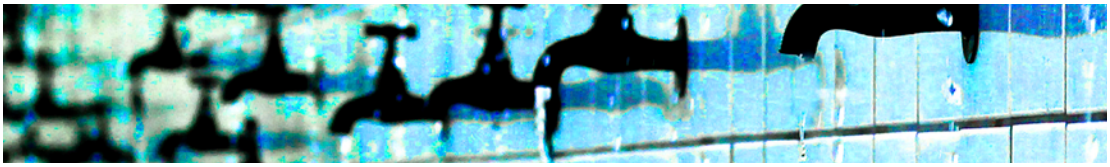
DRAFT 2008 Report of the Water Allocation Study team

to the NC Environmental Review Commission



DRAFT: for public comment and review

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A note on formatting in this report: This is a summary only. Text formatted like this contains links to much more extensive discussion and references on the water wiki.

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Summary

The central problem in water allocation in North Carolina is that the historically ample water supply makes it difficult to see the importance of proactive measures to guard against future shortages. The state uses water like a person who has no budget spends money. The only legal limit on using water, outside the capacity use area (CUA), is a vague requirement to "be reasonable."

The droughts of 2000–2002 and 2007–2008 have helped focus North Carolina on the importance of an assured water supply. The state's economy and environment depend completely on adequate fresh water. When the water supply is short, conflict can rise quickly to terrible levels, because people will do whatever it takes to get water.

The projected population increase in the next decades makes it very likely there will be more and more water shortages, and thus more conflict. But improving water supplies or becoming more efficient with the existing supply can take many years and substantial expenditures. It is imperative, then, that the state do the best job it can today of projecting where water shortages will occur in the foreseeable future, and ensuring that those places live within a water budget, either by adding more supplies or reducing demand.

The Water Allocation Study team recommends that the General Assembly take the following measures in 2009 in order to put North Carolina in a more secure position with respect to its water supply:

- **Clearly state policy goals to guide administrative and judicial decisions.**
- **Establish a permit for large water withdrawals.**
- **Conform existing laws to each other and to policy goals.**
- **Establish proactive, adaptive, river basin water supply planning.**
- **Simplify and integrate water and water-funding information.**
- **Address critical research and study needs.**
- **Ensure that water infrastructure is maintained.**
- **Reward and spread best practices and leadership efforts in water efficiency.**
- **Create more storage.**

It is no longer the case that each community and each water system can be left to figure out for itself its water future; water supply and demand up and down the river basins is much too interconnected to expect each system accurately to assess how much water it will have in the decades to come. At the same time, the state is too large and diverse economically, geographically, hydrologically, and institutionally to expect a centrally administered state water plan to be accurate, useful, and up-to-date.

The combination of a water-withdrawal permit for all large water withdrawers, similar to permit programs now in place in most other states, and a proactive, adaptive, river basin–planning system that is led by local water suppliers and water users can position North Carolina to be a leader in managing its water resources. Implementation of these and the other recommendations in this report, given the ample water supply the state normally has, would give the state a great comparative advantage in its water supply relative to the rest of the world.

North Carolina's approach to water allocation

Water allocation in North Carolina is a complex, un-integrated system. Its foundations are court decisions establishing riparian rights and reasonable use limits. On these un-integrated foundations the state has built a handful of regulatory programs. Alongside this state law are several important federal laws and the rules and operating policies of three federal agencies: the US Army Corps of Engineers, the Federal Energy Regulatory Commission, and the Tennessee Valley Authority. Poised atop these State and federal elements are the rules and operating policies of community water suppliers (both public and private sector suppliers), which are themselves constrained by local governing boards and, in the case of privately owned water suppliers, the NC Utilities Commission. Looming around all these elements are the claims of adjoining states to parts of the water supply and the possibility of international trade agreement limitations on state regulation of water. Further, water allocation is a social-ecological system, in the sense that there is a practically finite supply of water that varies independently of action by the state, and demands on this supply are the result of the decisions of many individual users and firms. There are also instream needs for water (such as for fish and other aquatic organisms and recreation). Finally, there are economic features of this system that are critical parts of the allocation puzzle: how water is priced and how water systems are funded.

Scenarios

Four scenarios will help show how the present approach to water allocation works and where there are gaps and weaknesses

that need legislative attention. Each scenario, or a close variation of it, has actually occurred in North Carolina, and each can be expected to recur.

1. Private firm buys old intake and consumes or exports water, even while downstream industries and water systems are running dry.
2. Private firm pumps groundwater and uses or exports it, even while adjoining farmer's wells dry up.
3. City is unaware of its precarious water supply and leaky pipes until it fails to deliver on promises to new development.
4. Strong population and commercial growth in the headwaters leaves a water system no or few options for additional supply.

Each scenario contains a brief discussion of the laws, policies, and institutions in the present system of water allocation that do and do not apply. At the end of the recommendations section of this report is a discussion of how the recommendations in this report would address each scenario.

1. Private firm buys old intake and consumes or exports water, even while downstream industries or water systems are running dry.

Imagine a major industrial facility in North Carolina that depends on a water intake from a river for its production. It could be producing paper, pharmaceuticals, food, or many other types of products; it could even be a power-generating plant that needs water for cooling. What if another company later located upstream by buying a facility that already has a water intake structure in the river, and the upstream company began to consume large quantities of water—either for its own production processes or to export bulk water to other locations in or outside the state? In low-flow periods, such as North Carolina experienced from 1998–2002 and 2007–2008, suppose the upstream company's withdrawal of water to export out of state meant that the major downstream facility had to stop operations because it could not get an adequate, assured supply of water? How do current North Carolina law and policy respond to this problem?

Under present law, there is little or nothing that state or local government could do. Assuming the upstream company has properly registered its large withdrawal, there is no executive-branch regulation of the amounts of water it can withdraw, even if its withdrawal causes substantial harm to prior, major downstream water users. There is no proactive review of whether the upstream user's plans are likely to cause a problem for downstream users, and there is no forum other than court to deal with the problem after it has occurred. The current law leaves it to the downstream user to litigate whether the upstream withdrawer's actions were unreasonable or otherwise violated the downstream industry's riparian rights—after the damage has been done. The outcome of this litigation would be highly fact-specific, uncertain, and likely take a long time to resolve. That outcome is unacceptable to most major water-using industries, and certainly to power plants.

Note that the downstream user could even be a community water system supplying water to tens of thousands of people; unless that system had rights under North Carolina's Stored Water Act (which is unlikely), it would be in just as bad and probably a worse position than the major industry to protect its water supply from a later withdrawer, even a withdrawer who was shipping bulk water to other places.

Note also that the upstream user could be an irrigator that, instead of using an existing water intake structure, put temporary pipes in the river and pumped water when it wished. In this variant of the scenario, which in fact occurred in the recent droughts in North Carolina, it might be very difficult for the downstream industry or community water system even to know who was taking the water, and thus whom to negotiate with or to sue. The irrigator is allowed to withdraw up to one million gallons per day without even reporting its withdrawal, and the pipes can be hard to see from the air.

2. Private firm pumps groundwater and uses or exports it, even while adjoining farmer's wells dry up.

Imagine a farm in North Carolina that relies on groundwater wells to supply water for its livestock—cattle and poultry. Livestock watering needs are not large, but streams in the Piedmont and mountains sometimes do not have enough reliable flow for assured watering, so wells and farm ponds are important agricultural water sources. Now imagine that a private firm buys an adjoining farm and installs large production wells to supply water for its own manufacturing needs. This could be for process water or to bottle water for export and sale. The new wells lower the water table and the farmer's wells go dry. The farmer drills new wells, but after spending tens of thousands of dollars drilling, still cannot find enough water to meet the farm's needs.

In this scenario, not only is there no help for the farmer from state or local executive branches of government, it is quite possible that the courts will award no damages or other relief. In the case of Bayer v. Nello Teer (1962), the North Carolina Supreme Court held that one property owner can extract groundwater and thereby damage another property owner's well without having to compensate the other property owner, so long as the first property owner is making reasonable use of water (not wasting it) on its own property.

The case might come out differently if the new wells were being used to bottle water for sale elsewhere. The law is unclear on this in North Carolina. If the new wells were being used to supply a nearby community water system, it is likely that the farmer would win an award of damages, under the reasoning of Rouse v. City of Kinston (1924), although the later *Bayer* case raises some questions about the continuing viability of *Rouse*.

What is clear is that the only state or local government remedy at present for conflicts over groundwater is the creation of a capacity use area (CUA). This statutory process requires the Environmental Management Commission (EMC) to find:

> the aggregate uses of groundwater or surface water, or both, in or affecting said area (i) have developed or threatened to develop to a degree which requires coordination and regulation, or (ii) exceed or threaten to exceed, or otherwise threaten or impair, the renewal or replenishment of such waters or any part of them.

North Carolina Gen. Stat. § 143-215.13(b). This procedure has been very useful for addressing generalized groundwater problems in the coastal plain, as discussed below in this report. But its usefulness in the Piedmont and mountains, with their very different, more complex

groundwater geology, and in highly localized disputes is questionable. All of the southeastern states now have capacity use area programs modeled more or less directly on North Carolina's; all of these states have created capacity use areas in their coastal plains; none have been attempted in the Piedmont or mountains (or for surface water).

It is also clear from the groundwater cases in North Carolina that landowners have no absolute property rights in groundwater. The Supreme Court addressed this question direction in 1924, in the *Rouse* case, and it follows implicitly from the *Bayer* case, where the court allowed one landowner to take the groundwater being used by another landowner without any payment of damages.

3. City is unaware of its precarious water supply and leaky pipes until it fails to deliver on promises to new development.

Imagine a medium-sized North Carolina city with a typically aged water distribution system serving 5,000 customers and a water source that was last expanded in the 1950s. The city has worked for years to attract growth, in part by keeping its water rates as low as possible, and always lower than its neighbors. Growth has largely eluded it, and in fact its population has been hurt by the departure in the 1990s of traditional manufacturing jobs. Its water supply has seemed adequate, since its population has been stable or slightly declining. In 2009, however, it has the good fortune of learning that a major manufacturing facility is interested in locating just outside the city limits, and wants water supplied by the city. After this announcement, several developers come forward with major subdivision proposals, also just outside the city, also wanting city water and sewer. How likely is it that the city is actually prepared to annex and serve or simply to serve these new customers? Might they make a commitment they cannot meet?

A city of this size in North Carolina that operates a water treatment and distribution facility is required to prepare a Local Water Supply Plan (LWSP). These plans are a laudable effort by North Carolina to improve water supply planning and ensure that major water systems do not get caught short of water or of treatment or distribution capacity. However, they have not fully achieved their potential as planning tools. It is quite likely that the city in this scenario never fully adopted its plan, that it never really came to the attention of its governing board, and that the city never actually invested in the supply and infrastructure it would need to meet the growth assumptions and aspirations that it has had.

Further, it is quite likely that this city, by managing primarily to keep water rates low, has not invested in the operations, maintenance, repair, and replacement of its water infrastructure. An audit of its water system would quite likely find large amounts of unaccounted-for water—representing lost revenue and actual lost supply. It would be, unfortunately, not at all surprising to find that this city could not easily keep the commitments it would want to make to supply water to the new developments proposed in its region. The economic development and development approval processes in North Carolina are not always connected to water supply availability, because of the historical assumption of ample water.

4. Strong population and commercial growth in the headwaters leaves a water system no or few options for additional supply.

Think of the high-growth, quickly urbanizing areas in North Carolina (as well as in Virginia, South Carolina, Georgia and Alabama). They are largely concentrated in the Piedmont—the upper Piedmont, typically (especially in the Triangle) near the headwaters of the major rivers. Unlike older large urban areas in other parts of the world, most of which were located in places accessible by ships and thus on major water bodies, our Piedmont cities tend to be located on much smaller streams. At the same time, they sit on rock that is hard and is underlain by relatively non-productive groundwater sources. In other words, they are not in optimal places from a water supply point of view. Their growth has depended historically on the normally ample supply of annual precipitation that North Carolina receives. As North Carolinians from the Blue Ridge mountains to the fall line (the interface of the Coastal Plain and Piedmont) have seen all too well in the past decade, it only takes a few months of rainfall shortages to put some water systems in the Piedmont under great stress.

But the population is scattered across the Piedmont, in a much dispersed form, with many small towns in addition to the major urban centers. There are very few sites where significant new reservoirs could be built that would not impinge on other towns' jurisdictions and substantial developed property. In addition, North Carolina's laws regarding interbasin transfers make it very difficult to move large quantities of water (more than two million gallons per day) from one river basin to a city in another river basin.

This makes it a great challenge and an expensive proposition to improve the safe yield and resilience of water supplies in the high-growth regions of the Piedmont. New reservoirs will be very expensive (the cheaper locations are long gone) and will require extensive intergovernmental cooperation or years of political fighting and litigation. At the same time, many of the towns that might optimally be part of a multi-jurisdictional solution have historically acted like the city in scenario 3: they keep their water rates as low as possible. This is another, important barrier to the city that wishes to make the needed investments in additional supply and maintenance of its infrastructure. To do so will require water rates that may be substantially higher than the rates charged by its neighbors. North Carolina has a system of water supply in its rapidly urbanizing areas that threatens to punish those systems that do the right thing, by investing in water. The incentives are out of alignment with the reality of population growth, where that growth is likely to occur, and how long it takes (decades) to site significant new water storage facilities.

In sum, as these four scenarios suggest, North Carolina has some useful pieces in its water allocation system, but they are not adequate to deal with increased water scarcity. The North Carolina system for regulating conflicts between water users relies largely on individual lawsuits and a highly reactive regulatory approach that may not even be usable west of the fall line. In the areas where North Carolina is expected to grow the fastest, the water allocation system actually discourages investment in water supply and infrastructure maintenance. Despite historically ample precipitation—or perhaps because of it—the state is not well positioned to meet the increasingly competitive needs of water users in the future.

Study background and key findings

How the study was carried out

This study's purpose is to frame and analyze policy options for water allocation for consideration by the North Carolina Environmental Review Commission (ERC). Water allocation is a social-ecological system (SES): a system in which humans make purposeful decisions that strongly interact with natural processes. The primary focus is geographically North Carolina and temporally the next fifty years, but the study also looks at larger and smaller scales both geographically and temporally. For example, decisions by local water supply systems about their sources of water, prices for water, connections to other systems, maintenance and repair of their water infrastructure are integral parts of North Carolina's water allocation system. Those are important smaller scale concerns. Similarly, decisions by states with which North Carolina shares borders and by federal agencies affect state water allocation, as do decisions by private corporations that have no real fixed geography. Those are important larger scale concerns. There are also important short- and long-term temporal scales. But the focus is North Carolina in the next fifty years.

The plan for the study emerged after comments on a series of framing questions were received at several public meetings around the state. The principal investigators and the research team spent hundreds of hours in 2008 meeting with experts and interested parties to understand their concerns and insight into water issues. As a result, the study focused on six current policy areas: the capacity use area program; the interbasin transfer process; the interconnection and regionalization of water systems; water pricing, funding, and institutional capacity; the local and state water supply planning process; and drought response. These are critical components of the water allocation system.

The supply/demand balance in NC: are we within our water budget?

The short answer: we have no water budget, so we do not know. Projecting and preparing for future water demands is critical to North Carolina's overall well-being. As noted by the Water 2030 study, conducted in 2004, a growing population will increase industrial, residential, and energy needs, thus increasing overall water usage. "The population is expected to grow from 8.5 million in 2004 to 12 million in 2030. Water consumption is expected to increase from 241 billion gallons per year for all households to 335 billion gallons if consumption continues on its current path." As a result, the Water 2030 study called for funding to address new supply infrastructure, education, and policy issues.

The Water 2030 study originally intended to estimate the overall water supply, but was ultimately unable to do so. The best method for assessing the state's supply/demand balance—in other words, whether the state is and is going to be using water within the water budget available to it—is through the hydrologic models of each river basin that are now under construction by the Division of Water Resources (DWR) within the Department of Environment and Natural Resources (DENR). Many factors, including climate change, land use changes, the lack of groundwater change data, and the varying quality of the Local Water Supply Plan data used as inputs to these models, make them imperfect, but they remain the best available scientific predictors of the times and places where water shortages will occur in North Carolina in future decades.

The United States Geological Survey (USGS) water usage survey offers a different perspective on projected demand from that of Water 2030. The USGS study states, "The early part of this history (1950 to 1980) showed a steady increase in water use. During this time, the expectation was that

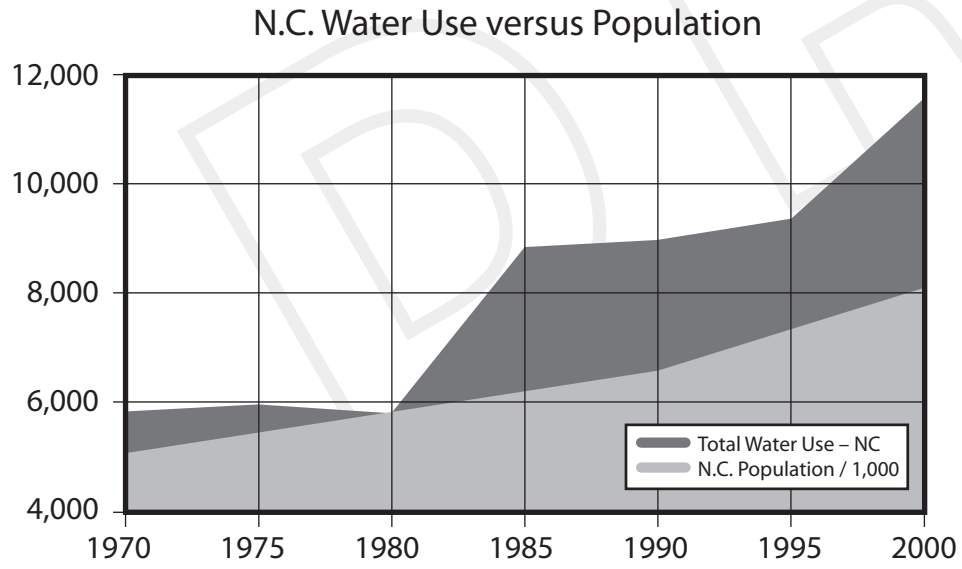


FIGURE 1. North Carolina's historical water use, in mgd, plotted against population growth (divided by 1,000 to scale to water use in mgd). Water use data from USGS; population data from NC State Demographics Office.

as population increased, so would water use. Contrary to expectation, reported water withdrawals declined in 1985 and have remained relatively stable since then. Changes in technology, in State and Federal laws, and in economic factors, along with increased awareness of the need for water conservation, have resulted in more efficient use of the water from the Nation's rivers, lakes, reservoirs, and aquifers."

Thus, it is not a foregone conclusion that as population increases water demand will increase at the same rate, especially if technology, legal restrictions, and efficiency-improvement efforts continue. The historical usage data plotted against population in North Carolina show this clearly: while water use overall does rise with population, the rates of increase in water use can vary from the increases in population. A great deal of this variation depends on how efficient water use is.

A recent study of Las Vegas water usage concluded that increasing the efficiency of home appliances and installing water-efficient landscapes "can be implemented at a lower cost and with fewer social and environmental impacts than developing new water supplies."

So predicting future water usage is a difficult task. As we have seen above, population rates may not be as closely tied to projections as previously thought. However, based on NC's 2000 overall usage structure the state's future water demands will be closely linked to its four largest users—energy production, residential consumption, agriculture, and industry. Efficiently managing these uses may negate the need for significant increases in "hard path" solutions (i.e., dams, aqueducts, pipelines, etc.).

NC's water usage in the categories examined by the USGS survey for the year 2000. Thermoelectric and public supply accounted for 92% of water use statewide.

User	Amount (mgd)
Energy use	9,470
Public Supply, including Institutional, Light commercial, and Residential	945
Industry	293
Irrigation	287
Domestic wells	189
Livestock	121
Mining	36.4
Aquaculture	7.88
TOTAL	**11,349**

In comparison with other states of similar size, North Carolina uses more water per capita. For example, in 2000 North Carolina withdrew approximately 11,400 million gallons per day (mgd) with a population of 8,049,313, while Georgia, with a population of 8,186,453, used only 6,500 mgd. The large discrepancy between NC's and GA's water usage is due to NC's greater use of water for thermoelectric power.

Finally, there are also critically important water "uses" in the stream—ecological flows, recreation, and waste assimilation.

Dr. Peter H. Gleick, an internationally recognized water expert and president of the Pacific Institute, outlines an alternative or "soft path" solution. "What is required is a 'soft path,' one that continues to rely on carefully planned and managed centralized infrastructure but complements it with small-scale decentralized facilities." The soft path takes into consideration convenience,

cost-effectiveness, and social acceptability. Gleick's estimates project that urban water use could be reduced by 33%. In his study "Waste Not, Want Not," Gleick examined California's urban residential, commercial, institutional, and industrial water uses.

More cautious estimates predict that conservation could reduce demand by as much as 25%. Based on these estimates, conservation efforts alone could reduce NC's daily municipal, farming, and industrial water use from 1,835 mgd to 1,376 mgd (from the USGS 2002 data). Overall, conservation could reduce NC's total daily water use from 11,349 mgd to 10,890 mgd. In some locations this reduction in use could significantly delay or even eliminate the need to develop a new water source. In essence, the new source is created by improved efficiency.

But these are numbers from the year 2000. As the population grows and the variability in flows increases due to climate change and other factors, demand will rise and supply will be less certain. The critical questions in establishing a water budget are: How fast will demand rise? (answer is driven by how efficient the water use is). Will there be adequate supply? (answer varies by place and time and is knowable only through hydrologic modeling). In places where demand will outpace supply, how will North Carolina deal with the resulting conflict? To answer this last question, the water allocation study looked at the existing laws, policies, and institutions in North Carolina that affect water allocation.

Current regulatory processes: key findings

Capacity use area program

North Carolina's capacity use area (CUA) program is of central interest to the Water Allocation Study because it provides actual examples of what happens when the state takes a more rigorous approach to water allocation than under the traditional riparian rights, common law approach. In particular, North Carolina has required withdrawal permits for significant groundwater users in its capacity use area. It has also begun a long-term program of mandated reductions in withdrawals. Finally, North Carolina's current capacity use rules allow trading of water allocations, thus providing potential insight into the ability of water markets or quasi-markets to work in a riparian rights setting.

The Capacity Use Area program is currently applied to the Central Coastal Plain (CCP), a rural region in the eastern third of North Carolina that is dotted with small towns. A group of formations collectively known as the Cretaceous aquifers supply the vast majority of water to communities in the CCP. The aquifers have had a reasonable yield and produce high-quality water that generally requires little, if any, treatment, resulting in an inexpensive water supply.

As population and water demand have increased in the CCP, water levels within the aquifer have been declining at a rate of more than one foot per year in many regions. Lower aquifer levels can create problems if wells are not deep enough and, as a result, pumps need to be lowered. Aquifer dewatering, which occurs when the water level drops below the aquifer's confining layer, can lead to

strata compacting and the permanent loss of storage space within the aquifer. Lower aquifer levels also permit salt water intrusion (water with elevated dissolved solids levels) to move inward from the coast. Monitoring data throughout the 1980s and 1990s suggested that the future viability of the formation was at risk, and the state invoked the Water Use Act of 1967, which authorizes the state to declare the affected region (including all or parts of fifteen counties) a capacity use area. This problem of overextraction of water in the coastal plain is shared by all the southeastern states in the United States.

Under the final CCPCUA rules, groundwater withdrawals for users pumping more than 100,000 gallons per day (gpd) are to be reduced beginning in 2002 over a three-phase, sixteen-year period. Depending on whether the user is withdrawing water from the declining water level zone or the salt water intrusion or dewatering zones, users are required to cut back either 10% or 25% relative to an approved base rate in 2002, respectively, at the end of each of the three phases (6 years, 5 years, 5 years), resulting in total reductions of either 30% or 75% by 2018. Since demand may rise over the sixteen-year period, at least some users will be entitled to withdraw even less than 70% or 25% of their demand by 2018. The CCPCUA rules became effective August 1, 2002. As of this writing, users who are required to cut back withdrawals should have completed a 10% or 25% reduction, since phase II began on August 1, 2008.

The Division of Water Resources within NC DENR provides permits to all users who withdraw more than 100,000 gpd. This includes public utilities, industry, agriculture, and other types of users. Intermittent users, defined by the capacity use rules as users who withdraw water fewer than sixty days a year, are not required to register for a permit. Many agricultural irrigators and fish farmers are, therefore, not affected by the CCPCUA rule.

Permits expire within ten years (usually fewer) and must be renewed. Only permitted users that withdraw groundwater from the Cretaceous aquifer zones are required to cut back withdrawals over time. An approved base rate of withdrawals prior to 2002 is established, and water allocations are determined from that base rate (after calculating the required cutbacks).

About 107 public water utilities (government owned or not-for-profit private utilities) operate within the fifteen-county CCPCUA, 79 of which withdraw more than 100,000 gpd and currently have CCPCUA permits. Of that number, 36 water utilities are required to cut back groundwater withdrawals. Here is a map of the 107 water utilities in the CCPCUA, identifying the 36 facing mandated cutbacks.

To make up for the reduced withdrawals, communities will need to use surface water, withdraw water from alternative minor aquifers in the region, purchase groundwater withdrawal rights from users reducing their withdrawals below the state-imposed maximum, or increase efficiency. The Neuse and Tar rivers are thought of as the viable surface water supplies for the area although, prior to the CCPCUA designation, there has been only one surface water treatment plant on each river in the CCPCUA (Goldsboro on the Neuse; Greenville Utilities Commission on the Tar).

As a result of declining groundwater levels and the CCPCUA, the Neuse Regional Water and Sewer Authority

(NRWASA) was created to provide treated water from the Neuse River to its eight members. When the 15 mgd water treatment plant begins wholesaling water in September of 2008, these communities will be able to meet the entire 75% groundwater withdrawal reduction while still in the first phase. The members agreed to a minimum 7 mgd purchase contract (their current usage) that allows the NRWASA to service its $59 million debt on the USDA-funded plant.

The CCPCUA has also created the incentive for Greenville to invite local communities to purchase excess capacity from its existing 22.5 mgd surface water treatment plant. Two communities, Farmville and Greene County, have signed forty-year contracts in which Greenville agrees to provide them water on an interruptible basis. The agreement has Greenville supplying substantial quantities of water to these communities during periods when it has excess capacity, but it reserves the right to withhold that water up to thirty-six days per year when it faces peak demands in its own service area. Farmville and Greene County's annual permitted groundwater capacity following the cutbacks will be adequate to meet their demand when Greenville interrupts the service. At present, all parties seem satisfied with this agreement, and other local water systems are in discussion with Greenville about entering into similar contracts.

The CCPCUA designation established rules for addressing water supply (groundwater) problems that has in turn led to a rich diversity of locally implemented water management strategies. Studying how dozens of different local governments within the same region addressed similar water supply challenges reveals the diversity in management approaches available to local utilities. The experiences in this region also provide insight into ways in which state policies and laws promote or hinder specific local measures. These measures are summarized in Appendix A, which is a list of measures that could be taken in any stressed river basin to improve water allocation, based on lessons learned in the CCPCUA.

Interbasin transfer regulation

North Carolina has very stringent regulations that limit new interbasin transfers (IBTs). A discussion of the present process and its history is here on the water wiki. In 2007 the process for obtaining an interbasin transfer was changed to include broader notification requirements and more public hearings, a more rigorous analysis of the environmental impact, and a more complex petition for the transfer. The bill makes the out-of-basin water need subordinate to the in-basin need while restricting the types of uses for water transferred out of the basin. On the whole, the process is lengthier and more expensive and may make it less likely that a permit will be granted.

There are legitimate and deeply felt concerns about interbasin transfers in North Carolina that account for these barriers. Many people in basins of origin for water transfers worry that their basin will need that water in the future to assure their communities' ability to grow and prosper. Others believe that water availability within a given basin should be viewed as a limit on growth in that basin. Still others believe that allowing easy transfers encourages communities to waste water and to avoid enacting efficiency and conservation

measures that would be more sustainable ways to supply water.

However, views about interbasin transfer tend to be driven by assumptions about what those transfers are like, and the assumptions are not always grounded in fact. The NC Chapter of the American Waterworks Association (AWWA) produced a white paper on interbasin transfers on December 19, 2006, authored by Barry Gullet, PE, of Charlotte-Mecklenburg Utilities, then chair of the NCAWWA. This is a good summary of how past and current IBTs in North Carolina actually work.

Although IBT permits need to be reviewed comprehensively, there can be clear benefits to allowing these transfers, and it is possible that the complexity of the certification process discourages beneficial transfers. Specifically, transfers can increase water supply reliability, delay the need for building reservoirs and treatment plants, and reduce environmental impacts.

Water supply reliability can be increased and costs reduced by the cooperation of water utilities entering into water transfer agreements, such as interconnects, that take advantage of variability in excess capacity and in supply and water usage patterns between the water systems. This variability may be higher in systems in different basins compared to ones in the same basin because of geographical differences in land use and weather. As a result, IBTs may allow even greater benefits.

Structurally augmenting supplies (e.g., reservoirs, wells) is becoming increasingly costly while also imposing unpopular environmental impacts (Gleick 2000; NRC 2001). A given geographical region will likely have a limited number of viable supply-enhancement options. This is particularly true in the fast-growing headwaters regions of North Carolina's Piedmont. It can be economically and environmentally beneficial to develop the best option and share it with neighboring systems, even those in other basins, to prevent development of more expensive systems in more environmentally sensitive areas.

IBTs are typically requested to meet projected ongoing demand, and once the IBT certificate has been granted, utilities can withdraw up to the allotted amount given they meet the other conditions of the certificate, which may include implementing drought-management measures during times of drought. Conditional withdrawals are another option that preserve much of the gains in reliability and cost while minimizing total transfers. Work with interconnects (Palmer 2006) between three utilities in North Carolina's Triangle area shows that by allowing transfers only under certain conditions (a utility having fewer than a specified number of days of supply remaining or having a risk of failure above a certain level), the volume of water transferred is reduced by 60% to 80% over a simple daily transfer cap. Although this work considered transfers of finished water between communities, it should also apply to transfers of raw water.

The IBT certificate process has its own costs that make it more difficult for systems, especially small ones, to cooperate. According to Tom Fransen, Water Allocation Section chief for DWR, regarding the request by Concord and Kannapolis for an IBT to draw water from the Catawba and Yadkin rivers, "It's costing people roughly $1 million to go through the process, and doesn't guarantee that you get the permit" (Carolina Journal

Online 2007). As of the date of this report, litigation continues over the IBT certificate for Concord and Kannapolis, so the costs continue to mount.

Regionalization and interconnections of water systems

The droughts of 2000–2002 and 2007–2008 showed the value of having interconnections between water systems for emergency sources of water, and the State of North Carolina actively encouraged and financed emergency interconnections. Yet the state's interbasin transfer policy actively *discourages* permanent movement of water across river basin boundaries as a primary means of supplying water. At the same time, the Regional Water Supply Planning Act of 1971, as set out in G.S. 162A-20 et seq., formally commits the state of North Carolina to a regional approach to water service delivery.

Regionalization of water supply systems involves the planning and construction of systems that serve several populations that traditionally would have been served by individual systems created by county or municipal agencies. Larger regional plants provide savings through economies of scale for construction, operation, and maintenance and generally can afford staffing levels to provide the necessary testing and oversight to ensure safe water is being produced. Interconnects, on the other hand, are physical connections between the distribution systems of existing facilities that allow water from one water treatment plant to be delivered to the customers of another. Interconnects can decrease construction costs by delaying the need for a treatment plant or reservoir expansion and by increasing the reliability of water supply by taking advantage of different usage and supply patterns among the facilities. Interconnects, however, leave control largely in the hands of the local authority or municipality running each plant.

Regionalization

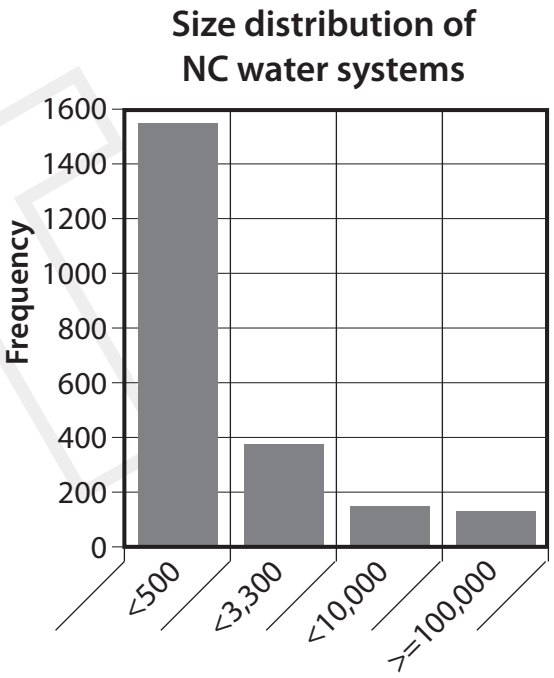
North Carolina is rife with small water systems and this has been a policy problem for decades. The preamble to the Regional Water Supply Planning Act of 1971 mentions the dominance of small systems, which are " . . . generally inferior to systems serving larger communities as regards adequacy of source, facilities and quality . . ." as a justification for promoting regionalization. It claims that 80% of the then 1,782 public water supply systems served fewer than 1,000 people each. Thirty five years later, the News and Observer presented data from the USEPA showing that in 2005 North Carolina had more water systems (over 7,000) than any other southern state and more than double the national average. The vast majority of the systems are small, with over 90% of them serving populations of fewer than 3,300 people. The article asserts that the state agency overseeing drinking water quality has been overwhelmed trying to monitor safety tests and that, as a result, too many systems do not meet current water-quality standards. More recently this number has been steadily declining as urban areas have grown and absorbed many smaller systems. Yet in mid-2008, it was still the case that the vast majority of water systems in North Carolina, even of community water systems, were small systems.

Regionalization takes advantage of the economies of scale because one larger treatment facility replaces several smaller ones. Treatment plant capital costs can be estimated using a power function (Clark

and Morand 1981) where capital costs increase less than proportionally to an increase in treatment capacity. For example, a 100% increase in treatment capacity would result in only a 60% increase in plant construction costs. A similar effect holds true for operating and maintaining the plant (Wooten Company et al. 2000), although to a lesser extent. Some of these savings are offset by conveyance costs, which are required to build pipelines and pump water over longer distances.

The concept of regionalized treatment facilities has been historically explored almost exclusively within the context of wastewater treatment (Kirsch and Characklis 2005). Models have been developed to determine the optimal number, size, and location of regional facilities. The ultimate objective of these models was minimizing total regional cost. This was sensible at the time, as the federal government was providing much of the funding for wastewater infrastructure, but these approaches did not give much attention to the costs such regional solutions might impose on individual communities.

In situations where little external (i.e., federal) funding is available, communities are likely to pursue whichever solution meets their individual needs at the lowest cost rather than alternatives that lower aggregate regional costs. This is the fundamental economic reason why the policies stated in the Regional Water Supply Planning Act of 1971 have not been fully met. There are also strong perceived political reasons for maintaining local autonomy—to preserve local control over public water as a growth-inducing service and to preserve local control over water prices.



Community systems "active" in DENR's Drinking Water Watch database as of June 16, 2008.

FIGURE 2. NC COMMUNITY WATER SYSTEMS BY SIZE OF POPULATION SERVED, 2008

Researchers have partially addressed the potential for inequity in regional solutions by devising cost-apportionment methods to divide costs among users once a minimum cost regional solution is identified (Giglio and Wrightington 1972). However, these methods do not ensure that each community is meeting its objectives at its lowest cost; scenarios can be demonstrated in which each cost-apportionment method is shown to be disadvantageous to at least one participant, such that the participant is better off acting independently, despite the regional system's advantage to the region as a whole. When a large percentage of capital funding does not require participation in a regional system, water supply services generally end up being delivered on the basis of the choices of individual communities.

Those communities will often have several alternatives other than regional approaches (i.e., surface and groundwater).

When a proposed regional system encompasses users in different river basins it must be approved under North Carolina's interbasin transfer policy. Obtaining an interbasin permit is uncertain and difficult, and this can discourage the development of such systems. This might lead to higher costs and decreased water supply quality for some communities while increasing the reliance on raw water supplies that might be more environmentally sensitive or that have a lower sustainable yield than if interbasin transfers were more easily available.

Examples of Regionalization

As a result of the central coastal plan capacity use area (CCPCUA), the Neuse Regional Water and Sewer Authority was created to provide treated water from the Neuse River to its eight members. The members agreed to a minimum 7 mgd purchase contract (their current usage) that allows the NRWASA to service its $59 million debt on the USDA-funded 15 mgd plant.

The CCPCUA also created the incentive for Greenville to invite local communities to purchase excess capacity from its existing 22.5 mgd surface water treatment plant. Two communities, Farmville and Greene County, have signed forty-year contracts in which Greenville agrees to provide them water on an interruptible basis.

The Kerr Lake Regional Water System is a public water system serving the City of Henderson, City of Oxford, Town of Kittrell, Town of Norlina, Town of Warrenton, Town of Middleburg, Franklin County, and City of Louisburg. This system has requested an increase in its allowed interbasin transfer from the Roanoke to the Tar and Neuse river basins to meet supply needs until 2030.

After twenty years of planning, groundbreaking occurred in August of 2008 on a $42 million plant and $20 million network of lines and pumps for the Regional Water Treatment Plant at Randleman Reservoir serving communities in the Triad: Greensboro, High Point, Randolph County, Randleman, Archdale, and Jamestown. The plant is expected to begin providing drinking water to designated areas in 2010.

Interconnections

Traditional approaches to meeting demand, such as structurally augmenting supplies (e.g., reservoirs, wells), are becoming increasingly costly to develop while also imposing unpopular environmental impacts (Gleick 2000; NRC 2001). One method of increasing the efficiency of water allocation, both spatially and temporally, is through transfers of existing supplies between users (Jordan 1999). While there is no provision for the private ownership of raw water in the eastern United States, once water has been acquired and treated, utilities often have an ability to transfer treated water to other communities. When this transfer occurs between two otherwise independent water systems an interconnect is created.

Interconnections can reduce the risk of water supply shortfalls while saving money for the participating utilities. Risk reduction occurs because even nearby utilities can have differences in their supply of raw water, treatment plant capacity, usage patterns, and susceptibility to drought. By combining the water supply capacity of the participating systems, the risk of failure is lowered. Many utilities, for example, have interconnections with neighboring

systems for the sole purpose of supplying or receiving water during emergency situations, including contamination of one system's water supply or in times of short-term supply concerns. Interconnections, especially emergency interconnections, are relatively common, as seen in this map of water system interconnections in 2002 in North Carolina's Central Coastal Plains.

Excess capacity usually exists because new treatment plants and reservoirs are designed with capacities that anticipate growth over several decades, and these systems are therefore underutilized when they first come online. Interconnects allow new systems to be more fully utilized while delaying the need for large capital projects for older utilities that are purchasing finished water.

If interconnects are to become more common, utilities must become more comfortable with creating transfer agreements that determine the timing and volume of transfers. Transfer "triggers" can be constructed to reduce risk to the buyer and seller, but a very low-risk tolerance can reduce the benefits of the interconnect. Transfer contracts can include the use of low-risk thresholds for triggering transfers, thereby reducing the probability of a buyer shortfall; seasonal restrictions on transfers, which might reduce the seller's responsibility to transfer water during its peak demand months (i.e., summer); limits on transfer volume, which act to ensure reliability for the seller's own customers; and rules for sharing the seller's available treatment/conveyance capacity among multiple buyers.

Interconnects can also require an interbasin transfer permit if the utilities have customers in different river basins and the volume of possible transfers exceeds 2 mgd.

Case Study

Caldwell and Characklis (2008) analyzed inter-utility transfer agreements that would allow three Triangle utilities (Cary/Apex, Durham, and the Orange Water and Sewer Authority (OWASA)) to meet their future demands in the face of regional growth. The transfer agreements developed in this work would allow Durham and OWASA to meet dry year demands in the short- and medium-term by taking advantage of an existing supply with available capacity at Cary/Apex, even as they undertake long-term plans to develop new water supplies.

The analysis involves moving beyond consideration of the minimum-cost scenarios and toward the types of transfer agreements that the utilities felt would be more likely to be implemented because they include different types of conditional limits on when and how much water can be transferred. Within this framework, the objectives of the study were to conduct an in-depth analysis of the volume, frequency, and timing of transfers expected under specified scenarios and to provide estimates of the costs associated with any particular transfer agreement.

With respect to the agreement types considered, results show that over an eighteen-year simulation period (which includes two of the most severe droughts on record) transfers could successfully assist the participating utilities in meeting future demands. Depending on the utility and the risk-reduction mechanisms in place, transfers only occur between one and six years over the eighteen-year simulation period. The integration of various risk-reduction mechanisms into the transfer agreements was shown to have significant

impacts on the timing and volume of transfers.

Ultimately, the results of this study suggest that, with the proper infrastructure, transfers from Cary to OWASA and/or Durham could be used to avoid shortfalls during periods of drought until such time as new sources are available. While the cost of these transfer agreements may be high during drought years, the average cost is likely to be relatively small. In fact, the estimated annual average costs of the transfer programs considered here compare quite favorably with the capital costs associated with building new capacity, suggesting that these programs could even be used as a means of forestalling the development of new sources.

Water pricing, funding, and institutional capacity

Water System Economics and Rates

The twentieth-century business model for both public and private water systems was to borrow funds to build water supply, water treatment, and water distribution systems and to sell gallons of water to pay operating, maintenance costs, and debt service. Water systems have high fixed costs. Most public and private water systems make their "profit" selling more water during the summer for irrigation, cooling, and other purposes. High water sales and revenues (in many systems record-high water sales) during July and August 2007 cushioned the blow of water conservation and low water revenues in the fall of 2007 and winter of 2008.

This business model is a major barrier to implementation of water efficiency and conservation programs. Water systems need to change their business model to sell water services instead of gallons of water. Local elected officials and the NC Utilities Commission set rates for public and private systems, respectively. Electric and gas utilities are beginning to sell electric and gas services instead of kilowatts and therms. Section 9 of HB 2499 provides an incentive for water systems seeking state grants and loans to adopt conservation rates. A quick, useful way to check and compare water rates among systems in North Carolina is to consult the rates dashboards compiled and published by the UNC Environmental Finance Center.

Few public water systems in North Carolina practice true asset management, depreciate their assets, and set rates accordingly. Many systems are not sending the correct pricing signal to their customers (understood as the price that fully covers the costs of extracting, treating, and distributing the water, including the depreciation of the system). Accordingly, customers waste water. Appointed members of water and sewer authorities are more likely to charge for the true costs of providing water services than are local elected officials. Appointed members are more likely than elected officials to vote for rate increases. Some elected officials perceive raising water rates as raising taxes.

Water System Funding

It is important that the sources of capital funding for water systems do not, through their funding alternatives, create disincentives for efficient system management. Historically, many of North Carolina's water systems depended on grant funding—originally from the federal government and then, when federal grant funding began ramping down in the 1980s, on state grants. Today there is a stronger sense that water system revenues and low- or no-interest loans are preferable to grants,

from a policy point of view, and most water system funders in North Carolina are moving in these directions. But North Carolina systems still rely disproportionately on grants.

G.S. § 159G-23 sets out eight important criteria that funders of clean water grants and loans should consider before approving funds. An improved Local Water Supply Plan (LWSP) could become the basis upon which local governments demonstrate public necessity, efficiency, sound management, capital improvement planning, and other criteria to funders. This would provide an incentive to local governments to develop, adopt, and implement the LWSP. The water Funders Forum, including the Division of Environmental Health, Division of Water Quality, Clean Water Management Trust Fund, Rural Economic Development Center, and USDA Rural Development, has begun discussing how to implement changes to G.S. 159G-23(3) on efficiency, enacted by the 2008 General Assembly in S.L. 2008-143 (HB 2499), Improve Drought Preparedness and Response. The results of this Funders Forum have been shared with the State Water Infrastructure Commission (SWIC)

Local water supply planning

North Carolina's water supply planning initiative originally developed as a response to a severe drought that occurred in 1988. The first Local Water Supply Plans (LWSPs) were submitted to the state's Division of Water Resources (DWR) in 1989 and primarily included data regarding municipal water demand. Every subsequent drought has generated new questions for the LWSP surveys and additional legislative initiatives to build on the program first implemented nearly twenty years ago.

Beginning in 1992, G.S. § 143-355(l) required Local Water Supply Plans for all municipal water systems and all community water systems serving more than 3,000 people or 1,000 connections; the statute also requires that plans be updated every five years, which to date has included 1992, 1997, 2002, and 2006–2007.

North Carolina's State Water Supply Plan, dated January 2001, is based on LWSPs developed during 1998 and 1999, which reflect the water system data reported by over 500 local government water systems for 1997. This plan serves as a reference point for statewide water supply needs, water use, and supply issues across the state. The Division of Water Resources has recently adopted a new river basin–oriented planning strategy to correspond with the Division of Water Quality's river basin planning and to further foster long-term sustainable water resources management.

Overview of Local Water Supply Plan Submittal, Review, and Tracking Process

The Division of Water Resources begins each round of LWSP submittals by working with the Public Water Supply Section (of the Division of Environmental Health) to verify the current list of systems meeting the submission criteria. In coordination with the NC Rural Water Association, DWR notifies systems early in the year about their required submittal the following July and provides a series of workshops around the state for technical support in developing municipal plans. The workshops provide a comprehensive overview of the planning process and provide a step-by-step guide to developing the information needed to submit the plans online. In addition, DWR's software allows staff to provide virtual online assistance in real time—both

the person filling out the survey and the staff member can review the screen at the same time.

With each submittal cycle, the LWSP questionnaires have grown in sophistication. The 1989 data are skeletal, and summary statistics provide only system-consumption parameters. DWR is in the process of transitioning the submittal process to correspond with river basin modeling and to spread their plan reviews over five years (instead of requiring all plan submittals the same year). For the purpose of this study, researchers had access to plans for 1989 (demand only), 1992, 1997, and 2002. The LWSPs for 2006–2007 are still under review and have not been completed. Portions of WSP data from '97 and '02 can be found online at the DWR website; no data prior to '97 are available online. Each WSP cycle has grown in the sophistication of information requested via online submittal. While originally submittals were hardcopy, now systems can submit their entire plans and supporting documents online.

After the plans are submitted for a particular round, DWR staff begin the review process. The surveys are designed with checks and balances throughout the questions to ensure accuracy of information wherever possible. Where answers do not match or are not complete, DWR staff provide a follow-up list of questions to the water system. This review process can take two or three iterations in some cases. When the process is complete, DWR sends a notification that the system has received approval for its plan. At that time, the local government formally adopts the plan, and it is considered final until the next cycle. Many systems never complete the process. Summary statistics are provided in the quantitative section regarding the percentage of plans that are deemed approved, completed, or incomplete.

Methodology

Because the scope of the LWSP surveys changes with each cycle, few consistent parameters exist among the plans submitted in 1989, 1992, 1997, and 2002. The data requested during each survey cycle included municipal demand; however, even this data changed parameters from 1989 to 1992 when the surveys began to distinguish between average daily demand (ADD) and service area demand (SAD). ADD is the entire average daily water produced by a water-treatment facility or utility system, including water distributed (usually for a fee) to other systems. The SAD is that portion of the ADD used by the utility's own service area—including (but not limited to) the customers that receive water from a system or facility.

Two approaches (one qualitative, one quantitative) were used to analyze North Carolina's Local Water Supply Plans.

Quantitative Analysis

Sampling bins and data sources. With input from Don Rayno of DWR and Shadi Eskaf of the UNC School of Government's Environmental Finance Center, two primary parameters were determined to be useful for describing the sampling bins: system size (service population) and system source (surface, ground-, or purchased water). Service population was requested beginning with the 1992 LWSPs. Systems that submitted LWSPs in 1997 and 2002 were asked to provide information on their supply sources (surface, ground-, and purchased). All systems from the 1997 and 2002 LWSP data were evaluated to determine the predominant source (> 50%)

1997 Local Water Supply Plans review summary			
	Adopted	**Completed**	**Incomplete**
GW - Small	87 (16%)	42 (8%)	30 (6%)
GW - Medium	27 (5%)	4 (1%)	6 (1%)
GW - Large	10 (2%)	3 (1%)	4 (1%)
PW - Small	54 (10%)	25 (5%)	31 (6%)
PW - Medium	25 (5%)	5 (1%)	7 (1%)
PW - Large	4 (1%)	2 (0%)	1 (0%)
SW - Small	20 (4%)	10 (2%)	6 (1%)
SW - Medium	27 (5%)	3 (1%)	10 (2%)
SW - Large	38 (7%)	5 (1%)	13 (2%)
Other (Military)	9 (2%)	10 (2%)	17 (3%)
Unknown	7 (1%)		
Totals	**301 (56%)**	**109 (20%)**	**125 (23%)**

GW = Groundwater
PW = Purchased water
SW = Surface water

Small systems: < 3,000 service population
Medium systems: 3,001–10,000
Large systems: > 10,000

2002 Local Water Supply Plans review summary			
	Adopted	**Completed**	**Incomplete**
GW - Small	12 (2%)	44 (8%)	86 (16%)
GW - Medium	1 (0%)	22 (4%)	25 (5%)
GW - Large	2 (90%)	13 (2%)	11 (2%)
PW - Small	5 (1%)	25 (5%)	76 (14%)
PW - Medium	2 (0%)	12 (2%)	23 (4%)
PW - Large	0 (0%)	8 (2%)	6 (1%)
SW - Small	5 (1%)	13 (2%)	10 (2%)
SW - Medium	2 (0%)	12 (2%)	18 (3%)
SW - Large	6 (1%)	34 (6%)	19 (4%)
Other (Military)	6 (1%)	n/a	n/a
Unknown	3 (1%)	17 (3%)	17 (3%)
Totals	**44 (7%)**	**200 (38%)**	**291 (55%)**

GW = Groundwater
PW = Purchased water
SW = Surface water

Small systems: < 3,000 service population
Medium systems: 3,001–10,000
Large systems: > 10,000

of supply: surface water, groundwater, and purchased water. The systems were subsequently allocated by population served for three sizes: small (0–3,000), medium (3,001–10,000), and large (> 10,000). It is worth noting that the state deems systems serving greater than 3,000 people to be "large" and thus subject to various reporting requirements.

A document with descriptive statistics for all the systems evaluated is available here.

LWSP review process. As noted earlier, DWR spends an extensive amount of time reviewing the Local Water Supply Plans. Staff responsible for plan review often have conflicting priorities and are not able to complete plans in a timely manner. In recent years the legislation has changed several times. Each time the rules change regarding plan requirements, DWR (assisted by divisions such as Public Water Supply and the NC Rural Water Association) must embark on a public notification campaign. In some instances DWR finished the notification process only to have another set of rules go immediately into effect. The tables below summarize the review process for 1997 and 2002 both by system size and by water source. In 1997, 43% of plans were never adopted by their municipal government; over half of these systems (28% of the total systems) were "small" systems. In 2002, 93% of LWSPs were never formally adopted by their government. Over half of the plans (55%) were deemed incomplete, either because they were not submitted or had unresolved questions. Small systems (47% of the total) again showed lack of ability to take plans through to the "adoption" stage. The 2002 and 2003 extreme droughts likely contributed to the lack of plans adopted. In addition, in 2003 the rules changed (again) to require all municipalities to submit Water Shortage Response Plans in concert with their Local Water Supply Plans.

Qualitative Analysis

For the qualitative analysis, a paper review of randomly sampled LWSPs was performed to provide additional insight regarding changes in plan quality over time; consistency of supply estimation; content of water shortage response plans; suggested improvements; and synchronization with the river basin models. To consider changes over time within systems, the study reviewed all available plan years for each system.

For the 2002 LWSPs, the qualitative review analyzed the following types and numbers of plans:

System size	Number of systems reviewed by source type (*N*=22; 4% of total LWSPs)		
	Surface water source	Ground-water source	Purchased water
Small	1	6	4
Medium	2	3	2
Large	2	1	1

Evolution of water supply plans (changes in quality over time). DWR distributed paper surveys in 1989 and 1992, and municipalities returned them along with supporting materials. Beginning with the 1997 plans, DWR began offering a partial online submittal process; in 2007 the online submittal process was streamlined such that both the survey and all supporting materials can be submitted electronically. In addition, DWR staff can now provide real-time technical support while the survey is being filled out—with both parties reviewing their computer screens simultaneously.

As discussed earlier, the original plans in 1989 requested very little data. Each subsequent year the plans have increased in sophistication.

A general difference in quality for small systems versus medium and large systems was observed during review of paper plans, especially those submitted in the first two rounds (1992 and 1997). This is quite understandable given the general lack of resources within small systems. Often the paperwork is filled out by the mayor's assistant, who is expected to handle all leftover tasks not assigned to other employees. Systems could often provide only general system demand and not specific consumption by customer type (residential, commercial, industrial, etc.). DWR provides extensive technical support to small systems in particular, ranging from a few minutes to more than eight hours per municipality. With each round of plan submittals, it is apparent that respondents are getting better at providing the requested data.

*Submittal and review***.** Because the LWSP process was new in the 1990s and both municipalities and DWR staff were on a learning curve, plans submitted often had to go through several iterations before receiving final approval. Because there are no enforcement mechanisms, plans might be submitted late, if at all. (Note: A financial incentive does exist in the form of requirements for state and federal funding to meet "all statutory obligations," which would include submission of the LWSP.)

In tandem with the basin modeling process, DWR has recently initiated a phased submittal process whereby approximately 20% of municipalities will submit their LWSPs each year. In 2007, 100 municipalities were scheduled to submit their 2006 plans. At the end of August 2008, 90% of the 2007 plans due had been submitted.

Often the five-year plan cycle would catch utility staff by surprise because they had not been involved in the previous cycle. They, like their predecessors, had to come up to speed on their system's parameters, programs, and capabilities. However, with the new reporting requirements implemented in March 2007, all LWSP systems must report on an annual basis the system's annual and monthly ADD, number of connections and consumption by category (residential, industrial, commercial, and institutional), and other demand statistics. DWR staff anticipate that the new annual reporting requirement will make the five-year survey much easier to fill out.

*Usefulness of supply estimation in the plans***.** For each planning cycle from 1992 onward, systems were asked to provide details on both current and long-term projected water supplies. The ability of municipalities to accurately answer this question directly relates to the quality of the data and the extent of planning considerations used. Some respondents considered available water supply to equal the system's current water treatment plant's capacity. Some systems studied the limitations of their well withdrawals; others estimated supply based on current purchase contract agreements. The quality of answers is improving over time, as the LWSP survey now provides a definition of "available supply" for consultation during the survey process. Many groundwater system estimates have changed over time. The benefit of this question is that it compels utilities to begin considering long-term system needs, especially when the calculations provided in

the survey show that demand is approaching supply capacity over the coming years.

Water Shortage Response Plans as means of drought response. A Water Shortage Response Plan (WSRP) sets the process for a municipality or other water provider to declare a water shortage. The WSRP defines different phases of water shortage severity and outlines appropriate responses for each phase.

After the severe 2002 drought, the North Carolina General Assembly required local government and large community water systems to include a section in their 2003 LWSPs to describe how the water system would "respond to drought and other water emergencies and continue to meet essential public water supply needs during the emergency." The sudden requirement to include the Water Shortage Response Plans in their 2003 plans substantially delayed submission by many municipalities of their LWSPs due July 1, 2003. To further clarify content needed in the WSRPs, the Environmental Management Commission (EMC) adopted rules in March 2007 providing detailed requirements (15A NCAC 02E .0612–.0614).

Most WSRPs need a lot of work; often there is a gap in planning for what happens after enacting restrictions to limit outdoor water uses. For some municipalities, the next step is stated to be providing bottled water to customers, whereas in reality numerous options exist in the range between restricting outdoor water use and providing bottled water. The Division of Water Resources evaluates the WSRPs against a defined checklist with criteria that include enforceability, triggers to move in and out of response levels, public notification processes, authority to enact, severity of stages, and opportunity for public comment.

While reviewing the sample of 2002 plans, the reviewer noted that all of the small system plans included copies of water shortage response ordinances but did not provide documentation of approval; i.e., the ordinance provided did not have a code assigned and did not show the date of adoption. Ordinances reviewed for medium and large systems provided substantiation of adoption.

While research was under way for the 2008 Water Allocation Study, S.L. 2008-143 was approved requiring local Water Shortage Response Plans to have formal DENR approval and setting the following criteria for an approved plan:

1. The plan must have tiered levels of water conservation measures or other response actions based on the severity of water shortage conditions.
2. The tiers must result in progressively more stringent water conservation measures that correspond to increased severity of water shortage or drought conditions. *Note: A plan that lacks specific triggers for water conservation measures or makes implementation of measures optional at each step (or dependent on a decision by a public official or governing body) will not meet this requirement.*
3. The plan must meet all other requirements set out in the EMC's rules (15A NCAC 02E .0612–.0614).
4. Water Shortage Response Plans cannot regulate or require the metering of private drinking water wells (defined as wells that serve fourteen or fewer service connections or twenty-four or fewer individuals).

Under the newly adopted rules, a WSRP submitted to DENR is presumed approved until DENR notifies the system of disapproval. If the system's existing Water Shortage Response Plan meets the new criteria, the water system can continue to operate under that plan. Otherwise, an updated Water Shortage Response Plan must be submitted to the Department by July 1, 2009.

As of September 5, 2008, 398 of the required 544 water systems (73%) had submitted local Water Shortage Response Plans. As noted earlier, these WSRPs are considered approved until they are formally disapproved. The Division of Water Resources, in concert with the North Carolina League of Municipalities (NCLM), is in the process of developing formal criteria for approval. Some systems have elected to utilize the default rules, which may not provide the desired flexibility and customization to their particular system's needs in the case of a water shortage.

Improving Local Water Supply Plans

Although most southeastern states require permits for water withdrawals, they have not until recently required the development and adoption of Local Water Supply Plans. North Carolina has been a leader in local water supply planning. Virginia has recently finalized its rules for Local Water Supply Plans and this year began accepting and reviewing plans.

The Division of Water Resources relies heavily upon the local data in the LWSPs to develop river basin models/budgets, to identify potential conflicts and shortages, and to identify opportunities for regional cooperation. However, the LWSPs function more as local water supply reports than plans. Public water systems view them as another state reporting requirement. They largely do not use them as planning exercises and complain that they must submit a number of duplicative water reports to DENR water divisions. Each report has different reporting deadlines. Some data are reported electronically and some on paper. The North Carolina Clean Water Responsibility Act and the federal Safe Drinking Water Act also require public water systems to make an annual report to their water and wastewater customers. Private (for-profit and nonprofit) water systems are not required to provide LWSPs to DWR. The federal Safe Drinking Water Act does require private water systems to make an annual report to their water customers.

The water systems that actually plan for maintaining and operating their systems and for their growth use more sophisticated planning methods than the LWSP, including population trends, asset management, and capital improvement plans. Some local governments have developed and adopted "urban service boundaries or districts" that provide water systems with more certainty on where water services will be expanded. The future of LWSPs lies in their evolution into Integrated Water Resource Management (IWRM) exercises, in which drinking water is considered along with stormwater, reclaimed water, streams and lakes, groundwater, and wastewater as water service possibilities and amenities for local governments.

Water systems and their managers are often excluded from local land use decisions and regional economic development planning, including construction of public schools, that increase demand for water,

wastewater and stormwater services, increase operating and capital costs, and affect the ability of water systems to assure adequate water supplies and wastewater treatment for the future. Few North Carolina local governments have effective comprehensive plans that link land use changes, development approvals, and infrastructure decisions.

Water systems—public and private—may welcome an opportunity to reduce their reporting burden to the state (and the US Environmental Protection Agency) by consolidating their drinking water, wastewater and stormwater reports into an annual or regular Water System Report. Water systems could serve their data on their websites and periodically and electronically report data to the state. Consolidated reporting could improve local, regional, and state water budgeting and improve cooperation between local, regional, and state water, wastewater, and stormwater agencies.

The Water Allocation Study team supports DWR's approach of requesting LWSPs every five years on the river basin planning schedule and enabling electronic reporting. DWR currently posts LWSPs on its website after the LWSP has been reviewed and approved. But the 2 1/2 staff at DWR who review and approve plans, in addition to their other duties, are overwhelmed. DWR could post LWSP data on its website with a caveat before it is approved, and/or DWR could encourage systems to post the draft LWSP on their own websites. More rapid posting of LSWPs on the web may facilitate regional planning.

State policy now requires all local water systems and large community water systems to develop and submit LWSPs. DWR's small staff is not able to review and approve all the LWSPs submitted in a timely manner and also respond to droughts, floods, emergencies, and other water resource problems. NC's water resource priority should be to develop scientifically sound river basin models/budgets for the major river basins. Good data from water systems that directly withdraw or discharge 100,000 gpd or more are more important to the development of river basin models/budgets than smaller systems that use less than 100,000 gpd or that buy water services from larger systems.

Local definitions of "essential water use" vary. But the drought response legislation enacted in 2008, S.L. 2008-143, creates a standard definition of "essential water use" as G.S. 143-30(3) that will now have to be accommodated in Local Water Supply Plans:

> "Essential water use" means the use of water necessary for firefighting, health, and safety; water needed to sustain human and animal life; and water necessary to satisfy federal, State, and local laws for the protection of public health, safety, welfare, the environment, and natural resources; and a minimum amount of water necessary to maintain the economy of the State, region, or area.

G.S. § 143-350(3). Local governments in past droughts have restricted such outdoor water uses as irrigation, car washing, and pressure washing because it is easier to enforce and irrigation is a major consumer of water during hot weather. Thus the economic impact of drought restrictions fell

disproportionately on the green industry, car washes, and power washing industry. In the short run (before year-round conservation takes hold) a shutoff of outdoor water use during droughts can reduce peak uses by up to 30%. Average annual outdoor use over 2003–2006 in four studied cities is estimated to range only from 7.6% to 14.4% of the total annual use (using November 16–April 15 as an estimate of average indoor use).

Drought is a risk that businesses can insure against, but few industries have purchased insurance. In contrast, many farmers purchase crop insurance to insure against droughts and floods. New practices and technology are available to make the green and car washing industries more efficient.

The public is confused by different restrictions in different jurisdictions that are within the same media market or same river basin with similar levels of drought. The Catawba-Wateree LIP and Triangle J COG efforts may lead to common restrictions and shared public education, which would help with future drought response.

Beyond the study of LWSPs, the Water Allocation Study team looked directly at drought response in North Carolina, as a window into the ways the state does and does not adapt well to water scarcity.

Drought response

The Water Allocation Study followed and documented the state's response to the drought of 2007–2008. The following discussion of "lessons learned" is tied to the sketches of municipal and state drought response found here.

Successful State/Local/Federal/Private River Basin–Based Collaboration

The Low In-Flow Protocol (LIP) developed by stakeholders, including Duke Energy, DENR, Charlotte-Mecklenburg Utilities and other NC and SC local governments during the Federal Energy Regulatory Commission (FERC) relicensing of Duke's dams on the Catawba-Wateree River system worked well. The FERC license created a drought management group and a water management group. The LIP was implemented in 2007 before the FERC license became effective in 2008. (Duke Energy's proposal to charge a water withdrawal permit fee helped catalyze the water management group.) Most upstream and downstream communities appear to have confidence in the Catawba-Wateree hydrologic model/budget and basinwide planning and other data used to trigger drought response measures. Most water systems participated in weekly calls and in implementing consistent drought response measures, such as restrictions on irrigation.

Weekly conference calls led by the US Army Corps of Engineers with water systems and state and federal agencies in the Yadkin/Pee Dee, Cape Fear, Neuse, and Roanoke river basins worked well. The Tennessee River Valley Authority (TVA) shares information and conducts similar conference calls with the seven valley states through their water partnership program. These calls have been a good forum not only to understand what is occurring within TVA reservoir operations, but also as an exchange of drought information for most of the southeast (except for SC and FL).

The NC Drought Management Advisory Council (DMAC) has a technical subcommittee that has a weekly conference call every Tuesday to assess current drought

conditions in the state. Participants usually include a wide range of experts from various locations around the state. The primary purpose of these calls is to provide North Carolina's input into the national Drought Monitoring map that comes out every Thursday. NC has become a leader in its approach to providing state input into this national drought management product.

As part of North Carolina's Emergency Response Plan, the Water Resources Task Force was activated in 2007. This task force had a weekly call to review the status of the water supplies across the state. The task force's work made a valuable contribution to helping define the impacts associated with drought. However, a great deal of work remains to be done to bring North Carolina's emergency management network into coordination with its water resource monitoring systems.

Weekly calls by regional engineers from Division of Environmental Health (DEH) in DENR were appreciated by water systems. Weekly calls and information sharing increased awareness of the value of river basin–based planning, modeling, budgeting, and managing. Good leadership by DENR, the Corps, Duke Energy, and water systems fostered a "we're in this together" spirit as opposed to an "I've got mine" mentality and avoided major conflicts.

DMAC performed its primary mission well: sharing technical information collected by state and federal agencies about the drought. It provided useful information to water systems and managers about the severity of the drought. Some systems heeded its warnings, and some did not. Communication between DMAC and water systems works well. However, communication between DMAC and policy makers, including the Governor's Office, NC Utilities Commission, city and county managers, and local elected officials needs improvement. DMAC provides good information to water managers, but usually it is city managers, county managers, and local elected officials who enact drought response measures.

Governor Mike Easley appealed to local governments and citizens to reduce water use in the late summer and fall of 2007. Local governments and the public responded and conserved water. The information on which public water systems conserved and how much they conserved can be found at the Division of Water Resources' website.

Private water companies serve approximately 400,000 people in North Carolina. The North Carolina Utilities Commission ordered private water companies to restrict water uses during the drought. Restrictions set by local government and by the Utilities Commission order can be different and can be imposed and relaxed at different times, despite the fact that communities served by a private water company and by a municipality can be literally across the street from one another, facing the same level of drought. There are some nonprofit water companies that appear to escape water conservation regulatory requirements altogether.

Communities with year-round water conservation programs, conservation pricing or tiered water rates, and interconnections to their neighbors, such as Cary, Charlotte-Mecklenburg, Greensboro, and Orange Water and Sewer Authority (OWASA), were more resilient than systems that lacked these features and fared better in

the drought. (It should be noted that Cary, Greensboro, and OWASA all suffered through extreme droughts in recent years and have implemented year-round water efficiency measures.) Cary, Charlotte-Mecklenburg, Greensboro, and OWASA all lost revenue because of conservation during the drought but lost less than communities without conservation rates. Most local water conservation programs have not set water use reduction goals or per capita consumption goals. Beyond encouragement, the state provided little financial or technical assistance to Cary, Charlotte-Mecklenburg, Greensboro, and OWASA to adopt year-round conservation programs.

Communities without year-round conservation programs fared worse than communities that have conservation programs. They lost more revenue and came closer to running out of water. Systems deferred maintenance to balance their books. When leak detection and repair were more important than ever, systems had less revenue to respond to leaks and to perform routine maintenance.

Many water systems raised their water and wastewater rates effective in the 2008–2009 fiscal year to make up for lost revenues in 2007–2008 and to begin to send a conservation pricing signal to their customers. Few systems have conducted water audits, consistent with American Water Works standards, to account for non-revenue water and to identify cost-effective measures to save water and revenue. Few systems have leak detection programs. A handful of systems participate in the "Water: Use It Wisely" educational campaign.

Some systems, primarily in the Research Triangle region, require separate meters for new in-ground irrigation systems; most do not. New G.S. 143-355(a), part of the 2008 drought legislation, requires these meters for new construction in local government and large community water systems across the state.

Most local governments manage water and wastewater as a combined utility. This facilitates consideration of reclaimed water as an alternative source of water. Stormwater utilities are more likely to be managed with roads and public works. This frustrates consideration of stormwater as an alternative source of water. Stormwater utilities typically have much smaller budgets than those of water and wastewater utilities. State and local stormwater requirements are written with water quality, not quantity, in mind. As a result, most local governments do not give developers credit against stormwater requirements for installing cisterns and other stormwater storage and reuse systems. Developers are understandably reluctant to finance both stormwater ponds and practices and cisterns.

Some citizens drilled private wells for irrigation to avoid local restrictions. Some industries drilled private wells for cooling and processing and to decrease their use of publicly supplied water. Municipalities and counties lack clear authority to regulate withdrawals or uses of groundwater during droughts. Groundwater is an important contributor to stream flow in North Carolina, especially in low-flow periods. An important, open question for the state is how it sustains groundwater resources and prevents neighbors from drying up wells and reducing stream flows.

Comparison of State-Local Flood Response and Drought Response

Emergency managers understand their responsibilities systematically: (1) prepare/plan for emergencies, (2) respond, (3), mitigate and (4) recover. Federal Emergency Management Agency (FEMA) funds are available only to address problems identified in plans. But North Carolina state and local emergency management plans and hazard mitigation plans do not currently address drought, even though Governor Easley turned to the state's emergency management system to respond to the drought of 2007–2008.

North Carolina citizens have come to expect strong leadership and competent state and local response to floods. State and local emergency managers have trained together and have practiced and improved their responses after Fran in 1996, Floyd in 1999, and other storms. Roles and responsibilities are relatively clear. State, local, and federal funding is available. Floodplains are mapped and regulated (although filling and developing the floodplain continues). The State Emergency Response Team (SERT) makes decisions during floods. The Drought Management Advisory Council (DMAC) is technical and advisory. It does not make policy decisions during droughts. Who does? In the future, warmer world, both the southeastern and southwestern United States will likely experience more extreme droughts. Developing an effective drought response system will make NC more resilient and will safeguard both North Carolina's environment and economy.

Public Education and Awareness

News media, including video and photographs of dry lakes, increased public awareness of the severity of the drought. State and local officials asked the public to conserve water. Most citizens responded positively. The public was hungry for information about the drought, steps they could take to conserve water, and steps their community could take to conserve water. Communities with year-round conservation programs responded to the public demand for information, but the state, most local governments, and private water systems were not prepared to respond to the demand.

Public and industrial water users began to shift away from using drinking water for non-potable purposes, such as cooling, processing, irrigation and toilet flushing. Public awareness and comfort in using different "grades" of water or using different kinds of water for different purposes increased. Some now view stormwater and reclaimed water (treated wastewater) as resources instead of wastes.

But neither the public nor state and local policy makers in North Carolina understand such basic facts about water as the connection between groundwater and surface water in the state; that more lawns die from over- than from underwatering; the correct amount of water needed to maintain lawns, trees, and shrubs; or that although rain may increase during summer months, evapotranspiration is generally greater than precipitation.

Recommendations

Improve existing institutions and laws

Clearly state policy goals to guide administrative and judicial decisions

There is no clear, general set of goals set by the legislature for water allocation to guide administrative and judicial decisions.

The Water Allocation Study team recommends the following goals as a starting point for legislative discussion and debate about water allocation in North Carolina.

These goals combine the work of the Regulated Riparian Model Code drafters with the existing, scattered statements about water resources in the North Carolina Constitution and General Statutes and the water law reform efforts of other states in the United States. They also are the goals the team assumed in making the other recommendations.

1. ***Water (surface and groundwater) is a public trust managed by the state to protect its lands and waters for the benefit of all its citizens.***

   The waters of the State are a natural resource owned by the State in trust for the public and subject to the State's sovereign power to plan, regulate, and control the withdrawal and use of those waters, under law, in order to protect the public health, safety, and welfare

by promoting economic growth, mitigating the harmful effects of drought, resolving conflicts among competing water users, achieving balance between consumptive and nonconsumptive uses of water, encouraging conservation, preventing excessive degradation of natural environments, and enhancing the productivity of water-related activities.

This is verbatim from section 1R-1-01 of the Regulated Riparian Model Code and is a restatement of existing law in North Carolina, starting with Article XIV, Section 5, of the North Carolina Constitution, which provides:

> It shall be the policy of this State to conserve and protect its lands and waters for the benefit of all its citizenry, and to this end it shall be a proper function of the State of North Carolina and its political subdivisions to acquire and preserve park, recreational, and scenic areas, to control and limit the pollution of our air and water, to control excessive noise, and in every other appropriate way to preserve as a part of the common heritage of this State its forests, wetlands, estuaries, beaches, historical sites, open lands, and places of beauty.

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2. Administrative and judicial decisions about water should ensure efficient and productive use of water and water conservation.

Pursuant to this [Act], the State undertakes, by permits and other steps authorized by law, to allocate the waters of the State among users in a manner that fosters efficient and productive use of the total water supply of the State in a sustainable manner in the satisfaction of economic, environmental, and other social goals, whether public or private, with the availability and utility of water being extended with a view to preventing water from becoming a limiting factor in the general improvement of social welfare.

This is verbatim (other than one grammatical change) from section 1R-1-02 of the Regulated Riparian Model Code.

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3. Legal security for water rights and property rights and procedural protections for water rights.

In order to provide legal security for water rights within the constraints provided in this [Act], this [Act] establishes a system of permits that make a water right a matter of legal record entitled to legal protection. The State shall provide procedural protection and fairness to parties to disputes over water rights through public proceedings on the allocation or modification of water rights, making available and encouraging formal and informal procedures for dispute resolution, and encouraging alternative dispute resolution mechanisms.

This is a combination of Regulated Riparian Model Code sections 1R-1-06 and 1R-1-08.

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4. Protection of instream flows and groundwater levels.

The state shall Preserve flow regimes and groundwater levels in all water sources as necessary to protect their physical, chemical and ecological integrity by reserving the appropriate portion of surface waters from allocation; By seeking a long-term balance between the amount of groundwater withdrawn from each aquifer or growth area and the amount of water recharged to the aquifer or growth area; and by authorizing additional protections of the waters of the State.

This is an updated and extended combination of Regulated Riparian Model Code section 1R-1-11 and Arizona's Groundwater Act of 1980. The Water Allocation Study team recommends that a working group be established to define more precisely how this goal would be implemented in the proposed permitting and planning programs.

5. Flexibility through adaptive planning to ensure that water extraction does not exceed the budget of water that is available; conservation of water; coordination with water quality.

> The State shall coordinate the plans, laws, regulations and decisions pertaining to water allocation with those pertaining to water quality, and shall adapt and update plans and models to ensure that actual and projected water consumption in the state plus the water needed for instream uses does not exceed the water supply. The State shall conserve the waters of the State through suitable policies and by encouraging private efforts to conserve water and avoid waste.

This is an adaptation of section 1R-1-09 of the Regulated Riparian Model Code to accommodate the more regional, adaptive, and hydrologic model–based planning process recommended by the Water Allocation Study team, along with Regulated Riparian Model Code section 1R-1-10 on water conservation.

6. Pricing water to fully cover the costs of its capture, treatment, distribution, collection, scarcity, and reuse rather than to keep rates as low as possible.

> The State shall encourage, through its funding and oversight of local government and utility finances, that water be priced to fully cover the costs of its capture, treatment, distribution, collection, scarcity and reuse, including the maintenance, repair and replacement of water infrastructure, rather than being priced to keep rates as low as possible.

This provision is designed to encourage the use of conservation rates, drought pricing, and capital budgeting to fully cover the costs of water. The Water Allocation Team believes that price should be a central tool in the allocation of water during shortages; it is a signal to water users that lets the users decide how and when to cut back on use most efficiently.

7. Efficient and equitable allocation during shortfalls in supply and procedures for resolving disputes between water users.

> The State, in the exercise of its sovereign police power to protect the public interest in the waters of the State, undertakes to provide, through this [Act], an orderly strategy to allocate available water efficiently and equitably in times of water shortage or water emergency.

Given the slow and politically charged governance structure for water price setting, it is essential to supplement full-cost water pricing with administrative mechanisms to deal with water shortages and the conflicts they produce. The withdrawal permit plus state and local drought-response powers and Water Shortage Response Plans provide those mechanisms, and this goal, which quotes verbatim Regulated Riparian Model Code section 1R-1-05, sets out the general goals (efficiency and equity) for judging those mechanisms.

8. Reasonable use and unreasonable injury.

> No person shall make any use of the waters of the State except insofar as the use is reasonable as determined pursuant to this [Act]. No person using the waters of the State

shall cause unreasonable injury to other water uses made pursuant to valid water rights, regardless of whether the injury relates to the quality or the quantity impacts of the activity causing the injury.

Verbatim from Regulated Riparian Model Code sections 2R-1-01 and 2R-1-03.

9. No prohibition of use based on location of use.

Uses of the waters of the State on nonriparian or nonoverlying land are lawful and entitled to equal consideration with uses on riparian or overlying land in any administrative or judicial proceeding relating to the allocation, withdrawal, or use of water or to the modification of a water right. Nothing in this [Act] shall be construed to authorize access to the waters of the State by a person seeking to make a nonriparian or nonoverlying use apart from access lawfully available to that person.

Verbatim from Regulated Riparian Model Code section 2R-1-02.

10. Regulating interstate and interbasin water transfers to achieve these goals on a regional, not just a state, basis.

The State shall maintain the waters of the State both for supplying water requirements within the State and within each river basin of origin and, under appropriate circumstances, for out-of-state and out-of-basin transportation and use. The State shall protect the reasonable needs of water basins of origin through the regulation of interbasin transfers.

This is a combination of Regulated Riparian Model Code sections 1R-1-13 and 1R-1-14 that recognizes the need to undertake planning not just on the basis of each river basin, but also with consideration of interbasin transfers and the interests of adjoining states. The Water Allocation Study team believes it would be in the interests of the southern Atlantic coastal states to coordinate their regulation of water more consistently.

Establish a permit for large water withdrawals

Most eastern riparian states, including Florida, Georgia, all eight states bordering the Great Lakes, Connecticut, Kentucky, Maine, Mississippi, Maryland, New Jersey, New Hampshire, Pennsylvania, Tennessee, and Virginia, require permits for large water withdrawals. In its 2007–2008 session, the South Carolina General Assembly debated but did not pass a water withdrawal permitting bill.

The Water Allocation Study Team recommends that the legislature require a state permit for anyone who withdraws large quantities of water, either from groundwater or surface water.

A large-quantity withdrawal permit program should be the basis for all other improvements in North Carolina's water allocation system, giving increased certainty of supply to major withdrawers and better information to planners at state, regional, and local levels about their water budgets. Eventually the permit system could be the basis for simplifying and harmonizing all of North Carolina's programs for regulating riparian rights.

Threshold for Coverage

A permit should be required for all new and existing withdrawers from NC ground or surface water of 100,000 gallons or more per day in any single twenty-four-hour period. Existing withdrawers who have registered their use with DWR by July 1, 2009, should be grandfathered in the amount

of their permit for the first permit review cycle (five years or whatever is necessary to coordinate with the DWQ river basin planning schedule). Business, industrial, and institutional users of 100,000 gpd or more that purchase their water from public water systems would not have to apply for a state water withdrawal permit; the public water system that sells the water to large users would instead be the permit holder. The Water Allocation Study Team strongly believes it is important that the withdrawal permit program apply to any and all major withdrawers of water, no matter what the stated or intended use of the water.

Estimated Numbers of Required Permittees

The Water Allocation Study team estimates that between 1,000 and 1,500 facilities in North Carolina would be required to obtain water withdrawal permits at a threshold level of 100,000 gpd. This includes community water suppliers, industrial withdrawers, and agricultural withdrawers. There are around 345 facilities currently registered in the Division of Water Resources registration and withdrawal database with either average or maximum daily withdrawals over 100,000 gpd. Around 300 of the 628 water supply systems that submitted local water supply plans in 2002 had average withdrawals of 100,000 gpd or more; 375 systems had a maximum daily use over 100,000 pgd, including both withdrawn and purchased water. Around 250 farms and aquacultural operations beyond those that have already obtained permits through the CPCCUA would likely be required to get permits. Most swine, poultry, and dairy operations use less than 100,000 gpd.

Critical Features to Withdrawal Permit Recommendation

There are many choices to be made in the implementation details for a withdrawal permit program, and as always, the details are important. But these are the features that appear to the Water Allocation Study team to be most important as guiding standards for the legislature to give to the stakeholders who will work out implementation details:

- Permits should have fixed terms. Permit duration might be longer than the five-year period recommended for review of allocation amounts; the permit itself, other than the actual amount allowed to be withdrawn, could be issued for terms that match the large capital investments or other regulatory licenses that may be typical of facilities with major water withdrawals.
- Allocations should be issued and reviewed on a schedule that synchronizes with National Pollutant Discharge Elimination System (NPDES) permits.
- There should be "reopener" provisions similar to those in wastewater permits in river basins where the hydrologic model shows that water is overallocated (out of budget).
- There should be "credits for early adoption" or "salvage" provisions so that efficiency/conservation improvements are rewarded and not punished during allocation decisions and droughts.
- Other than credits for efficiency, no "banking" of unused water should be allowed. Permits should be adjusted up or down to account for actual use, minus documented salvage/efficiency reductions.

- There should be no trading of allocations allowed outside of capacity use areas until (a) several permit adjustment periods have passed, to make sure allocated amounts are reasonable, and (b) there is further legislative debate on the wisdom of trading and it is decided to proceed with trading.
- There should be electronic permitting and data management systems that encourage withdrawers to frequently post their withdrawals and returns, lake levels, groundwater levels, and other water use and management data on websites in easily accessible fashion.
- The legislature should establish tiered water withdrawal permitting fees based on amount of withdrawals to cover the cost of implementing the program and to pay for ongoing water modeling/budgeting. State and federal appropriations support the basic system of stream gauges, groundwater monitoring wells, and climate stations and data, but the state will have to build additional capacity to initiate and refine the withdrawal permit program.

There are many other features of withdrawal permits that are important to implementation but that need study and discussion among stakeholders and that will take time to work out. For example, over time the state should begin to integrate water quantity and water quality planning and permitting.

Potential Benefits of Water Withdrawal Permits Implemented in This Way

A robust, well-implemented withdrawal permit program would be the state's primary backstop against failure of planning measures in the event of water scarcity. It would allow rational decision making in difficult times. It could create strong incentives for water efficiency. It would align North Carolina with most other states, including most of its neighbors, facilitating interstate management of groundwater and surface water resources and improving the state's position in potential and actual interstate conflicts. It could eventually be the basis for either water trading (markets) or comprehensive state water planning. It could eventually be the basis for reform of all other water regulatory programs, such as interbasin transfers.

Conform existing laws to each other and to policy goals

After the legislature debates and decides on a set of water allocation goals and policies for the state and considers a withdrawal permit program, there should be a careful and concerted effort to review and conform existing laws to each other and to the set of agreed upon policy goals.

Improve our knowledge base

Establish proactive, adaptive, river basin water supply planning

Building on the successes of the Catawba-Wateree water management group planning initiative, the NC/SC Bi-state Commission, the Eno River Voluntary Capacity Use Area, the Cape Fear River Assembly, and numerous other river basin–focused water groups in North Carolina, **the General Assembly should structure river basin planning efforts in each basin where the state's hydrologic models predict a strong possibility of water shortages in the next thirty to fifty years.**

North Carolina already has some good elements of water planning in place: local water supply plans, river basin hydrologic

models that are being extended across the state to all basins, a strong history of river basin planning and permitting for water quality, and numerous groups organized to advocate for or facilitate negotiations and planning in river basins. What is needed is a legislatively led structure that knits these elements together for water supply purposes.

The Water Allocation Study team believes that the new and evolving hydrologic models, such as has recently been constructed for the Cape Fear River, should serve as scientifically grounded screens to identify those basins where water shortages are likely to occur over the next thirty to fifty years ("overallocated basins") and then continue to use the models as planning tools that evaluate different measures for getting the basin back into its "water budget."

Instead of assigning this effort entirely to the state, however, the Water Allocation Study team recommends that each overallocated basin have a structured entity comprising all the water systems; significant permitted water users who have demonstrated their understanding of and commitment to water efficiency, including agriculture; environmental and wildlife advocacy groups; and technical advisors for these entities, including staff of the relevant state agencies, along with a governing board of interested and representative elected officials and appointed leaders. This group should be assigned the task of creating a water supply plan for the basin that gets it back into budget, according to the state's hydrologic model. The group should be encouraged to consider a low-inflow protocol similar to that established on the Catawba.

The basin planning group should be funded by mandatory contributions from all the major water withdrawers in the basin, allocated according to the volume of their withdrawal, but decisions of the technical and governing boards should be made on a one member, one vote basis. The group should be budgeted and encouraged to hire staff to facilitate its efforts from any of the numerous qualified entities in the state, such as the Councils of Government, nonprofit water advocacy groups, consultants, and engineers. Small systems and small local governments in the basin should be allowed to pool their interests and expertise and to have their interests protected by capable representatives, such as the North Carolina League of Municipalities (NCLM) and the Rural Center, funded out of the basin budget.

The basin should be given a fixed time table for organization and planning; perhaps five years for initial organization and planning. The plan and model should be revisited every five years to see how projections and actual supply and demand have changed and whether new plans are necessary. The basin group should be given significant power to approve expedited supply enhancements (see below), designate high-priority funding projects, and support or reject proposed water transfers and new consumptive uses.

However, as a backstop for failures of regional planning, once the fixed time for plan creation or modification has passed, or the group has shown its inability to organize and undertake work, the state Environmental Management Commission and its staff should be free to create its own plan through the capacity use area statute to get the basin back into budget.

This planning process would require several important changes to current

law. First, the river basin boundaries for DWR and interbasin transfers should be aligned with the river basin boundaries for DWQ river basin planning. Second, a technical working group should establish the performance criteria under the state's hydrological models for identifying the basins in which water shortages are likely to occur over the next thirty to fifty years. The assumptions need to consider the possibility of flow alterations due to climate change and land use change and the high uncertainty surrounding demand projections so that there is widespread consensus that any basin that passes the test is extremely unlikely to have systems run short of water or have to implement emergency water shortage plans. Third, the models also need to incorporate the findings of the instream flow technical working group recommended under the "clarify goals" recommendation, above. Fourth, the withdrawal permit program needs to be integrated with the models so that new major withdrawals are not permitted unless they fit within the water budget for each basin. If a proposed new withdrawal "breaks the budget" for a basin, then the basin planning group must have a chance to evaluate ways to accommodate the new withdrawal and maintain the budget for the basin.

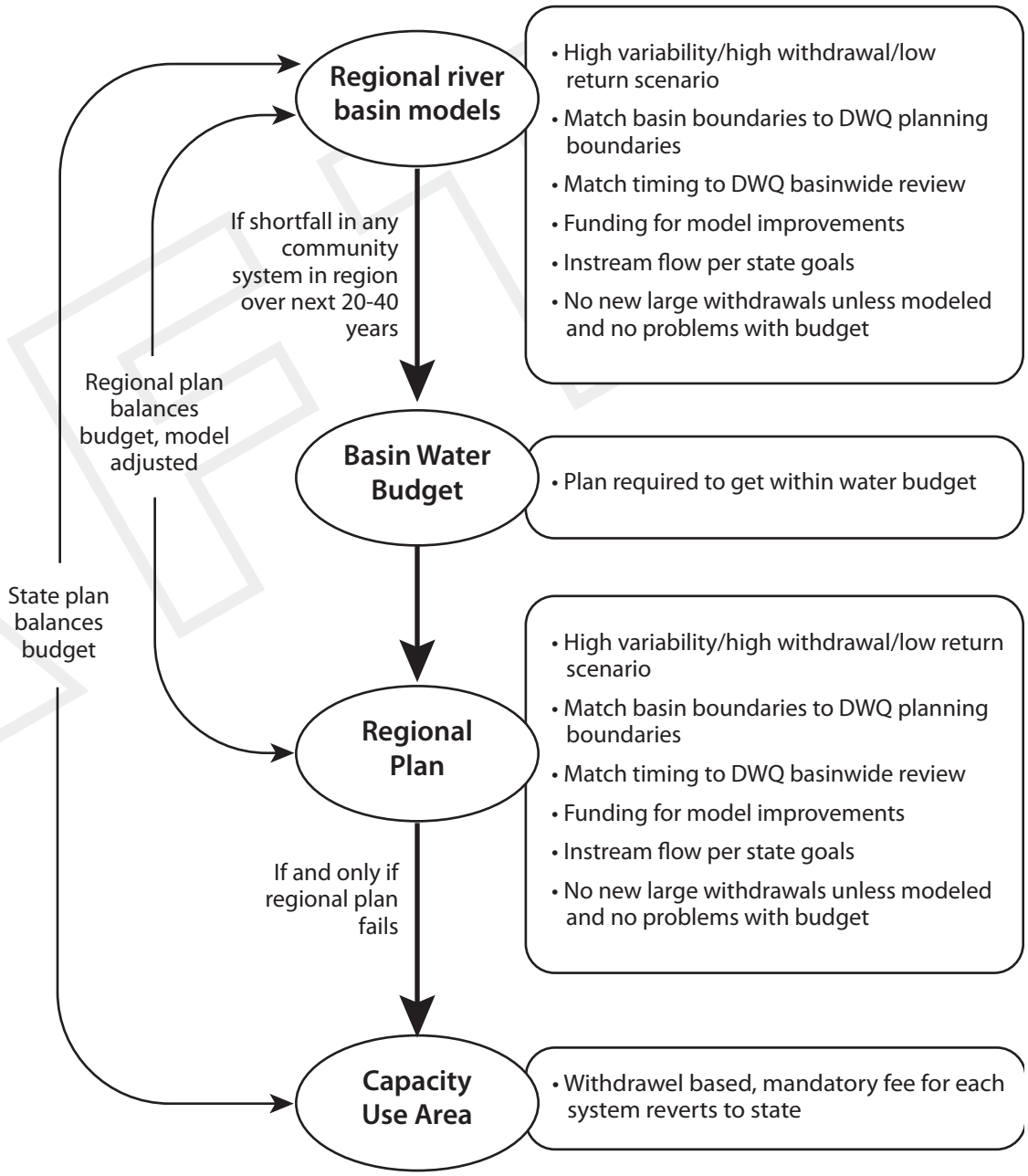
Simplify and integrate water and water-funding information

LWSPs (submitted to DENR), which may include operation and maintenance plans and capital and improvement plans, should be better integrated with financial data (submitted to the Local Government Commission (LGC) in the Department of the State Treasurer), which include asset management, depreciation, and revenues. See also the recommendations on enhanced oversight by the LGC. Plans without financing will not be implemented. G.S. § 159G-23(6) requires funders of clean water grants and loans to consider "sound (fiscal) management." State grant funds are generally restricted to helping water systems address existing problems. Water systems are expected to use local funds to pay for water infrastructure to serve new growth.

The Water Allocation Study team recommends that the North Carolina League of Municipalities, the North Carolina Association of County Commissioners, private water systems, and DENR: (1) inventory state and US EPA water-reporting requirements, (2) identify and phase in both electronic reporting to DENR and provide information to the public on websites and other means, and (3) develop and begin to implement a plan to consolidate as much water data as possible into one comprehensive Water System Report to the state and the public.

Improved LWSPs could also become a basis for water systems to provide data to state and federal agencies for permit decisions and preparation of environmental documents. LWSP data could be plugged into permit applications and environmental documents, saving time for both applicants and reviewers. For example, when the Division of Environmental Health's Public Water Supply Section reviews plans for water treatment plants and waterline extensions, it assumes that the applicant has analyzed its ability to supply the water source for the new facilities. An improved LWSP, in conjunction with DWR basin modeling results, would provide more assurance to DEH that the water source is truly available.

Proactive, adaptive, river basin planning for stressed basins



LWSPs should disclose the assumptions underlying risk management and/or safe yield calculations. DWR could convene a group of stakeholders, including water systems, university researchers, and private consultants, to develop best practices for risk management. Risk management decisions should be left to local water systems. However, the risks should be disclosed to the public and the DWR.

LWSPs will begin to achieve their real potential when they are treated as integrated water resources management (IWRM) plans, including supply side planning and demand side planning. Plans should prompt systems (and groups of systems) to consider meeting water supply needs through additional sources (potable, reclaimed, gray water, rainwater) while also reducing demand (increased efficiency). North Carolina should be evolving toward IWRMs in which wastewater capacity is also incorporated into the planning universe. The Water Allocation Study team sees the planning efforts needed in the overallocated basins as the place to begin experimentation with IWRMs.

Address critical research and study needs

The following are critical research and study needs that the Water Allocation Study team believes should be funded and undertaken simultaneously with the legislative changes proposed in this report.

What are the limits for groundwater withdrawal, especially in hard-rock settings (Piedmont and mountains)? How do large groundwater withdrawals affect nearby wells and surface flows, particularly in overallocated basins?

How do we adjust DWR's hydrologic models to predict shortages and account for future flow variability?

Could the entire southern Atlantic coast, including the states of Virginia, North and South Carolina, and georgia, work on water allocation in a more coordinated way?

How well does reclaimed water work with turfgrass varieties and other major landscaping needs?

How exactly should the state implement the instream flow goal agreed to pursuant to the above recommendations?

Improve our supply

Ensure that water infrastructure is maintained

How do you value irreplaceable water supplies and water assets like Durham's Lake Michie (built in the 1920s), Falls Lake (built by the US Army Corps of Engineers in the 1970s), or expansion of Wilson's Buckhorn Reservoir in the 1990s? These assets have appreciated, not depreciated, in value. But the distribution and treatment systems that make these assets more and more valuable do wear out and need replacing. Without a source of focus on this infrastructure problem, though, most citizens (and the governing boards of many water systems) wait until there is catastrophic failure, hoping that someone else (state or federal taxpayers) will step in and pay to help fix the problems. Meanwhile, rates for many systems are set to be as low as possible, certainly lower than those of the neighboring jurisdictions, producing a "race for the bottom" in operation and maintenance of water (including wastewater and stormwater) infrastructure.

The Water Allocation Study team recommends that the legislature direct the Local Government Commission (LGC) to take a more active role in monitoring the financial side of local government's operation and maintenance of water infrastructure.

At the same time, DENR's regulators of public water systems have not historically viewed themselves as operational regulators; instead, their principal focus has been on the approval of system expansions and new systems.

The Water Allocation Study team recommends that the legislature direct DENR, in conjunction with the LGC, to monitor and regulate the ongoing financial and managerial capacities of water systems rather than just review system capacity when there are requests for expansion or new systems.

THE LGC is a logical source of heightened financial focus on water infrastructure. State law requires all local government units, including local water and wastewater systems, to annually provide financial data to the LGC in the Department of the State Treasurer. The LGC publishes this information in several ways, including a statistical analysis of water and sewer funds. The LGC also reviews and approves all debt issued by local governments, including general obligation bonds, revenue bonds, certificates of participation, and lease-purchase agreements. Local governments cannot borrow funds without approval of the LGC. Rule 34 of the General Accounting Standards Board (GASB 34) requires governments to value and depreciate their assets. The LGC oversees compliance with GASB 34 for water systems.

The LGC already incorporates and links to information from DENR about systems under a moratorium on wastewater expansions due to capacity or compliance problems. Some similar connection is needed for systems lacking financial or managerial capacity on the water side.

The LGC tracks financial results and key ratios for water and sewer enterprises. This information shows or suggests which water systems are operating at a loss, which systems do not have an operating reserve, and which systems undervalue and underprice water services. Given that it is difficult for local elected officials to raise water and wastewater rates on their residential, commercial, institutional, and industrial customers, the LGC and DENR should be more active in identifying and challenging the systems that are not adequately investing in their water infrastructure. LGC analysis compares systems to each other and to statistical measures of central tendency and variance. But there is no statement in current LGC reporting of absolute benchmarks that should be met but are not being met. There is no separate scheduling, reporting on, or notification of systems that consistently fail to cover operational and capital needs.

Thanks to data collected by the NCLM, LGC, and the US census, the Environmental Finance Center at UNC–CH's School of Government has built a database/dashboard system that shows metrics which help identify which water systems are not covering their actual costs, which water systems are collecting sufficient revenues to allow for capital investments, which water systems send their customers

stronger pricing signals to conserve, and which water systems charge more or less than 1.5% of median household income (high unit cost). See www.efc.unc.edu.

Water audits should be coordinated with financial audits for water systems in overbudgeted basins. Water audits identify unaccounted for water and lost revenue. The Division of Water Resources requires Local Water Supply Plans (LWSP) every five years. Water audits could become part of water supply planning.

It would also be advantageous if LWSPs and the criteria for funders set out in G.S. 159G-23 were better integrated, starting with G.S. 159G-23(7), capital improvement planning. The Funders Forum could work with the NC League of Municipalities and the NC Association of County Commissioners and the Division of Water Resources and report to SWIC on best practices for water systems to develop and adopt capital improvement plans. Best practices vary with the size of water systems. Applicants for and funders of clean water grants and loans need more guidance on developing effective capital improvement plans. DENR and SWIC should also encourage water systems to post their capital improvement plans on their websites. Easier access to local operation and maintenance plans and capital improvement plans would aid the SWIC and other policy makers in assessing the state's water infrastructure needs. The Rural Center's Water 2030 Plan provides good estimates of drinking water, wastewater, and stormwater needs, but the data are now out of date

Reward and spread best practices and leadership efforts in water efficiency

In many, if not most, cases, the cheapest source of "new" water for North Carolina will be improved efficiency in water use. This is particularly true in outdoor water use by private residences, where the advent of cheap irrigation systems that are not operated properly by homeowners has led to large peaks in water use in many water systems at just the time (late summer and early fall) when the state's water supplies are normally under the greatest stress.

The state has not set clear goals to reduce demand for water or to increase water efficiency and conservation. The state does not have a water efficiency strategy or plan. In contrast, the NC Energy Policy Council has adopted a state energy plan. Responsibility for water efficiency policy is shared by multiple state agencies, including the Division of Water Resources (DWR), the Division of Pollution Prevention and Environmental Assistance (DPPEA), the Division of Environmental Health (DEH), the Division of Water Quality (DWQ), the Building Code Council in the Department of Insurance, the NC Utilities Commission (NCUC), and the Public Staff.

Legislation enacted in 2007 and codified in 2008 (S.L. 2008-203, Codify Energy Efficiency in State Buildings, by Senator Janet Cowell) sets both water and energy efficiency goals for state buildings. But no baselines exist to compare or benchmark water use and water use reductions for sectors, industry types, public systems, private systems, households, etc. Section 9 of HB 2499 (S.L. 2008-143, Drought/Water Management Recommendations of 2008, by Reps. Lucy Allen and Pryor Gibson and Senator Dan Clodfelter), provides incentives for water systems seeking state loan and grant funds to be more efficient. Section 18 of HB 2499 directs DENR in consultation with others to study water efficiency standards.

The most important means of improving water efficiency, in the judgment of the Water Allocation Study team, are by pricing water so that outdoor irrigation faces a significantly higher price, especially during droughts; by giving credits for efficiency measures to water systems that can be added to the system's allocations under their water withdrawal permits; by education, outreach, and further research on water efficient landscape design, installation, irrigation, and maintenance; and by encouraging the use of stormwater for irrigation. The policies behind and implementation approaches to conservation pricing are the subject of a separate study under way at the direction of the 2008 drought bill. The education, outreach, and research components of this efficiency recommendation are discussed further under the heading of Addressing Critical Study and Research Needs. The matter of stormwater as a source of usable water is elaborated below in the general discussion of increased storage.

Create more storage

Western states in the United States can grow and prosper with much less precipitation than North Carolina gets primarily for two reasons: more efficient use of water and more storage. The west has large reservoirs, funded through the decades by substantial federal appropriations, that store multiple years' worth of precipitation and snowmelt. It is highly unlikely that North Carolina will ever be able to get federal funding for major new reservoirs; the net benefits of remaining reservoir sites are not likely to justify federal dollars. The costs are too high and the other options for water too numerous. Still, there are likely to be smaller-scale needs for more storage, including storage at the very small scale (farms and backyards) where peak needs for irrigating landscapes and watering livestock can be met at times when stream flows in North Carolina are usually at their lowest.

Traditionally the state has provided some technical and financial assistance, when requested by local governments, to help them develop and expand new sources of surface water and groundwater. But the state does not have a plan to increase water supplies or for the state to plan, finance, and develop new water supplies. Piedmont Triad Water Authority's Randleman Dam project on the Deep River in Randolph County, Raleigh's Little River project in Wake County, and the City of Wilson's expansion of Buckhorn Reservoir—the state's three biggest recent water storage projects—were locally financed. Options for new or expanded surface water storage appear to be limited (Moreau 1992) Lack of local planning and financing (i.e., willingness to raise rates today for future water) and difficulty in creating regional partnerships to acquire new water storage have probably raised a larger barrier to new supplies than have regulatory issues. Dr. Moreau is updating his 1992 study with financial assistance from the Clean Water Management Trust Fund and others. Dr. Moreau's study will evaluate new sources and potential to expand existing sources of water supply. The exact potential for new water supplies is unknown.

Reservoirs (above-ground storage)

New reservoirs in North Carolina will be expensive and difficult to site and construct. It is not just a matter of environmental permitting; it is a function of the pattern of property ownership, development, and governmental jurisdictional boundaries likely to be covered by new reservoirs.

Furthermore, many of North Carolina's Piedmont and inner coastal plain streams are at or above nutrient-sensitive limits, making shallow reservoirs on those streams highly subject to eutrophication and other water quality problems. Nevertheless, the Water Allocation Study team recommends that the legislature create an expedited regulatory path for new reservoirs that meet certain upfront conditions:

- they are sited in places that do not have federal- or state-listed threatened or endangered species;
- they are designed and constructed solely for water supply purposes rather than for real estate development or flood control;
- they are built and operated with a release regime that fully meets instream flow goals;
- they are in a river basin where the hydrologic modeling indicates that the water budget is out of balance;
- they are approved at an intergovernmental level by the regional planning body called for in this study (see "Establish proactive, adaptive, river basin water supply planning, below").

If these conditions are met, then the State Environmental Policy Act review should treat these reservoirs as akin to projects that meet "minimum criteria" for environmental review.

Groundwater Storage and Retrieval and Desalination

Greenville has begun an experiment with groundwater storage and retrieval. This method of using underground storage instead of reservoirs could be important for future water supplies in North Carolina, particularly in eastern parts of the state where subsurface sediments provide

The Water Allocation Study team recommends that the legislature create an expedited regulatory path for new reservoirs that meet certain upfront conditions.

enough porosity to store large quantities of water. The experiment should be carefully monitored and, if it succeeds, should be encouraged as a possible option for other growth areas in the east.

As with desalination, though, it is not likely that groundwater storage and retrieval will be a significant source of water for high-growth areas in the Piedmont and western parts of the state in the near future, due to the different subsurface geology and costs and complexity of pumping over long distances and many hills.

Reclaimed and Gray Water

As discussed in the section on drought response, there has been an intense level of interest in the state during the past two droughts in reclaimed (treated) and gray (captured for reuse and not exposed directly to waste) water. Past restrictions on both types of water have been eased. Several North Carolina water systems are already providing reclaimed water to customers, either through bulk deliveries in trucks or at the treatment plant. There are some dual-piped buildings being built, such as at the UNC–Chapel Hill campus.

The state should continue to monitor the increased use of these resources. Reclaimed water, in particular, is becoming an important, cost-effective source of water supply in some arid regions of the western United States and in Florida. It faces formidable economic challenges in North Carolina at present because of the cost of its treatment and distribution. But where,

as at new UNC–Chapel Hill buildings, the cost of dual-piped new construction can be justified, reclaimed water could become an important way to supply future needs in the high-growth Piedmont region. Economic developers in overstressed basins should also seriously consider siting industrial facilities that need assured water supplies in close proximity to wastewater plants.

Two particularly important research needs are improved understanding of how reclaimed water works with commercially important turfgrass varieties and how it would affect aquatic habitat health in low- or "zero-flow" streams. Reclaimed water could be an important source of irrigation water for golf courses, an important part of the state's tourism economy, and an important means of ensuring that communities are not completely reliant on groundwater and captured stormwater in times of water stress. Because of the large costs of mistakes in watering expensive turf at golf courses, it is important to know for certain how reclaimed water would work with different cultivars. The concern in low-flow streams is how systems that treat water to reclaimed standards would be able to use it if there are not enough customers to take the entire supply. North Carolina, by rule, currently prohibits new discharges into low- or no-flow streams, but it is possible that releases of reclaimed water into these streams, as into wetlands, could improve aquatic habitat, particularly during low-flow periods.

Decentralized Storage: Farm Ponds, Stormwater, and Private Property Owner Storage

As with electrical energy, there has been a resurgence of attention to decentralized forms of supply in North Carolina over the past decade. More than 16,000 farm ponds were built in North Carolina from 1947 to 1964, when the federal government provided funding through PL566. Through lack of maintenance and lack of funds for repair and replacement, as well as development pressure, many of them have become high-risk dams, or have silted up, or have been incorporated into subdivisions where responsibility for their maintenance is unclear. As a result of the 2007–2008 drought and its severe impacts on agriculture, the North Carolina agricultural cost share program has begun providing cost share funds for farm pond restoration. This represents a return of the agricultural cost share program back toward its roots after several decades of focus solely on water quality. The state should continue to encourage the restoration and maintenance of farm ponds and other water storage structures on private property, as they (along with private wells) can improve the overall resilience of the water supply. Given the low probability that water systems will find many places where large new reservoirs are feasible, it is even more important today to encourage private property owners to provide for their own needs in watering livestock and irrigating turf and crops, especially where those efforts do not create conflict with downstream users by removing large quantities of water from flowing streams.

Similarly, the rising number of stormwater retention structures (primarily detention ponds, wet ponds, constructed wetlands, and cisterns) provides possibilities for reuse of water and reinfiltration into the groundwater. Newer golf courses are already designed and constructed to make use of onsite stormwater catchments to provide the maximum amount of water for irrigation without having to draw on municipal

sources, streams, or groundwater. On a very small scale, the droughts of 2000–2002 and 2007—2008 generated much interest in backyard rain harvesting by individual property owners, with sales of rain barrels rising substantially.

The state and local stormwater programs should explore their rapidly evolving stormwater systems to see how they could further encourage the reuse of water from stormwater best management practices and the harvesting of rain by homeowners. There are states in the arid western United States where water is so constrained that the state asserts its right to control the supply and use of water in such structures. North Carolina can and should, at this time, instead support the right of private property owners to make use of water captured from rainfall (or in ponds fed by springs and rainwater only) without restriction by the state.

How the recommendations would address the four scenarios

1. Private firm buys old intake and consumes or exports water, even while downstream industries and water systems are running dry.

A good water withdrawal permit program, in conjunction with planning based on hydrologic models, would eliminate or minimize this type of conflict between major water users. An existing major user, such as an industrial plant or public water system, would have a permit that authorizes its withdrawal of water. New major withdrawers would be permitted if and only if the river basin model proves that the new withdrawal would not cause problems for downstream users, even under very low-flow conditions and planned growth by existing users. Before a new withdrawal that might cause problems could be permitted, the group of water systems, users, and citizens already in the basin would have to agree on measures—either increasing storage, increasing water use efficiency, or realigning permitted withdrawals—that reduce the chance of conflict.

2. Private firm pumps groundwater and uses or exports it, even while adjoining farmer's wells dry up.

A good water withdrawal permit program would cover major extraction of groundwater as well as surface water. To receive a permit for a significant new groundwater withdrawal, a facility would need to demonstrate that its pumping is unlikely to cause problems for nearby wells. At the present time, this is likely to be done based on best professional judgment and rules of thumb. But the permit program would also give an administrative mechanism for addressing conflict that arises over groundwater withdrawals rather than requiring the private parties to go to court. It is highly likely that geologists, engineers, and persons familiar with well construction are better positioned than judges to help resolve these disputes, at least in the fact-gathering initial stages of litigation.

The state's present river basin models do not account for groundwater withdrawals. This is a major gap in the state's knowledge of its water resources. In the Piedmont and mountain regions, it is a difficult, site-specific task to assess the likely influence of a proposed new well on other wells. But studies are under way in several places on this question as well as on the question of the impact of groundwater withdrawals on surface water supplies. This report recommends the collection, publication, and

ongoing funding of these studies as a top priority research task for the state.

3. City is unaware of its precarious water supply and leaky pipes until it fails to deliver on promises to new development.

These recommendations address this problem in four ways. First, the use of hydrologic models in every river basin means that forecasting future water budgets will no longer be left to each water system on its own. This brings the best current scientific models of water supply and demand to bear on this important forecasting need. A well-designed hydrologic model will show with high levels of confidence whether and where there are likely to be water supply/demand imbalances in the foreseeable future.

Second, where the models show problems are likely to exist in the next twenty to forty years, these recommendations propose a regional approach to planning, using the river basin planning models already demonstrated in part in the Catawba and Cape Fear basins. Water systems that are predicted to have difficulty meeting their expected commitments will be a shared problem of the entire river basin. This allows for the possibility of regional efforts to bring future supply and demand into balance, just like an agency or a family that must balance a budget.

Third, local water supply planning and other reporting requirements about water will be consolidated, streamlined, and open to more scrutiny. More resources will be devoted to creation, review, and approval of water supply plans, reducing the chance that local governing boards do not understand the degree to which their supply is not capable of supporting the growth they want.

Fourth, the Local Government Commission will be more involved in review of revenues and expenditures of water systems, with a particular focus on whether operations, maintenance, repair, and replacement of infrastructure are adequately funded. The state's goal for pricing water should be to fully cover costs, including depreciation of the infrastructure; it should not be to come up with the lowest possible cost for water.

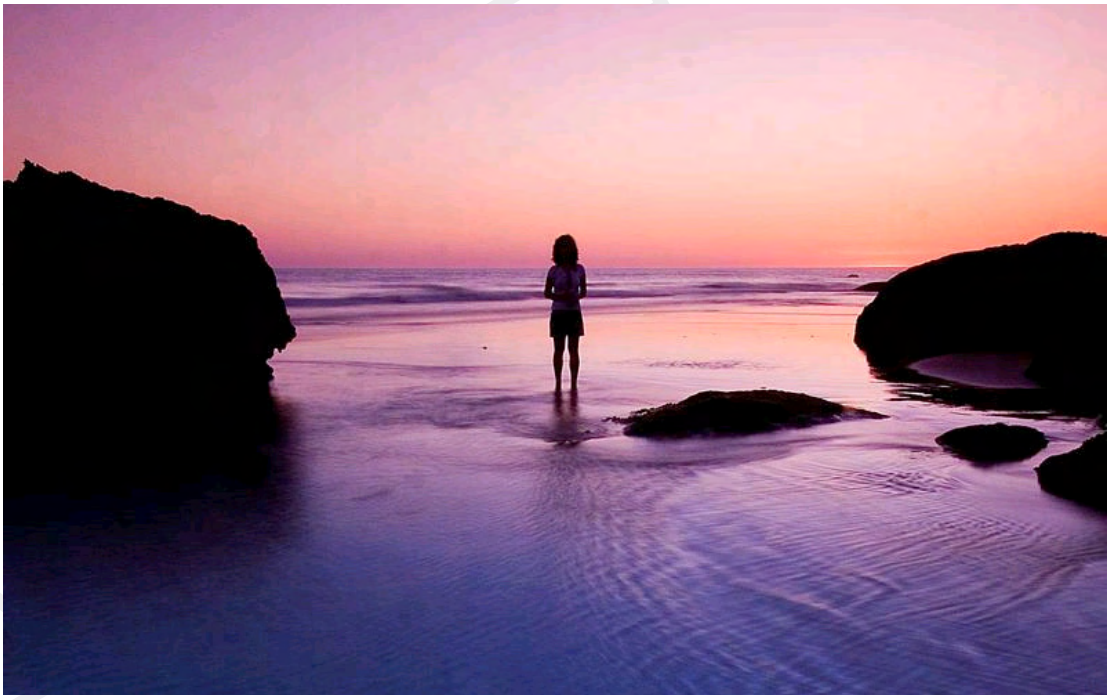
4. Strong population and commercial growth in the headwaters leaves a water system no or few options for additional supply.

These recommendations address this problem, the difficulty and expense of water supply development in the state's high-growth regions, in two ways. First, by setting out a path for water supply reservoir development in places with minimal environmental impacts and maximum benefits as a water supply, the recommendations would help reduce the long lead times for developing water supplies. Second, by setting up river basin planning groups that could build trust and working relationships between water systems and water users, and giving those groups the power and a means of promoting shared water facilities with enhanced access to state funding resources, the recommendations could help solve the difficult intergovernmental problems posed by settlement patterns across North Carolina.

Changes from the draft report

This is a placeholder for a summary of changes to the draft report, which will be included in the final report when it is issued after public review and comment on the draft report.

Conclusion



North Carolina is geographically blessed with ample precipitation in normal times. If the state manages its water resources properly, they can be a huge comparative advantage to the economy and the quality of life in the state. Almost all experts predict significant conflict over scarce water in much of the world, including the United States, in the near future.

However, the legacy of this ample water supply is a set of institutions, laws, and policies that do not deal very well with places and times of water scarcity. Even in North Carolina, as in the rest of the southeast, there are likely to be many more such places and times in the decades to come.

The recommendations in this 2008 report of the Water Allocation Study would build on the water resource laws, institutions, and policies already in place in North Carolina to protect economic investments and the state's environment. The study team believes that adoption of these recommendations would greatly help ensure the long-term future of quality of life in North Carolina. The study team stands ready to assist the legislature and the many stakeholders on these issues as they discuss and debate these recommendations.

Appendices

Appendix A: Strategies for improved water allocation in overbudgeted basins

Strategies for adapting to water supply stress are listed in general categories below, along with specific examples of their implementation in the CCPCUA.

Creation of new local institutions

The CCPCUA rules have resulted in the creation of at least two new units of government to address CCPCUA prescribed groundwater reductions.

The Neuse Regional Water and Sewer Authority (NRWASA), a new drinking water wholesale utility, was created to construct a new surface water treatment plant and to sell treated water to eight existing local governments/utilities throughout the region. The volume of water sold to the member utilities would cover the entire cutback faced by each utility in 2018 (75% or 30% cutbacks). NRWASA has focused its energies over the past five years developing its institutional identity (crafting bylaws, developing interlocal agreements, changing memberships, etc.) and constructing a large new surface water treatment facility. During this time, membership within NRWASA changed as local governments/utilities opted in or opted out of the original agreements. The Authority's work has been bolstered by the receipt of millions of dollars in subsidized federal and state loans and grants, including USDA and SRF loans and grants from the Tobacco Trust Fund and the NC Rural Center. The creation of the new authority cost over $140 million as of 2008. The treatment plant is expected to be operational in early fall 2008.

The Martin County Regional Water and Sewer Authority (MCRWASA) was recently created by Martin County, Williamston, and Robersonville to play a similar role in Martin County. To date, the authority has played primarily a planning role with the goal of constructing a new treatment facility, but no assets are currently owned under this new entity. MCRWASA will eventually supply its member entities with sufficient water to cover the cutbacks they face in the future.

The creation of a new water and sewer authority is relatively rare in North Carolina, with only approximately ten to fifteen having been created since the authorizing statutes were first written. The creation of a new authority normally results in existing local governments transferring significant assets and management authority to a new separate unit of government in which they exercise a reduced level of control through the appointment of directors on the governing board. This change in the level of local control is very significant since maintaining local control is often cited as one of the most important roadblocks to creating interlocal partnerships. While many documents and leaders cite the numerous benefits of creating larger regional single-purpose water utilities, many if not most of the

existing authorities in the state are the direct result of addressing water supply or water treatment stress. As with the example of NRWASA, new regional entities are often able to attract significant public funding support. This funding support becomes a very powerful incentive that helps local governments enter into partnerships that they might otherwise have avoided due to control issues.

Interlocal agreements

Most local utilities in North Carolina that work together do so not by creating an entirely new entity, but rather by relying on interlocal agreements to craft partnerships in particular areas. Utilities within the CCPCUA have entered into dozens of interlocal agreements with each other covering a range of services that impact water supply. The majority of the new agreements involve the bulk sale of treated water between utilities. The new agreements within the CCPCUA also include several very creative clauses not typically seen in other areas of the state. For example, the Greenville Utilities Commission (GUC) has entered into interruptible service agreements that provide purchasers with relatively inexpensive water for most of the year as long as they agree to maintain backup supplies that can be used for the short period of time when the GUC requires all of its capacity to serve its citizens. The economics of this type of agreement are quite favorable for both the provider and the purchaser. The provider is able to convert unused capacity into new revenue, and the purchaser is able to meet its reduction requirements without having to construct expensive new facilities. Utilities in other areas of the state most likely could benefit from sharing excess capacity; however, the concern over losing local control and relying on others is a powerful disincentive to sharing capacity.

Physical interconnections

Utilities construct interconnections with other utilities for multiple reasons, including reducing vulnerability to water shortages and droughts. The number of interconnections in the CCPCUA has ballooned over the past five years (see maps). Interconnections, when properly designed and controlled by a well thought out agreement, provide utilities with many water resource benefits. Utilities are able to access water from their neighbors during emergencies. They also permit utilities that are so inclined to trade water for economic benefits as was done in the case of the GUC agreements. What should be the role of the state in promoting interconnections? One option, as described in proposed state legislation over the past few years, would be to have the state promote interconnections and the evaluation of interconnections through regulatory requirements. Local utilities and professional associations have fought this approach, preferring that the state focus more on providing financial assistance and incentives for these connections. As far as the CCPCUA is concerned, the state has specifically required interconnections, but they have not provided significant funding assistance for utilities choosing to construct interconnections.

Pricing

As mentioned above, water service pricing for government-owned utilities in North Carolina falls under the authority of locally elected or appointed governing boards (municipal councils, county boards, etc.) Historically, most utilities have viewed

pricing primarily as the tool they use to raise revenue to meet their costs. In recent years, utilities have increasingly recognized pricing as a tool to influence customer behavior and water usage. It is this ability to influence/reduce water usage that has led many to see pricing as a critical water supply management strategy. State policy makers have begun incorporating pricing recommendations and requirements into regulatory programs, including the CCPCUA rules. The CCPCUA rules require that utilities include pricing in their water use reduction strategies through the "adoption of a water conservation–based rate structure, such as: flat rates, increasing block rates, seasonal rates, or quantity-based surcharges." The rule does not state when these types of rates need to be in place.

Transfer of water allocation credits

One of the most complicated local strategies for addressing water shortages involves the transfer of water allocation rights or credits. Water permit or allocation trading is significantly different from the water transfers that occur under bulk sales agreements in that the "goods" traded in the former are not actual withdrawals of water, but the right to use/withdraw a certain amount of water. This strategy requires having a legal framework that supports some type of water credit/allocation market. These markets are common in the western United States but are relatively rare east of the Mississippi. Current North Carolina water law and regulations make this type of trading impossible or irrelevant in most of North Carolina with one major exception—the fifteen counties covered by the CCPCUA rules. The CCPCUA permit system and rules have created the possibility of water allocation trading. This type of market trading has been used by at least four communities within the region as part of their adaptive strategies. The town of LaGrange had the opportunity to purchase water from NRWASA but opted instead to purchase a water allocation from Farmville that allowed LaGrange to pump more from its existing wells than it would have otherwise been allowed to pump. This allocation sale reduced the amount of water that needed to be transferred; reduced the total cost to Lagrange of providing its citizens with water; and provided a source of funds to Farmville for a resource that they no longer needed due to the water sales agreement they entered into with NRWASA. In another area of the CCPCUA, the town of Williamston has begun purchasing water withdrawal rights from the town of Robersonville for $1.69/1,000 gallons. Robersonville's loss of a significant industrial client since its permitted flows were established has left it with an excess permitted capacity that can be converted into revenue (approximately $9,000 per month).

Extended distance water transfers

Many water interconnections are constructed to allow water to travel relatively short distances between neighboring utilities, but some connections can be used or are specifically designed to allow water to be transferred within much longer distances. Long distance water transfers become a desirable adaptive strategy when supply or treatment constraints make closer supplies of water unavailable or prohibitively expensive. Long distance water transfers constitute an essential component of assuring water supply in areas such as

California and have become an important part of local strategies in the CCPCUA area.

Water efficiency/Loss detection and prevention

Water leaks and poor metering can lead to very significant water losses. A thorough water audit would quantify the volume of water as it flows from source intakes through the points of consumption, identifying water losses through leaks. Water leaks through the distribution network can sometimes amount to 30% or more of the total water treated and put into the distribution network. Although leaks can cause significant water loss, few systems have active leak detection programs. A handful of systems participate in the "Water: Use It Wisely" education campaign, a national public awareness program originally developed in Phoenix, Arizona. Leak detection and pipe repair or replacement can require a substantial portion of a utility's operating budget but usually are cost-effective means of reducing water loss that in turn amounts to lost revenue. Similarly, an aggressive meter replacement program that aims to replace all meters within five to seven years might be an expensive but cost-effective means of reducing unaccounted for water and revenue losses.

Due to the CCPCUA rules, Pinetops was required to cut back 10% of its withdrawals between 2002 and 2008. Pinetops was able to achieve, and exceed, these cutbacks solely by reducing water losses through an aggressive program of leak detection and pipe replacement as well as meter replacement. Pinetops expects to be able to meet its next 10% cutback requirement by 2013 through the same method. Pinetops increased its water rates in the past few years to fund the capital costs required for pipe and meter replacement but at the same time avoided having to find expensive new sources of water.

Appendix B: Water Allocation Study team members, 2008

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