogen and phosphorus). We then expanded this model to include point source discharge data to better understand the magnitude of the contributions from a variety of sources. From these results, we were able to prioritize investments for year 1 of the water fund partnership and create a vision for implementation of solutions in years 2 and beyond.

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Introduction

The Nature Conservancy proposes a water fund partnership in the Cape Fear River with a goal of reducing nutrient loading into the basin, through investments in watershed conservation and other major nutrient sources, such as urban runoff and point source dischargers. The water fund will provide a sustainable finance source governed by a multi-stakeholder coalition to achieve these goals and improve water quality at a scale that has an impact on drinking water quality.

The Cape Fear River forms from the confluence of the Haw and Deep Rivers just below Jordan Lake in the piedmont of North Carolina. The river itself runs for over 200 miles, emptying in the Atlantic Ocean near Southport, NC. The river is unique for many reasons, one of which is that its watershed is enormous (17% of the state's total land base) and includes portions of the Piedmont Triad, Triangle, Fayetteville and Wilmington. Most of these cities obtain their drinking water from the basin. Other unique attributes are that the entire basin is located within NC, which is uncommon for a river this size, and it is the only river in the state that flows directly into the ocean (all others flow into sounds). From a conservation perspective, the riverine system provides habitat for endangered, rare and threatened species including anadromous fishes like striped bass, Atlantic sturgeon, American shad and herring, all historic cultural fisheries. These species spend the majority of their lives in the ocean and move up the Cape Fear River into the piedmont to find the rocky substrate where they lay their eggs. The importance of the Cape Fear River to both the natural world and to many sectors of the human community, cannot be overstated.

The Nature Conservancy

The Nature Conservancy is a 501(c) (3) nonprofit conservation organization whose mission is to conserve the lands and waters on which all life depends. The organization achieves this mission through the dedicated efforts of a diverse staff, including more than 550 scientists, located in all 50 U.S. states and 33 countries. The work is further augmented with the help of many partners, from individuals and governments to local nonprofits and corporations. Finally, the Conservancy realizes its mission by using a non-confrontational, collaborative approach. That's how The Nature Conservancy has done more than any other non-profit to advance conservation around the world since our founding in 1951.

TNC's Work in the Cape Fear River Basin

The Nature Conservancy has been active in the Cape Fear Basin since acquiring the Green Swamp Preserve from Federal Paper Board in 1977. Since then, the Conservancy's strategy of forest protection has been prolific, with the majority of success deriving from unique partnerships that have leveraged resources and strategies. Formal collaborations with the United States Department of the Army (Fort Bragg), the United States Department of the Navy (Camp Lejeune), the State of North Carolina (State Parks, Wildlife Resources Commission), and private landowners have allowed the Conservancy to move forward in achieving its mission of protecting the lands and waters on which all life depends. This experience in the basin has laid the foundation for developing strategies specific to freshwater conservation, which has evolved into the Cape Fear Water Fund concept.

Algae Blooms in the Cape Fear & Their Impacts on Water Quality

The Cape Fear River has relatively significant nutrient and other pollutant problems. With more than 2 million people living in the Cape Fear Basin and 203 permitted industrial and municipal wastewater dischargers,[1] urbanization and population pressures are increasing as are other land uses such as

[1] NCDENR (North Carolina Department of Environment and Natural Resources). 2012. Basinwide Information Management System (BIMS). Accessed June 2012.

agriculture that have the potential to impact water quality. Between 1995 and 2006, parts of the lower Cape Fear Basin experienced statistically significant and increasing trends in ammonium concentrations ranging from a 100% increase in the main stem to a 300% increase in the Northeast Cape Fear River[2]. Agricultural nutrient sources also affect the Cape Fear River's water quality. Approximately 23% of the land use in the basin is devoted to agriculture and livestock production (Xian and Homer 2010)[3] that is dominated by swine and poultry operations[4].

From 2009 to 2012, the Cape Fear River has been host to unprecedented cyanobacterial blooms consisting primarily but not exclusively of *Microcystis aeruginosa.* These bacteria are known to lead to fish kills and human health problems. They have occurred mostly in the summer, mainly just above Lock and Dam 1[5]. This particular species is known to produce toxins[6]; toxins have occurred in at least some of the blooms in the basin. Specifically, two hepatotoxins—microcystin LR and microcystin RR—were isolated by University of North Carolina Wilmington in 2010[7]. Microalgal toxins directly damage fish by altering the functions of their internal organs and also affect the prey fish consume[8]. These toxins are also harmful to humans, causing in the best case scenario, gastrointestinal discomfort. Adding more metals or chemical contaminants to the Cape Fear River Basin, including waste products from industrial facilities and agricultural land use, can impact the entire food chain in the basin including impacting the quality of water for drinking.

Based on TNC's long history of success with the water fund model around the world, and building on the many years of experience around the United States in source water protection projects, we propose building a Cape Fear Water Fund to help improve the water quality in the Cape Fear Basin and restore it to being a healthy river for recreation, for drinking, and for nature.

Economic Benefits of a Water Fund

Many components of the water treatment process including chemicals, treatment capital facilities, staff time, electricity, and sludge removal relate directly to the quality of raw water to be treated. There are numerous cases where individual communities report reaping huge benefits over time by investing in watershed protection efforts. There are also multi-utility studies that have shown aggregate long-term benefits for specific water improvements or the adverse financial impacts of dealing with water of poor quality. For example, an analysis of data and past studies within the Neuse River Basin found that a 30% improvement in raw water quality would lead to a savings of between $2.6 and $16.7 million over 30

[2] Burkholder, J.M., et al. 2006. Comprehensive trend analysis of nutrients and related variables in a large eutrophic estuary: A decadal study of anthropogenic and climatic influences. Limnology and Oceanography 51:463-487.

[3] Xian, G., and Homer C. 2010. Updating the 2001 National Land Cover Database impervious surface products to 2006 using Landsat imagery change detection methods. Remote Sensing of Environment, 114:1676-1686.

[4] CFRP (Cape Fear River Partnership). 2013. Cape Fear River Basin Action Plan for Migratory Fish. http://www.habitat.noaa.gov/protection/capefear/pdf/CapeFearActionPlan.pdf

[5] NCDWQ. 2011. Algal Assemblage Assessments in the Cape Fear River in 2010. North Carolina Division of Water Quality, Environmental Science Section, Raleigh, NC; December 2011.

[6] Burkholder. J.M. 2002. Cyanobacteria. In "Encyclopedia of Environmental Microbiology" (G. Bitton, Ed.),952-982, pp. Wiley Publishers, NY.

[7] Isaacs, J.D. 2011. Chemical Investigations of the Metabolites of two strains of Toxic Cyanobacteria. Master's thesis. University of North Carolina Wilmington, Wilmington, N.C.

[8] See "5"

years across the entire region. [9] There have been other cases that have documented significant benefits from investing in nature and conservation as opposed to more infrastructure-based solutions. For example in Oregon, Clean Water Services (CWS), a wastewater treatment plant, had to meet new thermal requirements for wastewater. They had the option to spend $60-150 million of capital costs, excluding operation and maintenance costs, on a new refrigeration facility, needed to reduce the water temperature as dictated by the new regulations, or they could invest in reforestation of agricultural lands along the river, essentially creating a forested riparian buffer. By investing in reforesting riparian buffers CWS saved between $55-146 million over 8 years and met the standards they needed to meet[10].

Rather than focusing on the piecemeal benefits of incremental improvements, many utilities justify their overall modest watershed investments in terms of protecting their investments and reducing risk. Not every utility investment can clearly be tracked to a dollar saved – some investments are done to reduce risk, improve service, or provide external benefits. In most cases, watershed investments are a fraction of the costs that utilities spend on pipes and plants. The City of Raleigh invests approximately $1.5 million dollars each year in acquiring critical land in the Falls Lake Watershed. This promises benefits to both water quality as well as recreation and wildlife, among others, though precise measurements of any of these benefits are still in progress.

Examples of direct budget expenditures by water utilities impacted by raw water quality include:

<u>Chemical Costs.</u> The specific relationship between chemical costs and raw water quality are highly dependent on the facility's water treatment process. The two facilities that treat the vast majority of water from the Cape Fear River, Brunswick County's Northwest Water Treatment Plant and Cape Fear Public Utility Authority's Sweeney Plant employ different processes. Some specific examples of chemicals that are influenced by water quality include:

Activated Carbon. This is used by water treatment plants to eliminate the taste and odor problems associated with algae blooms and other issues. Brunswick County's Northwest Water Treatment Plant uses activated carbon to manage the adverse impacts of algae blooms. Activated carbon is expensive and according to the Plant Superintendent represents the biggest opportunity for cost savings if raw water quality can be improved.[11]

Chlorine Dioxide. An oxidant used by some plants, including the Brunswick NW plant, to address color, taste, and odor issues on a recurring basis. Increased pollutants require an increased dosage.

Aluminum Sulfate. Alum is used to settle out turbidity in raw water and as turbidity increases, water treatment operators will increase the amount of alum added to water.

<u>Sludge Disposal.</u> Water treatment plants generate solid wastes (sludge). The amount of sludge can be influenced by water quality and chemical additions. For example, adding activated carbon increases sludge and sludge disposal costs.

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[9] Elsin, Y. K., Kramer, R. A., & Jenkins, W. A. (2010). Valuing Drinking Water Provision as an Ecosystem Service in the Neuse River Basin. Journal of Water Resources Planning and Management, 136(4), 474–482. doi:10.1061/(ASCE)WR.1943-5452.0000058

[10] CWS. (2005). Healthy Streams Plan (pp. 59). Hillsboro, Oregon: Clean Water Services.

[11] Personal communications with Glenn Walker, Brunswick County Water Resources Superintendent.

Water. Some treatment processes require treated water and as water quality deteriorates, more treated water must be used for treatment purposes. For example, Brunswick County uses 35 gallons a minute of treated water to introduce activated carbon into raw water. Over a 24 hour period, that is equivalent to 50,000 gallons of water.

Labor costs. Staff are often diverted from other important tasks when water quality issues arise.

Electricity Costs. Increased chemical use increases the use of energy resulting in higher electricity bills. The production of ozone from liquid oxygen is more electricity intensive, and ozone facilities such as CFPUA will see more significant electricity costs as ozone concentrations are increased, even if relatively modest.

Estimating Cost Savings for Utilities from Water Fund Investments

The overarching goal of the water fund is to develop a set of strategic conservation actions that will reduce nutrient loading into the basin. As mentioned above, there are a number of benefits to utilities from decreases of nutrient loads entering the treatment plant. Estimating exact savings depends on the facility and their technology. As such, there are a variety of ways we can estimate potential cost savings from improving the quality of water and reducing the nutrients in the basin.

An indirect way to estimate potential benefits from reducing nutrients is to look at research that has been done on wastewater treatment. Research done by the US Environmental Protection Agency (EPA)[12] provides estimates of the cost of nitrogen and phosphorus removal from waste water (costs are estimated based on requirements to lower discharge levels to a particular level). The amount of nitrogen and phosphorus in waste water is directly impacted by the amount of these nutrients in the raw water. From a wide range of studies, EPA estimates that just Operation and Maintenance costs for removal (which included electricity, labor, and chemicals like alum for phosphorus and methanol for nitrogen) range from:

1) $0.23-$1.81 per pound of Total Phosphorus
2) $0.14-$0.99 per pound of Total Nitrogen

Two examples illustrate potential cost savings (just in O&M – not including any capital cost savings) from nutrient reductions based on costs of nutrient removal to a particular level in the wastewater.

1) In Johnston County, NC – in one year it was estimated that the plant removed 69,900 lbs of phosphorus and 619,000 lbs of total nitrogen. This equaled a combined cost of over $400,000.
2) In Cary, NC – in one year it was estimated that the plant removed 156,000 lbs of phosphorus and 1,121,000 lbs of total nitrogen. This equaled a combined cost of about half a million dollars.

The goal of the water fund is to reduce the levels of nitrogen and phosphorus entering the treatment plant by investing in watershed conservation which ultimately could be less expensive and more sustainable than continual O&M costs to otherwise treat the water. Additionally, in the above examples only O&M expenditures, not capital expenditures, were included.

[12] See Kang, S.J; K. Olmstead; K. Takacs; and J. Collins. 2008. Municipal Nutrient Removal Technologies Reference Document. Prepared by Tetra Tech, Inc under U.S. Environmental Protection Agency Contract EP-C-05-46. Download: www.epa.gov/owm

Another example of how cost savings can accrue from the water fund is specific to the increasing presence of algae blooms. This affects Brunswick County and Pender County in particular as these treatment plants do not use ozonation technology. Here Brunswick's Northwest treatment plant is used to illustrate potential cost savings, as this is the most significant and measurable short term expenditure impact. There is clear evidence that algal blooms have caused Brunswick County to incur significant expenditures over the last few years and are likely to continue to pose a problem in the future. While the abundant rains of 2013 appeared to have contributed to reducing algal blooms, in 2012, the river experienced multiple blooms. Once elevated levels of blue green algae cells are detected by the plant operators, they take steps to introduce powdered activated carbon at the plant. This material reduces the taste and odor problems but leads to increased chemical costs, electricity costs, sludge management costs, and labor costs. Operators estimate that the last major bloom in the summer of 2012 lasted 50 days and cost approximately $40-50,000. There were two other events that year with slightly less cost impacts. In consultation with the plant superintendent, a financial impact model was created that suggests moderate algal blooms will cost the county approximately $800 to $1,300 per day (see Appendix A for the financial model).

For CFPUA, the two primary expenditures linked to water quality (chemical purchases and electricity) represent significant annual outlays ($1 million budgeted for chemical costs and just under a $1 million for electricity in 2014). Even relatively modest reductions in these inputs due to water quality improvements would translate to significant annual savings.

Science as a Starting Point for Action

Given the dominance of agriculture in the Cape Fear Basin and the clear issues with high nutrient (nitrogen and phosphorus) loads as seen in the manifestation of algae blooms, TNC decided to spatially model non-point source nutrient inputs. To do this, a model, called InVEST, was used that was designed and developed by The Natural Capital Project -- a partnership between TNC, World Wildlife Fund, Stanford University, and the University of Minnesota. The goal was to use a model that could be built in-house with limited time and resources that would provide a general sense of watershed function. The purpose was to generate broad priorities for further research to define the most effective and efficient conservation investments to help reduce nutrient loads. As such the InVEST Nutrient Retention model was used.

National Agriculture Statistics Service (NASS) 2012 land cover was the starting point for InVEST. Values were assigned for nitrogen and phosphorus application and uptake rates of these nutrients by the crops on the landscapes. These rates were selected based on InVEST literature searches and North Carolina Extension Service's 2011 Neuse River fertilizer application study. A second model was run with land cover input incorporating swine concentrated animal feeding operations (CAFOs) data with nutrient loads. The model is a surface flow model that takes into account a number of factors beyond crop type including precipitation, soil type, and proximity of the farm to the river, among other variables. InVEST then estimates the average nutrients (both nitrogen and phosphorus) exported from the landscape into the basin (see Maps 1, 3, and 5 in Appendix B). The model was then expanded to include another version of the outputs incorporating discharge point source data for nitrogen and phosphorus within the study area (see Maps 2, 4, and 6 in Appendix B). These maps show both numeric results of nutrient export (e.g. Maps 1 and 2) as well as general patterns of areas of high, medium, or low export across the region (Maps 3-6).

Results from this analysis indicated several important things:

1) Both non-point and point sources are important nutrient contributors to the Cape Fear Basin, but more needs to be known to better understand and quantify both the extent of their contribution and potential solutions for diminishing their contributions.
2) Non-point sources are nutrient contributors and tile drains[13] may be a key factor in this contribution.
3) Point sources are important sources of nutrients and it is worth exploring opportunities to reduce their nutrient loads.

As a result, in the first year of the water fund partnership, TNC is advocating that investments go towards:

1) developing a watershed model for the entire Lower Cape Fear;
2) purchasing and installing equipment that can, in the long run, provide data and better calibrate models;
3) mapping tile drains in priority subwatersheds;
4) scoping opportunities to engage with point source nutrient contributors.

Launching the Cape Fear Water Fund

Year 1: Refining our Priorities

A <u>watershed model</u> would complement the nutrient model the NC Department of Environment and Natural Resources (DENR) is creating for the Cape Fear River. These two models together would provide the ability to quantify percent contributions of nutrients from different sources. Additionally, the watershed model will be a much finer-scaled analysis than InVEST allowing for the creation of scenarios to help optimize the location of particular practices to yield the greatest returns in terms of decreasing nutrient loading into the Cape Fear. This would include being able to more reliably predict at what scale actions would be needed in order to see a return on investment at the point where the utilities withdraw their water. This is the highest priority to accomplish in Year 1 of the water fund partnerhsip.

In presenting the InVEST results to a wide variety of partners and stakeholders, a concern was raised that tile drains may be a large contributor to the nutrient loading in the basin. Even with best management practices, like riparian buffers, if a field has tile drains nutrient loading can still be high. This is true for both row crop agriculture and swine CAFO spray fields. To better explore this potentially significant nutrient source, we propose to <u>locate and map tile drains[14]</u> in a few experimental, high priority areas. From this, we will be better able to prioritize where solutions, such as controlled drainage, have the capability of having a strong impact. Additionally, this provides us an opportunity to explore new energy technologies with priority swine farms attempting to convert their liquid waste to solid waste allowing them to not have to use a spray field. Finally, given the clear contributions of point sources to the nutrient levels in the Cape Fear, we will <u>explore opportunities to engage point source contributors</u> in the water fund. This could be done by either finding ways the water fund could support reduction in nutrient loading from these point sources or by bringing them in as partners to the water fund effort.

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[13] Tile drains are essentially a network of below ground pipes originally installed to remove water from the land but now serve as a potential conduit for nutrient export into ditches and then river systems.

[14] There are numerous methods for mapping tile drains. Among the more successful is using infrared remote sensing or infrared aerial photography particularly after a rain storm.

Beyond Year 1

The investments made in Year 1 will define the highest priority investments for reducing nutrient loading into the Cape Fear ensuring that resources in Year 2, and beyond, are spent on the best possible activities in the highest priority places. Though Year 1 will define the activities for investment, some obvious best management practice examples include forest protection and restoration, planting riparian buffers, restoring wetlands, installing controlled drains, and exploring opportunities to work with new energy technology that converts liquid swine waste to energy. There will also be possible urban or point source investments. The budgets for Years 2 and beyond will be heavily influenced by the extent and number of practices put on the ground each year which will be informed by the studies completed in Year 1. The watershed model, in particular, will provide an opportunity to develop specific scenarios that can predict nutrient reductions. The costs of those practices can then be integrated to determine a return on investment and prioritize practices.

Challenges and Hurdles

The water quality issues in the Cape Fear come from a variety of sources and have been building for many years. There are high remnant concentrations of nutrients in soils throughout the basin from years of agricultural, urban, and other land uses. As such, there is an inevitable time lag between actions taken to reduce nutrients now, and the potential to see water quality improvements in the immediate term. Additionally, the water withdrawal location for the utilities near Lock and Dam 1 are impacted by all upstream land areas and land uses.

One of the biggest challenges for the water fund will be demonstrating the effectiveness of deployed practices (in years 2 and beyond) in improving water quality. TNC has planned for this and intends to measure, at a sub-watershed scale, the benefits to water quality that can accrue from practices the water fund partnership prioritizes. However, given the natural response time of hydrologic processes to interventions and the numerous variables contributing to water quality degradation, it could take 5-10 years before concrete scientific results are in-hand. At a site scale, benefits can be demonstrated in a much shorter time period, approximately 1-2 years, but for a scale that is meaningful to the drinking water quality of CFPUA, Brunswick County utilities, and Pender County utilities, more time will be required. This scale can be estimated using the watershed model proposed in Year 1.

Given this challenge, measurable economic returns to utilities in any of these types of investments can be difficult to measure and observe in the short-term. In many cases, the economic return may be future costs avoided from acting now rather than waiting until water quality is worse. Models and scenarios based on real data collected in the above mentioned 5-10 year time frame can help predict these avoided costs but realizing them on a budget sheet can take much longer.

What can be measured, are the direct benefits to water quality from water fund investments. If set up experimentally, the water fund will be able to show actual returns on investment and this data can then be used to calibrate models and provide predictions of return on investments at a much larger scale.

Budget Proposals and Milestones

The highest priority for next year, Year 1, is to complete the watershed model for the basin. This model, complimented with the nutrient model that DENR is completing, will enable the understanding of the relative contributions of nutrients and pollutants from different sources in the basin. Without this information, it is difficult to determine highest priority investments for the water fund.

Below are three budget proposals for Year 1 of the water fund that would officially launch this partnership. Please note these proposals represent potential options. The primary goal for TNC is to launch the water fund in 2014, and the utilities are a critical part of this partnership helping us to lead the way in this new effort.

Budget Proposals

The level of funding the water fund partnership can put towards Year 1 objectives will influence what can be accomplished and delivered. To that end, three possible budget scenarios are presented. Budget A is the most expensive (see Table 1 below), but would accomplish all of the objectives described in the previous section. Budget A would fund the watershed model, would map tile drains in two priority sub-watersheds (identified through the InVEST analysis see Appendix B Map 7), and possible engagement with point source contributors will be explored. In Budget B (Table 2), tile drains will only be mapped for one priority sub-watershed. Mapping only one sub-watershed could potentially limit the number of farmers we could begin to engage with in Year 2 and beyond. Success is based on participation; the more farmers we know we can approach the greater our chances of success. Finally, Budget C (Table 3) represents just financing the watershed model and exploring point source options. Losing the ability to map tile drains at all creates the risk that certain practices deployed in Year 2 will not be as effective as they otherwise may have been and will need to involve more testing and experimentation. It also limits the activities the water fund can effectively finance.

The following tables describe the three budget scenarios; the table on the left outlines the activities and actions to be done and associated costs. The tables on the right indicate the cost for each utility based on water usage. Note the * refers to the fact that DENR is providing this match.

Table 1: BUDGET A

Activity	Total Cost	TNC Match	Other Match	Remaining Need
Watershed Model	$400,000	$50,000	$200,000*	$150,000
Map Tile Drains	$130,000	$40,000	-	$90,000
Explore Point Sources	$50,000	$50,000	-	-
Total	$580,000	$140,000	$200,000	$240,000

Entity	Contribution
CFPUA	$117,600
Brunswick County	$88,800
Pender County	$33,600

Table 2: BUDGET B

Activity	Total Cost	TNC Match	Other Match	Remaining Need
Watershed Model	$400,000	$50,000	$200,000*	$150,000
Map Tile Drains	$60,000	$40,000	-	$20,000
Explore Point Sources	$50,000	$50,000	-	-
Total	$510,000	$140,000	$200,000	$170,000

Entity	Contribution
CFPUA	$83,300
Brunswick County	$62,900
Pender County	$23,800

Table 3: BUDGETC

Activity	Total Cost	TNC Match	Other Match	Remaining Need
Watershed Model	$400,000	$90,000	$200,000*	$110,000
Explore Point Sources	$50,000	$50,000	-	-
Total	$450,000	$140,000	$200,000	$110,000

Entity	Contribution
CFPUA	$53,900
Brunswick County	$40,700
Pender County	$15,400

In Table 4, each budget with respective line items is summarized. With the highest priority being the watershed model this is represented in all three budgets as is initial exploration of point source opportunities as TNC has these resources in hand.

Table 4: Summary of Investments for Each Budget

Budget	Watershed Model	Tile Drain mapping	Point Source
A	Whole priority region modeled	Two sub-watersheds mapped	Initial Exploration
B	Whole priority region modeled	One sub-watersheds mapped	Initial Exploration
C	Whole priority region modeled	None	Initial Exploration

Milestones and Measures of Success

Year 1 will ensure the future water fund investments are well-targeted and cost effective. A model will be produced that can estimate benefits from a wide variety of practices and the ability to strategically partner with non-point source contributors to maximize return on investment. Years 2 and beyond will be the implementation of practices that will reduce nutrient contributions to the basin. This will include investments in measuring the effectiveness of the investments ensuring that they are indeed returning cleaner water. With this data, the partnership will be able to more accurately project the scale of conservation needed to secure clean water into the future.

Table 5, below, illustrates the types of milestones and measures of success for Year 1 of the Cape Fear Water Fund Partnership. Accomplishments will vary depending on funding levels but each objective in Year 1 will ensure that the water fund is as successful as possible in reducing nutrients and pollutants in the Cape Fear in future years.

Table 5: Milestones for Year 1

Milestone	Benefits to Water Fund
Location of tile drains determined	Clear priorities for investment in potentially largest source of non point contamination
Contribution of nutrients from different sources quantified	Better able to target investments to highest priority nutrient source
	Better prioritization of non point best management practice investments
Detailed budget for future years	Clear set of priorities and deliverables established for future years of the partnership

Years 2 and beyond of the partnership will involve implementing projects on the ground. At this point, milestones and measures become increasingly important. There are two kinds of measures that are important: activity measures and outcomes measures. Activity measures use an indicator of action to determine accomplishments while outcome measures look at the result of that activity. Table 6, below, summarizes examples of milestones and measures for future years of the Cape Fear Water Fund Partnership.

Table 6: Examples of Outcome Measures for Future Years of the Water Fund

Action	Indicator	Measure
Plug ditches/drains	Linear feet of ditches plugged	Concentration of nutrients in ditch before and after plugging.
Grow riparian buffers	Number of acres of buffers planted	Nutrient concentration in river before and after buffer.
Restore Wetlands	Number of wetlands restored	Concentration of nutrients entering wetland compared to exiting wetland.
Convert swine waste from liquid to solid	Number of farmers with improved technology	Amount of liquid waste converted.
		Amount of energy generated.

Conclusion

TNC looks forward to launching the Cape Fear Water Fund – a partnership to make the Cape Fear a healthy river for drinking water, for recreation, and for animals and plants. Improving water quality by reducing nutrients and other pollutants into the basin promises long term benefits for the natural environmental of the Cape Fear, but also for drinking water. Improving water quality can lower costs for water treatment and can reduce risks to the future sustainability of the water resources. TNC looks forward to partnering with the Cape Fear Public Utility Authority, Brunswick County Utilities, and Pender County Utilities in launching the water fund and contributing to the shared goals of securing clean water into the future.

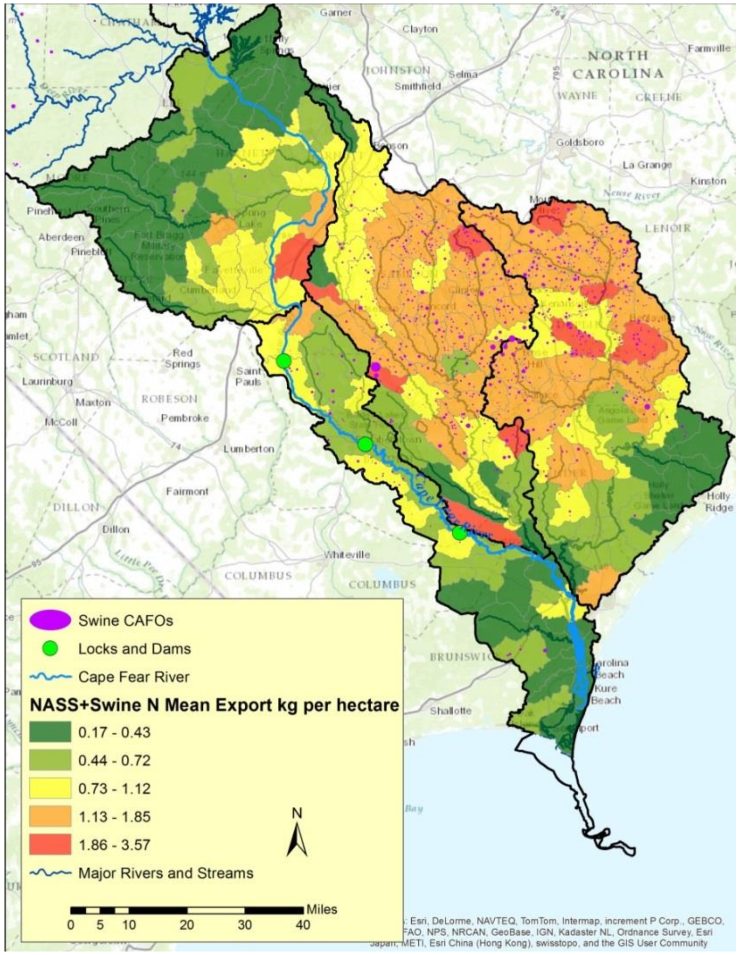
Appendix A: Financial Model for Costs from Algae

Days of Algae Blooms	75
Total Estimated Impact	$100,575

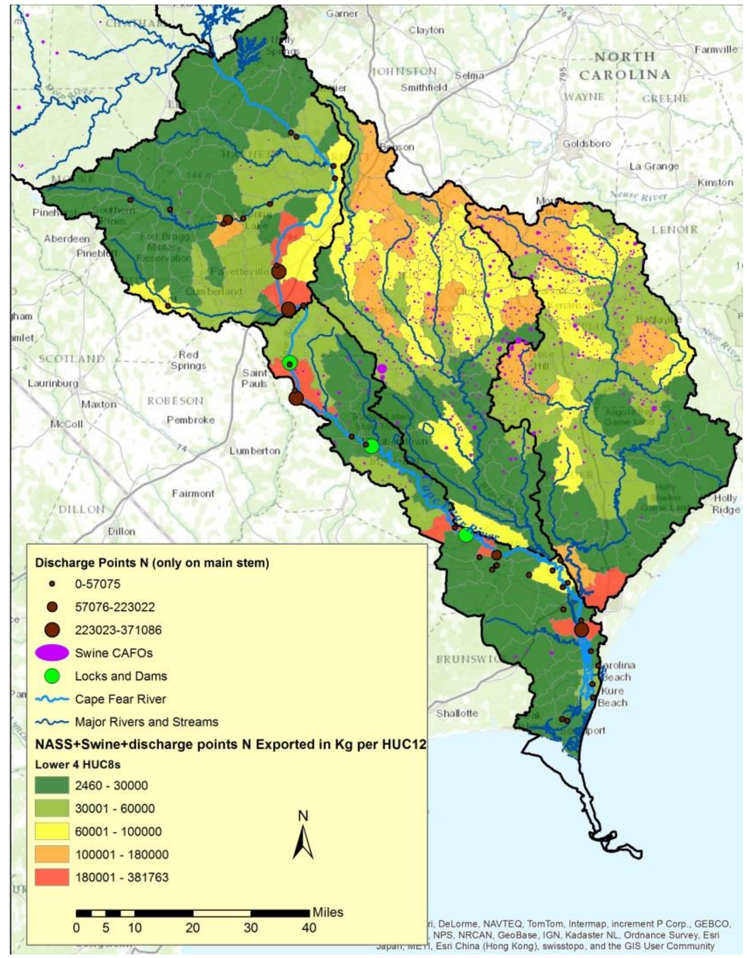
Expenditure	Estimated Expenditure per day	Note
Labor	40	assumes $20/hr for 2 hours
Electricity	1	small increase needed to run 7 hp feeder pump
Activated Carbon	1,000	Assumes feeding 10 ppm during a summer outbreak when plant is operating at 16 to 17 MGD day.
Sludge Management	250	Assumes the generation of approximately 1250 pounds of sludge a day at a cost of $504 per ton to dispose
Water	$50	Plant needs to use treated water to add activated carbon. Assume 35 gpm x 1440 minutes per day x $1 per 1,000 gallons of treated water.
Total	**$1,341**	

Appendix B: InVEST Results and Prioritization

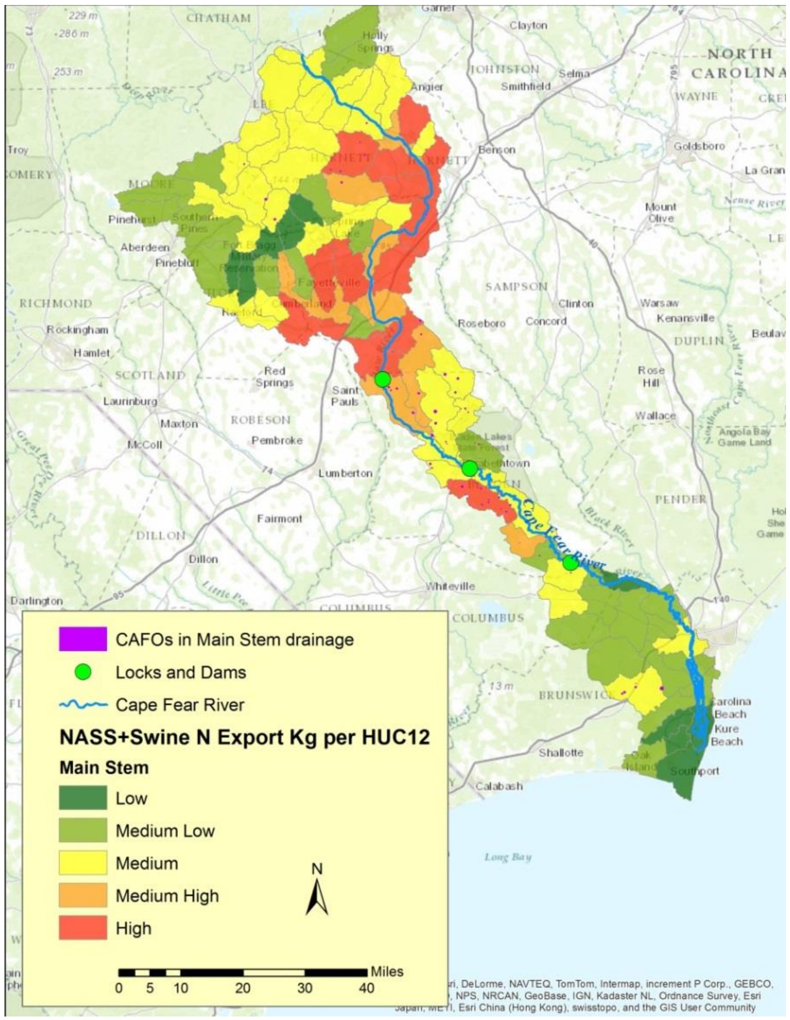
Map 1: Crop and Swine average nitrogen export (kg/Ha)



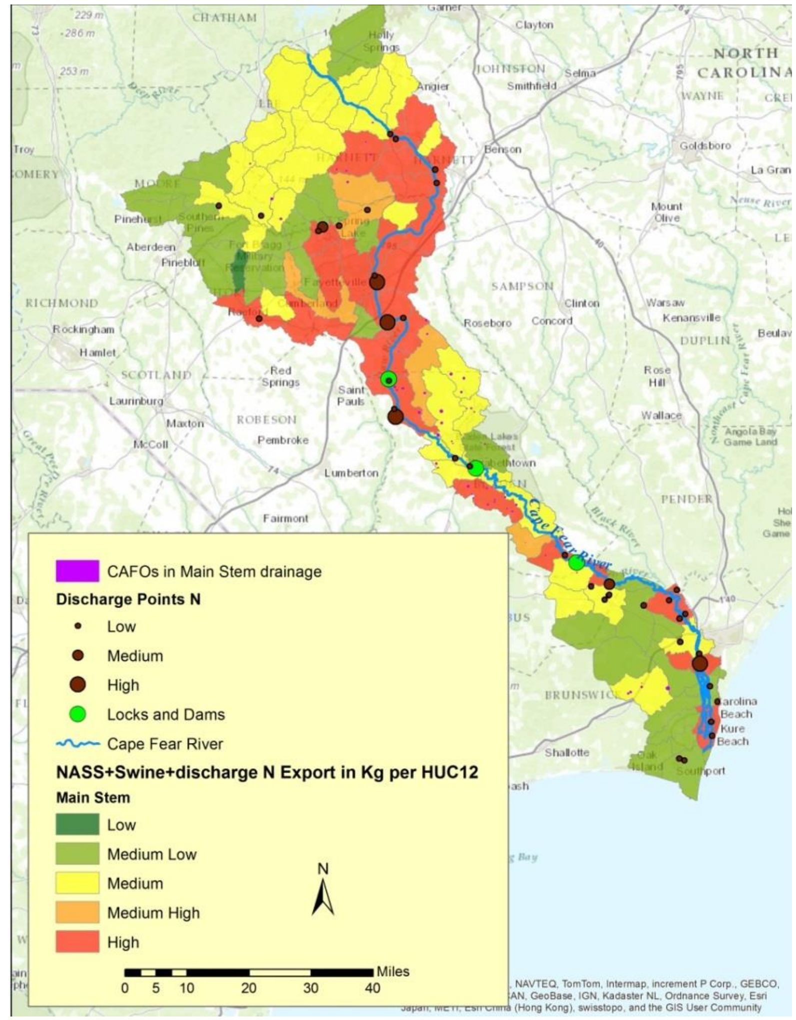
Map 2: Crop, swine and point source discharge total nitrogen export kg/HUC12



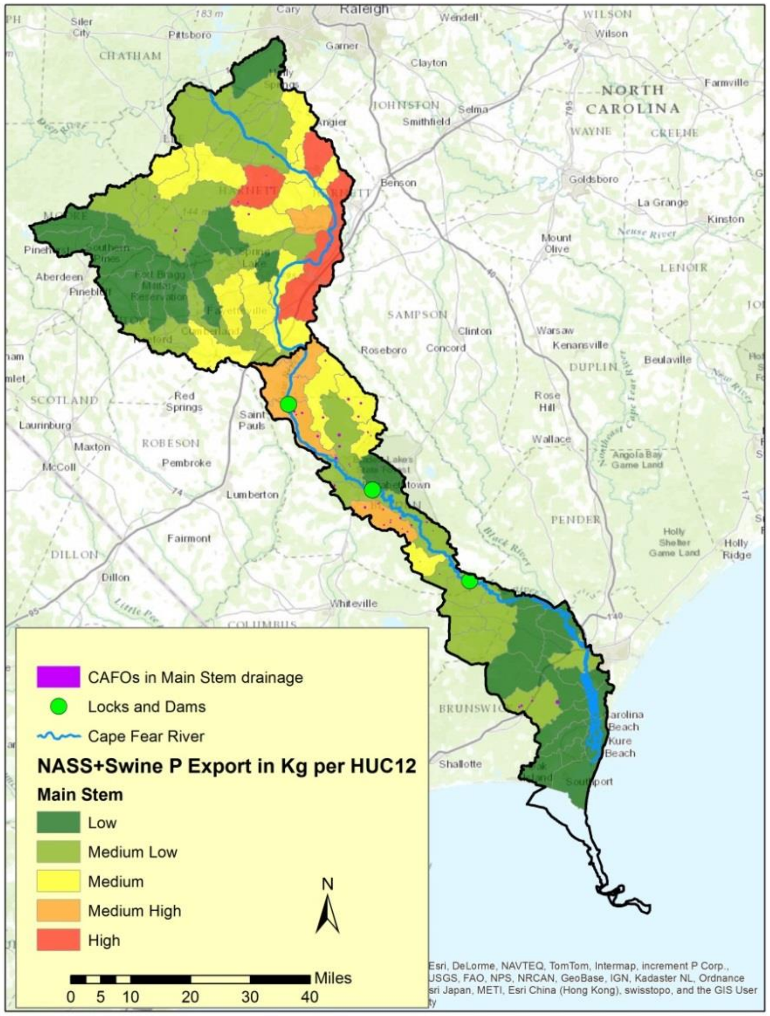
Map 3: Relative Nitrogen contribution by HUC 12 for crops and swine farms



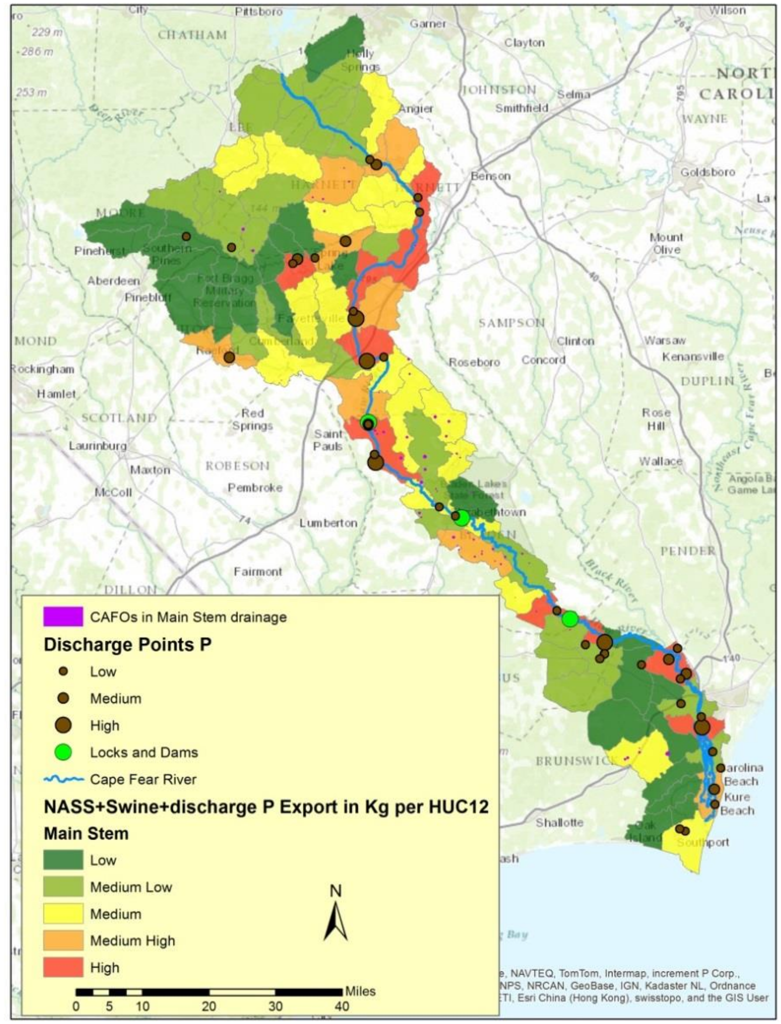
Map 4: Relative nitrogen contribution by HUC 12 for crops, swine farms, and point source dischargers



Map 5: Relative phosphorus contribution by HUC 12 for crops and swine farms



Map 6: Relative phosphorus contribution by HUC 12 for crops, swine farms, and point source dischargers



Map 7 – Priority HUCs for mapping tile drains. Two highest priority HUCs are circled in black. Budgets A and B would allow mapping of both of these priorities