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I. INTRODUCTION

This report consists of a series of papers that address a common theme, namely the economic and land use implications of regulations to protect watersheds that drain to public water supplies in North Carolina. Public concern about protection of these supplies has been increasing for the past 15 years, peaking in the vigorous debate over regulations formulated by the North Carolina Environmental Management Commission (EMC) to implement House Bill 156 passed by the General Assembly of North Carolina in 1989. That debate occurred over a period of nearly three years from March 1989 until February 1992. Several of the papers included in this report were shared in draft form with the EMC and staff of the Division of Environmental Management (DEM) during the course of that debate.

A primary cause of public concern about public water supplies is the increasing gap between demand and the availability of sites at which new, pollution free sources can be developed. An indirect but very useful indicator of trends in public water use is urban population. More than 90 percent of urban residents in North Carolina are served by public supplies, and most of the water produced by public supplies is used within urban areas. As shown in Figure I-1, the number of people living in towns and cities in North Carolina has grown rapidly and steadily throughout the twentieth century. In 1900, less than 200,000 people resided in urban areas in the state. In the first 40 years of this century, that number increased by 800,000. That same number was added in the next 20 years. Since 1960, the urban population has almost doubled, with a net increase of 1.5 million, bringing the 1990 count of urban residents to 3,300,000. Thus, in the past 50 years the urban population has quadrupled, and it is reasonable to assume that water use has increased by at least that much.
As shown in Figure I-2, much of the urban population growth has been concentrated in the Piedmont region of the state, where public water supplies are drawn predominantly from surface waters. The 1989 data compiled by DEHNR and reported by USGS indicate that 88 percent of all public supplies in the state is taken from surface sources. In the Piedmont region, where groundwater can be withdrawn only at relatively small rates, all water systems that serve more than 10,000 people take their water from rivers and reservoirs.

Historical data on consumption of water from public supplies in North Carolina is very limited. Good data of public use was compiled in 1989 in a statewide survey by the Department of Environment, Health, and Natural Resource (DEHNR), but prior to that survey less certain estimates assembled by the U.S.
Figure I-2. 1990 Population Densities in North Carolina for 5-Minute Grid Cells

Legend:
- Population
  - 5,000 - 9,999
  - 10,000 - 24,999
  - 25,000 - 49,999
  - 50,000 - 74,999
  - 75,000 - 100,000
Geological Survey (USGS) are available. Estimated use since 1970 is given in Table I-1.

Table I-1. Water Use by Public Supplies in North Carolina in MGD

<table>
<thead>
<tr>
<th>Year</th>
<th>Surface</th>
<th>Ground</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td>450</td>
</tr>
<tr>
<td>1975</td>
<td></td>
<td></td>
<td>530</td>
</tr>
<tr>
<td>1980</td>
<td>500</td>
<td>70</td>
<td>570</td>
</tr>
<tr>
<td>1985</td>
<td>507</td>
<td>88</td>
<td>595</td>
</tr>
<tr>
<td>1990</td>
<td>668</td>
<td>137</td>
<td>805</td>
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USGS reported that in 1980 water was withdrawn from surface and groundwater sources in for public water supplies in North Carolina at the rate of 570 million gallons per day (MGD). That rate is equivalent to an average use of 202 gallons per day per urban resident (that number includes commercial, industrial, and public use as well as residential use). Similar estimates for 1989 showed withdrawals of 805 MGD, with an average use of 241 gallons per day. As stated earlier, the historical data are subject to considerably more uncertainty than the 1989 data, but, if valid, publicly supplied water use increased by 41 percent in the 1980s. The USGS data indicate that public water use has increased by nearly 80 percent just since 1970. Those data also suggest that per capita use of water is increasing.

The supply of developed water sources is not increasing as quickly. In fact, the rate of expansion of reservoir capacity in North Carolina is declining. Moreau (1992) has shown that approximately 84 percent of the state's reservoir capacity in 1992 was built prior to 1950 (based on normal capacities, not brimful capacities). While those numbers apply to reservoirs used for all conservation purposes, not just water supply, for all purposes, there has been a dramatic reduction in expansion of
water supply reservoirs over the last 15 years. As shown in Figure I-3, storage capacity in water supply reservoirs rose steadily from 1950 to 1975. Since 1975, the capacity curve has remained relatively flat. During the 1950-1975 period, about 53,500 gallons of storage was added for every new urban resident. Only 7,200 gallons have been added for each new resident since 1975.

The slow-down can be attributed to several factors. Most prime reservoir sites have already been developed. As prime sites have been developed, remaining sites have become more costly. Since 1975, new reservoirs have come under increasingly critical environmental reviews, and, at least at the national level, the rate of investment in infrastructure of all kinds has been on the decline.
It is not surprising, therefore, that North Carolinians have become more active in protecting existing sources of public water supply, and an historical account of the evolution of watershed protection policies in the state is given in Chapter II. That account, written by Jeri Gray, traces development of these policies from the mid-1970s when debate over a new water supply for Chapel Hill raised questions about the adequacy of that part of North Carolina's stream classification system that is applicable to sources of public water supply. The account continues through state, regional and local government efforts to regulate development around two large multiple-purpose reservoirs in the Research Triangle region. That discussion also covers the three-year debate on House Bill 156 that resulted in adoption of statewide minimum standards in 1992. Gray recounts the work of the Watershed Advisory Council and staff of DEM that led to a rather ambitious proposal by EMC. She goes on to tell how the combined forces of the development community and local governments brought substantial modifications to the original proposal before the regulations were adopted in 1992.

In Chapter III, Renee Purdy reviews the literature that is pertinent to economic effects of land use regulations similar to those contained in the regulations for watershed protection. That discussion adopts changes in economic efficiency as the appropriate criteria for assessing economic impacts on an affected community. Beneficial and adverse effects are classified into four categories, direct and indirect benefits and direct and indirect costs. Most of the literature addresses indirect benefits and both categories of cost; very little effort has been made to evaluate direct benefits. The literature suggests that, for the type of regulations and conditions under which watershed protection is occurring in North Carolina, there could be both beneficial and adverse effects on property. If the regulations affect the price of land, owners of undeveloped land are the ones likely to absorb any losses and owners of developed
property are likely to be the beneficiaries of any gains. This review of the literature also covers some of the empirical estimates of direct costs to new housing that have been attributed to a broad range of environmental regulations. Most of these estimates place the combined costs of a bundle of regulations at less than 6 percent.

Chapter IV is an examination of the issue of whether watershed regulations as proposed in North Carolina would pose a limit on the availability of land to accommodate new residential development. In that paper, Moreau and Kathy N. Watts summarize results of calculations of densities of residential development in each of the more than 400 water supply watersheds. Those densities are then compared with densities that would have been allowed under the regulations as proposed in 1991 and with densities that are allowed under the regulations as adopted in 1992. They conclude that the regulations would be a limiting factor on residential development in only a small number of very small watersheds. Both versions of the regulations would have accommodated populations of several times the existing population of the state on about 22 percent of the state's land area.

Chapter V, written by Moreau, Watts, and Purdy, reviews the probable impacts of the watershed protection regulations in each of eight of the most widely affected counties in North Carolina. Growth and spatial patterns of development are examined in each county with special attention to how development is locating in water supply watersheds. Local development regulations are compared to state regulations to determine how future development would be affected with state regulations and without them. The authors draw several conclusions from this analysis. First, the regulations will have little effect in those counties where local governments have a history of protecting sources of public water supplies from over-development. Second, most watersheds that will be affected by the regulations could be brought into
compliance with allowable densities if the stormwater management option is implemented. Third, large areas of rural lands that are not now and are not likely to be subject to urban development in the foreseeable future will be brought under urban-type density limits by these regulations.

Chapter VI, written by Moreau, is a cross-county analysis of how recent development projects would have been affected by the various versions of the regulations. In that chapter the author examines development densities in a sample of 65 subdivisions that have been built in water supply watersheds in five counties since 1985. Those development densities are then used to estimate how the regulations, in both their 1991 and 1992 versions, would have affected land requirements for these developments. That analysis shows that under the 1991 version of the regulations, substantial increases in land requirements would have been necessary to bring those developments into compliance with density restrictions. Furthermore, in Class WS-II watersheds, no relief from density restrictions would have been granted for protective measures such as stormwater controls. A similar analysis of the rules as adopted in 1992 shows that the rules will have minimal effects on current development practices and costs of new housing in the affected areas.

REFERENCES

II. HISTORY OF THE DEVELOPMENT OF NORTH CAROLINA'S WATER SUPPLY WATERSHED PROTECTION ACT

by
Jeri Gray

THE NATIONAL CONTEXT

General Background on Watershed Protection. In the 19th century, it became evident that disease was being transmitted by water. At that time, before the advent of modern water treatment technology, the only way to ensure that drinking water was free of contamination was to exercise strict sanitary control over the water supply watershed, and the only way to do that was to acquire the entire watershed and put it off limits to most human activity. As a vestige of that era, municipally owned watersheds today dot New England and other areas of abundant surface water supplies. In North Carolina, the Asheville-Buncombe Water Authority owns the entire 31-square-mile watershed for its reservoirs.

During the latter two decades of the nineteenth century and first decade of the 20th century, important advances were made in water treatment technology (filtration and disinfection by chlorination). These advances made it possible to use less than pristine sources when protected sources were unavailable. As population growth increased pressure to use watershed areas for agricultural and urban uses, the option of using only isolated sources became less feasible. Thus, while watershed protection is still regarded as the first line of defense against drinking water contamination, treatment technology has become a common, almost universal supplement.

By the end of the 1960s the results of decreased reliance on watershed protection were evident. In 1969, the Bureau of Water Hygiene of the Public Health Service conducted a nationwide survey of community water supply systems. Only 59% of the systems
met all of the Public Health Service drinking water quality standards, and 26 percent reported specific problems with surface raw water quality. In all, the Public Health Service indicated that over 25 million persons were obtaining substandard drinking water and that approximately 8 million were consuming potentially dangerous water (Burby et al. 1982).

The Safe Drinking Water Act of 1974. In the decade preceding passage of the Safe Drinking Water Act of 1974, there were more than 200 outbreaks of disease or poisoning caused by contaminated drinking water in the United States. More than 54,000 people became ill, and 22 died (U.S. Congress 1974).

During three-years of hearings leading up to the passage of the Safe Drinking Water Act, the U.S. Public Health Service, the Environmental Protection Agency, the General Accounting Office, and professional and citizen groups presented Congress evidence of widespread bacterial and viral contamination of public water supplies and increasing contamination by synthetic organic chemicals (U.S. Congress 1974; McDermott 1974).

In May 1973, Congressman Howard W. Robison of New York read newspaper headlines regarding unsafe water supplies to a Senate subcommittee and said, "These statements of concern about the safety of drinking water echoed in every corner of the country during the last year in what can fairly be called a 'tide of national concern (U.S. Congress 1973).''"

The congressional hearings on drinking water revealed not only that existing water treatment technology was not being uniformly applied but also that existing technology was no longer adequate to assure the safety of drinking water drawn from sources receiving increasing discharges of wastewater effluents. The law that resulted expanded the scope of drinking water standards to cover bacterial, viral, inorganic, organic, and radiological
contaminants and expanded enforcement from simply interstate carriers to the majority of all public water supplies. The Safe Drinking Water Act of 1974 also established as national policy the involvement of the public being served in the process of monitoring and regulating the safety of its drinking water. (U.S. Congress 1974)

THE STATE CONTEXT

The Watershed Protection Seed: Water Supply Classification. In the 1970s, the exercise of examining water supply options for the University of North Carolina at Chapel Hill and the surrounding area brought under intense public scrutiny the issue of human health threats from contamination of water supplies by organic chemicals. Against the backdrop of national concern about drinking water quality and an emerging public involvement in environmental matters spurred by the National Environmental Policy Act of 1969 (NEPA) and encouraged by the Safe Drinking Water Act, a search was carried out for an additional drinking water supply for Chapel Hill, Carrboro, and southeast Orange County, NC.

Faced with an urgent need to supplement its University Lake water supply, the University of North Carolina in 1969 sponsored a study of the potential sources of water in southeast Orange County and, following the study, initiated efforts to build a reservoir on the primarily forested watershed of Cane Creek. In 1977, the university divested itself of its utilities and turned over responsibility for providing water and sewer services for Chapel Hill, Carrboro, and southeast Orange County to a multi-government organization called the Orange Water and Sewer Authority (OWASA). The task of developing the Cane Creek Reservoir fell to OWASA.

To construct the Cane Creek dam, OWASA had to apply to the Army Corps of Engineers for a Clean Water Act Section 404 permit.
Under Section 102(2) of the NEPA, the Corps had to prepare an Environmental Impact Statement before issuing the 404 permit for the Cane Creek project (U.S. Army Corps of Engineers 1980). In addition, under the N.C. Environmental Policy Act, in order to obtain power of eminent domain to purchase land for the Cane Creek project, OWASA had to convince the state Environmental Management Commission (EMC) that Cane Creek was the most feasible option for meeting its water supply objectives (N.C. Division of Environmental Management 1982). Both processes required that OWASA examine other options for water supply. Public hearings were held by the EMC on OWASA's request for power of eminent domain during the spring of 1978, and a public hearing was held on the Corps' draft Environmental Impact Statement.

The Jordan Dam Controversy. Among the primary alternatives to Cane Creek that OWASA had to consider were withdrawing water from the Haw River and the soon-to-be-impounded B. Everett Jordan Reservoir, which the Haw feeds (N.C. Division of Environmental Management 1982). The likely quality of water impounded by Jordan dam was a matter of intense public debate. In November 1970, a group calling itself Citizens to Save the Cape Fear Watershed had launched an effort to halt the "New Hope" project (as it was then called), demanding that an Environmental Impact Statement on the project be performed.1 As the basis for its concerns, the group cited studies by the Federal Water Quality Administration (FWQA, a predecessor of EPA) and by Dr. Charles M. Weiss of UNC-Chapel Hill (Hunt 1980). According to Weiss (1971):

> It can be concluded from the water quality data summarized in this report that the existing water

---

1 Section 102 of the National Environmental Policy Act requires agencies to file environmental impact statements (EIS) on proposed actions "significantly affecting the quality of the human environment." Even though the Jordan Lake project was initiated 7 years before passage of the NEPA, the act did not address its applicability to projects already underway, and opponents of the Jordan project used NEPA to force the Corps to prepare an EIS.
quality is sufficiently poor to indicate that the usefulness of New Hope Lake for recreational pursuits will be questionable. The impounded water will also have quality characteristics that would make it undesirable as a raw water source for a municipal water supply.

The Corps released draft versions of an EIS in the spring of 1971, but the study did not satisfy the citizens involved in the challenge, and in August 1971, the Conservation Council of North Carolina brought suit against the Corps, seeking an injunction to stop the New Hope project. In 1972, the City of Durham and the Town of Chapel Hill entered the suit on the side of the plaintiffs. The legal challenge went on until 1979 when an appeals court upheld a 1977 decision in favor of the Corps. The decision was handed down during the time OWASA was completing requirements for permits for the Cane Creek Reservoir. Although ultimately unsuccessful, the effort to stop impoundment of the Jordan Reservoir created widespread publicity about the expected quality of water in the lake (Hunt 1980).

The pre-impoundment studies by FWQA and Weiss had indicated that existing levels of nitrogen and phosphorus would lead to algal problems in the Jordan Reservoir (Hunt 1980). In addition, on streams feeding the Haw River above the dam there were 143 point source dischargers of municipal and industrial wastes. Sampling revealed a number of synthetic organic chemicals, some of which could not be identified, in the Haw River and, therefore, the B. Everett Jordan drainage (U.S. Army Corp of Engineers 1980).

Newspapers outside the area reported the Jordan controversy (for instance, see Asheville Citizen March 15, 1978), and concern about water quality in the Jordan Reservoir and its tributaries prompted the 1983 Session of the N.C. General Assembly to authorize a study by the Legislative Research Commission on the quality of the water in the Haw River and Jordan Reservoir (House Joint Resolution Bill 1257). The committee presented its report to the 1985 General Assembly. Among its conclusions were that "The problems of toxic substances in the water is serious and growing" and "Watershed protection planning is essential to the solution of
The Cane Creek watershed was (is) essentially undeveloped, with no point source dischargers. Since there were no permitted point-source dischargers in the Cane Creek watershed, OWASA concluded that water quality in Cane Creek was superior to alternative sources and that the undeveloped nature of the source would insure the protection of the health of the people in the service area (N.C. Division of Environmental Management 1982). The authority, therefore, endorsed the Cane Creek option, and the EMC issued a Certificate of Authority granting OWASA eminent domain in April 1979 (U.S. Army Corps of Engineers 1980). Landowners in the toxics and other pollution problems (Legislative Research Commission 1985). In 1984, when the N.C. Environmental Management Commission reclassified Jordan for water supply it did so with qualification because of the uncertainty about public health impacts of upstream discharges (Howells 1989).

Quoting from the N.C. Division of Environmental Management 1982 Final Environmental Impact Statement: "The safety of using the Haw River or B.E. Jordan Reservoir waters as drinking water sources has been a much-discussed issue surrounding the OWASA water supply question. From the data available, there is no evidence that using any of these sources will cause adverse health effects. It should be noted, however, that data on all possible pollutants in these sources and their relative safety is limited. There has been much concern voiced over the possible presence of unknown chemicals (mainly SOC's) in the Haw River and Jordan Reservoir which might not be treatable by advanced treatment. The possibility does exist and would be expected to be greater in these two sources mentioned above than in Cane Creek or University Lake because of the greater number of point sources and urbanization. However, no demonstrable adverse health effects from use of any of the sources considered can be substantiated based on existing data. It must be recognized that meeting the State and Federal standards does not assure that a source is risk free. Knowledge of a chemical's adverse health effects and capability to adequately measure or control that chemical may lag behind its usage. The fear of unknown contaminants and uncertainty of effectiveness of treatment methods is a factor in OWASA's choice of sources. Cane Creek is generally recognized as a better quality source because, as stated before, it has no point source dischargers and receives a reduced threat from urban runoff or toxic spills. It has been identified as a 'more appropriate source than the Haw River or New Hope River' and as the 'best source' by the N.C. Division of Health Services and has been called the 'wise and prudent choice' by a former Secretary of the Department of Natural Resources and Community Development."
the watershed, however, opposed the choice, asserted that other water supply options were acceptable, and appealed the EMC decision in the N.C. courts, giving the issue further public exposure. All the legal and regulatory obstacles to development of the Cane Creek Reservoir were not cleared until 1982.

Okun, Howells and a New Water Supply Classification Scheme.
Debate over Cane Creek and the Jordan Reservoir convinced two local water resources experts that there was an urgent need to educate North Carolina citizens about the chemical threat to drinking water and an equally urgent need to provide ways that local governments could protect drinking water sources. UNC-CH Kenan Professor of Environmental Engineering Daniel A. Okun and Director of the UNC Water Resources Research Institute David H. Howells believed that the first step in protecting drinking water sources was to make fundamental changes in the way the state classified surface water for public water supplies.

At the time, the state had two classifications for public water supplies: A-I for isolated pristine sources that could meet drinking water standards without filtration and A-II for everything else. Okun and Howells argued that there was a deadly flaw in a classification system that failed to distinguish between headwater supplies with few or no sources of pollution and run-of-the-river supplies or impoundments with many dischargers and many potential nonpoint sources of pollution. The fact that very different water sources, such as Cane Creek and the Haw River, were classified the same (A-II) created the impression among the public and local governments that the supplies were equally safe. Okun wrote to Everett Knight, Director of the Division of Environmental Management (DEM) in September 1977, "the classification does not provide any basis for preventing urban or industrial development on a protected watershed."
Okun proposed to Knight that the EMC change the classification system to make A-I the class for protected drinking water sources with no point source discharges of wastewater and A-II the class for drinking water sources with wastewater discharges. Implicit in Okun’s proposal was a separate category for isolated, pristine watersheds not subject to development. This water supply category would be completely outside the classification hierarchy so that by protecting their water supply, local governments could achieve the highest classification, A-I. Okun reasoned that such a classification system would encourage communities to protect existing A-I sources and choose protected sources in the future because, first of all, they would know the difference between the two, and, secondly, the cost differential between developing more distant protected sources and nearby polluted sources would be reduced or eliminated by additional requirements for monitoring and treating more polluted sources (Okun letter to Knight, Sept. 29, 1977). However, no action was taken on reclassification of water supply sources until Howells was appointed to the EMC and began working for change.

Getting the water supply classification system changed required changing the view that bacterial contamination was the primary waterborne health threat and that conventional water treatment was the failsafe solution for any kind of water supply contamination (David H. Howells, personal communication, February 1991).

"Local governments would come to the EMC with a request for reclassification of a water source for public water supply, and we would ask where is your proof that this water is safe for human consumption. The answer always was that it meets bacterial standards," Howells said.

The existing classification system provided no encouragement for local governments to ask what other kinds of contaminants were in
the supply and whether conventional treatment could safely remove those contaminants or to consider more protected sources.\(^4\)

At its April 1984, meeting, the EMC was briefed by DEM staff on Howells' preliminary proposals for revising the public water supply classification scheme so that the classification of a source would tell the public something meaningful about the quality of the water. Howells argued for narrative rather than alphabetical designations for stream classifications, asserting that people automatically assume that A is better than B and B is better than C. A sounder approach, he argued, would be to designate water supply classifications as follows:

**Water Supply - Natural Watershed:** Watersheds which are undisturbed and essentially in a natural state. Would require maintenance of natural, undisturbed conditions.

**Water Supply - Rural Watershed:** Rural watersheds with no point source discharges. Could have agricultural/forestry activity as well as residences with septic tanks. Would require local plan to protect waters from nonpoint source pollution.

**Water Supply - Developing Watershed:** Watersheds which are being developed for residential use. Point source dischargers of treated domestic waste would be allowed. Local plan to protect waters from nonpoint source pollution.

\(^4\) As the North Carolina 305(b) Report (N.C. DEM 1986) put it: "Since all water supplies requiring full treatment were classified as A-II, this tended to encourage users to select sources with the largest water yield. These large yield sources generally had watersheds with more potential sources of contaminants than smaller, lower yield watershed."

For example, Howells (1990) reported that in 1984 the Asheville-Buncombe Water Authority requested that the EMC reclassify a section of the French Broad River for water supply in spite of the presence upstream of 60 wastewater dischargers, six considered major. The EMC hearing officer offered no recommendation on the request even though the source was considered suitable under the current regulations and policy. The reclassification was approved (with qualification), but in May 1989 a citizens' effort defeated a bond issue necessary for using the French Broad for water supply and has since turned the ABWA's effort toward system repair and conservation (Bill Eaker, Land-of-Sky Regional Council, personal communication, July 1992).
pollution would be required and no industrial development would be allowed.

**Water Supply - Industrial Watershed**: Watersheds which have portions with urban and industrial development. Hazards associated with toxic pollution must be considered in classification process. Sub-portions of the watershed might have more protective water supply classifications.

EMC Chairman Thomas W. Bradshaw appointed Howells, and Commissioners Jerry Lewis and Bill Small to an ad hoc committee (called the Water Supply Committee) to work with DEM staff in developing a proposal for consideration by the Commission (WRRI NEWS June 1984).

When the proposal came back to the EMC for action in early 1985, classifications were designated numerically, rather than in narrative form as Howells had suggested. The classifications were proposed as follows:

**Water Supply - Level I**: This classification was proposed to expand A-1 to include watersheds with controlled private development but no discharges. All point source discharges would be prohibited and nonpoint sources would be controlled by local governments.

**Water Supply - Level II**: In this classification, it was proposed domestic wastewater discharges would be permitted but industrial wastewater discharges would be prohibited. Local nonpoint source controls would be required.

**Water Supply - Level III**: This classification was conceived as similar to the existing A-II classification, except that control of toxics in industrial wastewater discharges would be strengthened. Special requirements would include full disclosure of toxics, development of spill and failure control plans and increased monitoring for toxics.

The committee's proposal was for a voluntary program through which the classification system could be used by local governments to protect high quality water supplies. Under this
voluntary program, all formerly A-I waters would become WS-I waters, and all others would initially become WS-III. With the initial classification changes, there would be no new requirements for existing water supplies. To protect their water supplies, communities with high quality water supply sources could request an upgrading from WS-III to WS-II. Nonpoint sources by this time had been documented as significant contributors of toxic contaminants, so the voluntary program incorporated incentives to implement nonpoint source controls. By agreeing to implement a nonpoint source pollution control program in their watersheds, communities that qualified for the WS-I or WS-II classification could get the state to prohibit industries or municipal wastewater treatment plants that accepted industrial wastes from discharging wastewater into their water supplies and thereby eliminate to a large degree the threat from synthetic organic chemicals.

This proposal did not include Okun's idea of putting isolated, pristine watersheds outside the classification system. Therefore, the distinction between isolated watersheds not subject to development pressures and undeveloped watersheds which would need protection from development pressures was not made.

Because the new classification scheme would not categorically restrict wastewater discharges in WS-III watersheds, there was a provision that industrial dischargers or indirect industrial dischargers subject to pretreatment standards could be required to disclose all potentially harmful chemicals that might be in their wastes or that might be spilled and washed into the water supply. Furthermore, these facilities could be required to have a plan for handling spills and treatment plant failures and to perform special monitoring for toxic substances.

Public hearings were held on the proposed classification scheme in the summer of 1985. In written comments to the EMC, Okun made
it clear he wanted the state to provide local citizens the information and the opportunity to act to protect their own water supplies. He said that the proposed system would "help those responsible for water supply and health in North Carolina and the people in the communities themselves -- and this is most important -- make informed choices about . . . the water they and their children will drink." He noted that in some communities people might choose to allow development to degrade their water supplies. "That," he said, "is their decision, but at least it will be an informed decision." (Environmental Management Commission 1985)

The new water supply classifications were adopted in December 1985 and became the framework for a voluntary water supply protection program that was officially put into place by the Division of Environmental Management in February 1986. While the plan provided a strong incentive for protection of undeveloped (WS-I) and lightly developed watersheds (WS-II), it offered no incentive for protection of watersheds where there were industrial or complex point source discharges (WS-III). An analysis of the classification potential of water supplies across the state showed that 84 would remain in the WS-III classification and would therefore remain without enhanced protection.5

Under a plan proposed by then Secretary of Natural Resources and Community Development (NRCD) Thomas Rhodes, the voluntary program would be followed by a Critical Water Supply Watershed Program, which would include (1) mandatory ordinances for WS-I and WS-II

5 Obviously, all surface waters received protection by the state's enforcement of regulations under the Federal Water Pollution Control Act and its amendments, including state stream classifications and water quality standards. However, those regulations do not prohibit categories of wastewater discharges into drinking water supplies, and most nonpoint source pollution controls are voluntary.
watersheds with multiple jurisdictions and (2) requirements for a protected area around WS-III intakes. The plan would require action by the N.C. legislature, since the EMC did not have the clear authority to mandate local land-use controls. It was NRCD's intention to pursue the Critical Water Supply Watershed Program after the voluntary program had progressed sufficiently to evaluate its effectiveness (N.C. Department of Natural Resources and Community Development 1986; Pugh. 1988; Holman. 1988)

The Impetus for Legislation: Falls of the Neuse Reservoir. While the Orange Water and Sewer Authority was struggling to develop Cane Creek, the City of Raleigh was watching its new water supply, Falls of the Neuse Reservoir, fill up. The floodgates on the Falls of the Neuse Dam were closed in January 1983 (Raleigh News & Observer. Jan. 16, 1983), but for more than 15 years, local officials had been fretting over the potential for pollution of the water supply from development and nutrient enriched wastewater discharges in the Falls Reservoir watershed (Raleigh News & Observer. Jan 13, 1966). The problem for Raleigh was that while the Capital City would drink water from Falls Reservoir and supply it to several smaller nearby municipalities, the Falls Reservoir watershed spreads out through the political jurisdiction of six counties and two major cities: Raleigh and Durham. The situation raised the issue of regional cooperation, and Triangle J Council of Governments, a regional organization of governments in Wake, Orange, Durham, and Chatham Counties (Region J), began to address the problem.

In their proposals for changing the state's classification system for water supplies, Okun and Howells had emphasized the state role--protecting water supply sources from the threat of synthetic organic chemicals in point source discharges. In developing watershed protection measures for Falls of the Neuse and Jordan Reservoirs, Triangle J focused on local government's role--controlling nonpoint source threats to water supplies, with
particular emphasis on urban runoff since both watersheds were subject to urbanization.

The Threat of Nonpoint Source Pollution. Nonpoint source pollution is pollution contained in stormwater and runoff from agricultural, urban, mined, and other land uses (N.C. Division of Environmental Management 1989). The amount and kind of nonpoint source pollution that enters a stream or reservoir used as a drinking water source depends on how the land in the watershed is used, that is what activities occur on the land. The amount of nonpoint source pollution reaching surface waters is related to runoff level, and runoff levels are related most directly to land use (Miller et al. 1980).

Many studies have been undertaken to characterize runoff from various land uses by quantity and pollutant loading, and studies of the quality of urban stormwater runoff date back to at least the 1950s (Bryan 1970). In the early 1970s, Edward H. Bryan of the Duke University Department of Civil Engineering and Newton V. Colston of North Carolina State University conducted studies for EPA and the UNC Water Resources Research Institute on urban runoff in a 1.67 square-mile basin (Third Fork Creek) in the City of Durham. The impetus for the research was the need for information on pollutant contribution of urban runoff from Durham to the planned "Neuse [Falls of the Neuse] and New Hope [Jordan] Reservoir projects east and south of Durham" (Bryan 1970). In addition, the Triangle J Council of Governments prepared an Areawide Water Quality Management Plan for the Triangle J region and for this plan performed a stormwater runoff sampling and modeling effort conducted across a range of land uses (urban, commercial, residential, and rural) and activity levels. All these studies documented that urban runoff contributed as much or more biological oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solids than effluent from secondary treatment plants as well as significant amounts of heavy metals,
nutrients, and synthetic organic chemicals (Bryan 1970; Colston 1974a,b; Triangle J Council of Governments 1976a,b). 6

The National Urban Runoff Program. In 1979, the Environmental Protection Agency launched the National Urban Runoff Program (NURP) 7 to "develop information that would help provide local decision makers, States, EPA, and other interested parties with a rational basis for determining whether or not urban runoff is causing water quality problems and, in the event that it is, for postulating realistic control options and developing water quality management plans, consistent with local needs, that would lead to implementation of least cost solutions (U.S. Environmental Protection Agency 1983)."

The NURP funded urban runoff studies in 30 locations, including Winston-Salem, NC, and Myrtle Beach, SC. NURP studies confirmed earlier findings that BOD and COD in urban runoff approximate the concentrations in secondary treatment plant discharges; that total suspended solids concentrations are high in comparison with treatment plant discharges; that nutrients are present but not in high concentrations when compared with wastewater treatment plants; that heavy metals are often present in high enough concentrations to be potential threats to beneficial uses of surface waters; that a number of organic priority pollutants may

6 To control nonpoint source pollution in the area, Triangle J recommended, among other things, a strengthened sedimentation control program to reduce soil erosion during site development, a fully-developed stormwater management act to control runoff from areas after development, and control of agricultural runoff either by assisting owners of active farms in implementing an approved Soil Conservation Service management plan or by extending the Sedimentation Pollution Control Act to some agricultural activities.

7 Much of the field work, water quality analysis and data analysis for the NURP was performed by the U.S. Geological Survey (USGS) under a Memorandum of Agreement with EPA (U.S. Environmental Protection Agency 1983).
be found in urban runoff although less frequently and in lower concentrations than heavy metals; and that total coliform counts exceeded EPA water quality criteria in undiluted runoff at virtually every study site every time it rained.

Among the conclusions of the NURP report regarding receiving water effects of urban runoff was the following:

Domestic water supply systems with intakes located on streams in close proximity to urban runoff discharges are encouraged to check for priority pollutants which have been detected in urban runoff, particularly those in the organic category. (U.S. Environmental Protection Agency 1983).

In a 1985 report on a study initiated to inventory sources of toxic substances in the Jordan Reservoir and examine the suitability of Jordan as a drinking water source (N.C. Division of Environmental Management 1985), the N.C. Division of Environmental Management performed an analysis using loading rates from the studies cited above and concluded:

Nonpoint sources are very important sources for toxicants (especially metals) in the basin. Comprehensive data are not available for the entire basin for all toxicants but available data for metals indicate that most of the lead comes from urban nonpoint sources. In general, amounts of copper and zinc from nonpoint sources are three times higher than from point sources. No easy generalization can be made regarding sources of synthetic organic chemicals since data are scarce. Both nonpoint (agricultural and urban) and point sources probably contribute significant levels of synthetic organic chemicals.

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8 In addition to quantifying pollutant loads from urban runoff, the NURP studies investigated the ability of various best management practices to reduce the urban runoff pollution load. For instance, the Winston-Salem study examined the effectiveness of street sweeping as a best management practice (N.C. Division of Environmental Management 1983a). The studies confirmed the ability of wet detention basins and recharge devices to reduce pollutants in urban runoff. Grass swales were found to provide moderate improvement in urban runoff quality, but street sweeping was found to be generally ineffective (U.S. Environmental Protection Agency 1983).
The Triangle J Watershed Management Guide for Falls and Jordan. In 1979, the Triangle J Council of Governments undertook, in cooperation with NRCD, to develop specific recommendations for county and municipal governments in the region for protection of the Falls of the Neuse and Jordan Reservoirs. Triangle J brought together a large number of local governments and technical agencies and initiated an ambitious program of research to establish a sound technical basis for water supply watershed protection in the Triangle area (Triangle J Council of Governments 1979).

Taking into consideration both technical and administrative factors, Triangle J developed a Watershed Management Guide (issued in 1982), guidelines for local governments in adopting stormwater management regulations (issued in 1984) and a series of supplementary technical bulletins focusing on critical technical issues (issued over a period of several years). The documents were intensely reviewed by a technical advisory committee which included local government personnel. The technical recommendations that emerged were based on a combination of research, data from field observation and experience with stormwater control programs in Maryland and Florida, and local conditions, including Triangle area soils and precipitation and typical development patterns (Raleigh News & Observer, Oct. 12, 1984).

In issuing the stormwater management guidelines for local governments with jurisdiction in Falls and Jordan watersheds in 1984, the Triangle J Water Resources Planning Committee said that, while some points of disagreement still existed on technical issues, the following technical recommendations had come to be generally accepted during development of the guidelines:
* establishment of a Water Quality Critical Area for a distance of one mile around the lakes,

* establishment of a Limited Industry Area extending to the ridge lines of areas draining to A-II (then the designation for water supply) portions of the lakes and a lesser distance for areas draining to non-A-II portions,

* control of the first one-half inch of runoff from all impervious areas,

* controls for industry and chemical storage in the Limited Industry Area,

* fifty-foot buffers along streams and ditches.

(Triangle J Council of Governments Water Resources Committee, April 19, 1984)

Among the Triangle J technical recommendations for nonpoint source controls in Triangle watersheds were the following:

* Because land-use activities near a reservoir have a relatively greater effect on water quality than those further away, a tiered approach to watershed protection should be taken, with stricter standards for "water quality critical areas" nearest the water source.

* Since studies have thoroughly documented that pollution loads in stormwater are more closely correlated with impervious cover than housing density, impervious surface limits, rather than minimum lot sizes, should be required in water supply watersheds.

* The first half-inch of runoff from all impervious areas should be infiltrated on-site for new development. Nonstructural measures for infiltration should be used whenever possible since they are highly reliable and require no maintenance and since local governments have the expertise to administer such provisions.

* In water quality critical areas, impervious surface area should be limited to 6%; in unsewered less critical areas, to 12%; and in sewered less critical areas, to 30%. Flexibility on impervious surface area should be allowed based on soil conditions and slope.

(Triangle J Council of Governments 1984)
State Actions to Protect Falls and Jordan. While Triangle J worked toward a long-term watershed protection plan for Falls of the Neuse and Jordan Reservoirs, Raleigh officials, with advice from Triangle J staff, attempted to use short-term measures to head off the worst of the potential problems in the Falls Reservoir. In June 1983, local officials persuaded the Environmental Management Commission to impose a temporary moratorium on sewage discharge permits in both the Falls and Jordan Reservoir watersheds.

At the same time, staff of NRCD were working on a strategy for protecting the Falls and Jordan Reservoirs, and NRCD Secretary Joseph W. Grimsley was trying to persuade local governments in the watersheds to implement nonpoint source controls. Responding to a call from Raleigh and Wake County leaders, Grimsley in 1983 convened a committee of local officials of 16 jurisdictions in the Triangle region and recommended to them a "State/Local Action Agenda." Developed by Triangle J and NRCD, the plan offered an arrangement whereby local governments might avoid expensive phosphate-removal requirements for wastewater treatment plants by enacting strong nonpoint source control programs (WRRI NEWS. May 1984). In October 1983, Grimsley introduced to the EMC his "stick and carrot" plan for getting local cooperation to control pollution in the Falls and Jordan Reservoirs, and the EMC gave him the authority needed to put the plan into effect by declaring both Falls and Jordan reservoirs "Nutrient Sensitive." With the Nutrient Sensitive designation in place, NRCD had the authority to require the reduction of phosphorus in existing large wastewater discharges and to set a limit on phosphorus in any future discharges in the Falls and Jordan watersheds.

Grimsley's plan for Falls and Jordan Reservoirs called for local governments to implement ordinances creating "water-quality critical areas" near the lakes where impervious surface area would be limited to 6 percent and 50-foot buffers would be
required around streams. He also called for acceleration of the 10-year upper Neuse and upper Cape Fear erosion plans and for counties and municipalities with jurisdiction in the watersheds to design joint plans for other protective measures (Raleigh News & Observer, Oct. 8, 1983). He warned that if local governments did not adopt ordinances and other measures to control sediment and other nonpoint source pollution, the EMC would have to require other, smaller wastewater treatment plants to begin removing phosphorus (Raleigh News & Observer, Oct 8, 1983). He also said that the department would support a phosphate detergent ban if local governments wanted one, and he proposed a plan for reducing agricultural nonpoint source pollution.  

James A. Summers, who succeeded Grimsley as Secretary of NRCD in 1983, also strongly warned local governments that they must enact measures to protect the reservoirs from nonpoint source pollution or face some kind of state action, including the possibility of establishing a regional anti-pollution commission which would supersede local government authority. Summers even set a deadline of May 1, 1984, for the submission of local ordinances.

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9 Among the recommendations Grimsley made for controlling pollution in the Falls and Jordan watersheds was a state program for sharing with farmers the costs of best management practices to reduce agricultural runoff. In December 1983, Grimsley announced his intention to submit a budget proposal to the General Assembly for a Nutrient Sensitive Waters program (WRRI News, May 1984). In June 1984, the General Assembly passed a bill allocating $50,000 to each of 15 counties in Nutrient Sensitive Watersheds for implementation of practices to protect water quality (Raleigh Times, Aug. 22, 1984.). The program was called the Agricultural Cost Share Program for Nutrient Sensitive Waters. It was viewed by some as a method whereby people who benefited from protection of water supplies could help share the costs of protection (Everett Billingsley, Memo to OWASA Board of Directors, Dec. 13, 1984). The program proved to be popular with local governments and farmers and was eventually expanded to include all 100 counties of the state. The "Nutrient Sensitive Waters" suffix was dropped from the name when the program was expanded to include counties outside nutrient sensitive watersheds.
In March 1984, Triangle J released its technical recommendations for protecting Falls and Jordan watersheds, and Summers praised the plan, saying it was very similar to the state's. Water Quality Section Planning Branch Head Alan W. Klimek said the only difference between the state plan and the Triangle J plan was in the definition of the critical area. In place of the one-mile critical area measured from normal pool level which Triangle J recommended, the state recommended one-half mile plus 300 feet measured from the high-water mark, or edge of the reservoir at flood stage (Raleigh News & Observer. March 1984).

Concern about Pollution of Falls Reservoir Grows. When in April 1984, it was revealed that the Corps of Engineers had miscalculated the volume of the Falls Reservoir and overestimated water supply storage by nearly 27 percent, fretting over potential pollution of the water supply turned to outright alarm. The Falls of the Neuse Reservoir had been expected to provide a plentiful supply of high quality water for Raleigh and a number of other Wake County municipalities until the year 2030. However, the storage shortfall together with studies showing a high rate of sediment delivery to the reservoir and high nutrient concentration with potential for accelerated eutrophication, made the pollution picture even grimmer. Moreover, the shortfall in the quantity of water available for future use was of concern,

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An article in the April 13, 1984, edition of the Raleigh Times read: "Raleigh Mayor Avery C. Upchurch said today he was alarmed about the future of Raleigh’s water supply after a discussion by state, U.S. Army Corps of Engineers and local officials about the storage capacity of Falls Lake."

An article in the May 14, 1984, edition of the Raleigh News and Observer read: "State officials are concerned with various environmental issues related to the lake’s smaller size, including the possibility that the lake could be more vulnerable to growth of nuisance algae."
and Raleigh officials asked the Corps to study the possibility of raising the reservoir level (Raleigh *Times*. April 13, 1984).

In November 1984 when Summers made a progress report to the EMC on the Falls and Jordan watershed issue, only Wake County and the City of Durham had enacted watershed protection ordinances consistent with the State/Local Action Agenda recommendations (Raleigh *News & Observer*. Nov. 1984). Orange County incorporated standards for "protected watersheds" into its zoning ordinances in November 1984 but zoned only portions of University Lake, Cane Creek and the Upper Eno for protection (Moubry 1987). Raleigh's effort to implement an ordinance it had adopted in May 1984 ran into stiff resistance from developers opposed to a 6 percent impervious surface limitation1 proposed for the entire 2,800-acre area under the city's zoning jurisdiction (Raleigh *News & Observer*. Aug. 11, 1984), and the city did not incorporate watershed regulations into its code until March 1985.

Questioned following the EMC's November 1984 meeting about what action the commission might take if localities did not submit protection ordinances, chairman Thomas W. Bradshaw said the commission might consider proposing legislation but could offer no details (Raleigh *News & Observer*. Nov. 11, 1984). An editorial in the Raleigh *News & Observer* following the November EMC meeting faulted the commission for inaction on the Falls and Jordan watershed protection issue (Raleigh *News & Observer*. Nov. 13, 1984).

Then, in August 1985, a company named Durham Research Properties, Inc., announced development of Treyburn, a 5,300-acre residential and industrial park, in the Falls of the Neuse watershed. Among the industries were to be pharmaceutical and electronics

11 With stormwater controls impervious surface could be substantially increased.
manufacturing firms that would use a number of potentially toxic chemicals. Because of its location with respect to the Little River and Falls Reservoir, Treyburn became an important factor in the watershed protection debate.

Perceived threats to water quality in Falls Reservoir, failure of the state to provide any mechanism for providing additional protection for Raleigh's drinking water source, and the apparent inability of local governments (including his own) to resist development pressures in watersheds finally sent Raleigh Mayor Avery Upchurch to the state legislature for help in protecting Falls Reservoir.

EVENTS LEADING TO PASSAGE OF A WATER SUPPLY WATERSHED PROTECTION ACT

The Watershed Study Commission. In April 1987, at the urging of Triangle J Council of Governments and Mayor Upchurch, Representative Aaron E. Fussell of the Wake County legislative delegation introduced a bill in the General Assembly to require local governments to enact minimum protection measures in watersheds feeding public water supplies that were designated Nutrient Sensitive. Falls of the Neuse watershed and Jordan Reservoir watershed had been designated Nutrient Sensitive by the EMC in 1983. Jordan Reservoir had been classified for public water supply but no allocations for that purpose had been made (WRRI News. Nov/Dec 1988).

The original bill mandated that local governments with jurisdiction in nutrient-sensitive water supply watersheds prepare and submit to the EMC for approval a watershed protection plan. The bill provided for regional watershed management and protection in that local governments could delegate plan preparation to a regional organization. It included specific minimum water supply watershed standards, including
* a requirement for hazardous materials inventory and spill containment plans,
* control of the first one-half inch of runoff from all impervious surfaces,
* acceptable structural methods of stormwater control, ranked by preference, and a performance standard for structural methods of 70 percent removal of phosphorus,
* 50-foot permanent vegetative buffers along both sides of rivers and streams and 100-foot buffers around the normal pool shoreline of reservoirs, and
* a critical area designation of one-mile from the normal pool shore line within which development on more than one acre could not exceed 6 percent impervious surface area and within which production, storage, use or distribution of hazardous materials was prohibited.

The proposed bill also provided that the EMC could approve a local plan that did not comply with the minimum standards if the commission determined that extra safeguards ensured equivalent protection.

Hurriedly introduced, just meeting the filing deadline for statewide bills, the tentative "Watershed Protection Act" lacked the backing of local government organizations which feared loss of local control over land use (Raleigh News & Observer. April 30, 1987). The bill was widely viewed as an attempt by Raleigh to impose standards on Durham that Raleigh itself would not have to meet (Raleigh News & Observer. May 12, 1987). In May, the Durham City Council voted to oppose any watershed legislation that would affect Durham and Durham County that year. They also called for a study to develop a uniform statewide policy for the protection of water supply watersheds. A week later, at the recommendation of Mayor Upchurch, the Wake County legislative delegation requested that the watershed protection bill be assigned to a study committee (Raleigh Times. May 12, 1987).
On May 26, 1987, House Bill 1203, "Watershed Study Commission" was filed setting up a 12-member panel to study "whether protection of watersheds requires State imposed minimum standards or whether such protection may be achieved solely on the basis of local regulation." The bill passed, and the study was funded. The Watershed Study Commission was to report to the General Assembly on or before the first day of the 1989 session.

The Phosphate Detergent Ban. That same year an effort to ban the sale of phosphate detergents was resurrected in the General Assembly. The effort had found little support in the legislature in 1985. However, a study by Raleigh and estimates by Durham of the cost of removing phosphorus at wastewater treatment plants helped convince legislators that the ban would be helpful to municipalities in nutrient-sensitive watersheds (Raleigh Times, Nov. 4, 1985; Raleigh Times, March 1985). Raleigh had become involved in the phosphorus-removal issue in 1983 when a DEM study put municipal wastewater dischargers throughout the Neuse River Basin on notice that nutrient control could be required in the future (N.C. Division of Environmental Management 1983b). In spite of intense lobbying by the soap industry, the phosphate detergent ban was approved by the legislature in April 1987 and became effective January 1, 1988.

Support for Watershed Protection Outside the Research Triangle Area. Watershed protection was viewed differently in the three physiographic provinces of the state. In the Coastal Plain, where groundwater provides most public and private water supplies, protection for surface water supplies was not a relevant issue (Moreau et al. 1988). In the Piedmont, particularly the Research Triangle, where population growth and development were seen by many residents and local government officials to be clear and present threats to water quality, watershed protection was an intense issue generating significant popular support. In the western part of the state, where population growth had been slow,
water quality had been less impacted, and local governments had traditionally been reluctant to impose land use controls, support for watershed restrictions was less evident, except in some notable, isolated cases.

Prior to adoption by the EMC of the state voluntary watershed protection program in 1986, no local governments outside the Piedmont had adopted local measures to protect water supplies. In 1987, Moubry surveyed local governments and found that before 1986 only Durham County and the City of Durham; Guilford County (including Greensboro and High Point); Wake County and the town of Wake Forest, the City of Raleigh and the Town of Creedmoor; and Orange County and the Town of Carrboro had adopted zoning regulations or other ordinances to protect water supply watersheds.

A report on a study funded by the N.C. General Assembly at the request of the Canton, NC, Town Board, indicated the reluctance of local governments in the western part of the state to impose regulations. The study assessed the status of local government controls that could be used for watershed protection in 24 Western North Carolina counties. It showed that while land-use plans had been adopted by 17 of the 24 counties, only six had adopted even partial zoning, only 7 had adopted subdivision regulations, and only 2 had enacted local sedimentation and erosion control ordinances (Moreau et al. 1988).

Voluntary Watershed Protection Program Participation. With the adoption of the voluntary water supply watershed protection program, however, regional councils of government and the N.C. Division of Community Assistance began working with the coordinator of the voluntary program to encourage participation by local governments in Piedmont and Western North Carolina. In November 1986, the Land-of-Sky Regional Council, the Department of Natural Resources and Community Development (predecessor of
the N.C. Department of Environment, Health, and Natural Resources), the Water Resources Research Institute, and the University of North Carolina at Asheville sponsored a conference to introduce the voluntary watershed protection program to local government officials. As a result of this effort, several Western North Carolina communities launched efforts to develop watershed protection programs.

The Town of Canton and the Upper Pigeon River Watershed. The most aggressive effort to protect a water supply in Western North Carolina was undertaken by the Town of Canton. The Town had been monitoring the issuance of wastewater discharge permits in its upstream Pigeon River watershed for a number of years and had become concerned about the possibility of serious water quality impacts from wastewater discharges. In 1986, at the urging of Dr. Garret Smathers, an ecologist on the town’s planning board, Canton adopted a plan to remove the exiting wastewater dischargers from its watershed and thereby qualify for a WS-I classification under the state’s new classification scheme, which would prohibit any new dischargers in the upper watershed. After the Town passed a resolution asking the Division of Environmental Management for the reclassification, DEM imposed a moratorium on the issuance of discharge permits in the watershed (Smathers 1992). Canton had also been able to get the N.C. General Assembly to appropriate money for a study (by the UNC Water Resources Research Institute) of the need for watershed protection in the western part of the state and specifically in Canton’s water supply watershed (Bill Eaker, Land-of-Sky Regional Council, personal communication, July 1992.). DEM suggested that a final decision on reclassification should be postponed until the study was complete (Smathers 1992).

However, in 1987 DEM proposed to issue a National Pollutant Discharge Elimination System (NPDES) wastewater discharge permit to the National Park Service for its concessionaire operations at
Mount Pisgah Inn. The permit would allow the Pisgah Inn to discharge 32,000 gallons of wastewater per day into Pisgah Creek, a pristine headwaters creek of the Pigeon River. The Town of Canton challenged the permit action but in 1988 withdrew its WS-I reclassification request to allow the permit issuance (Smathers 1992). In 1989, the Town resumed its efforts to have the Pigeon River watershed reclassified WS-I, basing its efforts on the watershed study performed by the Water Resources Research Institute. The plan called for assisting wastewater dischargers to either connect to a sewer line or move to a non-discharge system, thereby eliminating all existing dischargers in the upper watershed, and for extending the Town's extraterritorial jurisdictional power. The Town and Haywood County had held five public meetings with affected property owners on the plan and were well into the process of developing a voluntary watershed protection program when the N.C. General Assembly adopted the Water Supply Watershed Protection Act. As proposed water supply watershed classifications and rules began to emerge, it became evident that the Pigeon River watershed would not be able to qualify for a WS-I classification even by removing existing wastewater dischargers, and the Town announced its intention to pursue a WS-II classification (Smathers 1992).

**Town of Hendersonville and the Mills River.** Another notable watershed protection effort launched following the 1986 watershed protection workshop at UNC-Asheville, was the Town of Hendersonville's (Henderson County) initiative to develop a WS-II protection program for the Mills River. Because Hendersonville has no jurisdiction in the Mills River watershed, the town must rely on Henderson County to implement a watershed protection

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12 It was not feasible for the Town of Canton to oppose issuance of an NPDES permit for the National Park Service but support the re-issuance of an NPDES permit for the Champion International paper plant downstream. The re-issuance of a permit for Champion was being intensely opposed by the state of Tennessee.
ordinance. Assisted by the Land-of-Sky Regional Council and the N.C. Division of Community Assistance, Hendersonville inventoried dischargers in the Mills River watershed and in March 1989 proposed options for gaining a WS-II classification. The option chosen by the Hendersonville Town Council involved moving the city's water supply intake upstream some 400 feet to avoid the potential of hazardous materials spills posed by a major DOT bridge. The town began communicating with upstream landowners who would be affected by land-use restrictions. It was the intention of town officials to explain the purposes of watershed protection and gain landowner support before an ordinance was proposed. Before an ordinance could be developed, however, the state watershed protection act was passed, and the town's plans for watershed protection were put on hold pending development of a state model ordinance (Tom Kilpatrick, director of public utilities, Town of Hendersonville, personal communication, September 22, 1992).

Other early efforts in the western part of the state to protect water supply watersheds included the City of Brevard's (Transylvania County) effort to develop a protection program and secure a WS-I classification for its Catheys Creek watershed; and Catawba County’s successful effort to adopt a protective ordinance for Jacob’s Fork, which supplies the City of Newton, and Maiden Creek, which supplies the Town of Maiden.

In February 1988, Robert Holman, coordinator of DEM’s voluntary watershed protection program, issued a memo report on the status of water supply reclassification. At that time 32 local governments had formally requested upgrading of water supply classification and had passed resolutions expressing their intent to develop watershed protection programs (See Table II-1). This list showed 10 local governments in the western part of the state had passed resolutions stating the intention to ask for reclassification of their water supply watersheds.
Many of the 32 requests were for WS-I and WS-II reclassifications for small single-jurisdiction watersheds; however, requests for reclassification had also been filed for several multijurisdictional watersheds. Greensboro had requested WS-II classification for its Lake Brandt, Lake Higgins, and Lake Townsend watersheds. Durham had requested WS-I reclassification for its Little River watershed and WS-II reclassification for its Lake Michie watersheds. Raleigh had requested WS-II reclassification for its Swift Creek and Walnut Creek watershed, although the potential for a WS-II classification of these sources was questionable. The highest classification Raleigh could expect for the Falls of the Neuse Reservoir was WS-III, which under the voluntary plan offered no categorical restriction on point sources and provided no incentive for nonpoint source controls (Holman 1988). Reclassification had already been completed for four of the local governments listed in the 1988 status report. The first to complete the process was OWASA, which received a WS-I classification for Cane Creek and Morgan Creek. The reclassification requests for Cane Creek and Morgan Creek were unopposed (Raleigh News & Observer. Jan. 16, 1988).

More Efforts for Watershed Protection in the Research Triangle. In 1988 the Raleigh City Council passed a protective ordinance for their part of the Falls of the Neuse watershed that restricted impervious surface area to 6 percent. The ordinance replaced one passed in 1985 that allowed greater impervious area if stormwater detention ponds were used. Developer Clifton L. Benson brought suit against the City of Raleigh seeking to invalidate the ordinance (Raleigh News & Observer. Oct. 27, 1988).
### Table II-1. Status of Voluntary Water Supply Watershed Protection Program as of February 1988

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Source</th>
<th>Potential Classification</th>
<th>Date of Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asheboro</td>
<td>Back Creek&lt;br&gt;Cedar Fork&lt;br&gt;Uwharrie River (Yadkin Basin)</td>
<td>WS-II WS-I WS-II</td>
<td>April 1986</td>
</tr>
<tr>
<td>Beech Mountain (Banner Elk)</td>
<td>Pond Creek&lt;br&gt;Buckeye Creek¹ (Watauga Basin)</td>
<td>WS-I WS-I</td>
<td>December 1985</td>
</tr>
<tr>
<td>Biltmore Estates</td>
<td>Busbee Lake&lt;br&gt;(French Broad Basin)</td>
<td>WS-I</td>
<td>October 1987</td>
</tr>
<tr>
<td>Boone</td>
<td>Winkler Creek²&lt;br&gt;S. Fork New River (New River Basin)</td>
<td>WS-I WS-I</td>
<td>February 1986</td>
</tr>
<tr>
<td>Brevard</td>
<td>Catheys Creek&lt;br&gt;(French Broad Basin)</td>
<td>WS-I</td>
<td>February 1986</td>
</tr>
<tr>
<td>Burlington</td>
<td>Lake Burlington&lt;br&gt;Big Alamance&lt;br&gt;(Cape Fear Basin)</td>
<td>WS-II WS-II</td>
<td>January 1987</td>
</tr>
<tr>
<td>Canton</td>
<td>Pigeon River&lt;br&gt;Rough Creek²&lt;br&gt;(French Broad Basin)</td>
<td>WS-II WS-I</td>
<td>August 1986</td>
</tr>
<tr>
<td>Columbus</td>
<td>UT Horse Creek&lt;br&gt;(Broad Basin)</td>
<td>WS-I</td>
<td>February 1986</td>
</tr>
<tr>
<td>Concord</td>
<td>Lake Concord&lt;br&gt;Lake Fisher&lt;br&gt;Coddle Creek¹&lt;br&gt;(Yadkin Basin)</td>
<td>WS-III WS-III WS-I</td>
<td>October 1986</td>
</tr>
<tr>
<td>Creedmoor</td>
<td>Lake Rogers&lt;br&gt;(Neuse Basin)</td>
<td>WS-I</td>
<td>September 1986</td>
</tr>
<tr>
<td>Location</td>
<td>Site Description</td>
<td>Water Sample</td>
<td>Date</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------------</td>
<td>--------------</td>
<td>------------</td>
</tr>
<tr>
<td>Durham</td>
<td>Flat River Little River (Neuse Basin)</td>
<td>WS-II</td>
<td>December 1985</td>
</tr>
<tr>
<td>Graham</td>
<td>Quaker Creek (Cape Fear Basin)</td>
<td>WS-I</td>
<td>May 1986</td>
</tr>
<tr>
<td>Greensboro</td>
<td>Lake Brandt/ Lake Higgins Lake Townsend (Cape Fear Basin)</td>
<td>WS-II</td>
<td>February 1987</td>
</tr>
<tr>
<td>Hendersonville</td>
<td>N. Fork Mills River Mills River Bradley Creek (French Broad Basin)</td>
<td>WS-I</td>
<td>January 1986</td>
</tr>
<tr>
<td>Kannapolis (Cannon Mills)</td>
<td>Irish Buff. Creek Coddle Creek (Yadkin Basin)</td>
<td>WS-I</td>
<td>September 1986</td>
</tr>
<tr>
<td>Kannapolis</td>
<td>Second Creek (Yadkin Basin)</td>
<td>WS-I</td>
<td>September 1986</td>
</tr>
<tr>
<td>Landis</td>
<td>Lake Wright Lake Corriher (Yadkin Basin)</td>
<td>WS-I</td>
<td>January 1986</td>
</tr>
<tr>
<td>Maggie Valley</td>
<td>Campbell Creek Jonathan Creek (French Broad Basin)</td>
<td>WS-I</td>
<td>December 1985</td>
</tr>
<tr>
<td>Monroe</td>
<td>Lake Twitty Richardson Creek (Yadkin Basin)</td>
<td>WS-II?</td>
<td>December 1985</td>
</tr>
<tr>
<td>Mt. Pleasant</td>
<td>Dutch Buff. Creek (Yadkin Basin)</td>
<td>WS-I</td>
<td>January 1987</td>
</tr>
<tr>
<td>Newton</td>
<td>Jacobs Fork (Catawba Basin)</td>
<td>WS-I</td>
<td>December 1985</td>
</tr>
<tr>
<td>N. Wilkesboro</td>
<td>Reddies River (Yadkin Basin)</td>
<td>WS-I</td>
<td>September 1986</td>
</tr>
<tr>
<td>OWASA</td>
<td>Morgan Creek Cane Creek (Cape Fear Basin)</td>
<td>WS-I</td>
<td>November 1985</td>
</tr>
<tr>
<td>Oxford</td>
<td>Lake Devin Tar River (Tar-Pamlico Basin)</td>
<td>WS-I</td>
<td>December 1985</td>
</tr>
</tbody>
</table>
In August 1988, the North Carolina Chapter of the Sierra Club launched a campaign to increase protection of water supply watersheds. The chapter's State Conservation Issues Chair, David H. Howells, and the chapter's lobbyist, Bill Holman, issued recommendations for legislative and administration action, and the chapter organized a statewide Safe Drinking Water Conference, which was held September 24, 1988, in Raleigh. The conference, whose keynote speaker was Daniel A. Okun, brought together a number of the state's leading water quality and legal experts to examine the topic "Watershed Protection: What Is the State Role?" This was the same question being considered by the Legislature's Watershed Study Commission and was aimed at influencing the commission's deliberations.
In its 10 Point Safe Drinking Water Plan, the Sierra Club North Carolina Chapter recommended that the legislature establish new institutional arrangements and/or create regional authorities to resolve jurisdictional conflicts over watershed land use; authorize and fund an expanded state water supply program to assure future supplies of safe drinking water; and authorize adoption of minimum statewide standards for watershed protection.

Watershed protection had also become a high priority item for the City of Durham, which faced a dilemma similar to Raleigh's in that the watersheds for its Lake Michie and Little River lay largely in other political jurisdictions. In November 1988, the preliminary results of a study conducted by the consulting firm Camp, Dresser & McKee on how to protect Durham's watersheds were made public. The study recommended that a regional cost-sharing program be established through which Durham, which would benefit from watershed protection, would help pay for watershed management costs in upstream jurisdictions, primarily Person and Orange counties (Urban Water Consortium News, March 1989; Raleigh News & Observer. Nov. 3, 1988).

**Deliberations of the Legislative Watershed Study Committee.** House Bill 1203, passed in 1987, directed the Legislative Research Commission to "study the need for standards applicable to development within watersheds including whether such standards are needed on other than a local basis, . . . [to] investigate the need for controls on the amount of impervious surface allowed in developments in watersheds, . . . [to] examine other controls which may be useful in controlling what substances enter water supplies and in maintaining the quality of such supplies." The committee which conducted the study was chaired by Senator Kenneth C. Royall, Jr. of Durham and Representative Aaron E. Fussell of Raleigh.
The Watershed Study Commission met four times. During the first meeting the committee heard presentations from state regulators on the current water supply watershed classification and protection standards. Officials of the N.C. Department of Human Resources informed committee members that the only state mandated development density restriction within watersheds was a 40,000-square foot lot requirement for lots with septic tanks. Officials of NRCD described for the committee the state's voluntary watershed protection program and told committee members that the EMC was considering a Critical Water Supply Watershed Program with mandatory protection ordinances for WS-I and WS-II watersheds with multiple jurisdictions and for protected areas around WS-III intakes. State officials said that no criteria had been developed to designate "critical" water supplies, and protected areas for WS-III intakes were to be determined on a case-by-case basis.

At the first meeting the committee also heard from local officials and representatives of regional governmental organizations on regional and local watershed protection programs and from Clay Hamner, head of the Treyburn development in Durham County, about developers' concerns. The League of Municipalities urged the legislators to adopt a statement that watershed protection should be administered cooperatively by state and local governments and that an advisory committee be created to help the Environmental Management Commission develop statewide standards.

At the second meeting, the committee heard proposals for statewide watershed protection standards from state and local officials and the Sierra Club. At the third meeting, the committee heard additional proposals for standards and reviewed draft legislation. At their final meeting, the committee adopted a report recommending "An Act to Authorize and Direct the Environmental Management Commission to Develop and Adopt Rules
During the course of the meetings the members of the committee discussed and came to agreement on the following major points:

* that statewide standards were needed,
* that there was a need for a provision for designation of certain watersheds as "critical water supplies" and for enforcement within critical watersheds of standards stricter than statewide standards,
* that local governments should be able to adopt standards more stringent than the statewide standards,
* that water supply watershed protection should be a cooperative effort between state and local governments,
* that the relative merits of lower density controls over structural controls should be considered in developing protective standards, and
* that the continuing population growth and urbanization of the state make projected use of water and identification of potential water supplies crucial.

House Bill 156. In 1989, the bill drafted by the Legislative Study Committee on Watershed Protection was introduced in the N.C. House by Wake County Representative Aaron E. Fussell. House Bill 156, the Water Supply Watershed Classification and Protection Act, directed the Environmental Management Commission to adopt rules for the classification of water supply watersheds and minimum statewide water supply watershed management requirements and provided for a cooperative program of watershed protection to be administered by local governments. The bill also provided that if local governments did not implement measures to protect public water supplies, the state could step in and enforce the minimum statewide standards and fine local governments, who would help fund state administration of the local program. In addition, the bill provided that the EMC could designate "critical" watersheds and enforce in critical
watersheds management practices more stringent than the statewide minimum standards. The bill did not attempt to establish minimum standards, as the first watershed protection bill had done, but left that chore to the EMC and established a Water Supply Watershed Protection Advisory Council to assist the commission in developing classifications and standards (Legislative Research Commission. 1989).

Issues which arose in the House and resulted in changes to the original watershed protection bill included the following:

* **The method for dealing with agricultural nonpoint source pollution.** The final version specified that reduction of agricultural nonpoint source discharges must be accomplished primarily through the voluntary Agricultural Cost Share Program.

* **State assistance to local governments in developing watershed protection ordinances.** The final bill specified that the department (then Natural Resources and Community Development) must assist local governments in developing their watershed protection ordinances and mandated that the department develop and make available a model ordinance. The final bill also provided for planning grants to local governments.

* **Inclusion of "performance-based alternatives" to density limitations in the model ordinance.** The final bill specified that standards would include the use of engineered structures for controlling stormwater as a method of increasing the allowable density of development in watersheds.

The bill's policy statement was reworked to make it explicit that local governments would administer watershed protection programs and that the state's role was primarily to set minimum standards. The final bill also changed the make-up of the Watershed Protection Advisory Council, reducing the number of members from regional organizations, increasing the number of members from county and municipal governments, and adding representatives of the development industry and the water resources and soil and water conservation professions.
House Bill 156 set tight deadlines for development and implementation of the watershed protection program. It required the EMC to adopt water supply classifications and regulations by January 1, 1991, and to reclassify all water supply watersheds by January 1, 1992. It required local governments to submit their protection ordinances to the EMC for approval by July 1, 1992. The deadlines allowed only 18 months for development and adoption of the classifications and standards, including the public hearing and comment period required under the state’s Administrative Procedure Act.

The bill cleared the House by a 110-1 vote on March 29, 1989, and cleared the Senate by a 46-0 vote on June 19, 1989 (Third reading vote record, H.B. 156). The nearly unanimous vote by state politicians in favor of the bill probably reflected the strength of popular support across the state for protecting drinking water supplies. The vote was certainly no indication of the level of difficulty that would be involved in implementing the law. As the bill neared approval, Raleigh Mayor Avery Upchurch was quoted in the Raleigh News and Observer as saying he was worried that the bill’s focus was too broad to provide the protection needed for Falls of the Neuse Reservoir. Upchurch said he feared the statewide regulations that emerged might not be strict enough to protect Falls but would give local governments an excuse not to adopt stricter standards (Raleigh News & Observer. Mar. 28, 1989).

**Work of the Watershed Protection Advisory Council.** The Watershed Protection Advisory Council, chaired by Mayor Upchurch, met six times between February and April 1990 and received presentations from a wide range of interests. The council was assisted in developing water supply watershed classifications and standards by staff of the Division of Environmental Management, which used as a starting point the classification scheme and rules developed for its voluntary watershed protection program. In developing a
watershed protection proposal, DEM staff expanded the state's current watershed classifications from three to five and proposed density and/or impervious surface limitations, point-source controls, and hazardous materials control standards for each class. The scheme retained the WS-I classification for isolated, pristine watersheds; designated the WS-II classification for watersheds with no point source discharges and the WS-III classification for watersheds with only domestic discharges; and added a WS-IV classification, which could provide protection for watersheds such as Falls of the Neuse and Jordan which received domestic and industrial discharges. The WS-V classification was added to protect run-of-the-river water supply segments where higher quality water supplies were not available.

In the beginning, DEM listed its uncertainties and questions about the proposed program. Among the concerns of staff were the following:

* **The classification hierarchy.** Since state water quality standards were the same for every water supply source (except for a total coliform standard for unfiltered supplies and the manganese standard), the watershed classification scheme was understood as a mechanism for conveying the level of risk of pollution, with risk being a function of development density. Considerable uncertainty existed regarding the number of classifications needed and the appropriate density for each.

* **Designating the critical area in large (proposed Class V) watersheds.** Uncertainty existed about whether critical area should be designated as a fixed size, as a percent of the watershed, by travel time, or on a case-by-case basis.

* **Operation/maintenance of stormwater controls.** Assigning responsibility for inspecting and maintaining structural controls was identified early as a major issue. Local governments did not want the responsibility, but developers and homeowners groups were not viewed by staff as reliable entities for such an important water quality responsibility.
* Clustering. Allowing development to be "clustered" in one area of a site so long as the overall density limitation was met had at one time been viewed as an efficient way of utilizing infrastructure investment while meeting density limitations. However, clustering had come under fire from one of the local government groups because of the fear that it would encourage the use of package wastewater treatment plants, which had been found to be the source of many water quality problems.

* Hazardous substance controls. There was a question whether the requirement that local governments perform a hazardous waste inventory and develop a plan to respond to spills or container failures was specific enough.

* Equity. A major concern expressed by staff was striking a balance between upstream property rights and downstream protection.

* Flexibility. There was the question of whether additional flexibility for local governments should and could be designed into the standards.

(Klimek 1990)

In addition to these questions, other issues emerged during hearings held by the Watershed Protection Advisory Council. Among them were the following:

* Local government authority to adopt ordinances restricting certain activities. The UNC-CH Institute of Government pointed out that local governments have no authority to restrict agricultural activities and advised the Council about the problem of requiring local governments to do things the state has not provided them authority to do.

* Classification of watersheds. Representatives of environmental groups and some members of the Council urged requiring each watershed to be assigned the highest possible classification. Doing so, it was argued, would make it possible to preserve existing water quality. Not doing so would allow degradation of high quality water supplies at the discretion of local governments. Development interests argued that classifying watersheds as high as possible was not in
the spirit of the Watershed Protection Act, which required "appropriate classification."*13

* The rationale for decreasing protection measures across classifications. It was the perception of some that the proposed standards did nothing to protect the water supplies that were in most need of protection.

* Preferential treatment for agricultural activities. Both environmentalists and developers pointed out that the provision of House Bill 156 allowing agricultural nonpoint source pollution in watersheds to be addressed primarily through the voluntary Agricultural Cost-Share Program created an obvious inequity.

* Prohibition of structural stormwater controls in primarily undeveloped watersheds. Development interests argued that the Watershed Protection Act specifically required "performance-based" alternatives to density limitations.

* Special use provisions. Developers argued for a provision that would allow for case-by-case exemptions for new development that does not comply with standards but incorporates special safeguards against pollution of surface waters.

* Prohibition of sewer line connections in critical areas of primarily undeveloped and lightly developed watersheds. This prohibition presented a dilemma about how to correct a problem with failing septic tanks in areas where soils were found to be poorly suited for septic systems.

* Prohibition of sludge application and commercial development in critical areas of certain watersheds. Both the Home Builders Association and local government representatives objected to these prohibitions on the grounds that they could increase the costs of sludge disposal and prevent building of needed schools, churches, and retail businesses in watershed critical areas.

* Impact of the rules on housing costs. Developers asserted that the rules could have the effect of limiting "the availability of affordable housing."

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* Impact of the rules on siting future electrical generating facilities.

After four hearings covering dozens of hours of testimony and two work sessions, the Water Supply Watershed Protection Advisory Council voted April 30, 1990, to send a report on its deliberations to the Environmental Management Commission but declined to adopt the draft watershed protection regulations that resulted from its work. At the meeting on April 30, the Council voted to

* limit the scope of the regulations as they applied to agriculture to requiring that local governments encourage participation in the Agriculture Cost Share Program,

* remove a provision that would have prohibited commercial development in critical areas of WS II and WS III watersheds,

* defeat a motion to require that watersheds be classified for their highest potential water supply classification, and

* defeat motions to remove references to sanitary landfills, sludge application, and hazardous substances and rely on other state regulatory programs to control these potential sources of pollution.

Draft regulations that went forward to EMC were accompanied by a letter listing issues of concern that the council did not have time to sufficiently consider. Among those issues were (1) sewer connections in critical areas, (2) pesticide controls in critical areas, (3) incentives for local governments to request the highest possible classification for water supplies, (4) failed package wastewater treatment plants, (5) the amount of privately owned land affected by WS-I regulations, (6) local government responsibility for structural stormwater controls (letter from Avery Upchurch to EMC chairman Charles Baker, May 1, 1990).
Interests Active during Development of Proposed Rules. A large number of individuals and organizations offered verbal and written comments to the Water Supply Watershed Protection Advisory Council, including the Director of the UNC Water Resources Research Institute, the UNC Institute of Government, the Sierra Club and other environmental organizations, the N.C. Forestry Association, municipal water utilities operators, engineering consultants, the electric power industry, and others. Among the most active organizations throughout the process of formulating and adopting measures for watershed protection was the North Carolina Home Builders Association (NCHBA). Paul Wilms, former Director of the Division of Environmental Management, represented NCHBA at meetings of the Council, and, later as NCHBA became quite outspoken in its opposition to watershed protection measures, Wilms became more of a central figure in the debate. He made a significant number of technical recommendations to the Watershed Protection Advisory Council, including the following:

* endorsed a fixed-size critical area extending one-half mile from an impoundment's mean pool elevation mark and a critical area one-half mile in width adjacent to free-flowing rivers and streams extending one mile upstream from the intake,

* recommended that the percent slope algorithm for determining minimum width of vegetative buffers along streams and reservoir shorelines be abandoned and that buffer widths be set at 100 feet within the critical area and 50 feet outside the critical area,

* recommended that the prohibition of new landfills and land application of sludge in WS-II and WS-III watersheds and critical areas of WS-IV and V be deleted, and

* recommended that the prohibition of sewer line connections in critical areas of WS-II and WS-III watersheds be deleted.

Wilms also repeatedly emphasized the inequities created by virtual exemption of agriculture and silviculture from watershed protection rules. He pointed out that hazardous materials regulations did not apply to pesticides and recommended that the
N.C. Pesticide Board should be asked to develop a reporting system for agricultural chemical use in water-supply watersheds sufficient to determine the risk posed by pesticides. He also pointed out that language in the Watershed Protection Act left open the possibility of mandatory restrictions on agriculture. Wilms recommended rules requiring agricultural producers to utilize best management practices to effect a "no-net-loss" of soil and requiring vegetated buffers in agricultural operations equal to those required in residential developments. (Wilms letter to Avery Upchurch, March 15, 1990)

Also active during deliberations of the Water Supply Watershed Protection Advisory Council were agricultural interests. As they had during hearings by the Legislative Study Commission, representatives of the N.C. Department of Agriculture, the N.C. Farm Bureau Federation, and others opposed mandatory controls on agricultural nonpoint source pollution. They contended that "farmers have to meet water quality standards just like everyone else" and that provisions of the Farm Bill have the effect of imposing nonpoint source regulations on farmers. Agricultural interests interpreted the watershed protection legislation as making "it clear in the preamble that the General Assembly intended for the Agriculture Cost Share Program to define the scope of how agriculture would participate in this program" (letter to Avery Upchurch from Ray Forrest, Assistant Commissioner of Agriculture, April 24, 1990).

Representatives of local government organizations were also active during development of proposed water supply watershed protection regulations. The N.C. League of Municipalities and the N.C. Association of County Commissioners were concerned about the requirement that local governments take responsibility for inspection and maintenance of engineered runoff control structures as well as other regulations (such as prohibition of sludge application sites and new landfills in critical areas)
that they believed would put additional financial burdens on local government. The local government organizations also spoke frequently about the need for planning grants, which the legislation approved but which the General Assembly had not appropriated (Statements to the Water Supply Watershed Protection Advisory Council by Ellis Hankins, N.C. League of Municipalities, and Ed Regan, N.C. Association of County Commissioners, February 22, 1990).

**EMC Sessions and Public Hearings on Proposed Watershed Rules.** In an effort to meet the statutory deadline for adopting water supply watershed classifications and regulations, the EMC agreed in May to put before the public the regulations drafted by the staff of DEM and the Watershed Protection Advisory Council. However, it was clear the commission had serious reservations about the draft rules and expected substantial changes to result from the public hearing process. In presenting the request to proceed to public hearings to the full commission, the EMC Water Quality Committee had noted that the panel would have to depart from its regular procedures in order to meet the deadline for adoption imposed by House Bill 156. The Water Quality Committee had received a report from the Watershed Protection Advisory Council and the draft regulations only a few days before the May meeting (WRRI News. May/June 1990).

It was also clear that the EMC was concerned about communicating to the public and to local governments the far-reaching implications of the proposed rules and about procedural problems that might result if the public hearings produced significant changes in the rules as published in the N.C. Register. At the direction of the commission, staff of DEM made extraordinary efforts to communicate the potential impact of the rules both in the wording of the public notice and in the extent of the public information process. Eight public hearings and more than 40 informational meetings were held across the state during the
summer of 1990 (N.C. Department of Environment, Health, and Natural Resources. 1991). The public information package provided by DEM clearly stated that refinement of the proposed rules was expected to result from the public hearing process (Environmental Management Commission. 1990).

In spite of efforts of DEM to publicize the hearings and educational meetings on the proposed rules, the public hearings held in August 1990 were not heavily attended. Only 802 people attended the eight hearings, with 160 commenting for the record. The first hearing held in Raleigh on August 15 was attended by around 200 people, with 28 commenting for the record. Local government representatives objected to being required to develop and enforce watershed protection ordinances without being given financial assistance, to being made responsible for structural stormwater controls, to the prohibition of land application of sludge and siting of landfills in critical areas, and to the prohibition of sewer connections in critical areas. Environmentalists criticized the rules for not requiring the "highest" possible classification of all watersheds, for not mandating Environmental Impact Statements and erosion controls on Department of Transportation activities in watersheds, and for exempting agriculture and forestry from mandatory nonpoint source controls.

In addition to verbal comments made at the public hearings, DEM received some 1,600 pages of written comments on the proposed classifications and rules.

Adoption of First Set of Regulations. After reviewing the public hearing record and written comments, EMC hearing officers and DEM staff modified the proposed rules and presented them to the commission at its December 1990 meeting. In Tables II-2 and II-3, standards proposed originally and sent to public hearing in 1990 are in the column labeled "Proposed 1990." Standards as modified
following public comment are in the column labeled "Proposed 1991." The primary changes in the rules were (1) a change in the definition of the critical area, (2) elimination of the complete prohibition of hazardous materials in WS-II and WS-III critical areas, (3) elimination of the prohibition on sewer lines in critical areas of WS-II and WS-III, (4) modification of the prohibition on sludge application in watershed critical areas, (5) modification of the vegetated buffer requirement to eliminate use of a formula for calculating width, and (6) increase in the high-density option built-upon area in WS-III. All of the issues, except critical area definition, had received significant attention early in the process of rule development. The staff of DEM had identified the method of defining the critical area as a potential issue at the beginning of the process. During the public comment period, apparently, the size of the critical area for reservoirs emerged as a major concern and was increased to one mile from normal pool elevation (Zoufaly 1990). The EMC voted to adopt the classifications and standards as recommended by its hearing officers and staff of DEM.

The Treyburn Challenge. Five months later, at the May meeting of the Environmental Management Commission, the developers of Treyburn in the Falls of the Neuse Watershed petitioned for a Declaratory Ruling on the effect of the proposed critical area definition.14 The Treyburn petition asserted that the EMC did not comply with requirements of the Administrative Procedure Act when it adopted a more inclusive critical area definition than had been legally advertised. The developers argued that the change in the critical area rule increased substantially the number of

14 The North Carolina Administrative Procedure Act provides that a person aggrieved may request a "declaratory ruling as to the validity of a rule or as to the applicability to a given state of facts of a statute administered by the agency or of a rule or order of the agency." Failure to issue a declaratory ruling within 60 days constitutes a denial of the request. Declaratory rulings, including denials, are subject to judicial review.
<table>
<thead>
<tr>
<th>Area</th>
<th>Proposed 1990¹</th>
<th>Proposed 1991²</th>
<th>Adopted 1992 ³</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WS-II Critical Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without stormwater controls</td>
<td>1 dwelling unit per 2 acres or 6% built upon</td>
<td>1 dwelling unit per 2 acres or 6% built upon</td>
<td>1 dwelling unit per 2 acres or 6% built upon</td>
</tr>
<tr>
<td>with stormwater controls</td>
<td>No high-density option</td>
<td>No high-density option</td>
<td>6-24% built upon</td>
</tr>
<tr>
<td><strong>WS-II Watershed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without stormwater controls</td>
<td>1 dwelling unit per 2 acres or 6% built upon</td>
<td>1 dwelling unit per 2 acres or 6% built upon</td>
<td>1 dwelling unit per 1 acre or 12% built upon</td>
</tr>
<tr>
<td>with stormwater controls</td>
<td>No high-density option</td>
<td>No high-density option</td>
<td>12-30% built upon</td>
</tr>
<tr>
<td><strong>WS-III Critical Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without stormwater controls</td>
<td>1 dwelling unit per 2 acres or 6% built upon</td>
<td>1 dwelling unit per 2 acres or 6% built upon</td>
<td>1 dwelling unit per 1 acre or 12% built upon</td>
</tr>
<tr>
<td>with stormwater controls</td>
<td>6-30% built upon</td>
<td>6-30% built upon</td>
<td>12-30% built upon</td>
</tr>
<tr>
<td><strong>WS-III Watershed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without stormwater controls</td>
<td>1 dwelling unit per 1 acre or 12% built upon</td>
<td>1 dwelling unit per 1 acre or 12% built upon</td>
<td>1 dwelling unit per 1/2 acre or 24% built upon</td>
</tr>
<tr>
<td>with stormwater controls</td>
<td>12-30% built upon</td>
<td>12-50% built upon</td>
<td>24-50% built upon</td>
</tr>
<tr>
<td><strong>WS-IV Critical Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without stormwater controls</td>
<td>1 dwelling unit per 1 acre or 12% built upon</td>
<td>1 dwelling unit per 1 acre or 12% built upon</td>
<td>1 dwelling unit per 1/2 acre or 24% built upon</td>
</tr>
<tr>
<td>with stormwater controls</td>
<td>12-30% built upon</td>
<td>12-30% built upon</td>
<td>24-50% built upon</td>
</tr>
<tr>
<td><strong>WS-IV Protected Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without stormwater controls</td>
<td>2 dwelling units per 1 acre or 24% built upon</td>
<td>2 dwelling unit per 1 acre or 24% built upon</td>
<td>1 dwelling unit per 1/2 acre or 24% built upon</td>
</tr>
<tr>
<td>with stormwater controls</td>
<td>24-70% built upon</td>
<td>24-70% built upon</td>
<td>24 - 70% built upon</td>
</tr>
<tr>
<td><strong>WS-V</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ original proposals that went to public hearing in 1990
² modified proposals that went back to public hearing in 1991
³ standards as modified and adopted following second round of public hearings

Classification added as river segment, with no restrictions
Table II-3. Comparison of Various Proposed Watershed Regulations

<table>
<thead>
<tr>
<th>Proposed 1990¹</th>
<th>Proposed 1991²</th>
<th>Adopted 1992³</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WASTEWATER DISCHARGES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WS-II Critical Area</td>
<td>Only existing discharges qualifying for general permit</td>
<td>Only existing discharges qualifying for general permit</td>
</tr>
<tr>
<td>WS-II Watershed</td>
<td>Only existing discharges qualifying for general permit</td>
<td>Only existing discharges qualifying for general permit</td>
</tr>
<tr>
<td>WS-III Critical Area</td>
<td>No new discharges</td>
<td>No new discharges</td>
</tr>
<tr>
<td>WS-III Watershed</td>
<td>Domestic and non-process discharges only</td>
<td>Domestic and non-process discharges only</td>
</tr>
<tr>
<td>WS-IV Critical Area</td>
<td>Domestic allowed, no new industrial</td>
<td>Domestic allowed, no new industrial</td>
</tr>
<tr>
<td>WS-IV Protected Area</td>
<td>Domestic and industrial</td>
<td>Domestic and industrial</td>
</tr>
<tr>
<td>WS-V</td>
<td>Domestic and industrial</td>
<td>Domestic and industrial</td>
</tr>
<tr>
<td><strong>CRITICAL AREA DEFINITION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For reservoirs: 1/2 mile from shore line in all directions draining to the reservoir or to the watershed ridge line, whichever is less</td>
<td>1 mile and draining to water supplies from the normal pool elevation of reservoirs or 1 mile and draining to a river intake</td>
<td>1/2 mile and draining to water supplies from the normal pool elevation of reservoir or 1/2 mile and draining to a river intake</td>
</tr>
<tr>
<td>For in-stream intakes: 1 mile or to the watershed ridge line, whichever is less, in all directions draining to the intake point</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BUFFER REQUIREMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required around all perennial streams. Minimum width of 50 ft. plus 4 times the percent slope. In critical areas, 100 ft or 50 ft. plus 4 times the percent slope, whichever is greater.</td>
<td>Required around all perennial waters. Minimum width of 100 ft. Recommended first 25 ft. to be natural vegetation.</td>
<td>Required around all perennial waters. Minimum width of 30 ft. with low density option. Minimum 100 ft. width with high density option.</td>
</tr>
</tbody>
</table>
### Table II-3. Comparison of Various Proposed Watershed Regulations (continued)

<table>
<thead>
<tr>
<th>HAZARDOUS MATERIALS CONTROLS</th>
<th>Proposed 1990¹</th>
<th>Proposed 1991²</th>
<th>Proposed 1992³</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS-II and WS-III Critical Areas</td>
<td>No hazardous materials allowed</td>
<td>Inventory and spill/failure plan required</td>
<td>Inventory and spill containment structures required for new industry where hazardous materials are used, stored, or manufactured.</td>
</tr>
<tr>
<td>WS-II and WS-III Watershed</td>
<td>Inventory and spill/failure plan required</td>
<td>Inventory and spill/failure plan required</td>
<td>Inventory and spill/failure plan required</td>
</tr>
<tr>
<td>WS-IV Critical and Protected Areas</td>
<td>Inventory and spill/failure plan required</td>
<td>Inventory and spill/failure plan required</td>
<td>Inventory and spill/failure plan required</td>
</tr>
</tbody>
</table>

| SEWER LINES | No new sewer lines allowed in critical areas of WS-II and WS-III watersheds. | Sewer lines allowed throughout all watersheds except WS-I. | Sewer lines allowed throughout all watersheds except WS-I. |

| SLUDGE APPLICATION | Sludge application prohibited in WS-II watersheds and critical areas of WS-III and WS-IV watersheds. | No new sludge application sites allowed in critical areas. | No new sludge application sites allowed in critical areas. |

¹ original proposals that went to public hearing in 1990 ² modified proposals that went back to public hearing in 1991 ³ standards as modified and adopted following second round of public hearings
acres of their land subject to the most stringent restrictions, seriously impacting the land's development potential, and that they had not had an opportunity to comment on the rule. A number of commissioners expressed sympathy with the petitioners' assertion that they had not been aware that a more restrictive rule might emerge from the public hearings, but the commissioners also expressed concern with preserving the procedures by which they develop and adopt environmental regulations. The commissioners were unwilling to grant the petition for a Declaratory Ruling because they felt it would call into question the process by which rules are modified in response to comments from public hearings. Instead, the commission voted to submit the entire set of rules to the public comment process again. At the same time, public comment was to be taken on proposed classifications of water supply watersheds across the state.

**New Deadlines.** Legislation ratified by the N.C. General Assembly in July 1991 gave the EMC an additional six months to complete reclassifying of watersheds and gave local governments new deadlines for submitting local ordinances: July 1, 1993, for municipalities with populations of 5,000 or more; October 1, 1993, for smaller municipalities; and January 1, 1994, for counties. The same legislation also provided for a number of minor changes in the watershed protection act.

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15 In 1991 the N.C. General Assembly recodified and amended the Administrative Procedure Act sections concerning rulemaking to provide guidance on when an agency must publish a new notice of intended rulemaking because of changes to a proposed rule. The APA now prohibits State agencies from adopting a rule that "differs substantially" from the text of a published proposed rule unless the agency publishes the revised rule in the N.C. Register and takes comment for 30 days. The APA now says that an adopted rule "differs substantially" from the proposed rule if it (1) affects the interests of persons who, based on the original notice of rulemaking, could not reasonably have determined that the rule would affect them, or (2) addresses an issue not addressed in the proposed rule, or (3) produces an effect that could not reasonably have been expected based on the original notice.
The Second Set of Public Hearings. A second set of eight public hearings on watershed protection rules and on proposed water supply reclassifications was held in August 1991. Controversy spawned by the Treyburn challenge to the rules generated more frequent and broader press coverage, and the press began to report potential impacts of the rules (Raleigh News & Observer. Aug. 13, 1991). This time public participation in hearings was heavier, and four hearings had to be reconvened to accommodate all those who wanted to offer verbal comments. More than 2,400 people attended the second set of hearings, with 477 choosing to make presentations. In addition, the comment period was extended and more than 3,000 written comments were received (N.C. Department of Environment, Health, and Natural Resources 1991). Development interests were more evident at these hearings, and environmentalists accused developers of packing the hearings to prevent others from being heard (Raleigh News & Observer. Aug. 15, 1991). Central to many of the developers objections to the rules was the assertion that they would increase the cost of housing in watersheds and that the increases would affect the supply of homes for middle and working class people.

The WRRI Analysis. In fall 1991, the Water Resources Research Institute of The University of North Carolina undertook an independent analysis of the impact of the watershed protection rules on land availability and housing costs in watersheds. WRRI Director David H. Moreau reported preliminary results of the first phase of the study to the Legislative Environmental Review Commission at a meeting on November 22, 1991. The first phase involved measuring existing housing densities in watersheds where regulations are proposed to be implemented and comparing those densities to densities allowed under the watershed protection rules. Moreau told legislators that rules adopted in December 1990 would not significantly limit the supply of land available for housing in North Carolina and that under the rules an additional 21 million people (three times North Carolina's
current total population) could build homes and live in the state's watersheds.

The conclusions of the study's first phase were disputed by development interests, who pointed out that in calculating available land the study failed to exclude undevelopable lands such as parks, national forests, and areas covered by water -- an exclusion which the researchers readily acknowledged. Wilms also continued to assert that density restrictions would drive up the cost of housing. He was quoted by the Raleigh News and Observer as saying that middle and lower income home owners would be "hit." (Raleigh News & Observer. Nov. 27, 1991).

The Current Watershed Protection Standards. In February 1992, the Environmental Management Commission considered the report and recommendations of its hearing officers for the second set of public hearings on the watershed protection rules. The recommendations included (1) reducing the size of the critical area from one mile to one-half mile; (2) reducing the buffer requirement from 100 feet to 30 feet for the low density option; and (3) substantially increasing the allowable densities and built-upon areas across all watershed classifications except the WS-II critical area. After a lengthy and contentious meeting, the commission voted 11-5 to accept the recommendations of the hearing officers. In Tables II-1 and II-2 modified rules adopted in February 1992 are in the column headed "1992 Adopted".

ACKNOWLEDGMENTS
Thanks to all the people whom I interviewed for this history, particularly Bill Eaker of the Land-of-Sky Regional Council, who provided many valuable contacts. Thanks also to those who reviewed the draft and made comments and suggestions: David Howells, Director Emeritus of WRRI; Ed Holland of the Orange Water and Sewer Authority; Paul Wilms of the N.C. Home Builders Association; and particularly Geoffrey Willett of the N.C. Division of Community Assistance, who corrected my myopia.
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III. EFFECT OF LAND-USE CONTROLS ON ECONOMIC EFFICIENCY: LITERATURE REVIEW

by
Renee Purdy

Adoption of regulations to protect watersheds that drain to public water supplies in North Carolina will have both beneficial and adverse economic effects on communities that are affected by the regulations. Predicting those benefits and costs is no simple matter, however, and there is a limited body of prior knowledge on which to draw. In this chapter, the literature on this topic is reviewed for the purpose of shedding light on two basic questions: (1) what methods have been used for the analysis of problems of this kind? and (2) what findings from prior studies have been reported?

Special attention is given to those aspects of the regulations that place density limits on new developments within designated watersheds. Density limits, as well as other aspects of the watershed protection regulations, cause those rules to fall within a general class of land use controls, and the body of literature on economic effects of land use controls is applicable, at least in part, to this particular topic.

One of the important distinctions that is made in that literature is between "closed" cities and "open" cities. Much of the literature assumes a closed-city framework in which land is in short supply relative to population and economic forecasts. Therefore, much of the literature on land-use regulations has focused on issues how policies which reduce the supply of land affects prices of both existing housing and undeveloped land. In North Carolina, by contrast, land supply is relatively unrestricted when examined in the context of existing and projected population and economic growth; (see Chapter V) therefore, an open-city framework for analysis is more
appropriate. Because supply is not unduly restricted, excess demand is not created as a result of land-use regulations. Issues of concern in the North Carolina context are: 1) the cost of additional land required by density restrictions, 2) availability of affordable homes, 3) increased construction costs and costs of delays, and 4) administrative costs of enforcement.

In both closed and open cities an unanswered question remains: are economic costs of the regulations less than or greater than the economic benefits that flow from the regulations. The rationale for adoption of land use controls for protecting watersheds is that they produce benefits, including: 1) avoidance of reservoir storage loss due to erosion and sedimentation, 2) reduced damage to public health through protected or enhanced water quality, 3) wildlife habit preservation, and 4) amenity-related benefits of low-density residential areas. Incorporating benefits into the overall assessment of land-use regulations requires 1) measurement or estimation of the types and magnitude of benefits, 2) dissemination of this information to the public, and 3) measurement of aggregate willingness-to-pay for the land-use regulation. Aggregate willingness-to-pay is then used as a measure of total benefits and compared with the total cost of the regulation.

Most of the literature on the impacts of land-use regulation on land and housing has focused on the costs. Furthermore, costs have often been narrowly defined to include only direct costs such as increased construction costs, administrative costs of enforcement (permits, fees, etc.), and the cost of additional land. Rarely has the literature attempted to measure indirect costs resulting from land-use regulation such as: 1) the cost of

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1 The impact of the North Carolina Water Supply Watershed Protection Regulations on land supply for residential development is discussed in Chapter V.
construction delays, 2) the effect of market reorientation on the availability of affordable homes, 3) scarcity costs, and 4) changes in land and housing value. An accurate assessment of the impacts of land-use regulation on land and housing value requires measurement of both costs, direct and indirect, and benefits. Note that in the following review of literature only the costs of land-use regulation are addressed; therefore, the overall effect of land-use regulations may be overestimated.

According to Nicholas (1981), the impacts which may result from land-use regulations include reducing supply, increasing fixed costs of development, increasing the marginal cost of production, and imposing a quasi-tax on producers. These impacts may be manifested in scarcity costs, direct regulatory costs, and costs of construction delays. Ideally, we would like to be able to isolate and quantify each of these costs; however, this is very difficult. Therefore, empirical estimates are generally measures of all costs resulting from land-use regulations.

In the following review of literature, we first introduce a typology of land-use regulations. Second, we evaluate the strengths and weaknesses of various research designs which have been used to assess the impacts of land-use regulations on development. Then, we address the impact of land-use regulations on the supply of land and the value of developed and undeveloped land. Finally, the direction and magnitude of changes in the cost, and price, of housing are examined.

A TYPOLOGY OF LAND-USE REGULATIONS

Land-use regulations can be classified by their function and scale. Elliott (1981) groups land-use regulations according to two regulatory functions, rate control and quality control, and two scales, which measure the pervasiveness of a land-use regulation. Rate control policies attempt to restrict the supply of housing or the rate of development in specific communities or
regions. Rate control policies may cause price increases through a demand-pull mechanism. That is, demand is greater than supply; therefore, in order to return to market equilibrium, price must increase. Examples of rate control policies include specific restrictions on the number of housing permits to be issued and growth moratoria.

Quality control policies stipulate design and construction requirements of developments. Environmental protection regulations usually fall into this category. Quality control policies typically increase the expense of development and, therefore, create cost-push price increases. Examples of quality control policies include reduction in allowable density and construction standards beyond those normally required. In the case of North Carolina, we are primarily concerned with quality-control policies.

Elliott uses two scales, single locality and multiple locality, to measure the pervasiveness of a regulation. The scale of a regulation has important implications for the magnitude of the impact. For example, adjacent localities may provide close substitutes for local housing. If a regulated community is a part of an otherwise unregulated housing market, demand can be met by the adjacent unregulated housing submarket without a price increase. If, on the other hand, the entire housing market is regulated then the price elasticity of demand will be inelastic because no substitutes exist. As a result, the price of housing may increase.

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2 Local environmental protection regulations in North Carolina which emphasize quality control policies include: Water Supply Watershed Protection Regulations, Stormwater Management, Erosion and Sediment Control, and National Floodplain Insurance Program Regulations.
RESEARCH DESIGN

In order to accurately assess the impact of land-use regulations on land and housing value, it is essential to develop a sound research design. Measuring different types of regulatory costs requires different methodological approaches. A survey instrument can be used to obtain regulatory costs that are directly measurable. These costs are usually accounted for during the construction phase of a project and may include: 1) increases in lot preparation costs, 2) administrative/permitting costs, and 3) costs of delays. The survey design approach has been used by Peiser (1981) and Seidel (1978).³

Indirect costs of land-use regulations are more difficult to measure. Indirect costs may include density restrictions, growth moratoria, and open space requirements. Because random assignment of groups is not possible when studying the impacts of land-use regulations, it has been necessary to resort to quasiexperimental (QE) research designs. A non-randomly selected control group, statistical controls or a combination of the two must be used. In order to isolate the effect of a land-use regulation on vacant land and existing housing prices there must be some type of with-versus-without comparison.⁴

³ Note that the survey tool primarily explores the cost of land-use regulations to new home construction.

⁴ In some cases a with-versus-without comparison is not possible. The land-use regulations associated with the National Floodplain Insurance Program (NFIP) are a case in point. The NFIP is a full coverage program; therefore, there are no localities which do not have NFIP-related land-use regulations. In the case of a full coverage land-use regulation where a with-versus-without comparison is not possible, impacts can be determined by examining the effects of variation in program characteristics such as: 1) variation in the allowable intensity of development and 2) variations in elevation requirements (Rossi, Wright, and Wright, 1979).
Generally, a hedonic price model is used to determine information of this nature. Housing is treated as a bundle of attributes (e.g. floor space, lot size, environment) for which separate implicit markets exist (Rosen, 1974). The price of a house is determined by an equilibrium reached in the implicit markets for housing attributes. Land-use regulations, depending on their function and scale, will affect implicit housing attributes differently. Therefore, the appropriate measure of the effect of the regulations is a measure of changes in the implicit markets.

Three comparison strategies are suggested by Schwartz et. al. (1986). These include:

1. A one-time comparison of housing prices between communities with controls and without controls, known as a post-test only comparison with a control group,

2. A before-after comparison in communities with controls, known as a pre-test/post-test comparison without a control group, or

3. A before-after comparison between communities with controls and those without controls, known as a pre-test/post-test comparison with a control group.

The first two strategies are the most frequently used; however, each faces significant threats to the internal validity of the results. If the post-test only comparison is used, it is impossible to control for historical differences between the communities. Any differences will be attributed to the land-use controls. If the pre-test/post-test comparison without a control group is used, it is difficult to control for changes in price over time that are not due to the land-use controls. In addition to these disadvantages, all three strategies face threats to the external and statistical validity of the results. Because the sample is not randomly selected and, therefore, may not be representative of the population, the ability to accurately generalize to the population is reduced. In addition, the sample
size is often small and measurements are often inaccurate in this type of study. Despite threats to external and statistical validity, the pre-test/post-test comparison with a control group is the best comparison strategy to use when evaluating the impacts of land-use regulations.

**SUPPLY OF LAND**

Whether or not regulations will affect the supply of land is largely dependent on the nature of development in the regulated community. Pollakowski and Wachter (1990) assert that in an open city or rural area where there is no constraint on land supply, land-use controls may have little or no impact on the price of a standard unit of housing. For a closed city, however, land use restrictions may lead to a positive effect on the price of developed land and a negative effect on undeveloped land. For example, a study of land-use controls and housing costs conducted in San Francisco Bay area communities (Dowall and Landis, 1982) led to the conclusion that reducing the supply of vacant land or restricting the permissible density of residential development could under restrictive conditions affect the cost of land. Therefore, according to Ohls et al. (1974), regulations which restrict vacant land supply below levels that would be normally exchanged in the market tend to increase the cost of developed land.

If the supply of land is restricted, a number of conditions may ensue which could affect the price of land and housing. First, demand may exceed supply. In order to return to market equilibrium, the price of housing will increase. Second, limited supply may restrict entry into the market and, therefore, facilitate monopoly power among developers. Third, a reorientation of the residential property market to cater to higher-income households may occur. The effect of these conditions on housing prices is discussed in Section D. The first two conditions are probably not an issue in North Carolina.
VALUE OF UNDEVELOPED AND DEVELOPED LAND

It is well known that zoning confers benefits on some and costs on others. This is apparent when comparing the value of undeveloped and developed land under land-use regulations. Conventional wisdom, as expressed in the literature, states that land-use regulations may increase the value of existing homes by restricting supply and protecting established amenities (Mark and Goldberg, 1986; Pollakowski and Wachter, 1990). Simultaneously, the value of vacant land may be depressed as land-use regulations diminish the opportunity cost of the undeveloped land (Muth and Wetzler, 1976; Ohls et al. 1974).

According to Fischel (1990) and others, land-use regulations generally cause the value of developed land to increase. The increase in property value is generally attributed to either an increase in amenity value or monopoly scarcity. Concurrently, land-use controls such as zoning and environmental regulations cause the value of undeveloped land to decrease (Brueckner, 1990; Holway and Burby, 1990; Pollakowski and Wachter, 1990). The decline in land value is often a result of an absolute increase in the raw land requirements, an increase in lot preparation costs, and a prolonged development process. Land-use controls may also reduce the highest use to which undeveloped land can be put. In a study examining the impacts of floodplain development controls, Holway and Burby (1990) note that regulations alter developers' production, cost and revenue functions and, therefore, reduce their willingness to pay for a site. Fischel (1990) concludes that, consequently, the costs resulting from a reduction in land value are borne by the owners of undeveloped land subject to restrictions. For example, Holway and Burby (1990) note that parcels zoned for one acre and larger were valued $268 per 1000 ft\(^2\) less than those zoned for medium density. Where all development is prohibited, land value for a
parcel more than 75% in a floodplain is $188 per 1000 ft² less than for a parcel less than 25% in a floodplain.

Though the majority of literature indicates that the value of undeveloped land decreases under land-use controls, the value may increase if development is not prohibited on the site, but land is scarce as a result of regulations. For example, a study of land-use regulations in the Chesapeake Bay region and the New Jersey Pinelands revealed that regulations increased the value of both developed and undeveloped land (Beaton, 1988).

Brueckner (1990) suggests yet another possibility. The value of undeveloped land is the net effect of two changes resulting from a land-use regulation. First, a land-use regulation may delay the date at which rents can be earned on the land or lower the opportunity cost of the land. This results in a lowering of the land’s value. Second, actual and potential urban rents may be raised by lowering the population growth and restricting density. In the case of North Carolina, urban rents may be raised as a result of increased environmental protection. This positive externality may raise the land’s value. Therefore, Brueckner concludes that the effect of land-use regulations on the value of undeveloped land is not generalizable.

Housing Costs and Prices

The magnitude of an impact on housing that results from land-use regulations is dependent on: 1) the level and character of housing demand, 2) the proximity of regulated communities to other unregulated communities, and 3) the restrictiveness of local land-use regulations (Dowall and Landis, 1982).

Though the majority of the literature supports the fact that new home prices may be higher in communities with land-use controls, after accounting for inflation, most studies indicate that the
price effect is far less than anticipated. In addition, Elliott (1981) and Katz and Rosen (1987) note that significant increases in housing prices caused by land-use controls only occur when regulations are enacted throughout the housing market. Localized land-use regulations are not likely to have a significant effect on housing prices because supply and demand imbalances cannot be isolated to a single community or submarket. Elliott estimates that in areas where the entire housing market is regulated, growth control regulations may account for 22% of housing price increases. In areas where only a portion of the housing market is regulated, growth control regulations have been shown to account for only 3-5% of price increases.

Land-use regulations may raise the cost of new housing by raising land costs\(^5\), increasing fixed costs of development, and delaying construction schedules (Frieden, 1979). These increases are typically passed on to homebuyers in the form of higher prices. In addition to effects on supply, two demand-driven forces create a positive impact on housing prices. First, excess demand may be created by restricting supply. Second, land-use controls may create an amenity whose value is then capitalized into housing prices. In the case of an open city or rural area such as North Carolina, excess demand does not play a role in determining the impact of land-use controls; however, an amenity-related price increase may be possible. The role of land-use regulations as an amenity is not well researched; however, the literature indicates that some buyers may be willing to pay more for developed land in

\(^{5}\) Dowall and Landis (1982) note that "while large lot zoning...tends to reduce the per-acre price of raw land, such reductions in price may be offset by higher land requirements." (p. 71)
regulated areas. The amount a buyer is willing to pay for greater than market protection is unknown.

In their study of land-use controls and housing prices in the San Francisco Bay area, Dowall and Landis (1982) note that, under the restrictive conditions of a closed city, a reduction in permissible development densities may have the largest effect on housing prices. Lower densities result in larger lot sizes. An increase in lot size will affect the selling prices of a house for two reasons. First, the raw land requirements are increased (see footnote 5). Second, the costs of land improvements are increased. Nicholas (1981) suggests that an indirect effect which may result in higher prices is a market reorientation in which developers choose to build larger homes on the larger lots. Construction costs are also increased as a result of land-use regulations. The magnitude of the increase varies with the type of regulation. For example, compliance with floodplain regulations is estimated to increase costs by 5% to 16% (Holway and Burby, 1990). Compliance with the North Carolina Sediment and Erosion Control Plan is estimated by Malcolm and Burby (1991) to cause a $1500 increase in average field cost per acre.

Estimates of the overall impact of regulations on housing prices indicate that land-use regulations rarely increase housing prices more than 12% (Nicholas, 1981). Most experts estimate that the increase in housing price is less than 6% (Peiser, 1981; Dowall and Landis, 1982). In a congressional hearing on the effect of environmental regulations on housing costs, Daniel R. Mandelker, a land-use expert from Washington University in St. Louis, testified that the cost of environmental regulations would run about 5%. In the same hearing, another testimony by Richard West

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6 An extensive literature exists on the impact of externality zoning on housing value and has shown that amenity-related price increases do occur when restrictive residential zoning is implemented (Mark and Goldberg, 1986).
of the Low Income Housing Information Center revealed that the
effects of all local zoning would account for 20% to 30% of
housing price and that environmental regulations were not a
significant factor in the increase (The Water Reporter, 1992). A
case study in Florida indicates that the increase in housing
price resulting from regulations may be less than 1% (Davies,
1977). Another case study undertaken in the San Francisco Bay
area in 1979 indicates that a decrease in development density, a
reduction in the supply of vacant land, and a 50% increase in
development fees would result in a 6% increase in the price of an
average new Bay area home (Dowall and Landis, 1982).
REFERENCES


IV. IMPACT OF REGULATIONS ON THE SUPPLY OF LAND FOR RESIDENTIAL DEVELOPMENT

by

David H. Moreau
and
Kathy N. Watts

PURPOSE

Protection of watersheds that drain to public water supplies in North Carolina as proposed and implemented under House Bill 156 raised many concerns among several interested parties. Among those concerns is the possibility that density restrictions in the regulations would limit the supply of land for new residential development and curtail growth in that sector of the economy. The purpose of this chapter is to explore the extent to which that concern may be valid. That is done by calculating existing housing densities in each designated watershed and comparing those results with densities that would be allowed under the regulations. Comparisons are made to both the rules as proposed in August 1991 and as adopted in February 1992.

Density restrictions in designated watersheds vary with classification. The classification system as adopted in 1992 defines five categories of watersheds. The most restrictive category is WS-I watersheds, those that are largely undeveloped and uninhabited. There are 58 of them; most are quite small (45 of them cover less than one square mile) and are unlikely to be developed. They are not considered further in this analysis. The least restrictive is WS-V, a category added just before the rules were adopted, to cover those portions of WS-IV watersheds that lie outside WS-IV Protected boundaries. Neither are they considered further in this analysis. The other categories are WS-II, WS-III, and WS-IV Protected, and a critical area is defined within each of these classes. WS-II watersheds are those in which agricultural and residential activities may occur but into which there are no discharges of municipal or industrial wastes.

83
WS-III watersheds may receive only domestic and nonprocess industrial discharges, and WS-IV watersheds are those into which both process and nonprocess industrial and municipal wastes may be discharged.

Density restrictions are shown in Table IV-1 for the regulations as they went to public hearing in August of 1991 and as they were modified in February 1992. They vary by class of watershed, and they are made dependent upon adoption of stormwater controls by local governments. The regulations apply to new developments on a project-by-project basis, and they apply to gross densities (total number of dwelling units in a project divided by total area of the project).

Table IV-1. Allowable Densities in Water Supply Watersheds

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WS-II Critical</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>WS-II</td>
<td>0.5</td>
<td>0.5</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>WS-III Critical</td>
<td>0.5</td>
<td>2.5</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>WS-III</td>
<td>1.0</td>
<td>4.0</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>WS-IV Critical</td>
<td>1.0</td>
<td>2.5</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>WS-IV Protected</td>
<td>2.0</td>
<td>6.0</td>
<td>2.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>

* density equivalent to allowable percent built-on

METHODS

Calculation of existing densities was done with a desktop geographic information system (ATLAS-GIS). A geographic file of the watersheds and counties in North Carolina was obtained from the Center for Geographic Information Analysis, North Carolina Department of Administration. Block-level data on housing and
population for the 1990 census were obtained from the Institute for Research in Social Sciences, University of North Carolina at Chapel Hill. Those data include the latitude and longitude of centroids for the census blocks as well as population and housing for each block.

Features of the GIS system were used to separate the geographic file for watersheds into layers, one for each watershed category. An overlay was then made of watershed boundaries on the map of the centroids of census blocks. That process is illustrated in Figure IV-1 using the area of Durham and Orange Counties as an example. Census blocks whose centroids fell within each watersheds were then captured for each watershed within each class. That process is subject to some errors, especially on very small watersheds, but the magnitude of error decreases as the size of watersheds increases. No correction is made to watershed areas for water surfaces within watersheds, a problem that may exist with a few of the WS-IV Critical areas. Areas and densities for the critical areas in all classes are based on the one-mile definition as contained in the August 1991 version of the rules. That definition was changed to one-half mile in February 1992.

RESULTS
The categories, number of watersheds, and total area are given in Table IV-2.

Table IV-2. Areas and Numbers of Watersheds by Class

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Watersheds</th>
<th>Area, Sq. Mi.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS-II Critical</td>
<td>62</td>
<td>167</td>
</tr>
<tr>
<td>WS-II Non-critical</td>
<td>58</td>
<td>1,789</td>
</tr>
<tr>
<td>WS-III Critical</td>
<td>40</td>
<td>152</td>
</tr>
<tr>
<td>WS-III Non-critical</td>
<td>39</td>
<td>2,345</td>
</tr>
<tr>
<td>WS-IV Critical</td>
<td>78</td>
<td>1,170</td>
</tr>
<tr>
<td>WS-IV Protected</td>
<td>83</td>
<td>5,872</td>
</tr>
<tr>
<td>Total</td>
<td>360</td>
<td>11,495</td>
</tr>
</tbody>
</table>
Figure IV-1. Watershed Boundaries and Centroids of Census Blocks: Orange and Durham Counties
Attribute files were constructed to include the following for each watershed within each category:

* area;
* number of dwelling units;
* population;
* housing density (dwelling units per acre); and
* population density (persons per acre).

Two-way tables showing the number of watersheds by size and housing densities (one table for each classification) were constructed from the attribute files. Those results are given in Tables IV-3 through IV-8 (see Appendix), and they are illustrated by thematic maps in Figures IV-2 through IV-4. Individual watersheds in Classes WS-II, WS-III, and WS-IV with housing densities equal to or greater than 0.5 dwelling units per acre (du/ac) are listed in Table IV-9 (see Appendix).

**WS-II Watersheds**

There are 62 WS-II Critical Area watersheds covering 167 square miles. All watersheds in this class are smaller than 15 square miles. Among them are 2 watersheds for which the housing density is greater than the allowable 0.5 du/ac, and both of them are smaller than 5 square miles. Two other watersheds have densities in the range 0.25-0.49 du/ac, but they are all smaller than 2.5 square miles. All other WS-II watersheds have existing densities of less than 0.25 du/ac.

Of the 1,956 square miles in WS-II and WS-II Critical Areas, the percentiles for 0.1 and 0.25 du/ac are as follows:

93 percent less than 0.10 du/ac; and
99 percent less than 0.25 du/ac.

Among the 58 WS-II watersheds outside of critical areas, there is only one that exceeds 0.5 du/ac. The one exception is on Pond Creek in the Watauga River Basin, but it covers only 0.3 square miles.
Figure IV-3. Housing Densities in Proposed WS-III Watersheds

Housing Units Per Acre

- < 0.1
- 0.1 to 0.24
- 0.25 to 0.49
- > .5
- No census blocks in watershed

Produced by the N.C. Water Resources Research Institute, November 1991.
WS-III Watersheds

Under the proposed 1991 standards, WS-III Critical Area watersheds would have had an allowable density of 0.5 du/ac. Among the 40 watersheds in this class, 4 have densities that exceed that limit, but the combined area of those four watersheds is only 7.0 square miles. Another 4 have densities in the range 0.25-0.49 du/ac, and each of them covers less than 10 square miles.

In the 39 WS-III watersheds outside of critical areas, the allowable density in the rules as adopted is 2.0 du/ac without any stormwater control (1.0 in the proposed 1991 rules). With stormwater controls, the density cap is increased to the equivalent of 4.0 du/ac. No watershed in this category exceeds the limit without stormwater controls, and only 2 watersheds having a combined area of 9.7 square miles would have exceeded the limit without controls under the rules as proposed in August 1991. One relatively large watershed in this class, Swift Creek in Wake County (58.1 square miles), has a density as high as 0.5 du/ac.

Of the 2,500 square miles in WS-III and WS-III Critical Areas, the percentiles for 0.1, 0.25, and 0.5 du/ac are as follows:

- 79 percent less than 0.10 du/ac;
- 91 percent less than 0.25 du/ac; and
- 96 percent less than 0.50 du/ac.

WS-IV Watersheds

In WS-IV Critical Areas, only one of the 78 watersheds has a density greater than the limit of 1 du/ac allowed under the August 1991 rules; none exceed the limit under the 1992 rules. That one watershed, on the Dan River at Eden, covers only 1.3 square miles. There are 5 other WS-IV Critical watersheds for which the density is greater than 0.5 du/ac, but their combined
area is 17.8 square miles. One watershed in this class with an area of more than 50 square miles has a density of between 0.25 and 0.49 du/ac.

The WS-IV Protected category includes 83 watersheds. Under the 1992 adopted rules, the density cap for this class is 2 du/ac without stormwater controls, the equivalent of 6 du/ac with controls. None of the watersheds in this class exceed the cap without controls. One watershed, Walnut Creek in Wake County, has a density of 1.97 du/ac, and future development in that watershed would be required to have stormwater controls. Four other watersheds are listed in Table IV-9 because they have densities above 0.5 du/ac.

Of the 7,040 square miles in WS-IV Protected and WS-IV Critical Areas, the percentiles for 0.1, 0.25, and 0.5 du/ac are as follows:

65 percent less than 0.10 du/ac;
95 percent less than 0.25 du/ac; and
99 percent less than 0.50 du/ac.

Limitations of the Analysis

The above analysis is intended to show a general picture of existing development densities relative to upper limits on densities contained in water supply watershed regulations as proposed in 1991 and as adopted in 1992. In the absence of more detailed digitized geographic information, the particular measure of density used here is gross density—total population divided by total land area. That measure is adequate for the purpose of this report, but a more refined measure would be "developable density"—total population divided by developable land. There is no official definition of developable land in North Carolina, and there are few absolute restrictions on what lands can be developed. Those lands owned by state and federal governments and others such as lakes and reservoirs are clearly off limits. Still
others, such as wetlands and those with very steep slopes may pose substantial barriers to development.

A detailed analysis of effects that these constraints might have on estimates of densities is unnecessary for purposes of this report. Data in Tables IV-3 and IV-4 and a map of the state are sufficient to conclude that the use of gross densities will not materially affect conclusions to be drawn from this analysis.

Less than 8 percent of the land in North Carolina is in state parks and federal ownership, and the largest portion of those lands are located in the western-most counties where there is only modest pressure for development. Most of the wetlands are located in the Coastal Plain, where very few WS-II, III, or IV watersheds are located. A large proportion of the watersheds of particular concern in this study are located in the Piedmont, where natural barriers to development are far less prevalent than in the Mountains or Coastal Plain.

Table IV-3. Land Use in North Carolina

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Percentage of Land in N.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Federal</td>
<td></td>
</tr>
<tr>
<td>Cultivated</td>
<td>18.7</td>
</tr>
<tr>
<td>Other Crops</td>
<td>1.1</td>
</tr>
<tr>
<td>Pasture</td>
<td>5.9</td>
</tr>
<tr>
<td>Forest</td>
<td>49.5</td>
</tr>
<tr>
<td>Minor</td>
<td>3.2</td>
</tr>
<tr>
<td>Urban and Built-up</td>
<td>4.8</td>
</tr>
<tr>
<td>Rural Transportation</td>
<td>2.1</td>
</tr>
<tr>
<td>Water</td>
<td>8.2</td>
</tr>
<tr>
<td>Federal</td>
<td>6.4</td>
</tr>
</tbody>
</table>

100.0 (except for rounding errors)

(Sources: USDA, 1982 Natural Resources Inventory and N.C. Center for Geographic Information and Analysis)
Table IV-4. Land Use in North Carolina by Supplemental Classification

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Percent of Land in N.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Parks</td>
<td>1.1</td>
</tr>
<tr>
<td>Federal</td>
<td></td>
</tr>
<tr>
<td>National Forests</td>
<td>3.3</td>
</tr>
<tr>
<td>Military</td>
<td>0.8</td>
</tr>
<tr>
<td>National Parks</td>
<td>1.1</td>
</tr>
<tr>
<td>Fish and Wildlife Refuges</td>
<td>0.7</td>
</tr>
<tr>
<td>Other</td>
<td>0.4</td>
</tr>
<tr>
<td>Wetlands</td>
<td>16.9</td>
</tr>
</tbody>
</table>

CONCLUSIONS

These findings lead to the clear conclusion that proposed reclassifications under the watershed protection standards adopted will impose a constraint on the supply of undeveloped land for residential uses in only a few localized cases. In all cases where existing densities would preempt any further development, the constraint applies only to very small watersheds that have been largely built out. No large watershed currently exceeds the density constraint without controls. In one case, development in the near future could trigger the requirement for stormwater controls.

The area of land covered by the rules, excluding WS-I and critical areas in WS-II, WS-II, and WS-IV classes, is approximately 10,000 square miles. At densities allowed without stormwater controls, prevailing sizes of households, and with very generous allowances for undevelopable land, these lands will accommodate a population many times the current population that which now resides in the state. With stormwater controls, the capacity would be even higher.
Chapter IV focused on the effects that watershed regulations as proposed in 1991 and as adopted in 1992 would have had on the supply of land for residential development in North Carolina. The fact that a significant constraint on the supply of residential land would not be created by these regulations does not necessarily lead to the conclusion that the regulations would not affect some aspects of the residential development process. In some instances, the costs of development may be increased, and in other cases, the amount of development may be limited. To examine these potential impacts in more detail, this chapter reports an analysis, performed in 1991, of the effects that proposed regulations and classifications would have in eight counties with significant portions subject to the regulations. For the most part, this analysis concerns regulations proposed in 1991, but in some cases comparison is also made with regulations as adopted in 1992 (see Proposed 1991 and 1992 Adopted columns in Tables II-2 and II-3).

Potential impacts were examined through a series of tests. First, within those parts of each county that were identified as being affected most by the regulations, development densities under state regulations were compared to those that were occurring or could occur without state regulations. In some counties, local regulations were found to be at least as restrictive as those adopted by the EMC, and in those instances the state regulations would have had no effect. Actual projects developed in recent years within the affected areas also provided a guide as to potential effects of state regulations. Those projects were examined to determine how they might have been...
affected by the regulations. Second, if the state regulations were found to be more restrictive without the option of stormwater regulations, local regulations were compared to state regulations with the stormwater option. If the state regulations with stormwater management are less restrictive than local regulations, then the effect of state regulations is to require stormwater management. Third, if density requirements under state regulations were found to be more restrictive than the local requirements, differences in density requirements were noted. Finally, in some cases it was possible to estimate the increase in housing costs associated with differential density requirements.

Any set of watershed regulations would affect some counties more than others. One indicator of the relative magnitude of impacts on counties is the proportion of each county that is covered by the proposed reclassifications. As shown in Table V-1, in 9 counties, regulations would apply to more than 50 percent of the land, and in another 10 counties, regulations would cover between 40 and 50 percent of the land.

Area affected is not a perfect indicator of the social significance of the regulations. A WS-II classification covering a smaller portion of one county may have a more serious impact than a WS-IV applied to a larger portion of another county. Furthermore, severe restrictions in some locations will have little if any effect because development may not be likely in those areas even without regulations. Nonetheless, the percent-of-county-covered is a useful guide for selecting a sample of counties for further examination.
Table V-1. Number of Counties by Areal Coverage

<table>
<thead>
<tr>
<th>Percent of County in Water Supply Watersheds</th>
<th>Number of Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 and over</td>
<td>9</td>
</tr>
<tr>
<td>40 - 49.99</td>
<td>10</td>
</tr>
<tr>
<td>30 - 39.99</td>
<td>12</td>
</tr>
<tr>
<td>20 - 29.99</td>
<td>18</td>
</tr>
<tr>
<td>10 - 19.99</td>
<td>12</td>
</tr>
<tr>
<td>0.1 - 9.99</td>
<td>17</td>
</tr>
<tr>
<td>None</td>
<td>22</td>
</tr>
</tbody>
</table>

Among those counties that will have the largest percentage of their areas covered by these regulations are: Catawba, Davidson, Durham, Gaston, Guilford, Moore, Person, and Rowan. Those counties also represent a mixture of urban and rural counties. Their past and present populations are given in Table V-2, along with future populations as projected by the North Carolina Office of State Budget and Management (OSBM) in 1988. Decadal growth rates are shown in Figure V-1. Each of these counties is examined in more detail in succeeding sections of this chapter.

Table V-2. Populations of Selected Counties Widely Covered By Proposed Reclassifications

<table>
<thead>
<tr>
<th>County</th>
<th>Historic Population, 1000s</th>
<th>Projected Population, 1000s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1980</td>
<td>1990</td>
</tr>
<tr>
<td>Catawba</td>
<td>105.2</td>
<td>119.8</td>
</tr>
<tr>
<td>Davidson</td>
<td>113.6</td>
<td>127.3</td>
</tr>
<tr>
<td>Durham</td>
<td>152.3</td>
<td>175.7</td>
</tr>
<tr>
<td>Gaston</td>
<td>162.6</td>
<td>176.5</td>
</tr>
<tr>
<td>Guilford</td>
<td>317.2</td>
<td>339.9</td>
</tr>
<tr>
<td>Moore</td>
<td>50.5</td>
<td>60.2</td>
</tr>
<tr>
<td>Person</td>
<td>29.2</td>
<td>31.7</td>
</tr>
<tr>
<td>Rowan</td>
<td>99.2</td>
<td>106.9</td>
</tr>
<tr>
<td>STATE</td>
<td>5,881.8</td>
<td>6,613.4</td>
</tr>
</tbody>
</table>
Figure V-1. Historical and Projected Population Growth Rates: North Carolina and Selected Counties

Source: North Carolina Office of Budget and Management
Figure V-2. Catawba County Watersheds and Housing Densities
ANALYSIS OF INDIVIDUAL COUNTIES

Catawba County

Watersheds and Development Densities. In Catawba County, water supply watersheds cover about 58 percent of the county, 42 percent in WS-IV, 12 percent in WS-III, and 4 percent in WS-II. They are shown in Figure V-2. The largest areas, accounting for 73 percent of the lands in water supply watersheds are those along the Catawba River that were proposed for WS-IV classification. The county also contains: (1) a large portion of the Jacob Creek watershed (WS-III) that serves Newton; and (2) Maiden Creek and Allen Creek watersheds (WS-II) that serve Maiden. A small portion of the Indian Creek Watershed (WS-II) that serves Cherryville is also located in Catawba County. The County was home to approximately 120,000 people in 1990, and the population is increasing. As shown in Table V-2, it grew at rates that were above those for the state for the past two decades. OSBM projects that the County will continue to grow at rates just above those for the state over the next two decades.

Residential development densities over a one square mile grid are also shown in Figure V-2. The highest development densities within the water supply watersheds are those in the City of Hickory and its surrounding area. High densities are also found in Newton and Conover, but those communities are not located in a water supply watershed. Density increases from 1980 to 1990 are shown in Figure V-3. Highest increases in density over that decade occurred in those census tracts in and around Hickory.

Development Without WS Regulations. Three areas of the county were of particular concern in this analysis, namely the two watersheds that serve Newton and Maiden and the proposed WS-IV areas in the northwestern portion of the county, along Lake Hickory and near the City of Hickory.

Watersheds that serve Newton and Maiden were already protected under Catawba County zoning. They were classified as Special District-2 (Watershed Protection Districts) as defined in the currently effective Catawba County Zoning Ordinance (January 1, 1990, Section 18.7.2), and their boundaries were the same as
Figure V-3. Changes in Population Densities in Catawba County, 1980 - 1990

Change in Density,
people per sq. mi.

- □ < 0
- □ 1 to 100
- □ 101 to 250
- □ 251 to 400

Miles

0 2 4
those proposed by the state for the Jacob's Fork (WS-III) and Maiden and Allen Creek watersheds (WS-II). Critical areas within these watersheds were also defined by the zoning ordinance and shown on the zoning atlas. Permitted uses in both critical area and the rest of the district were specified. Lot size for single family units within water quality critical areas was limited to 1 unit per 2 acres (80,000 sq.ft.), and for other areas the limit was 1 unit per acre (40,000 sq.ft.). There were other limits on impervious areas for non-residential lots. Stream buffers were also required. An enlarged view of the northwest part of the county in and near Hickory is shown in Figure V-4. The portion of this region west of Snow Creek in the proposed WS-IV Critical (1-mile definition) area lay within the zoning jurisdiction of the City of Hickory. Some of the critical area was located within the corporate limits of Hickory. Over half of the proposed WS-IV Protected area lay within Hickory's corporate limits, and approximately one-fourth of that area was covered by Hickory's zoning jurisdiction outside the city.

In the Catawba County Land Use Plan (Catawba County Board of Commissioners et al. 1984), most of that area was envisioned to be either "Urban" or "Transition" by 1995. In that document, urban areas were defined as cities and their densely populated outer perimeters, within which a variety of land uses are found. Transition zones were defined as rural areas that are developing at a rate which would place them in the urban category by 1995. Residential and agricultural uses tended to dominate those zones, but a wide variety of land uses were to be encouraged to develop within these areas.

As shown in Figure V-4, most of the area within the proposed WS-IV Critical area was zoned by the City of Hickory for low to moderate intensity residential development (R-1, R-2 and R-3 districts). A few small areas of more intense urban-type development were scattered within these zones. A district to the northeast of the airport was zoned for light manufacturing, and the area along US 321 towards the bridge across the Catawba River was zoned for more intense development.
Densities of existing residential developments in R-1, R-2, and R-3 zones in the proposed critical area were generally less than 2 units per acre. Zoning regulations permitted minimum lot sizes of 20,000 square feet (about 2 units per acre) in R-1, R-2, and R-3 districts without community water and sewer services, down to 12,500 square feet (about 3.5 units per acre) when both utilities were provided by community systems. However, project-wide densities for actual developments in the area were found to be much smaller. Two of the largest and most intense development projects within the residential areas had densities of just under and just over 1.6 single-family units per acre. Those projects covered about 160 and 115 acres, respectively.

A substantial portion of the remainder of the urban area of Hickory lay in the proposed WS-IV Protected area. This area contained a wide variety of residential, industrial, office and institutional, and other types of land uses common to urban areas.

Development With WS Regulations. Proposed reclassifications of Jacob’s Fork to WS-III and Maiden watersheds to WS-II would not have had significant effects on many development projects. Those watersheds were sparsely populated, and they were not under much pressure to urbanize. Special District-2 regulations under Catawba County zoning were not identical to state regulations, but they were comparable.

The more significant impacts would have been experienced along the entire length of Lake Hickory, especially that portion near the City of Hickory. The water supply intake for the City of Hickory is located at the upper end of Lake Hickory, on the east side of the US 321 bridge that crosses the lake at Hickory. The intake for Longview is located on the west side of that bridge. The 1991 version of the watershed protection regulations defined the critical area as extending 1 mile (or to the nearest ridge line) from the normal pool level of the reservoir in which the intake is located. Thus, the WS-IV critical area was
Figure V-4. Watersheds and Zoning in the Vicinity of Hickory, NC

Zoning
R1 - low intensity residential
R2 - low to moderate single family
R3 - low to moderate density residential
designated along the entire length of Lake Hickory. The Protected area of a WS-IV water supply was similarly defined but extended 5 miles (or to the nearest ridge line) from normal pool elevation.

It was found that development in the WS-IV Critical Area would not have been affected very much by the state regulations as adopted in 1992; although it could have been affected by the 1991 version of the rules. Without stormwater management, development densities in the critical area would have been limited to 1.0 units per acre or 12 percent built-on area under the 1991 version of the watershed regulations. The 1992 version reduced that limit to 1/2-acre, and most, if not all, developments would satisfy that condition. It was found that developments in the WS-IV Protected area could have been affected by the new regulations. Without stormwater management, project-averaged densities could not have exceeded 2.0 units per acre or 24 percent built-on area in the protected area. Local regulations and current development practices would not have satisfy those requirements for all projects.

Two options are available to make development patterns consistent with the regulations, namely: (1) reduce densities, or (2) implement stormwater management. Reducing density would require additional raw land for many development projects. If the two projects in the critical area mentioned previously were to have been developed under the new classification, the density of 1.6 units per acre would have to be lowered to 1.0, requiring an increase in raw land by 60 percent. Of course that does not mean that the final purchase price of houses in these developments would have increased by 60 percent. Raw land accounts for only a small part of total housing cost. Economic implications of increased land requirements are discussed later in this chapter.

Higher densities were allowed by the regulations in WS-IV watersheds if stormwater management was adopted by local
governments. With stormwater controls, existing residential development practices would have complied with the regulations as proposed in 1991, with possibly a few exceptions. The limit of 70 percent built-on area in the protected area could have affected large retail developments that might have wanted to locate there.

The area would not have been significantly affected by restrictions on new industrial dischargers in the critical area. No intensive manufacturing areas had been zoned in the critical area. No landfills were planned for the critical area, and no new sludge disposal sites were planned in that area.

Davidson County
Watersheds and Development Densities: Water supply watersheds were found to cover three-fourths of Davidson County as shown in Figure V-5. The majority of that coverage -- nearly 60 percent -- was due to proposed WS-IV watersheds along the Yadkin River, primarily High Rock Lake. Other proposed WS-IV watersheds included the Yadkin River upstream of High Rock Lake and Tuckertown Reservoir and Badin Lake. The remainder of the watershed coverage was in proposed WS-III watersheds. Abbotts Creek and Leonard Creek are located in the northeast portion of the county. The area around Lake Tom-A-Lex was designated as a WS-III Critical Area. A portion of the watershed that drains to Lake Reese in Randolph County also lies in Davidson County and had been proposed for a WS-III classification.

The county was home to 127,264 people in 1990, and the population increased at rates comparable to the state from 1980 to 1990. OSBM projections were that Davidson County would continue to grow at rates slightly above the state for the next two decades.

Existing residential development densities over a one-square mile grid are shown in Figure V-5. The highest densities were found in the vicinities of Lexington and Thomasville. Thomasville lies
Figure V-5. Davidson County Watersheds and Housing Densities

<table>
<thead>
<tr>
<th>Housing units per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to .1</td>
</tr>
<tr>
<td>.11 to .5</td>
</tr>
<tr>
<td>.51 to 1</td>
</tr>
<tr>
<td>1.1 to 2</td>
</tr>
<tr>
<td>2.1 to 3</td>
</tr>
</tbody>
</table>

Miles

0  2  4
entirely in an unclassified watershed, and, therefore, it will be unaffected by the state regulations. A large portion of the most densely populated areas of Lexington was found to fall in the protected area of High Rock Lake. A smaller portion fell in the critical area.

Growth by census tracts, shown in Figure V-6, indicated that the most intense development from 1980 to 1990 had occurred north of Lexington in a watershed draining to the Yadkin River, a watershed with a proposed WS-IV classification. Growth had also occurred in other parts of the county, especially along the Interstate 85 corridor and other transportation arteries.

Development Without WS Regulations: Development in local water supply watersheds in Davidson County would have been subject to density limitations even in the absence of state regulations. The County’s subdivision regulations required 40,000 square feet of area suitable for septic tanks on lots in watersheds of certain local reservoirs and water supply intakes. Those regulations did not apply to areas around High Rock Lake and other areas along the Yadkin River. Lots that were served only by public water and not public sewer and that were outside designated water supply watersheds were required to be a minimum of 20,000 square feet, or 2 du/acre. Lots served by both public water and public sewer or only public sewer were required to be at least 10,000 square feet, or 4 du/acre. The County’s zoning ordinance limited residential lot size to 12,000 square feet where public water and sewer were available and limited the lot coverage to a maximum of 30 percent.

Examination of eight residential developments in water-supply watersheds in the county since 1985 indicated that actual development densities had been, for the most part, in the range of 0.7 to 1.3 acres per lot. One development, a large mobile home park, had been built on the shoreline of High Rock Lake with quarter-acre lots.
Figure V-6. Changes in Population Densities in Davidson County, 1980 - 1990

Change in Density, people per sq. mi.

- < 0
- 1 to 25
- 26 to 75
- 76 to 100

Miles

0 2 4

109
Only a small number of observations were made on land and housing values in those developments, but findings from those observations were consistent with similar findings from other counties examined in this study. Developed land fell in the range of 14 to 19 percent of the combined value of housing and the land on which it is built.

**Development With WS Regulations:** Given the above county limitations, state watershed regulations would have had only a modest effect in Davidson County. None of Thomasville would have been affected. None of the WS-IV noncritical areas under county jurisdiction not in locally designated watersheds and not on public sewer would have been affected. Local regulations were the same as state regulations in those areas (state-imposed density limits were the same in the 1990, 1991, and 1992 versions of the regulations for WS-IV areas). Development in WS-IV critical areas would have been restricted under the 1991 version of the state regulations because the 1 unit per acre limit was more restrictive than the 1/2-acre county limit, but state rules adopted in 1992 contained a 1/2-acre limit. It was found that state rules could have had some effect in Lexington where allowable densities are substantially higher. The most probable effect would have been that high density development in the vicinity of Lexington would come under stormwater regulations. In water-supply watersheds designated under the county subdivision regulations, state regulations would have had no impact on density limits. All of those watersheds were proposed for WS-III classifications, and local rules, requiring 1-acre per housing unit, were at least as stringent as state rules. The 1991 version of the state rules would have required 2 acres per unit in WS-III Critical Areas, but that limit was reduced to 1 acre in 1992.

**Durham and Person Counties**

**Watersheds and Development Densities.** Durham and Person Counties are considered together in this analysis because the proposed
reclassification strongly linked watershed protection in the two counties. It was found that three-fourths of Durham County would have been covered by the proposed reclassifications, and 51 percent of Person County would have been affected. As illustrated in Figure V-7, the largest portion of Durham County affected was found to be in the WS-IV watershed of Falls of the Neuse Lake; a smaller WS-IV area would have been designated in the southwestern corner to protect Jordan Lake. These two areas covered 49 percent of the county. Another 23 percent of the county would have been included in the proposed WS-II watersheds on the Little River and Flat River that serve the City of Durham. Proposed WS-II watersheds covered 43 percent of Person County, including: (1) a portion of the South Hyco Creek watershed that drains to Lake Roxboro; (2) Storey's Creek Basin that drains to Isaac Walton Lake; and (3) a much larger area in the Flat River Basin. The first two of these sources are used by Roxboro, the third is a part of the Durham supply. About 7 percent of Person County was found to be located in a proposed WS-IV watershed in the Tar River Basin that serves Oxford.

Durham County is a largely urban county that experienced substantial growth in the 1970s and 1980s, growing at rates equal to or greater than those of the state. Its 1990 population is approximately 176,000 people. Person County, on the other hand, is mostly rural and it has experienced only modest growth over the past two decades. Its present population is about 32,000, and, as shown in Figure V-1, N.C. Office of State Management and Budget forecasts continued but modest growth over the next two decades.

Development densities in 1990 in the two counties are shown in Figure V-7. There it may be noted that densities in the northern portion of Durham County were quite low as they were though most of Person County. Roxboro is urban, but most of that city was found to lie in an unclassified watershed. Urban densities were found in a portion of the Little River watershed, and similar
Figure V-7. Durham County and Person County Watersheds and Housing Densities
urban-level densities were found in portions of the proposed WS-IV protected areas around Falls of the Neuse and Jordan Lakes. Most of the growth in Durham County was shown to have occurred in the southern part in and around the City of Durham. As shown in Figure V-8, the most intense development occurred in one tract just to the northwest of Durham, and the next most intense development occurred in tracts to the south and southwest of the city.

Impacts With and Without WS Regulations. A special Falls Lake Watershed Protection Task Force was organized in August 1991 under the auspices of the Triangle J Council of Governments. That group, composed of the water resources and planning staffs of Raleigh, Durham, Wake, and Durham Counties, was charged with determining the impacts of the proposed classifications on current development policies and to seek ways to mitigate those impacts. Consideration of the impacts within the Flat River Basin were added to that charge, and representatives from Person County made presentations to the Task Force.

The report of that task force was presented on September 25, 1991. It included a comparative analysis of existing development regulations of the several local governments with jurisdictions in the basins with the 1991 version of the state’s rules. Some of the findings summarized in that report were:

(1) The proposed WS-IV critical area around Falls Lake would have no effect on land use policies in Durham City/County because existing local ordinances are at least as strict as those of the state.

(2) The proposed protected area around Falls Lake would have an impact on a 13 square mile area zoned for industrial purposes. If the low density option without stormwater management is adopted, the City of Durham would find it difficult to recoup its investment in wastewater facilities to serve that area, and there is a concern about potential losses to the tax base. If the high-density option with stormwater management is adopted, Durham City/County would face higher costs for stormwater management.
Figure V-8. Changes in Population Densities in Durham County, 1980 - 1990
(3) The proposed classification of Flat River as a WS-II watershed would have no development policy impact on Durham County because local policies are at least as restrictive as state policies.

(4) The proposed WS-II classification of Flat River would require Person County to increase its minimum lot size from 1 acre per dwelling unit to 2 acres per unit.

(5) Industrial development in Person County would not be affected because the regulations would allow almost twice the amount of high-density development as that which is planned for industrial, commercial, and office space along the US 501 Highway corridor.

Under the rules adopted in 1992, the impacts on Person County residential development were found to be virtually eliminated.

Gaston County

Watersheds and Development Densities. Gaston County has a complex water supply situation with 9 municipal surface water supplies. About 61 percent of the county was found to fall under the proposed reclassification of water supplies, 50 percent in WS-IV areas and 11 percent in WS-II areas. The WS-IV designation was found to include three large areas: (1) the eastern quarter of the county along the Catawba River, Mountain Island Lake, and Lake Wylie; (2) a portion of the South Fork River Basin upstream of the water supply intakes for Ranlo, Dallas, and Gastonia; and (3) the Hoyle Creek basin that serves Stanley. Intakes for Charlotte (Mecklenburg County) and Mount Holly are located in Mountain Island Lake, and the City of Belmont has an intake in Lake Wylie just south of the US 29-74 bridge. Because Belmont's intake is located in Lake Wylie, the proposed reclassification applied along the entire length of that reservoir. Gastonia and Bessemer City have intakes on Long Creek, which was proposed as a WS-II supply, and Cherryville takes its supply from Indian Creek, also a proposed WS-II supply with a small portion of its drainage area in Gaston County. High Shoals takes its water from a
watershed that is located in Lincoln County. All of the watersheds in Gaston County are shown in Figure V-9.

Gaston County is heavily urbanized, and it is growing, although not as rapidly as the state as a whole. Over the decade 1970 to 1980 the county population increased by nearly 10 percent, and from 1980 to 1990, it grew about 9 percent to its current population of 177,000. As shown in Figure V-10, census tracts to the south and southeast of Gastonia and those in East Gastonia experienced the largest increases in population densities over the past decade.

Densities of development estimated for 1990 are shown in Figure V-9 for one square mile cells. The highest densities were those in the City of Gastonia, with somewhat lesser densities in the surrounding towns of Bessemer City, Cramerton, Belmont and Dallas. None of the designated water supply watersheds in the county had development densities that exceeded one dwelling unit per 2 acres when averaged over the entire watershed, but grid cells were found within those watersheds that approached 2 units per acre.

An examination of Figure V-9 suggested that development in much of the county could have been affected to some extent by the proposed reclassification. The southwest quadrant would have been untouched. High Shoals and a portion of Stanley were found to be located in the WS-IV protected area of the South Fork River; a large portion of Mount Holly, about one-half of Belmont, and all of McAdenville and Cramerton were located in the WS-IV critical area of Lake Wylie. The eastern half of Gastonia and all of Ranlo and Spencer were found to be located in the protected area of Lake Wylie. About one-half of Bessemer City was found to be in the Long Creek watershed.
Figure V-10. Changes in Population Densities in Gaston County, 1980 - 1990

Change in Density, people per sq. mi.

- < 0
- 1 to 100
- 101 to 250
- 251 to 500

Miles

0 2 4
Development Without WS Regulations. Each of these municipalities is responsible for zoning and growth management within its own municipal boundaries and its extraterritorial jurisdiction shown in Figure V-11. Gaston County has jurisdiction over all other areas of the county. Because at least a portion of each of the municipalities listed in the previous paragraph was found to be located in one classified watershed, a comprehensive analysis of the impacts of the regulations would have had to include a comparison of existing regulations in each municipality with those proposed by the state. This review was limited to an analysis of the impact on those areas under the jurisdiction of Gaston County.

The County had revised its subdivision ordinance in 1989. Under that ordinance (Gaston County 1989) minimum lot sizes for single-family dwelling units (SFDU) were:

(1) 20,000 sq. ft. with well and septic tank;
(2) 15,000 sq. ft. with either water or sewer service; and
(3) 10,000 sq. ft. with both water and sewer service.

In April 1991 a zoning ordinance had been proposed for the county, and the proposed zoning map is shown in Figure V-11. Under the October 11 version of that proposal (Zoning Ordinance Review Committee Draft), minimum lot sizes for SFDUs without water and sewer service would have been increased to 30,000 sq. ft. with very little change in the requirements when water or sewer service are provided.

A review of 25 recent development projects in Gaston County was conducted as a part of this study. Results of this review
indicated that, with the exception of a few very small subdivisions, project densities were falling in the range of 1.4 to 3.1 DU per acre. Three projects in the Long Creek watershed were in the range of 1.4 to 2.3 units per acre. One project in the South Fork Basin was 0.88 DU per acre, the other two 1.4 and 1.7. Densities tended to be higher in the Catawba River watershed. One project had 1.0 DU per acre, but 6 others fell in the range of 1.9 to 3.1. Data from the tax assessor's office indicated that prices of developed lots ranged from 11 to 20 percent of the purchase prices for homes built on those lots.

**Development With WS Regulations.** It was found that development in much of Gaston County would have felt the effects of the proposed reclassifications. Density limits in rules for WS-II and WS-IV are more restrictive than those imposed by local regulations. Development in the Long Creek and Indian Creek Basins would be limited to 1 unit per acre under the rules as adopted in 1992 (the 1991 version would have had an even greater effect at 1 unit per 2 acres). That impact could have been lessened, of course, by the adoption of stormwater management. The Long Creek Basin, which is subject to urban pressures, would probably be the most seriously affected.

The largest portion of the county in classified watersheds was found to fall in the WS-IV category where the 1992 adopted state density limit is 1 unit per 1/2 acre (1 unit per acre in the 1991 version). Most of the recent developments would not have satisfied that condition, but with stormwater management, they would have complied. Only one of the 8 projects in the Catawba River watershed would have met the density limit without stormwater management under the 1991 version of the state's rules; 4 of the 8 projects were found to satisfy the rules adopted in 1992. All of the projects could have met the requirements with stormwater management.
Guilford County

Watersheds and Development Densities. Guilford is among the most urban counties in North Carolina, and it has some of the most intensely developed watersheds in the state. Its 1990 population was about 340,000 people, and although its rate of growth has been below that of the state, it has increased by about 50,000 over the past two decades. Current development in the 13.5 square-mile watershed of the West Fork of the Deep River above Oak Hollow Lake in High Point averages 0.61 DU per acre; on the 23.6 square miles above High Point Lake on the East Fork of the Deep, development averages 0.52 DU per acre. Substantial development has also occurred in Reedy Fork Creek above the Greensboro water supply.

The analysis revealed that under the proposed reclassification, 48 percent of Guilford County would be in classified watersheds, 28 percent in WS-IV and 20 percent in WS-III as shown in Figure V-12. The largest area was found to be in the WS-IV portion of Big Alamance Creek watershed that drains to the City of Burlington's Lake McIntosh, but the more developed areas were the proposed WS-IV watersheds that serve High Point and the WS-III areas in Greensboro's watersheds. Lesser areas that serve out-of-county water supplies, all of which were proposed as WS-III areas, included: (1) a portion of the Polecat Creek Basin that serves Randleman; (2) a portion of the Sandy Creek Basin that serves as the water supply for Liberty; (3) a small fraction of the Uwharrie River Basin that serves Asheboro; and (4) a small portion of the Troublesome Creek drainage area that serves Reidsville.

The most densely developed areas are within the corporate limits of High Point and Greensboro as shown in Figure V-12, but some of the water supply watersheds in the county were found to also be located within those limits. Furthermore, considerable urban development was found between High Point and Greensboro in the Deep River Basin, including the City of Jamestown, and spillover
Figure V-12. Guilford County Watersheds and Housing Densities
development was found in Greensboro's water supply watershed to the north and northwest of the city. Those areas also experienced the largest increases in density over the decade of the 1980s as shown in Figure V-13.

Development Without WS Regulations. Guilford County was found to have a well-developed watershed protection program. Under the Development Ordinance, watershed protection districts had been established as overlay districts (Guilford County 1990). Watershed Areas were defined as the entire drainage area for a municipal water supply reservoir, and Watershed Critical Areas (WCA) were defined as those areas closest to the reservoirs. The watershed boundaries were found to be the same as the state watershed boundaries, and the WCAs outside municipal jurisdictions are shown in Figure V-14.

WCAs were further divided into 4 tiers with more stringent regulations in tiers closer to water supply reservoirs. The Development Ordinance contained a schedule for density limits for each tier with and without public sewer (Table 7-3-1). Stormwater management was also required in WCAs, the control of the first 1/2 inch being required for developments with less than 30 percent impervious areas and control of the first inch for areas greater than 30 percent.

Within Watershed Areas but outside WCAs, projects were required to meet a set of watershed performance standards that vary by type and intensity of development (Table 7-2-1). The key variable in the standards was stormwater management: whether it was required or not; and, if required, whether the amount to be controlled was 1/2 inch or 1 inch. Within WCAs, the local watershed rules generally governed densities; outside the WCAs, general zoning generally governed densities. As shown in Figure V-14, most of the watershed areas outside WCAs were zoned either for agriculture or residential with a one-acre minimum lot size. Areas for which either higher density residential or other more
Figure V-13. Changes in Population Densities in Guilford County, 1980 - 1990

Change in Density, people per sq. mi.

- < 0
- .1 to 100
- 100.1 to 200
- 200.1 to 350

Miles

0 2 4
Figure V-14. Guilford County Watershed Critical Areas, High Density Zoning, and State-Designated Watersheds
intense urban development was permitted are shown as cross-hatched areas in Figure V-14.

Development With WS Regulations. Some differences between the state regulations and the watershed protection program for Guilford County were found, but those differences were not large. Watershed boundaries were the same; as seen in Figure V-14, critical area boundaries that satisfy the state definition were almost the same as those that satisfied the definition stated by the county. Allowable activities within critical areas were similar, and stormwater management was mandated by the county ordinance in those areas. Some possible differences in details between county zoning and state regulations outside the critical areas were found, but the county zoning and watershed protection programs were comparable to those of the state. Therefore, the state program was judged to have very little potential impact in Guilford County.

Moore County Watersheds and Development Densities. In Moore County, proposed water supply watersheds were found to cover nearly 66 percent of the county: 46 percent in WS-III, 15 percent in WS-II and 5 percent in WS-IV. The largest portion of land was in the Lower Little River WS watershed (WS-III), which provides water for Vass and Fort Bragg. The county also holds much of the town of Robbins' Bear Creek watershed (WS-III), Southern Pines' water supply at Drowning Creek (WS-II), Aberdeen Creek (WS-III) and a portion of the Gulf-Goldston WS watershed on the Deep River (WS-IV).

Moore County's population in 1990 was 60,197, which reflected a 19 percent increase in growth from 1980 to 1990. The county's population has grown at a higher rate than North Carolina's for the past two decades, and it is projected to continue growing faster than the state for the next two decades. Housing densities estimated for the county are shown over a 1-square-mile grid in Figure V-15.
Figure V-15. Moore County Watersheds and Housing Densities
That grid shows that in spite of the growth in recent years, densities at the 1-square-mile level remain quite low, with the highest densities around the towns of Robbins, Pinehurst, Southern Pines and Aberdeen.

Much of the last decade’s growth was found to have located in the southern portion of Moore County, as is shown on Figure V-16. These townships experienced the greatest growth per square mile within Moore County during the last decade. These townships include the Pinehurst-Southern Pines-Aberdeen urban cluster. Those tendencies continue a trend identified in 1989 by Moore County’s Planning and Community Development Department which found that the southernmost townships experienced significant increases in their growth rate from 1970 to 1980 (Moore County Planning and Community Development et al. 1989).

An examination of growth at the 1-square-mile grid level indicated that the area near Pinehurst that lay in the WS-II watershed of Drowning Creek already had housing densities that exceeded the proposed 1991 density regulations of 1 DU/2 acres. In the Lower Little River (WS-III) and the Aberdeen Creek (WS-III) watersheds, the areas around Southern Pines and Aberdeen were found to have densities ranging from .51 to 2 DU/acre. The 1991 requirements for development without stormwater controls in WS-III watersheds limited densities to 1 DU/acre.

Development Without WS Regulations. Moore County’s current Subdivision Regulations required that all subdivisions provide a stormwater drainage system. The drainage systems were required to be designed to protect to the 10-year storm level, and commercial and industrial subdivisions were required to be protected to the 25-year storm level. The drainage system had to be designed to protect the subdivision and to prevent increased flood flows from new impervious surfaces (Moore County 1989). The county’s zoning ordinance specified lot sizes for various residential densities, ranging from 5-acre lots to half-acre lots.
A review of a sample of five subdivisions in Moore County suggested that lot sizes currently ranged from .5 to 3 acres, with most around .9 to 1.3 acres. Assessed values for developed land was found to average about 15 percent of total housing cost for the subdivisions sampled in Moore County. That percentage was highly variable, however, ranging from 3.5 to 22 percent.

Development With WS Regulations. It was found that the area within the Drowning Creek water supply watershed in the vicinity of Pinehurst could be affected by the proposed state reclassifications. The area was already experiencing urban development as shown in Figure V-15. The County's regulations allowed 2 DU/acre in its jurisdiction surrounding Pinehurst, twice the density that the 1992 state regulations allow in a WS-II area (four times the amount allowed under the 1991 version). Adoption of stormwater management policies would permit higher densities under the 1992 version of the regulations, however, and other impacts of the new rules would be minimal.

The analysis showed that development in the vicinity of Southern Pines, however, would probably not be seriously affected. Southern Pines was found to lie in small portions of two WS-III watersheds, which could have had up to 4 DU/acre with stormwater controls. Moore County subdivision regulations already required stormwater controls, so either 1991 proposed or 1992 adopted state standards were found to, in effect, allow more dense development than the county regulations. Current county zoning allowed for half-acre lots, but the state standards would allow quarter-acre lots with stormwater controls.

Rowan County

Watersheds and Development Densities. The analysis showed that the proposed reclassification of watersheds would affect 62 percent of Rowan County. Rowan, like Catawba and Gaston, was found to be affected by a WS-IV classification along a major
river, the Yadkin, that forms its border along one entire side as shown in Figure V-17. Over 40 percent of the county was found to fall into a WS-IV classification due to the water supply intakes for Salisbury and Denton on High Rock Lake and Stanly County municipalities on Tuckertown Reservoir. Another 17 percent of the county was found to be proposed for WS-II classification, and 5 percent was to be classified as WS-III. The proposed WS-II and WS-III watersheds were those in the southwestern part of the county that serve as supplies for Kannapolis and Concord.

The 1990 population of Rowan County was 107,000, some 17,000 more than in 1970. As illustrated in Figure V-17, there are two urban centers in the county, Salisbury and Kannapolis. Some of the small water supply watersheds that serve the Kannapolis-Concord area were found to have experienced significant urbanization, and the largest increases in densities in the county over the past decade were found between that area and Salisbury along Interstate 85. Much of that growth had been in unclassified watersheds. Other significant density increases had been experienced along US 52 from Salisbury to the southeast as shown in Figure V-18. That growth had been in the proposed WS-IV area.

Development Without WS Regulations. Growth in Rowan County outside the jurisdiction of Salisbury had not been controlled by zoning or subdivision regulations. Beginning in 1991, the Rowan County Planning Board had moved forward a set of policy statements and a growth management plan for the county (Rowan County Planning Board ND). However, ordinances to implement subdivision controls and zoning had not been adopted.

Current development practices were assessed in this study by examining the plats of 12 subdivisions in the county, 7 within
Figure V-18. Changes in Population Densities in Rowan County, 1980 - 1990

Change in Density, people per sq. mi.

- < 0
- .01 to 25
- 25.01 to 50
- 50.01 to 100

Miles

0 2 4
the proposed WS-IV critical area, 2 in the WS-IV protected area, and 3 in WS-II areas. For those in the WS-IV critical area, 2 were found to have densities less than 1 DU per acre; the other 7 had densities ranging from 1.1 to 1.4 DU per acre. Several of the higher density developments in that area were found on the banks of High Rock Lake. The 3 projects in WS-II watersheds had densities ranging from 0.5 to 0.7 DU per acre. Developed land in these projects ranged from $7,000 to $25,000 per lot, and developed land as a percentage of purchase price for housing ranged from 9 to 17 percent.

**Development With WS Regulations.** The proposed reclassifications were judged to have some potential impact on Rowan County. Both the proposed 1991 and 1992 adopted standards would have placed density restrictions on about 60 percent of the county where there had been none. Those restrictions would have changed development practices, especially in the WS-II critical area. To continue then current practices under the 1992 adopted rules, stormwater management would have to be implemented. Impacts outside the WS-II watersheds were not found to be significant, however. Under the 1992 version of the rules, not a single one of the 9 projects reviewed in this study would have been affected. Under the 1991 proposed rules, 7 of those 9 projects would have needed additional land, ranging from an additional 10 to 40 percent.

**SUMMARY AND CONCLUSIONS**
This review examined the potential impact of the proposed reclassification of water supply watersheds in eight counties that would have been most extensively covered by the regulations as proposed in 1991 and as adopted in 1992. Details for each county illustrated a wide array of development conditions and policy environments within which the impacts had to be evaluated. The regulations were found to have a significant potential impact in some counties, very little, if any, in others. Amidst the
considerable variety in the combinations of development conditions and local growth management policies that were found in these counties, a few general conclusions appear to be justified by this analysis.

First, either set of proposed reclassifications would have had little, if any, impact in those urban counties that have a history of concern for the protection of public water supplies. The study included 7 counties, three of which have populations of approximately 200,000 or more. In 2 of those 3 counties, Durham and Guilford, prior action had been taken at the local level to protect public water supplies, and in those counties, it was found that either set of standards would have had little effect. In Gaston County, by contrast, a considerable portion of the county would have felt an impact from either set of regulations. Zoning outside municipal jurisdictions in Gaston County had not been established. In the proposed zoning ordinance then under discussion, provision was made for the creation of Water Supply Watershed Districts (Section 3.3.4) as overlay districts, but none was proposed to be created when the proposed zoning map was prepared. The reclassification process will have the intended effect of pushing Gaston County, and possibly other urban counties in similar situations, toward the more well-developed practices that have been adopted by counties that have a historic concern for water supply protection.

Second, densities in current developments for most areas that would be significantly affected by reclassification could meet the limits if stormwater management rules are adopted. That statement is true for most of the areas in the eight counties that were examined in this study. There are some exceptions, however, most notably in WS-II watersheds that have not been zoned by local government.
Third, if local governments choose to satisfy the regulations by using the low density option, additional land requirements would be substantial for many residential projects in areas where local controls are less stringent than those of the state. A large fraction of the projects reviewed in this study would require increases of between 50 to 100 percent over the land area used without the regulations. Percentage increases in undeveloped land costs, however, are not translated into similar increases in housing costs. Raw land represents only a small fraction of total housing costs. For most of the projects reviewed in this study, developed land accounted for between 12 and 18 percent of assessed value of subdivision homes. Only rarely would undeveloped land exceed one-half the cost of developed land. Since clustering is permitted in the regulations, additional land that would be necessary to meet density limits for a given project could, in many cases, remain undeveloped.

Fourth, the water supply watershed protection standards apply to large areas of rural lands in North Carolina that are not now and are not likely to be subject to pressures for urbanization. As a consequence, any development within many sparsely developed rural areas will have to satisfy density requirements even though such developments in any given watershed may be few in number and have minimal impact on water supplies. Low density requirements in very rural areas may not be so easily justified, although other limitations such as those related to waste disposal and buffer requirements, may be readily justified regardless of density.
REFERENCES

Catawba County Board of Commissioners, Catawba County Planning Board and Catawba County Planning and Development Department. April 1984. Catawba County Land Use Plan.


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VI. EFFECTS OF REGULATIONS ON LAND REQUIREMENTS AND HOUSING COSTS

by
David H. Moreau

North Carolina's Water Supply Watershed Classification and Protection Act, commonly referred to as House Bill 156, was ratified in June 1989. The act establishes a mandatory local program of watershed protection that is consistent with statewide minimum performance standards to be set by the Environmental Management Commission (EMC). EMC was directed by the act to adopt watershed classifications and to assign to each water supply watershed in the state an appropriate classification. As regulations to implement the act were in the process of formulation and public review it became evident that the rules could have far-reaching implications for the state. Of particular significance is the fact that the rules would place caps on urban development densities on about one-fourth of all land in the state. Although density caps may have other beneficial and adverse effects as discussed in Chapter IV, one of the more widely discussed effects is the cost imposed on new homes. The purpose of this chapter is to report on estimates of the magnitude of these costs.

THE NEW RULES
Several versions of the rules have been developed and promulgated during the past three years. To assist the EMC in developing statewide minimum standards, House Bill 156 also created the Water Supply Watershed Protection Advisory Council. The makeup of the council was spelled out in the act and included a complete range of interests. During early 1990, the council held five public hearings and a work session, drafted a set of classifications and standards, and forwarded them to the EMC in April 1990.
The EMC voted in May to put the proposed classifications and standards before the public ("Proposed 1990" column in Table II-1). A series of educational meetings and eight lightly attended public hearings were held across the state in the summer of 1990, with most participants expressing support for the standards. In December 1990, the standards, which had been modified following public hearings, were adopted by the EMC.

In May 1991, opposition was mounted by a few influential developers who perceived the new rules posed a serious threat to their financial interests. They alleged that EMC had violated procedural requirements in adopting the regulations, and although EMC refused to invalidate any portion of its standards, the body did agree to send the entire set of classifications and standards back to public hearing ("Proposed 1991" column in Table II-1). In August 1991, eight public hearings were held on the standards adopted in December 1990. The second set of hearings was heavily attended, with environmentalists accusing developers of packing the hearings.

Following the second set of hearings, the classifications and standards were again modified. This third version of the standards was adopted by the EMC in February 1992 ("1992 (Adopted)" column in Table II-1). (WRRI NEWS)

CLASSIFICATIONS AND STANDARDS

As implemented, the watershed protection act might be characterized as a non-degradation policy similar to those in the federal Clean Air Act and the Clean Water Act. The classifications adopted by EMC are based on existing levels of development in watersheds, and nothing in the regulations is designed to mitigate existing conditions. The same water quality standards must be met in all classes, but the performance-based standards vary with existing levels of development. Uninhabited Class WS-I watersheds will remain that way. Watersheds that are
not subject to much urban development and are without known discharges are classified WS-II, and the regulations are intended to keep them in primarily undeveloped condition. Standards for WS-III are designed to hold the line in moderately developed watersheds with only domestic and non-process industrial discharges, and WS-IV standards are designed to maintain existing conditions in heavily developed watersheds with no categorical restriction on discharges.

In addition to restrictions on wastewater discharges, standards in water supply watersheds are set to guard against pollution from various sources of polluted runoff (nonpoint source pollution) and from accidental spills of hazardous materials. Nonpoint source control measures include vegetative buffer areas along streams and reservoirs, restrictions on activities and hazardous material use, and development density and impervious surface area limitations (1) without engineered stormwater control devices (low-density option) or (2) with engineered devices (high-density option).

Each watershed includes two areas: (1) a critical area, within which, it is judged, pollutants from uncontrolled runoff or spills would reach a water supply intake in sufficient concentration to pose an imminent threat to the water supply and where stricter nonpoint source controls are applied; and (2) a noncritical area, where controls can be less stringent. Some of the most intense opposition to the regulations centered on the definition of critical areas, which, for WS-II and WS-III watersheds had been increased from 1/2 mile from reservoir normal pool elevation in the 1990 version to 1 mile in the 1991 version. The rules adopted in 1992 reduced the critical area back to 1/2 mile and significantly increased allowable densities and impervious surface areas in all classifications except the WS-II critical area.
IMPACT OF RULES ON RESIDENTIAL DEVELOPMENT

One of the principal concerns expressed by developers has been the potential impact of the rules on costs of development, particularly the amount of additional land that would be necessary to satisfy new density requirements. An assessment of these land requirements can be made by comparing densities at which residential subdivisions have been developed in recent years with those specified in the rules. At least two indicators of impact are readily measurable: (1) the percentage of developments that would not be affected by the rules; and (2) the average percentage increase in land requirements to make recent development practices consistent with the rules.

Estimates of these quantities are possible from a statistical analysis of land consumption developments. Impacts of the rules were examined in eight of the most widely affected counties (Catawba, Davidson, Durham, Gaston, Guilford, Moore, Person, and Rowan). No impacts on residential development of any significance were found in Durham and Guilford because local regulations in those counties are comparable to the state regulations. Person County was excluded because of the limited number of developments in its watersheds. From the other five counties, 65 subdivisions, all developed since 1985 within water supply watersheds, were selected for further analysis.

A cumulative frequency analysis of development densities in these 65 subdivisions is shown in Figure VI-1. Some developments in this sample were located in areas with no density limits; the most restrictive density limits for any of the watersheds in which these subdivisions were located was one housing unit per quarter-acre lot. No development in the sample had a higher density; 10 percent of the subdivisions consumed less than 0.43 acres per housing unit (a/hu), and 25 percent consumed less than 0.53 a/hu. The median consumption in these developments was 0.82 a/hu.
Figure VI-1. Cumulative Frequency Analysis of Development Densities
Under the assumption that the sample is representative of development practices in unregulated watersheds, the cumulative frequency curve in Figure VI-1 can be used to estimate effects of the regulations in those areas where state regulations are more restrictive than local regulations. For instance, the curve can be used directly to estimate the percentages of subdivisions that would satisfy the rules under the 1991 and 1992 (adopted) versions of the rules with and without stormwater regulations. Results of that analysis are given in Table VI-1. The all-category percentage shown in Table VI-1 was calculated by weighting the percentages within each category by the relative sizes (land area) of the categories.

<table>
<thead>
<tr>
<th>CLASS</th>
<th>1991 RULES</th>
<th>1992 RULES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without</td>
<td>With</td>
</tr>
<tr>
<td></td>
<td>Storm-water Control</td>
<td>Storm-water Control</td>
</tr>
<tr>
<td>II-Critical</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>II</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>III-Critical</td>
<td>9</td>
<td>89</td>
</tr>
<tr>
<td>III</td>
<td>37</td>
<td>99</td>
</tr>
<tr>
<td>IV-Critical</td>
<td>37</td>
<td>89</td>
</tr>
<tr>
<td>IV-Protected</td>
<td>81</td>
<td>100</td>
</tr>
<tr>
<td>All</td>
<td>54</td>
<td>83</td>
</tr>
</tbody>
</table>

An examination of these results leads to the observation that differences between the rules as proposed in 1991 and as adopted in 1992 were significant. Potential impacts in WS-II, WS-III Critical, WS-III, and WS-IV Critical categories without stormwater controls were significantly modified by the changes. Changing the rules from those proposed in 1991 to those that were adopted in 1992 substantially increased the percentages of subdivisions that would not be affected, from 9 to 37 percent of...
WS-II developments, and from 37 to 81 percent of WS-III and WS-IV Critical developments. For all categories the percentage of exemptions increased from 54 to 72 without stormwater controls. With stormwater controls that percentage increased from 83 to 97.5.

A histogram of land consumption derived from the sample can be used to determine the average increase in land requirements for subdivisions under the new regulations in comparison with pre-rule development practices. That curve is shown in Figure VI-2. Percentage increases in land requirements necessary to satisfy the regulatory standard for each category of watersheds can be calculated for all values of land consumption. Then, if each of those values is weighted by its relative frequency in the sample, an average for each category can be calculated. Let the amount of land consumed per household unit be represented by a variable $c_i$ where $i$ is a variable indicating the intervals in the histogram. Then, for any given value of $c_i$, the amount of additional land, $A_i$, required to satisfy a standard, $c_s$, is:

$$A_i = \begin{cases} 100\times(c_s - c_i) & \text{if } c_i < c_s; \\ 0 & \text{if } c_i > c_s. \end{cases}$$

Then, the average increase in land required over all values of consumption is

$$A = \sum_{c_s}^{c_i} A_i f_i$$

where $c_s$ is the lower bound on consumption rates per unit of housing and $f_i$ is the relative frequency with which the consumption rate $c_i$ occurs in the sample. In a similar manner, the average consumption of land under existing development practice is

$$C = \sum_{c_s}^{c_i} c_i f_i$$
where \( c_b \) is the upper bound on housing consumption in the sample. Then the percentage increase in land requirements for a given classification is \( 100 \times \frac{A}{c} \). Results of these calculations are given in Table VI-2.

Furthermore, an all-category impact can be calculated by weighting the averages within each category by the relative sizes (land area) of the categories. Results of these computations are also given in Table VI-2.

Table VI-2. Average Percentage Increase in Land Requirements for Residential Development in Classified Watersheds

<table>
<thead>
<tr>
<th>CLASS</th>
<th>1991 RULES</th>
<th>1992 RULES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without</td>
<td>With</td>
</tr>
<tr>
<td>Storm-water Control</td>
<td>183</td>
<td>183</td>
</tr>
<tr>
<td>Storm-water Control</td>
<td>183</td>
<td>183</td>
</tr>
<tr>
<td>Storm-water Control</td>
<td>52</td>
<td>0</td>
</tr>
<tr>
<td>Storm-water Control</td>
<td>52</td>
<td>3.1</td>
</tr>
<tr>
<td>Storm-water Control</td>
<td>7.5</td>
<td>0</td>
</tr>
<tr>
<td>Storm-water Control</td>
<td>54</td>
<td>32</td>
</tr>
</tbody>
</table>

These results indicate that the average magnitude of impacts on developments was reduced sharply by changing the 1991 rules. Average increases in land requirements would have been 183 percent in WS-II non-critical areas under the proposed 1991 rules, and the high density option with stormwater controls was not allowed in those areas. The 1992 changes reduced that impact to 52 percent without stormwater controls and 3.1 percent with stormwater controls. Reductions of impacts on WS-III and WS-IV Protected areas were also quite significant. Overall, the average increase in land requirements was reduced from 54 to 18 percent without stormwater controls, from 32 to 1 with stormwater controls.

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If changes in the price of undeveloped land due to regulation are ignored, a rough approximation of effects on housing costs can obtained by changing raw land requirements and holding all other factors constant. Tax assessment data for the 65 watersheds in the sample discussed earlier indicate that the value of developed lots accounts for 10 to 20 percent of total housing value. Undeveloped land accounts for some lesser percentage, but those costs are so highly variable that reliable estimates are not available for the sample. Nonetheless, it is doubtful that raw land costs will exceed 50 percent of developed land except in those situations where only minimal improvements are made. Those cases with only minimal improvements (no water or sewer) tend to be located in rural areas where land costs are low anyway. If raw land costs are as high as 50 percent of developed lots, then that cost would be somewhere in the range of 5 to 10 percent of housing costs. Under those conditions, a 52 percent increase in land requirements under the 1991 rules (without stormwater control) would have meant a 2.5 to 5 percent increase in the cost of housing. The rules as adopted in 1992 would cause a rise of 0.5 to 0.9 percent increase in affected housing under these conditions. If stormwater controls are adopted, the reduced cost of additional land would be at least partially offset by the cost of the controls. The clustering option makes on-site improvements costs the same with and without regulation. Some additional off-site costs for streets, water, and sewer could be expected in areas where additional land requirements are very large.

CONCLUSIONS
Watershed protection rules as proposed in 1991 would have had a significant effect on land requirements for new developments in water supply watersheds in those counties that did not have comparable local ordinances. When both the size of affected areas and average impacts on individual developments are considered, the most important impacts would have been in WS-II non-
critical class. However, some modest changes to the rules or adoption of stormwater regulations could have substantially mitigated those impacts.

The drastic changes between the rules that were adopted in 1992 and the earlier version considerably reduced potential impacts on new development. Without stormwater controls, the overall impact on increased land requirements for new development was reduced from 54 percent to 18 percent.

Rough estimates of effects of these requirements on housing prices indicate only modest impacts under either version of the regulations. The rules as they were adopted will, on the average, have less than a one-percent impact.

Finally, it is apparent in hindsight that adoption of statewide stormwater regulations in water supply watersheds would have produced virtually the same level of protection as the complex set of density limits that were adopted in 1992. If a local government chooses to adopt stormwater controls, densities with state regulations will be about the same as those that would have occurred without any state regulations. The watershed protection benefit is, therefore, that which is provided by stormwater management.

REFERENCES

APPENDIX

(Tables IV-3 through IV-9)
Table IV-3. Critical Areas of WS-II Watersheds by Size and Housing Density

<table>
<thead>
<tr>
<th>Size, sq. mi.</th>
<th>&lt; .1</th>
<th>.1-.24</th>
<th>.25-.49</th>
<th>&gt; .5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1</td>
<td>13</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>1-2.49</td>
<td>20</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>26</td>
</tr>
<tr>
<td>2.5-4.99</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>5-9.99</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>10-14.99</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Total area, sq.mi. = 167.4
Existing housing units = 8,697
Existing population = 20,757
People/household = 2.39

Table IV-4. Non-critical Areas of WS-II Watersheds by Size and Housing Density

<table>
<thead>
<tr>
<th>Size, sq. mi.</th>
<th>&lt; .1</th>
<th>.1-.24</th>
<th>.25-.49</th>
<th>&gt; .5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4.99</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>5-9.99</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>10-24.9</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>25-49.9</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>50-99.9</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>100-149</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>150-199</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Total area, sq.mi. = 1,790
Existing housing units = 56,646
Existing population = 135,010
People/household = 2.38
### Table IV-5. Critical Areas of WS-III Watersheds by Size and Housing Density

<table>
<thead>
<tr>
<th>Size, sq. mi.</th>
<th>&lt; .1</th>
<th>.1-.24</th>
<th>.25-.49</th>
<th>&gt; .5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>1-2.49</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>2.5-4.99</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>5-9.99</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>10+</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Total area, sq.mi. = 152.0
Existing housing units = 18,242
Existing population = 44,260
People/household = 2.43

### Table IV-6. Non-Critical Areas of WS-III Watersheds by Size and Housing Density

<table>
<thead>
<tr>
<th>Size, sq. mi.</th>
<th>&lt; .1</th>
<th>.1-.24</th>
<th>.25-.49</th>
<th>&gt; .5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4.99</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>5-9.99</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>10-24.9</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>25-49.9</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>50-99.9</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>100+</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

Total area, sq.mi. = 2,345
Existing housing units = 128,607
Existing population = 305,388
People/household = 2.37
Table IV-7. Critical Areas of WS-IV Watersheds by Size and Housing Density

<table>
<thead>
<tr>
<th>Size, sq. mi.</th>
<th>&lt;.1</th>
<th>.1-.24</th>
<th>.25-.49</th>
<th>&gt;.5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2.49</td>
<td>9</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>2.5-4.99</td>
<td>19</td>
<td>11</td>
<td>6</td>
<td>3</td>
<td>39</td>
</tr>
<tr>
<td>5-9.99</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>10-24.9</td>
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<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>25-49.9</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>50-99.9</td>
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<td>1</td>
<td>1</td>
<td>0</td>
<td>4</td>
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<tr>
<td>100+</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Total area, sq.mi. = 1,170
Existing housing units = 76,167
Existing population = 168,365
People/household = 2.21

Table IV-8. Non-critical Areas of WS-IV Watersheds by Size and Housing Density

<table>
<thead>
<tr>
<th>Size, sq. mi.</th>
<th>&lt;.1</th>
<th>.1-.24</th>
<th>.25-.49</th>
<th>&gt;.5</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4.99</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>5-9.99</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>10-24.9</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>25-49.9</td>
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<td>5</td>
<td>1</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>50-99.9</td>
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<td>2</td>
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<tr>
<td>100-199.9</td>
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<td>6</td>
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<td>0</td>
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</tr>
<tr>
<td>200+</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

Total area, sq.mi. = 5,872
Existing housing units = 377,049
Existing population = 929,358
People/household = 2.46
Table IV-9. Watersheds with Existing Housing Density Greater than 0.5 Dwelling Units Per Acre

<table>
<thead>
<tr>
<th>Basin</th>
<th>Stream</th>
<th>Class</th>
<th>Area, Density, Sq. Mi.</th>
<th>du/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watauga</td>
<td>Pond Cr</td>
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