The Future of Water in North Carolina:
Strategies for Sustaining Abundant and Clean Water

A report accompanying The Future of Water conference, March 1st, 2007
McKimmon Center at NC State University, Raleigh, North Carolina

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"The vast possibilities of our great future will become realities only if we make ourselves responsible for that future." --Gifford Pinchot

Introduction

Clean and healthy water resources in North Carolina and the Southeast states provide much of what we all enjoy - lush green forests, rich farmlands, running creeks and rivers with fish, turtles, and frogs, and estuaries among the most productive in the world. The waters upon which North Carolinians depend are abundant—so much so that in the past we have drained water-rich places to promote agriculture and development.[1] But our water resources are also undervalued and under pressure. As the state's population grows and our forests and farmland make way for development, *clean* water may become a much more valued commodity. Though we are already observing conflict over water allocation, and constraints on supply at the coast and during droughts, water quality is likely to be a widespread problem before we face widespread limitations in water quantity.

North Carolina is the 10th most populous state. Its annual growth rate has more than doubled in the past 15 years. North Carolina's population surged nearly 40 percent in the mid-1980s and by 2006 reached 8.8 million people.[2] Over this same period, we have begun to see signs that our water supply and its ability to handle our wastes and our growth have limits.

- From 1998 to 2002, droughts in the Piedmont and Mountain regions stressed the ability of public supplies to meet growing demand, causing wide-spread economic losses. In response more than 90 public water systems mandated conservation measures and more than 250 communities enacted some form of water conservation.[3]
- In the coastal plain, the use of water from long-existing, confined aquifers has outpaced the rate of recharge, as development and agriculture have increased.[4] To attain a sustainable rate of use and avoid saltwater encroachment the state has implemented a regulatory program to limit withdrawals from these aquifers and develop alternative sources of water supply.[5]
- Many of the state's waterways are no longer able to support fish and shellfish species due to nutrients, bacteria, and other pollutants that run off urban and agricultural lands. This runoff has contributed to the closure of 19% of once productive coastal estuaries and inlets to fishing and shellfishing in the past two decades.[6] These closures have forced consideration of new coastal development regulations and systems to manage stormwater runoff.
- State monitoring has found that more than 10% of our streams and 36% of our lakes and reservoirs are degraded in some way, no longer providing the service or value for which they were historically used or designated.[7] Reversing this trend requires cooperation between local and state officials and the creation of local water resource plans to incorporate best management practices into land use decisions.

Faced with these and other challenges, North Carolina's decision makers continue to develop policies and programs to protect water resources in order to sustain healthy growth, but they and many others realize there is much more to do.[8]

As the people of North Carolina consider future growth, it is imperative to acknowledge that decisions and investments made now will determine the future for our water resources. Fortunately we have numerous opportunities to protect and restore healthy streams, rivers, and estuaries and achieve sustainable water use. Innovative strategies exist in parts of North Carolina that merit more attention and discussion. This report and the upcoming conference to which the report is a companion explore three fundamental strategies:

1. Improving the prioritization and protection of riparian buffers, forests and wetlands in a strategic and cost-effective way. We refer to these lands as "green infrastructure" because they, like water, wastewater, and transportation infrastructure, are vital to the long-term health and quality of communities.
2. Incorporating realistic values into our water services. This could entail water and

wastewater rate structures that reflect real costs to our communities. It could lead to valuing and paying for a service provided by forested stream buffers, like nutrient or sediment retention. Valuing water more highly could also entail a greater promotion of water efficiency and reuse.

3. Exploring new leverage to protect water resources, emphasizing the importance of streamlining, coordinating and maximizing regulatory policies and programs pertaining to water quality and quantity, identifying gaps in regulatory needs, and linking water resources and economic growth.

The Nicholas Institute and its partners seek to enhance the conversation regarding how to meet long-term water resource needs in a rapidly growing North Carolina by convening a conference on March 1st, 2007. At this conference, we intend to take a step back from day-to-day problems and consider big-picture strategies for improving water management.

This report first summarizes the status of North Carolina's water resources and the context of growth and land use change. Second, it discusses the three strategies introduced above that the conference will highlight and poses questions for discussion at the conference.

Trends in North Carolina

Population

North Carolina is the sixth fastest growing state in the country and currently the tenth most populous state. Our population is expected to increase by 50 percent, to over 12 million people, by the year 2030.[9] Population growth is not uniform. Places of highest growth include the Piedmont urban crescent, coastal counties, and some mountain counties.

Land Use

While most of North Carolina's 33 million acres remain undeveloped (Figure 1), our state is rapidly building in the open spaces that provide our high quality water supply. Undeveloped lands, including forestland and wetlands, are crucial to the quality and flow of water in rivers and streams. They maintain the natural hydrologic processes that recharge groundwater and regulate in-stream flows, and provide natural filters which remove pollutants and nutrients from surface run-off. The ecosystem services that our green infrastructure provides cease to function if the land undergoes significant conversion and disturbance.

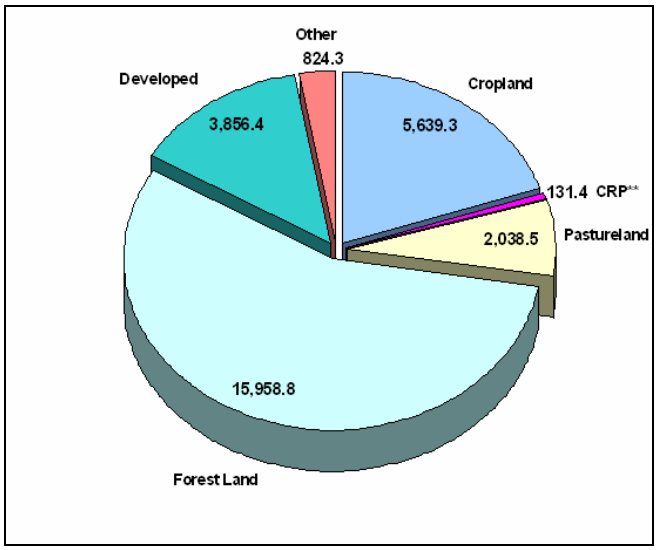

Figure 1: 2000 Non Federal Land Use in North Carolina, in acres[10]
**CRP=Conservation Reserve Program

Some recent trends in North Carolina land use are outlined below.

- Since the 1960's, 2.1 million acres of forestland have been converted to other uses, primarily for residential and urban development, an area of conversion greater than that seen in any other U.S. state.[11]
- The USDA's 2002 Southern Forest Resource Assessment projected that an additional 4 million acres of forestland will be lost in North Carolina over the next four decades, a 30% loss statewide and an average loss of 100,000 acres per year.[12]
- Forestlands are also increasingly fragmented, a trend that compromises their ability to provide clean water: 42 percent of forestland in the Southeast is in blocks of less than 100 acres.[13]

Between 1982 and 1997, developed urban lands in all three of North Carolina's major metropolitan areas increased by just over 88 percent, more than twice the rate of population growth.[14] Urban development is characterized by impervious surfaces such as streets, parking lots, houses, and other buildings. These surfaces channel water run-off from precipitation events, often carrying pollutants and sediments, rapidly and directly into waterways. Additionally, the impervious surfaces disrupt the hydrology of a water system by preventing aquifer recharge and the natural filtering ability of undisturbed stream banks, subsequently altering stream flow. [15] A study by the U.S. EPA projected that between 2000 and 2030 the number of watersheds in North Carolina with 20 percent or more impervious surface would double.[16] The percentage of impervious surface in a watershed can be an indicator of the health and proper functioning of the watershed. A watershed is characterized as protected when there are less than 10 percent impervious surfaces; impacted, with 10 – 30 percent impervious surfaces, and resulting in a decline in aquatic species, recreational values, and the quality of water for human use; and degraded with over 30 percent imperviousness.[17]

Economy

In the past two decades, the state's largest employers have shifted from manufacturing industries to the service sector, including education, health, tourism, hospitality, and business services.[18] In less than a decade, the manufacturing industry experienced a 27 percent decrease in employment while the education

and health services sector increased by 25 percent. People are moving to where the jobs are, resulting in uneven population growth across the state. From 1997 to 2004, 74 percent of the jobs added were located in Wake and Mecklenburg counties. Though the agricultural industry has maintained a constant presence in the State throughout this period, North Carolina is moving from a largely rural economy to one dominated by a specialized suburban commuter work force.

Based on current trends in population, land use, and economy, and absent policies and decisions that re-direct these trends, we foresee further decline in the natural systems that protect North Carolina's water and an increase in our dependence on intensive and costly water treatment and management systems. Reducing natural buffers, filtration, and flow regulation, and instead depending upon intensive systems is of particular concern when we consider the extreme events whose impact such systems cannot mitigate. Floods, droughts, hurricanes, shifts in rainfall, sea level rise, and shifts in barrier islands are likely to have greater negative impact on property, prosperity, and our water management system.

Fortunately, this is not the only option for North Carolina's future. With active and creative water and land management policies, perhaps we can craft a system for land management that accommodates growth with incentives to protect our land and water resources and their resilience. It is crucial that North Carolina addresses the risks of extreme events and climate change in planning for the future. The goal of the conference is to explore such ideas and strategies for encouraging an approach that combines economic development *and* maintenance of healthy waters.

North Carolina's Water Supply

Precipitation in most regions of the state is generous (Figure 2) and more than sufficient to supply our current population with water. Most of North Carolina receives an average of 40 to 55 inches of precipitation annually. For municipalities, though, more important is local water availability over time relative to need—something unique to each watershed.

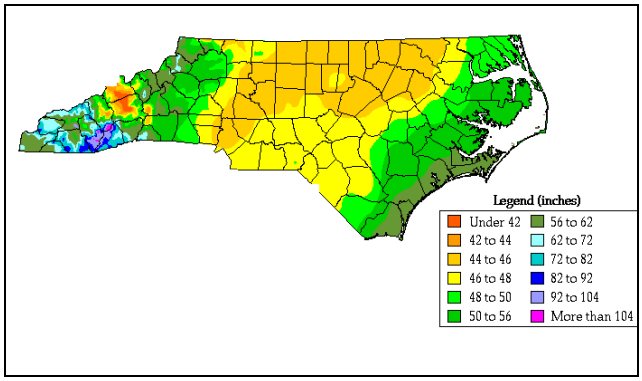

Figure 2: Average Annual Precipitation in North Carolina[19]

Quantifying flows in North Carolina's different watersheds and ground water aquifers is challenging, however, and a full accounting of water supply in North Carolina's river basins has not yet been completed. Dam relicensing processes have yielded advanced models for water supply in some North Carolina river basins. The models are generated from long-term data on the natural processes of seasonal water flows, and could provide a basis for more scientifically based and ecologically sound approaches to water allocation.

More easily measured than water supply itself is the demand for water supplies and how water moves from source to end user. Consumptive demand for North Carolina's water is divided among several groups: agriculture, industry, domestic, and mining (Figure 3). The total water use in 2000 was 11.3 billion gallons per day, 80 percent of which was used in electric power generation, a non-consumptive use.[20]

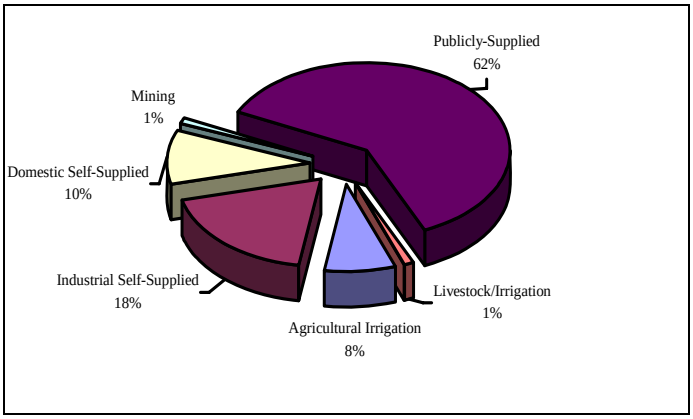

Figure 3: North Carolina Consumptive Water Demand, 2005 [21]
(Does not include water demand from electric power generation.)

Water demand is expected to increase with population growth, such that by 2030 daily water use will increase by 35% to 2.2 billion gallons consumed per day. [22] This level of increase will likely strain water supplies and public budgets in high-growth counties, particularly in dry years. It may also complicate our ability to maintain flows for economically valuable uses such as agriculture and industry, and for stream levels sufficient to sustain aquatic species.

Figure 4, compiled and created by the North Carolina Rural Economic Development Center, shows the expected growth in demand for water by 2030 across the state.

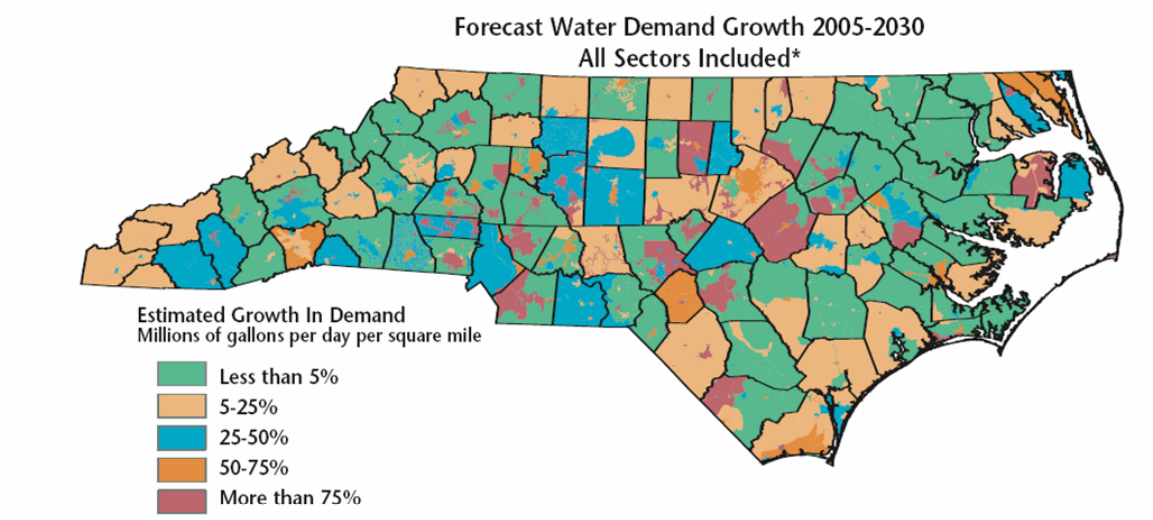

Figure 4: A forecast for growth in water demand by 2030[23]
*Includes consumptive water demand: public system users, self-supplied domestic users, self-supplied industry and mining users, and agricultural water users

Increased demand has begun to and will continue to push water supplies in growing counties to their limits. While we are finding ways to address our current needs, long range planning for growth and water resources will need to become more integrated and comprehensive across the state.

North Carolina's Water Quality

In North Carolina, pressures on water quality have begun to manifest themselves in several ways, including numerous polluted estuaries along the coast that are closed to shellfishing, and impaired waterways in the Piedmont and Mountain regions which threaten some drinking water supplies and the habitats of fragile and endemic species.

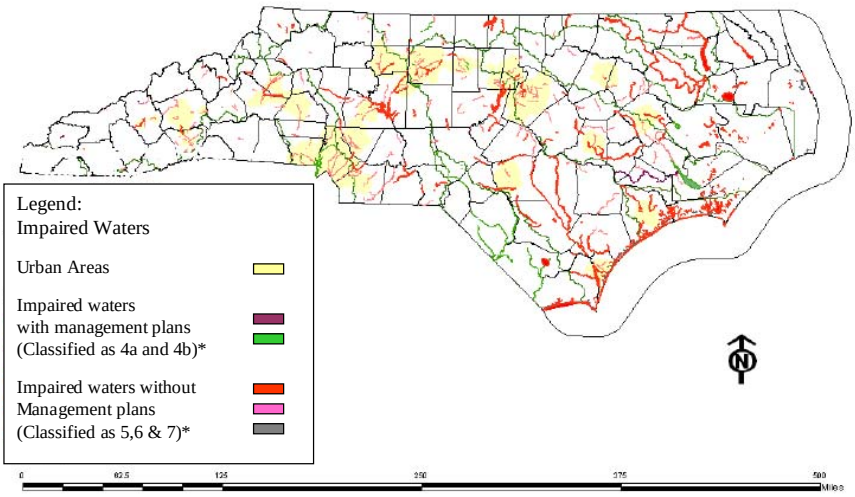

Figure 5: Impaired waterways across North Carolina[24]
*See endnote 25 for explanation

Figure 5 shows the extent of impaired streams in the state. At least 10 percent of the state's 38,000 miles of stream are impaired, representing approximately half of the stream miles with sufficient data to determine quality (for nearly 70 percent of North Carolina's miles of streams there are insufficient data). Up to 36 percent of lakes and reservoirs by surface area are impaired.[25] Impaired waters are those in which at least one of the designated uses, as determined by the state, are not met, for example, providing aquatic habitat or recreation and fishing. Main causes of impairment such as mercury in fish, high algal concentration, low dissolved oxygen, fecal coliform, and sediment, can come from the cumulative impact of pollution from many sources, many of which are diffuse, nonpoint sources. The sources are often impossible to trace and thus difficult to regulate. Nonpoint source pollution is the cause of degradation for 80 percent of impaired freshwater stream miles in North Carolina.

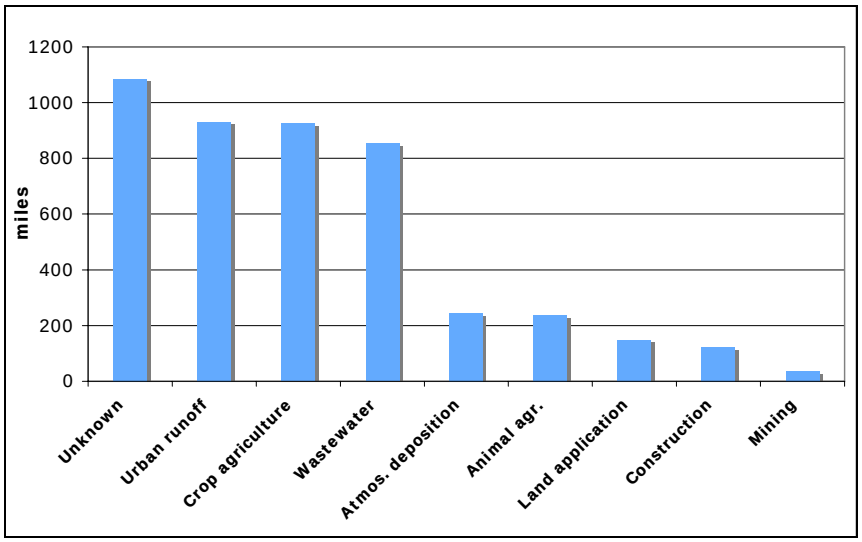

Figure 6: Sources of Impairment of Freshwater Streams and Shorelines, in miles, in North Carolina[26]

Urban areas, crop land, and wastewater - a combination of point and nonpoint sources - are the primary causes of observed impairment for North Carolina's freshwater streams and shorelines (Figure 6). Animal agricultural waste and active construction are also major sources of polluted runoff.

Our aging water and sewer infrastructure contributes to stream pollution as pipes and sewers fail and wastewater escapes to groundwater and streams without treatment, releasing nutrients, fecal coliform, and other substances. According to the North Carolina Division of Water Quality, conservatively 10 to 30 percent of septic tanks are failing because of their age, inappropriate location, or poor design. Repairs and replacement of old pipes and plants are often under-funded, even as we rapidly build new infrastructure. It is estimated that water and waste water utilities will see a 70 percent increase in the number of connections for new users by the year 2030.[27]

Protecting water resources from agricultural nutrients remains a challenge. In the mid-1990s, fish kills in the Neuse and Tar-Pamlico river basins highlighted the impact of nutrients on estuarine ecosystems and fisheries. Since then, North Carolina has implemented programs in these two basins resulting in shifts in agricultural practices that have helped to reduce nitrogen loading 47 percent in the Tar-Pamlico and 44 percent in the Neuse.[28] While this is an impressive success for these watersheds, North Carolina continues to import thousands of tons of nutrients into its watersheds, in the form of animal feed primarily from the Midwest. These imports far exceed both the natural scale of nutrient cycling and what can be used for crop production, and thus end up as sources of nutrient loading to water bodies.[29,30] Nutrient loading is a problem in many parts of North Carolina but is not directly monitored and regulated outside of the two basins.

The challenges we are already seeing for water quality in North Carolina suggest that we will need to proactively address how we maintain clean water as the state grows.

The remainder of this report introduces strategies for managing water resources that will be discussed during three panels at the upcoming conference. Some of these strategies are untried in the state while others are already being tested in North Carolina. We intend that the discussion of these strategies will bring new ideas and stakeholders to the forefront to help North Carolina plan for a future where growth and quality of life through our high quality and abundant water resources go hand in hand.

Panel 1: Better Prioritizing Green Infrastructure: Protecting Riparian Buffers, Wetlands, and Forests

North Carolina invests approximately $100 million each year through state funds for conservation of land for water quality, habitat, and recreation. These lands can be thought of as "green infrastructure" because they are vital to the long-term health and appeal of a community just as are other forms of infrastructure such as roads, power, and sewer. Conserved lands maintain the natural hydrologic processes which recharge groundwater and regulate in-stream flows, provide natural filters which remove pollutants and nutrients from surface run-off, and also provide wildlife habitat, recreational spaces, and beauty, benefits that are difficult or impossible to substitute.

In North Carolina land conservation is supported primarily through three funds: the Clean Water Management Trust Fund (CWMTF), the Natural Heritage Trust Fund, and the Parks and Recreation Trust Fund. Land acquisition funds from the CWMTF are focused on buffers, while other funds focus on expanding parks and protecting habitat. These all benefit water resources. North Carolina also coordinates and plans mitigation for impacts on wetlands from Department of Transportation projects through the Ecosystem Enhancement Program. This program has restored, enhanced, or preserved 265 miles of stream and over 18,000 acres of riparian, non-riparian, and coastal wetlands.[31] The state also funds conservation through its Conservation Income Tax Credit, established in 1983. Though precise tax expenditure data are not published, the tax credit has been used for over 150,000 acres of land valued at $620 million.[32] Significant private and some federal funds also go toward conservation.

In 1999, the state set a goal of protecting one million acres by the end of 2009, raising the total protected area to 3.8 million acres, which would cover approximately 12 percent of the state. The initiative is behind schedule and land prices in some places are rising rapidly. [33] Yet North Carolinians are increasingly supportive of land protection and the funding to support it. The public and some members of the General Assembly are rallying around a proposal by the Land for Tomorrow Coalition to increase funding for land protection by another $200 million per year over five years.

Land conservation efforts, however, need more than increased funding. We also need to spend funds wisely because even expanded budgets are likely to be limited in comparison to the need. The conference's first panel will explore how we can improve our prioritization of land acquisition and land management projects for water quality protection at local, river-basin, and statewide scales. It will also explore how state and private actors coordinate efforts.

A variety of prioritization processes are in place and more are anticipated. In the private sector, many land trusts and conservation NGOs like The Nature Conservancy have identified local or regional conservation priorities. The CWMTF has supported many riparian conservation plans. In the public sector, the Ecosystem Enhancement Program prioritizes wetland restoration activities. The state is in the preliminary stages of developing statewide conservation priorities.

How can these prioritization efforts be improved and better complement one another? Can the state and its trust funds become more proactive in identifying and acquiring land? How can we develop the tools and technical assistance to guide acquisition programs at local and river-basin scales? And how can we develop the institutional capacity to support the communication and data-sharing needed to ensure that we get the most benefits from land protection, including water quality?

Better prioritization of "green infrastructure" is a compelling and complex challenge, even in the simplest of situations. Yet there are potential ways to improve the outcomes of our prioritization and protection that are worth exploring. For example, we often have limited ability to evaluate and subsequently adapt the range of conservation policies and strategies. Though evaluative learning presents the opportunity for greater improvement in conservation efforts, few take an adaptive or experimental approach. Can the state and

conservation community improve their ability to evaluate and adapt conservation strategies and policies?

Finally, an important question is whether funding land conservation can sufficiently protect vital green infrastructure without complementary local or state land use policies. It is understandable that counties and towns may hesitate to bear local costs or forgo local financial benefits in order to protect water quality downstream to the benefit of those in other jurisdictions. Thus we may need a watershed-based or state initiative to fairly place the costs of protecting water resources among the beneficiaries.

Questions for Discussion

Would a more coordinated prioritization effort of land conservation and management across the state improve our use of scarce public and private funding, and improve our ability to maintain water quality and quantity?

How can existing prioritization processes be made more effective? What should subsequent prioritization efforts look like (e.g. a new statewide effort)? Can these efforts help ensure that funds are spent cost-effectively?

What are the barriers to better prioritization for the protection and restoration of lands vital for water quality? Technical, political, or financial?

Are there limits to what land conservation funds can accomplish? When should local governments or the state consider complementary protections such as riparian buffers?

How can the case for protection of "green infrastructure" be made more effectively to the public, local government, and landowners?

How can the goal to protect an additional one million acres be translated into strategic priorities so that land trusts, local governments, trust funds, and other land protection stakeholders can cooperate in a wider strategy?

How can the state river basin plans be used to better guide land protection?

How might better protection of green infrastructure mitigate the potential effects of climate change (extreme weather events, floods, droughts, etc.)?

Panel 2: Valuing Water, from Ecosystem Services to Efficiency

In this section we explore three strategies grouped under the general concept of more realistic valuing of water. First, how might we expand compensation to land managers and owners for the "ecosystem services" that provide clean water, prevent floods, and recharge groundwater? Such compensation will encourage land managers to continue providing these services, will reflect the public value in land management, and are a natural but little-used complement to our investments in water treatment and delivery. Second, how might reforms in the price structure used by water and sewer utilities allow us to better maintain water and sewer infrastructure and encourage efficiency? Third, how can we otherwise promote efficiency in our use of water for life at home, commerce, and agriculture?

Payments for Ecosystem Services

Forests, wetlands, and vegetated buffers in watersheds naturally manage our water resources in numerous and valuable ways. These ecosystems filter runoff from agricultural and urban lands, recharge groundwater supplies, and act like a sponge to moderate stream flows, reducing flooding during heavy rain and maintaining flows during dry weather. While performing all of these functions for water resources, they also provide habitat and recreational activities.

The maintenance of these "ecosystem services" is an issue of concern for all communities, because their function affects local recreational opportunities and land values, fish populations, function of wells, water treatment costs, and the magnitude and timing of flood and drought impacts.

While the services that ecosystems provide are not new, we have generally taken them for granted in the past since they were abundant and resilient. However, as we expand our use of land for the provision of other services – urban living areas, industrial parks, and agricultural production – the ecosystem services that regulate and clean our water supplies are diminished. As we see these natural services diminish we have begun to appreciate their benefits, and feel their loss in real economic terms. We literally may not be able to afford to take them for granted for much longer.

Though we lack a comprehensive analysis, North Carolinians are almost certainly paying for declines in our ecosystem services. These impacts/losses may include:

- greater costs for drinking water and wastewater treatment as pollutants and sediment more readily reach streams and lakes;
- lost recreational and professional fishing revenue due to degradation of fish and shellfish habitats;
- increased flood damages to private property;
- increased economic losses due to aggravated drought conditions;

Thinking of ecosystem functions as services that have economic value may lead to new strategies for improving our management of resources and water. Valuing ecosystem services provides a complement to traditional land conservation approaches by paying for land management choices on private lands that benefit the public and that otherwise would not be cost-effective to land owners. This approach provides new ways to reduce the impacts of other land uses. Markets for ecosystem services may not only lead to more land conservation, but could also restore or maintain wetlands on private lands, encourage runoff capture and water conservation in urban areas, and make cleaner management alternatives for industrial agriculture more profitable. This approach also makes it possible to ask those benefiting from these services to help finance them.

North Carolina has initiated or joined some innovative systems that encourage or provide payments for ecosystem services. These range from publicly-funded land management incentives to market-like structures. For example, North Carolina participates in the Conservation Reserve Enhancement and Wetlands Conservation Programs, which provides funding to land owners who maintain ecosystem services critical to water resources, and offers tax benefits for forestry and agricultural land uses. Also, in response to federal regulations on nutrient releases into waterways, North Carolina developed a cap-and-trade system for nitrogen in the

Neuse and Tar-Pamlico basins. A cap creates a monetary value, paid by the point source polluters, for the reduction of nonpoint pollution, an ecosystem service that is provided by buffers and better agricultural practices. The valuing of these activities stimulates a growing supply that can offset nutrient releases from the point sources. These activities and ecosystem services can cost less than nutrient reductions from wastewater and other point sources of nitrogen. Federal protection of wetlands has also driven the creation of the Ecosystem Enhancement Program, which coordinates mitigation for wetlands that are lost by the state's road construction. This program creates a market for restored and preserved wetlands to offset those lost, where the state's Department of Transportation is the primary buyer. The offset program is designed to maintain the many ecosystem services wetlands provide, including water quality and wildlife habitat.

Expanding the valuation of and financing for ecosystem services will require new tools to link the suppliers (land owners and managers) with the beneficiaries, techniques to reliably value services in a variety of landscape contexts, and possibly new policies and institutional capacity to create and direct markets. It will require political will. Moving from payment programs to full-fledged markets will raise questions about whether such markets are worth their inevitable imperfections, including limited knowledge, high transaction costs, and the spatially fixed and non-substitutable nature of the ecosystem services that function uniquely in the landscape. Whether we use payment programs or markets, more accurate valuation of ecosystem services may improve our management decisions in an environment of tighter scrutiny on pollution and increasing pressure from growth.

Questions for Discussion

How are payments for ecosystem services used to protect or improve water resources in North Carolina?

What is the state of knowledge about their effectiveness? Have markets such as nutrient trading regimes been able to reduce pollution at a lower cost or more effectively than non-market approaches?

What is the potential for payments for ecosystem services to expand and contribute to the long-term protection of water resources in North Carolina?

What are the barriers to using payments for ecosystem services to protect water resources?

What are the barriers and obstacles to developing smoothly-functioning markets for ecosystem services that protect water resources? Are regulations necessary to create markets?

How can we begin to work around these barriers?

How can or should North Carolina integrate the value of ecosystem services into existing conservation and mitigation programs (e.g. combining the Ecosystem Enhancement Program with the Clean Water Management Trust Fund)?

How might proper valuation of ecosystem services help North Carolina address the potential impacts of climate change?

Water and Sewer Rate Structure Reform

North Carolinians face an enormous deficit in funding water and sewer services.[34] They are not alone. Across the nation, water and sewer infrastructure is in decay from underinvestment. Local government is increasingly expected to collect the necessary revenue as federal and state governments contribute less, at a time when many local utilities are already struggling to generate sufficient income to meet current needs. According to

the University of North Carolina Environmental Finance Center:

> "…overcoming current deficits and meeting future capital needs will surely result in significant (and painful) pressure on local governments to increase the revenues that they collect from their customers…. [Yet] as difficult as it is to do so, leaders should never lose sight of the inevitable health and environmental costs of failing to ensure that their water and sewer operations have sufficient financial resources to serve the public."[35]

The challenge of sustainable funding for water and sewer services is intricately connected to the challenge of protecting water resources. On one hand, without the funds to maintain water and sewer infrastructure, water quality will inevitably suffer from breakdowns in an increasingly decrepit system. On the other hand, water and sewer rates are a potentially valuable tool to encourage water efficiency and to fund not only pipes and treatment plants but also better land management to protect flows of clean water.

The water and sewer funding deficit has its roots in a historical reliance upon federal and state government to fund growth in sewer and water infrastructure—funding that has fallen dramatically. These subsidies made it attractive for local authorities to offer low-cost service to their customers though the low prices were unsustainable. Many utilities have essentially been operating on loan from future rate-payers.

It is appropriate that taxpayers and their representatives are now contemplating major state-level investments in water and sewer infrastructure, and some communities may never be able to maintain services without state assistance.[36] Yet over the long-term the question of how to pay for these services remains. It is worth considering how citizens can fund sewer and water services through rates rather than income taxes. If a community pays according to its use rather than through subsidies from elsewhere, better incentives are created. Local solutions for local needs are not only more efficient, but can also create an incentive to conserve resources and ensure that both expansion and maintenance costs are met, while also meeting basic needs at low cost. For example, Chatham County implemented an increasing block rate (in which the rate increases with consumption) in an effort to reform rate structures with the goal of fairness to low-income residents and to encourage efficiency.

A question of growing importance is who pays for growth and whether long-term costs are accounted for when growth decisions are made. The cost of long-term infrastructure maintenance and the up-front design and installation are borne by different actors (the community and the developer, respectively) and not necessarily contemplated together. At present developers may have little financial incentive to take long-term costs into account when designing or locating developments and a community may also fail to take these costs into account as they decide what developments to approve and where. Consequently, communities may commit themselves to higher water and sewer service costs for which they may not be prepared. In response to the challenge of paying for growth, some jurisdictions are seeking to levy growth fees to cover some of their infrastructure costs.

The necessity of increased revenue for sewer and water infrastructure and likely price hikes present an opportunity for utilities to put themselves on a sustainable footing financially, but also to encourage water efficiency and funding of other vital elements of our water systems (including open space and buffers) through reforms in rate structures.

A similar challenge presents itself in the management of stormwater infrastructure. Long-term maintenance is crucial to our water resources, yet decisions about how to pay for maintenance and proper function involve not only cost recovery but also equity and institutional structure. Increasingly communities raise funds through charges for impervious surfaces, which have the benefit of acting like a user charge to create incentives to reduce impervious surfaces.

Questions for Discussion

Can rate structure reforms lead to better water management and sustainable funding?

What are the barriers to water and sewer rate reform? What is the potential for rate reform in water and sewer rates in North Carolina?

Can water and sewer utility rate structures address water quality problems as well as encourage efficiency? Are there similar advantages to instituting or modifying stormwater or impervious surface rates?

Should the state do more to encourage statewide rate structure reform toward local self sufficiency and sustainable infrastructure financing? If so, what are the options?

What is the possibility in North Carolina that it would be more cost-effective for water users to fund local land protection for water quality?

How might water and sewer rate structure reform be a strategy to also help North Carolina address the potential impacts of climate change?

Water Use Efficiency

Increased water use efficiency can help to accommodate our state's growth while maintaining healthy water-dependent ecosystems and sufficient supply margins for drought. Efficiency could also reduce the need for contentious inter-basin transfers. With the exception of a few local governments, North Carolina has not yet taken advantage of efficiency with concerted effort. Fortunately there may be significant potential for low-cost or cost-saving investments in efficiency.

Water use is becoming more efficient nationally, per capita and per unit of economic activity. Though the U.S. population grew 13 percent from 1990 to 2000, total water withdrawals increased little. Per capita water withdrawals declined 25 percent, from 2,258 m^3/year (1,634 gal/day) to 2,001 m^3/year (1,448 gal/day).[37] Gains in water efficiency have been primarily in industry, thermoelectric energy, and irrigation.

Trends in state water use data are more difficult to interpret. In 2000 the intensity of North Carolina's per capita water use for public supply and domestic self-supply, and for crop irrigation (per acre), was near or below the national average.[38] North Carolina's industrial water use declined in the years leading up to 2000 but it is difficult to know what portion might be attributable to increased efficiency versus a decline in industrial activity (e.g. textiles). From 1990 to 2000, however, water use in total water withdrawals per capita, public supplies per capita, and irrigation per acre increased significantly.[39] A portion of the observed increase may be attributable to the 1998-2002 drought; whether some of this trend is attributable to declining efficiency is a question worth investigation.

A sustained statewide effort to conserve water and become more efficient could include incentives, performance standards, and more education and technical assistance provided to municipalities, agriculture, and developers.

Where water resource problems result in state action, existing state policies can require improved planning for water management and result in increased efficiency. For example, local governments are required to develop plans for improved water management when they apply for an inter-basin transfer, or when their area is designated a capacity-use area for groundwater. Local water supply plans must now include drought contingency components. The Division of Pollution Prevention makes technical assistance available at the request of local governments. In addition, some local governments have voluntarily undertaken their own water conservation initiatives.

Questions for Discussion

Are there examples from other states on improving water use efficiency that could be helpful in North Carolina?

How much could North Carolina gain from better water use efficiency and conservation efforts?

Should North Carolina commission an analysis of how much water could be saved and conserved through improvements in efficiency, reuse, and management?

What are the barriers to greater water use efficiency in residential and commercial sectors? Agriculture? Energy?

How can we work around these barriers?

How might improving water use efficiency help North Carolina address the potential impacts of climate change?

Panel 3: Finding New Regulatory Leverage Points

Numerous federal, state, and local policies impact water resources in North Carolina (for example, stormwater, wastewater, land use, stream flow regulation, water quality, water supply allocation and planning, and wetlands). Are there better ways to coordinate or take advantage of current regulatory programs and/or are there crucial gaps in regulation that need to be addressed?

Here we will explore three different ideas in the area of leverage points: streamlining existing regulation; developing initiatives that combine incentives (carrots) with requirements (sticks); and finally searching for opportunities to make significant, revolutionizing improvements in North Carolina's water resources policy, to move beyond incremental evolution of the myriad regulatory programs for water resources. We explain each of these in more detail below.

Streamlining

The number of existing policies that affect water in North Carolina is at times overwhelming. Federal, state and municipal agencies all have different rules affecting water management. This can make efficient management, and perhaps effective management, difficult. Coordinating and streamlining policies may be one way to address this.

For example, municipalities in parts of North Carolina typically manage stormwater with up to 14 different rules. To address this, the Division of Water Quality developed the Universal Stormwater Management Program which allows local governments that opt in to replace stormwater management programs with the new unified program. The new rule is easier for developers and builders to decipher, poses less of an administrative burden on local governments that choose to adopt it, and is more protective of water quality.[40] Though no new rules have been added, because it simplifies the regulatory process, this program should prove to be more effective at managing stormwater.

Combining Carrots and Sticks

Sometimes combining regulations with incentives provides new opportunities for promoting good management.

For example, the Coastal Zone Management Act established a voluntary federal-state partnership. As part of the program, states that chose to participate had to develop and implement federally approved management plans for coastal zones. To encourage participation, states with approved programs were awarded grants and funding for implementation. Plans had to define the boundaries of the coastal zone, outline and prioritize the uses within the zone, and the mechanism by which the states would control the uses.[41] Since 1972 when the Act was passed, 34 of 35 eligible coastal states (including states surrounding the Great Lakes) and territories have begun implementation of approved coastal management plans.[42]

In North Carolina, the proper combination of regulation and incentives exist for managing nutrient loading and water quality, but have not been specifically linked together. The Neuse River Basin, subject to poor water quality as mentioned earlier, is required to reduce the quantity of nutrients in the waterways, specifically nitrogen, by 30 percent. To ensure long-term sustainable reduction in nitrogen and pollutants in the Neuse River, strategies should be comprehensive and have sufficient funds to encourage participation by all sectors. One underutilized source of funding, specifically for these issues, is the Clean Water Management Trust Fund, created to provide state funds to local governments, state agencies, and conservation non-profits for projects addressing water pollution problems. Linking the Clean Water Management Trust Fund's money more intentionally with the Neuse nutrient reduction strategies would create a more sustainable system.

Evolution vs. Revolution

North Carolina is a regional and national leader in many aspects of water management with numerous innovative programs. Its position as a leader comes in part from its willingness to make bold investments in water resources management. Governments often respond to continuous changes in the demands on and condition of water resources through incremental policy modifications to improve regulation. Incremental changes are often an improvement, and

in fact represent the best that can be accomplished given the intense competition among stakeholders. In many cases, however, they result in a slow evolution toward a more complicated regulatory environment, one that may be less effective than possible and more burdensome than need be. There is value in stepping back from the details to consider whether there are opportunities for significant, revolutionizing change in the way we manage and protect North Carolina's water resources.

Let us suggest a few opportunities for significant change. Considering these and other aspects of water management in the state could result in more effective, efficient policy and benefit both water resources and economic development.

- North Carolina has historically separated groundwater and surface water management. This separation does not reflect the reality that groundwater and surface water are a connected water resource.
- Water quality and water quantity are also separated into different departments in North Carolina's state government. Again, this separation does not reflect the reality of water resources, since water flows, allocation, and storage have a major influence on water quality, and water quality inevitably dictates what water is available to supply communities and ecosystems.
- River-basin-level and regional coordination of decisions that impact water resources is under-emphasized, though these are sensible scales at which to make water resources decisions. Decisions made at local scales often have side-effects for others in a watershed and discourage cooperation between communities. Shifting to more river-basin-level and regional management could yield improved coordination and flexibility for cost control.

One example where all the different aspects of the regulatory system were evaluated was in Georgia's 2004 Comprehensive Statewide Water Management Planning Act. It put into motion the review of water policies across the state and the development of a unified set of goals for local governments, developers, builders, and citizens, to simplify water management and foster more effective management and protection. Through its development, the planners are identifying and filling gaps in current Georgia water laws, regulations, and policies, and ensuring they meet such goals as: minimizing withdrawals of water by maximizing conservation, reuse and efficiency, and protecting water quality by reducing discharges of pollutants to streams and runoff from land.

It seems worth exploring whether North Carolina would benefit from a similar process of comprehensive evaluation to coordinate and improve water management for the future.

Linking Water and Prosperity: The Underlying Leverage

An underlying premise of this entire paper, and indeed the conference, is that North Carolina cannot have a healthy prosperous economy or quality of life without clean and sustainable water resources. It is necessary to explore and explain how economic growth depends on water, and how we can create more jobs and boost communities by using water resources. Incorporating water protection into plans for new growth by creating incentive programs, for example, can result in a protection plan that pays for itself and money savings for the long-term. Long-term planning for new growth based on water resources also addresses climate change adaptation. By protecting the natural buffers that will reduce the high costs associated with damages from flooding, storms, droughts, and other extreme weather events, municipalities will save taxpayers money and encourage sound, stable economic development. Every year, North Carolina's municipalities make decisions about their economies that impact water resources, explicitly or implicitly, locally and regionally. Raising the awareness of leaders and decision makers across the state to this co-dependence, and incorporating programs that maximize both, is vital.

Questions for Discussion

Are there opportunities for North Carolina to improve regulatory leverage for water resources in the short term?

Would there be a benefit from a more comprehensive reassessment and coordination of water resources policy in North Carolina?

Where streamlining, carrot-and-stick programs, or new coordinated state water planning have been tried, are they working as intended? Are there more effective ways we could use these strategies?

What are barriers to more effective regulation of water resources in North Carolina?

Should we continue to focus on evolving our existing regulatory structure, or would North Carolina be better off with revolution, a new regulatory structure?

How does North Carolina's economic prosperity depend upon clean, healthy water resources?

How can we better link water and prosperity, for example by creating jobs and boosting communities using water resources?

How might clarifying or making water management more comprehensive help North Carolina address the potential impacts of climate change? Can climate change itself be used as a leverage point?

[1] For example, early in the colonial period rich bottom lands and wetlands along the Chowan River and Albemarle Sound were drained. In Washington County, only 34 percent of the pre-colonial wetlands remain; wetlands once covered 186,000 acres. Dahl and Allord, "History of Wetlands in the Coterminous United States."
Available online at: http://water.usgs.gov/nwsum/WSP2425/history.html
In Hyde County in 1837, North Carolina's largest lake, Lake Mattamuskeet, was shrunk from 120,000 acres to 50,000, using slave labor, to expose more arable land. Subsequently the remaining lake was drained in 1916, 1920, and 1926.
The Mattamuskeet Foundation. Available online at: http://www.mattamaskeet.org
Between 1940 and 1960 most of the 37,000 miles of rivers and streams across the state were channelized or otherwise altered to promote development and agriculture by lowering the risk of flooding.
Farm*a*Syst North Carolina. Available online at: http://www.soil.ncsu.edu/assist/Stream/
[2] North Carolina State Demographics. Updated on June 7, 2005. Accessed June 16, 2006. http://demog.state.nc.us/
[3] Drought costs for 2002 were estimated at $15 to 20 million for municipalities and $398 million for agriculture—business and industry losses are not included in these estimates. The North Carolina Rural Economic Development Center estimated drought losses at $1 billion.
Weaver, J.C. 2005. The Drought of 1998-2002 in North Carolina—Precipitation and Hydrologic Conditions. U.S. Geological Survey Scientific Investigations Report 2005-5053. Available online at:
http://pubs.usgs.gov/sir/2005/5053/pdf/SIR2005-5053.pdf.
[4] USGS North Carolina Water Science Center. http://nc.water.usgs.gov/projects/9SY11/
[5] Central Coastal Plain Capacity Use Area Rules. Division of Water Resources, North Carolina Department of Environment and Natural Resources.
http://www.ncwater.org/Permits_and_Registration/Capacity_Use/Central_Coastal_Plain/CCPCUA_rule_summary_FAQ.php
[6] Rawlins, Wade. June 26, 2006. Land rush, runoff threaten inner coast's water; Coastal counties are just starting to act, and many developers exploit lax state rules. Raleigh News and Observer.
[7] North Carolina Department of Environment and Natural Resources. February 2006. "North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report)." Public Review Draft. Division of Water Quality, Planning Section.
[8] These efforts include a Capacity Use Designation for coastal aquifers to require coastal counties to reduce groundwater withdrawals; nutrient and sediment Total Maximum Daily Load rules and the Neuse Rules; nutrient trading and offset payments; basin-wide water quality and water supply planning; water quality funding sources like the Clean Water Management Trust Fund; mitigation programs such as the Ecosystem Enhancement Program.
[9] North Carolina State Demographics. Updated on June 7, 2005. Accessed June 16, 2006. http://demog.state.nc.us/
[10] USDA Natural Resources Conservation Service. 1997 National Resources Inventory. Revised December 2000. Downloaded on January 31, 2007 from http://www.nc.nrcs.usda.gov/technical/nri/landuse.html.
[11] McDow, W., K. Coracini, and D. Whittle. 2006. Standing Tall: a New Path for North Carolina's Forests. Environmental Defense. Data derived from David N.Wear and John G. Greis. 2004. The Southern Forest Resource Assessment, General Technical Report SRS-54, U.S. Department of Agriculture and U.S. Forest Service.
[12] McDow, 2006.
[13] McDow, 2006.
[14] U.S. Department of Agriculture, Natural Resources Conservation Service. 1997. National Resources Inventory. Available at http://www.nrcs.usda.gov/TECHNICAL/NRI/.
[15] Exum, L., S. Bird, J. Harrison, C. Perkins. May 2005. "Estimating and Projecting Impervious Cover in the Southeastern United States." Ecosystems Research Division, National Exposure Research Laboratory, U.S. Environmental Protection Agency. Athens, GA. EPA/600/R-05/061.
http://www.epa.gov/athens/publications/reports/Exum600R05061EstimatingandProjectingImpervious.pdf
[16] Exum, 2005.
[17] Taken from Brabec, E, Schulte, S, Richards, P.L. 2002. Impervious Surfaces and Water Quality: A Review of Current Literature and Its Implications for Watershed Planning. Journal of Planning Literature 16: 499. Original Source: Schueler, Thomas. 1995. Site Planning for Urban Stream Protection. Metropolitan Washington Council of Governments: Washington D.C. and Arnold, Chester L., Jr., and C. James Gibbons. 1996. Impervious surface coverage: Emergence of a key environmental factor. *Journal of the American Planning Association* 62, 2: 243-58.
[18] Graves, William. 2004. North Carolina Atlas Revisited. http://www.ncatlasrevisited.org/Economy/econtitle.htm#econtop
[19] Average Annual Precipitation in North Carolina. 2000. The Spatial Climate Analysis Service, Oregon State University. Accessed on Febraray 2, 2007. http://www.ocs.orst.edu/pub/maps/Precipitation/Total/States/NC/nc.gif
[20] USGS North Carolina Water Science Center. http://nc.water.usgs.gov/wateruse/data/Data_Tables_2000.html.

[21] Data from: Water 2030: North Carolina Water Supply and Demand Overview. NC Rural Economic Development Center. 2006. Available online at http://www.ncruralcenter.org/pubs/watersupplyanddemand.pdf.
[22] Water 2030: North Carolina Water Supply and Demand Overview, 2006.
[23] Water 2030: North Carolina Water Supply and Demand Overview, 2006.
[24] The classifications can be accessed from: http://h2o.enr.state.nc.us/tmdl/documents/Print2006IR20060503.pdf
They are as such:

Classification	Definition
4a	Waters with approved or established total maximum daily load requirements (TMDL's) for a defined pollutant or nutrient, but which have not achieved water quality standards.
4b	Water for which TMDLs will not be attempted as other required regulatory controls are expected to attain water quality standards by the next regularly scheduled listing cycle
5	Impaired for one or more designated uses by a pollutant including dredged soil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, wrecked or discarded equipment, industrial, municipal, and agricultural discharge
6	Impaired based on biological data; Have no identified causes of impairment although aquatic life impacts have been documented
7	Impaired but the proper technical conditions do not yet exist to develop a TMDL

[25] North Carolina Department of Environment and Natural Resources. February 2006. "North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report)." Public Review Draft. Division of Water Quality, Planning Section.
[26] NC Division of Water Quality. 2005. "Nonpoint Source Pollution Reduction Report: 2005 Annual NPS Report to the U.S. Environmental Protection Agency." Available at: http://h2o.enr.state.nc.us/nps/index.html.
[27] Water2030. Water, Sewer, & Stormwater Capital Needs, 2006.
[28] NC Division of Water Quality, 2005.
[29] Barker, J. C., and J. P. Zublena. 1995. "Livestock manure assessment in North Carolina." In Proceedings of the Seventh International Symposium on Agriculture and Food Processing Wastes. Washington, D.C.: American Society of Agricultural Engineers.
[30] Stone, K., P. Hunt, F. Humenik, and M. Johnson. 1998. "Impact of Swine Waste Application on Ground and Stream Water Quality in an Eastern Coastal Plain Watershed." Transactions of the ASAE. 41(6):1665-1670.
[31] North Carolina Ecosystem Enhancement Program. 2005-2006 Annual Report. Accessed at http://www.nceep.net/news/annualreport/2006/EEP_2005_2006_Annual_Report.pdf.
[32] The allowed income tax credit is 25 percent of fair market value of donated property interest, up to a maximum credit of $250,000 for individuals and $500,000 for corporations. Any unused portion of the credit may be carried forward for five succeeding years. Approximately $375 million of the total value of $620 million has been applied toward the tax credit, and nearly $250 million in value has been donated in excess of the values applicable toward the tax credit. Because the full potential tax credit cannot be used by many donors whose income is too low, the actual tax expenditure is less than the maximum potential tax expenditure of $94 million through 2006 (25 percent of the value applied toward the tax credit).
[33] Since the initiative began, 150,000 acres of land have been protected.
[34] Many utilities' water and sewer rates in North Carolina cannot cover the full cost of providing service, most prominently falling behind in funding infrastructure maintenance. In a sample of utilities with similar rates for an average household, the

UNC Environmental Finance Center found that operating expenses of two thirds of the utilities that exceeded revenues. This finding has been supported by the North Carolina Local Government Commission. The NC Rural Economic Development Center has quantified this deficit, estimating that $16 billion are needed by 2030 to pay for infrastructure repair and construction.

[35] Hughes, Jeff. 2005. The Painful Art of Setting Water and Sewer Rates. Popular Government. Spring/Summer 2005. pp. 4-14.

[36] The State Water Infrastructure Commission has recognized the short-term challenge of funding and longer-term challenge of sustainable financial management. The SWIC in a November 2006 report to Governor Easley recommended that the state approve a $1 billion bond for sewer and water infrastructure. At the same time it recommended that some funding be conditional upon sound and sustainable financial and technical management.

[37] Gleick, P.H., N.L. Cain, D. Haasz, C. Henges-Jeck, M. Kiparsky, C. Hunt, M. Moench, M. Palaniappan, V. Srinivasan, G. Wolff. 2004. The World's Water 2004-2005: The Biennial Report on Freshwater Resources. Washington, D.C.: Island Press. pps. 316, 320.

[38] USGS. 2000 (modified 2005). Water Use in North Carolina, Water Use Data, 2000. Accessible online at http://nc.water.usgs.gov/wateruse/.

[39] For example, per-capita daily water use from public supplies shot up to 177 gal/day in 2000 from 154 gal/day in 1995. In 1995 and 2000, irrigation water used per acre under irrigation was more than double the intensity from 1985 and 1990, taking NC from one of the most efficient states in the Southeast to one of the least. In 1995 and 2000 per-capita domestic self-supplied water use increased by 10-15 gallons per day over 1985 and 1990.

[40] http://h2o.enr.state.nc.us/su/usmp.htm

[41] Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service. Coastal Zone Management Act of 1972. Webpage accessed on February 13, 2007. http://www.fws.gov/laws/laws_digest/COASZON.HTML

[42] Coastal Management Program. Webpage accessed on February 13, 2007. http://coastalmanagement.noaa.gov/resources/docs/coastal_factsheet.pdf