WATERSHED PROTECTION IN WESTERN NORTH CAROLINA

with Special Attention to the Pigeon River Upstream of Canton

by

David H. Moreau
Mary Jo Moubry
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March 1988

Water Resources Research Institute
OF THE UNIVERSITY OF NORTH CAROLINA

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CHAPTER I

INTRODUCTION

Only a few of the many watersheds that are used for public drinking water supplies in western North Carolina are adequately protected by public policy from the threat of degradation from improper management of urban development and the failure to adopt best management practices in agricultural and silvicultural operations. This report examines the nature and extent of risks to water supplies; it explores what powers are available to local governments in North Carolina to manage the risk of degradation; and it reviews how those powers are being exercised. The nature of the risk is described first by examining water supplies in 24 counties in the western part of the State. Special attention is then given to the Pigeon River watershed upstream of the Town of Canton in Haywood County. The report concludes with recommendations for further development of public policy at both the state level and in Haywood County.

BACKGROUND

Every year millions of visitors are attracted to the mountains of western North Carolina to enjoy their natural beauty and to take advantage of a variety of recreational opportunities. Many of these same people are choosing to make the area their permanent home, an option that has been exercised by a large number of retirees. Improved access over new interstate highways and other road improvements, in hand with enhanced efforts toward economic development, have increased the number of jobs in this region that has long been classified as being economically depressed.

While growth and development have brought many benefits to the area, they have also brought many costs. Heavy traffic, construction activity, and unmanaged growth threaten the beauty of the natural landscape which has attracted so many people to the area. These activities threaten not only the natural beauty of the region, but also the quality of some of the most productive public water supplies in the United States.

The threat to public water supplies is not limited to urban development, however. During the past 25 years a revolution has occurred in the manufacturing and use of agricultural chemicals, and western North Carolina has not escaped the potential for adverse effects that could result from transport of these chemicals into public water supplies through stormwater runoff. The mountainous terrain that is typical of much of the region limits the total volume of agricultural production, but the flood plains and terraces along many of the streams are used intensively for a variety of crops. Furthermore, the proximity of agricultural operations to the streams and the frequent intense storms that occur in the region lead to direct runoff of pesticides, herbicides, and other chemicals into water supplies. The Pigeon River watershed upstream of Canton is illustrative of this kind of problem.

In fact, contaminants can enter public water supplies from a variety of sources as illustrated in Figure 1. They include: (a) the effluents from industrial and municipal wastewater treatment plants; (b) effluents from small so-called "package" wastewater treatment plants that serve individual residences, subdivisions, or institutions; (c) stormwater runoff from agricultural and silvicultural operations, urban areas, and construction sites; (d) seepage from septic tanks, landfills, underground storage tanks and other subsurface waste disposal and storage practices; and (e) accidental spills of hazardous chemicals during transport or storage of these substances. An overly simplified but widely recognized classification system, puts all of these sources into one of two categories; namely, "point" and "nonpoint" sources. Point sources are those, such as effluents from treatment plants, that are discharged at known, easily pinpointed locations. By contrast, sources such as agricultural drainage enter streams at a large number of diffuse locations and are therefore referred to as nonpoint sources.

The threat to public health from point sources has been recognized by the public for over a century. David Howells, professor emeritus at North Carolina State University, uncovered the following account from the Second Biennial Report of the Raleigh water supply for the year 1887-1888:

> "Raleigh's supply depends for its safety upon the permanency of the lively appreciation of danger at present evinced by its health authorities." (p. 176). Continuing, "The public water supply should be guarded with special care by the local authorities, but in many instances these would be powerless

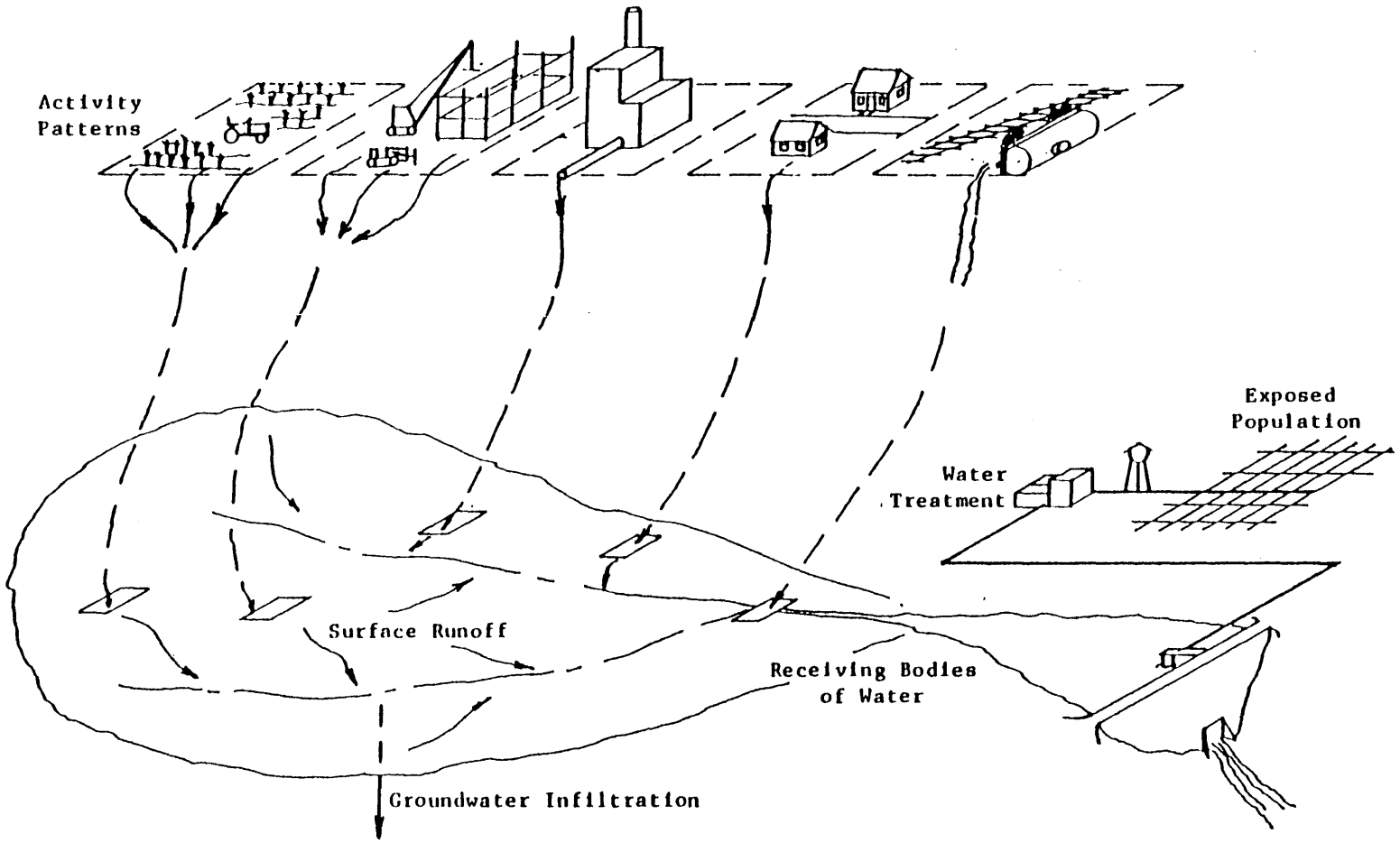


FIGURE 1. PATHWAYS FOR CONTAMINANTS IN SURFACE WATER SUPPLIES

> without cooperation of the authorities of the State. This is shown by the action of Raleigh in securing special legislation to prevent the pollution of its source of water supply. Without such legislation, every public water supply in the State, located outside the corporate limits of a town, is completely at the mercy of every ignorant or wanton trespasser." (p. 178).

The State did adopt regulations in the late nineteenth century to protect public water supplies from the discharge of sewage upstream.

Recognition of the risk from nonpoint sources, however, is of more recent origin. Rapid growth in and around Raleigh, Durham, Greensboro, High Point, and Winston-Salem have caused each of these cities to formulate management plans to protect their supplies from the effects of urban encroachment. The State of North Carolina has become an active partner in these efforts and is playing a leadership role.

To some extent the concerns being expressed in North Carolina are typical of those nationwide. A 1983 book by researchers at the University of North Carolina at Chapel Hill recounted the evolution of water source protection (Burby, et al., 1983). Source protection became a basic tenet of practice after it became understood in the nineteenth century that diseases could be transmitted through water supplies. Then, with improvements in water treatment technology, source protection was seen as being less important until new light was shed on the topic by several studies in the late 1960s and early 70s. Among those studies were the 1969 report by the Bureau of Water Hygiene of the U.S. Public Health Study, the reports of excessive cancer deaths among residents of New Orleans and Jefferson Parish, Louisiana, and an array of studies on the quality of runoff from urban and agricultural areas. For the first time in 1972, in the amendments to the Federal Water Pollution Control Act (Public Law 92-500), nonpoint sources were recognized as significant sources of pollution that must be addressed by water quality management plans.

Quantities and Effects of Land Use

The quantities of pollutants from nonpoint sources and their concentrations in stormwater runoff can be quite significant. There are also important differences in the quantities generated by different types of land uses. Brovitz (1985, p.43B) compiled the set of loading rates shown in Table 1 from a number of

Table 1.

Uncontrolled Nonpoint Pollution Loading Rates

	Lead lb/ac/yr	COD lb/ac/yr	Phosphorus lb/ac/yr	Nitrogen lb/ac/yr	Sediment ton/ac/yr
Agricultural and Residential Land Use[1]					
Single Family Residential					
Large Lot					
0.5 du/ac	.14	32(est.)	.8	6.2	.09
1.0 du/ac	.17	92	.8	6.7	.11
2.0 du/ac	.25	181	.9	7.7	1.4
Medium Density					
3 du/ac	.34	200	1.0	8.0	.16
Townhouse/Garden Apt. (10-20 du/ac)	1.04	350	1.7	13.6	.33
Cropland					
Tillage	.04	193	3.5	16.6	1.8
Pasture	.02	115	.5	6.3	.06
Forest	.02	82	.1	2.7	.06
Idle	.02	100(est.)	.2	3.3	.05
Commercial and Industrial Land Use					
Commercial[2]	3.59	981.3	3.68	24.8	1.32
Industiral (R&D)[3]	4.0	50.0	2.2	7.9	.03
Institutional[4]	4.0	50.0	2.2	7.9	.03
Major Highways/Airports	3.59	981.3	3.68	24.8	1.32
Open Space[3]	0.01	1.8	0.06	3.0	.003

[1] All estimated loading rates in this category (Estate Single to Idle Land) from Oak Hollow Watersned Study (1984).
[2] Winston-Salem NURP Study (NRCD 1983).
[3] Washington State Report (Horner and Mar 1982).
[4] Assumes Institutional = Industrial (R&D) and Major Highway/Airport = Commercial
du = dwelling unit

Table 2.

Mean Concentrations of Pollutants in Median Storm Events:
National Urban Runoff Program
(all concentrations in milligrams per liter)

	Land Use Type			
Parameter	Residential	Mixed	Commercial	Nonurban
Biochemical Oxygen Demand, mg/l	10	7.8	9.3	
Chemical Oxygen Demand, mg/l	73	65	57	40
Total Suspended Solids, mg/l	101	67	69	70
Lead, mg/l	.144	.114	.104	.03
Copper, mg/l	.033	.027	.029	
Zinc, mg/l	.135	.154	.226	.195
Kjeldahl Nitrogen, mg/l	1.900	1.29	1.18	.965
Nitrites and Nitrates as Nitrogen, mg/l	.736	.558	.572	.543
Total Phosphorous, mg/l	.383	.263	.201	.121
Soluble Phosphorous, mg/l	.143	.056	.080	.026

studies reported in the literature. Much of that literature has focused on the problem of excessive nutrients in lakes and estuaries, and hence, estimates of phosphorous and nitrogen loads are frequently reported. Considerable attention has also been given to soil erosion and sediment damage in streams and lakes. Less attention has been given to heavy metals, but loading rates for lead are quite common. The estimates given in Table 1 support the observation that the quantities of pollutants that are transported by stormwater runoff are not negligible, and that there are important variations in these quantities from one type of land use to another. Those variations are also reflected in results of the National Urban Runoff Program, given in Table 2, which show the concentrations of several substances for the median storm event covered by that study.

Public Health Implications

Translating loading rates and ambient concentrations of contaminants into effects on human health is a task involving many uncertainties. These effects may be either acute or chronic. Acute effects, those that are realized shortly after the population is exposed, have been assessed by classical methods of toxicology and epidemiology. The Safe Drinking Water Committee of the National Academy of Sciences (1977) recommended the use of those methods to arrive at "no-observed-adverse-effect" concentrations for a long list of substances and organisms having acute effects on humans. That committee recognized the limitations of research on health effects, however, and recommended the use of safety factors in setting drinking water standards.

The committee's basic presumption for chronic effects is that there is no threshold level for contaminants below which health effects will not occur. Effects of this kind, including cancer, are the result of long-term exposure to low-level concentrations of a variety of chemicals where symptoms of the disease may not occur for as long as 20 to 30 years after initial exposures. Assessments of risk from substances that cause those kinds of effects are based largely upon animal studies where the subjects are exposed to relatively high doses. Although these experiments are generally recognized as being appropriate for the study of health effects in humans, their results must be extrapolated to get predicted responses in animals at dose levels found in the environment, and those findings must be extrapolated from animal populations to human populations, the so-called "mouse-to-man" extrapolation. Since the presumption is that there is no "safe"

level for these substances, the choice of a drinking water standard for these substances must be based on the concept of acceptable risk. As might be expected, assessments of chronic risks are subject to considerable uncertainty. Various models that are used for the extrapolations can yield results that differ by orders of magnitude.

Some acute and chronic effects can be reduced through conventional water treatment processes, others cannot. One of the most disturbing facts about many synthetic organic chemicals is that the health effects remain unknown and their presence in drinking water is difficult to detect. These are the primary reasons for renewed attention to protection of the sources of drinking water. In 1962 the Advisory Committee to the Public Health Service recommended,

> ...the production of water supplies which pose no threat to the consumer's health depends on continuous protection. Because of human frailties associated with this protection, priority should be given to the purest source. Polluted sources should be used only when pure sources are economically unavailable...

The U.S. Environmental Protection Agency has adopted the same rationale in regard to protecting water supply lakes and reservoirs. It stresses the importance of the sanitary survey and recommends that frequent surveys be made to locate and identify health hazards which might exist in the watershed.

OUTLINE OF REPORT

That line of reasoning is followed in this report. In Chapter II the nature and extent of threats to public water supplies are examined in 24 counties in western North Carolina. The status of watershed protection in those counties is also included in that discussion. A more detailed examination of the problem in the Pigeon River watershed and Haywood County is presented in Chapter III. New initiatives have been taken at both State and local levels to protect water supplies in North Carolina, and they are reviewed in Chapter IV. That discussion gives special attention to recent changes in the state stream classification system and related guidelines for watershed protection. Also included is an examination of the statutory authorities available to local governments upon which watershed protection policies can be formulated. That chapter concludes

with a review of policies that have been developed in six counties in North Carolina.

The report concludes with a summary and recommendations in Chapter V.

CHAPTER II

PROTECTION OF PUBLIC WATER SUPPLIES IN WESTERN NORTH CAROLINA

Western North Carolina, as a part of the Appalachian region, has been thought of for many years as an economically depressed area, not subject to the kinds of urban development pressures that are facing the more rapidly growing cities and counties in the Piedmont. Even in an era when that perspective may have been more valid than it is today, there was far more pressure on the quality of water resources of the area than could have been inferred by population densities and growth. Figures of that kind ignored the millions of non-residents who annually visited the area, one of the most attractive vacation regions in the country. They also ignored the thousands of non-residents who were building second homes in the area.

In recent years the permanent population of all counties in the region has increased at rates that are approximately the same as those for the State as a whole; several counties are among the fastest growing in the State. This growth, like that in other parts of the State is posing a threat to the quality of public drinking water supplies, and a large number of cities, towns, and counties in the area have adopted few, if any, public policies to protect their supplies.

The increasing numbers of residences, industries, and accommodations for visitors are significant threats. With them come increased construction activity with off-site damage to streams from erosion and sedimentation. They also increase rates at which water-borne wastes are generated; they increase the volume of effluents from waste-disposal facilities; and they increase the problem of disposing of sludge from waste-treatment plants.

Increasing numbers is not the only factor affecting water quality, however. The topography of the region dictates that much of the urban activity is located near the streams where surface runoff and seepage from soil disposal systems flow directly into tributaries of water supplies. The same is true for agricultural activities.

The increasing use of synthetic organic chemicals in homes, industries, and agriculture also increases the risk to drinking water supplies. This factor is not

unique to western North Carolina, but it is a problem that deserves the attention of water managers and citizens alike.

These threats are examined at two levels of detail in this report. A regionwide perspective is presented in this chapter, and a more detailed case study of the Pigeon River watershed is given in Chapter III.

THE REGION AND ITS GROWTH

The region of concern consists of the 24 counties in western North Carolina shown in Figure 2, all of which may be generally classified as being mountainous. The region is defined as containing all of the counties that wholly, or in sizable part, are in the geologic Mountain Province of the State. Its total population in 1985 was 908,000, with individual counties ranging in size from 7,000 to 168,000. The average county populations was 37,800.

As shown in Table 3, some of these counties actually lost population in the 1960s while the regionwide population increased by about 10 percent. In the 1970s every county in the region experienced growth in the population as indicated in Figure 2, while the region absorbed 125,000 new residents, an increase of 17 percent. Estimates of the 1985 population indicate that growth is continuing into the 1980s, albeit at a rate that is more like the 60s than the 70s.

Several counties in the region have grown very rapidly. The population of Henderson County increased by over 18 percent in the 60s, then by 37 percent in the 70s, and another 13 percent from 1980 to 1985. Over that 25-year period, the population has doubled. The population of Watauga County has more than doubled during that period, with increases of more than 33 percent in each decade. Growth rates of that magnitude impose very heavy burdens on local governments if they are to properly manage growth to avoid a variety of adverse effects of urbanization, degradation of water quality in streams being among them.

With that growth comes construction activity. Even though growth has slowed somewhat in the 1980s, the annual rate of construction activity reached about 14,000 units in 1985, and, as shown in Table 4, approximately one half of those were new single-family homes.

PUBLIC WATER SUPPLIES

Most of the water supplies in the region which serve more than a few customers take their water from surface sources. A 1977 survey of public water supplies in

FIGURE 2.

Annual Growth Rates, 1970–80

Selected Counties in Western North Carolina

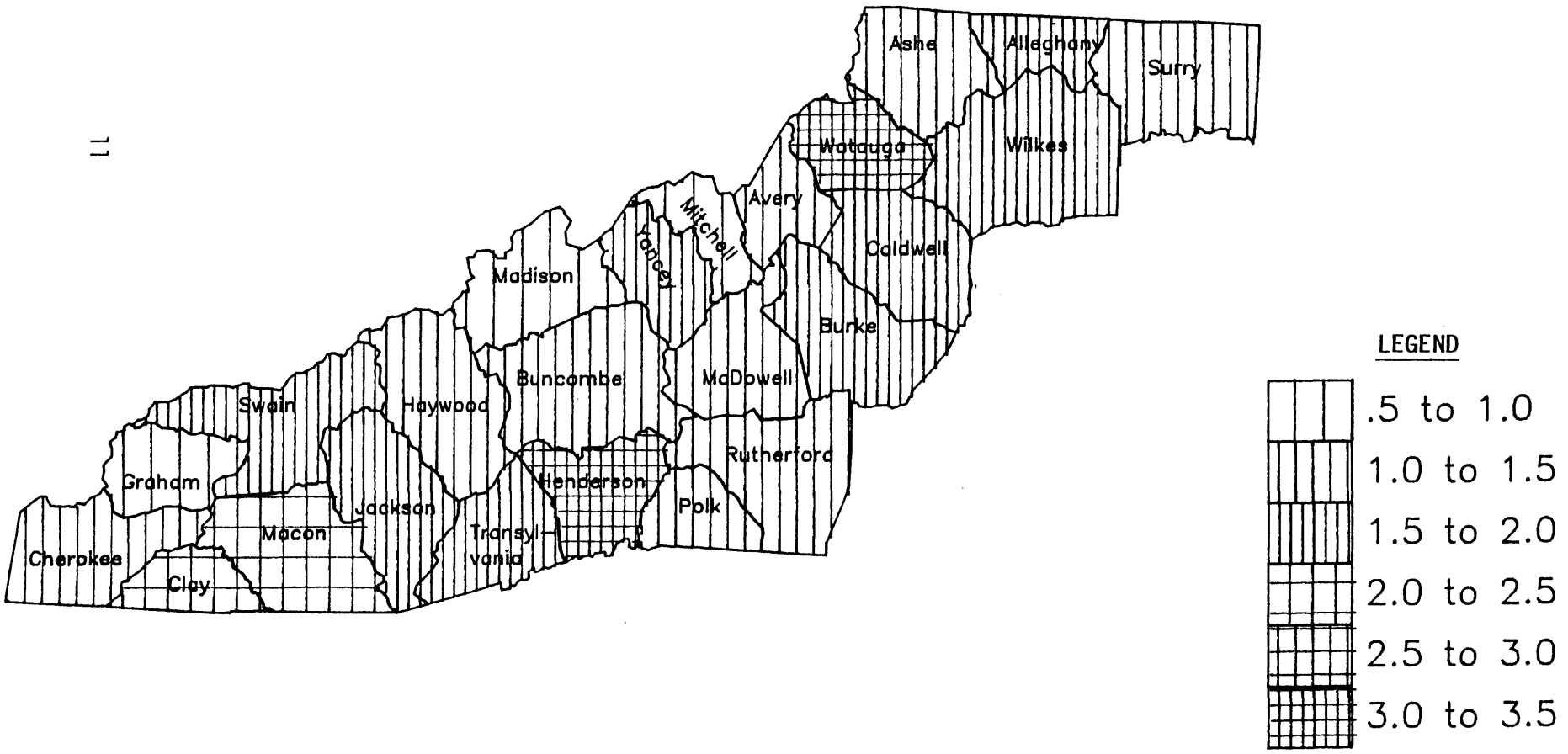


Table 3. Population of Western North Carolina Counties

	Population				Percent Change
	1960	1970	1980	1985	1970-85
ALLEGHANY	7,734	8,134	9,587	9,692	19.2
ASHE	19,768	19,571	22,325	23,423	19.7
AVERY	12,009	12,655	14,409	14,996	18.5
BUNCOMBE	130,074	145,056	160,934	168,281	16.0
BURKE	52,701	60,364	72,504	75,548	25.2
CALDWELL	49,552	56,699	67,746	70,245	23.9
CHEROKEE	16,335	16,330	18,933	20,207	23.7
CLAY	5,526	5,180	6,619	7,026	35.6
GRAHAM	6,432	6,562	7,217	7,189	9.6
HAYWOOD	39,711	41,710	46,495	47,905	14.9
HENDERSON	36,163	42,804	58,580	66,186	54.6
JACKSON	17,780	21,593	25,811	26,967	24.9
MACON	14,935	15,788	20,178	23,072	46.1
MADISON	17,217	16,003	16,827	17,191	7.4
MCDOWELL	26,742	30,648	35,135	36,281	18.4
MITCHELL	13,906	13,447	14,428	14,559	8.3
POLK	11,395	11,735	12,984	14,388	22.6
RUTHERFORD	45,091	47,337	53,787	56,941	20.3
SURRY	48,205	51,415	59,449	60,827	18.3
SWAIN	8,387	8,835	10,283	10,699	21.1
TRANSYLVANIA	16,372	19,713	23,417	25,581	29.8
WATAUGA	17,529	23,404	31,666	34,173	46.0
WILKES	45,269	49,524	58,657	60,802	22.8
YANCEY	14,008	12,629	14,934	15,575	23.3
TOTAL	672,841	737,136	862,905	907,754	23.1

TABLE 4.

Authorized Construction in Western North Carolina

	1983	1984	1985
No. of counties reporting	17	17	15
All units	9,800	11,400	13,300
Distribution by type (%):			
Single-family	53	50	53
Multi-family	11	15	14
Non-residential	10	12	12
Additions and alterations	25	22	21

North Carolina identified 36 systems in the region that served more than 500 customers; 29 of them used surface sources exclusively (Mann, 1978), six used only groundwater, and one used a combination of surface and ground supplies. The North Carolina Division of Environmental Management now lists 50 surface water suppliers of all sizes in the region (see Appendix A), and those suppliers take water from 76 different sources.

It is not surprising that in this region supplies are taken predominantly from surface sources. As shown by the generalized geology of the area, illustrated in Figure 3, much of the region consists of relatively shallow layers of soil and saprolite underlain by fractured bedrock consisting of granite and metamorphosed igneous and sedimentary rocks. These crystalline rock aquifers have low porosity (void spaces); thus, they hold very little water. Wells drilled into aquifers of this type have relatively low yields, usually in the range of 10-25 gallons per minute, but if a driller is fortunate and happens to hit a water-bearing fracture, the yield may be as high as 200 gallons per minute (USGS, 1985, p. 330).

Wastewater Discharges

The primary concern of study is: how well are these supplies protected? That question is not an easy one to answer without a detailed analysis of each of the 76 sources. There are some general indicators, however, that provide some insights into the nature of the threat. One of the most important of these is the location of municipalities, industries, institutions, and, in many instances, individual residences who discharge wastewaters into streams that flow into public water supplies.

The best data set for waste dischargers is the NPDES permits. Any person or public or private organization who discharges wastes to a stream in the United States is required to have a permit to do so in accordance with provisions of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) and its amendments, known as the Clean Water Act. These permits are commonly referred to as NPDES permits because they are part of the National Pollution Discharge Elimination System. The North Carolina Department of Natural Resources and Community Development has jurisdiction over the issuance of these permits, and 524 of them were active in August of 1987. The distribution by county is given in Table 5.

FIGURE 3.

Generalized Geologic Map of Western North Carolina

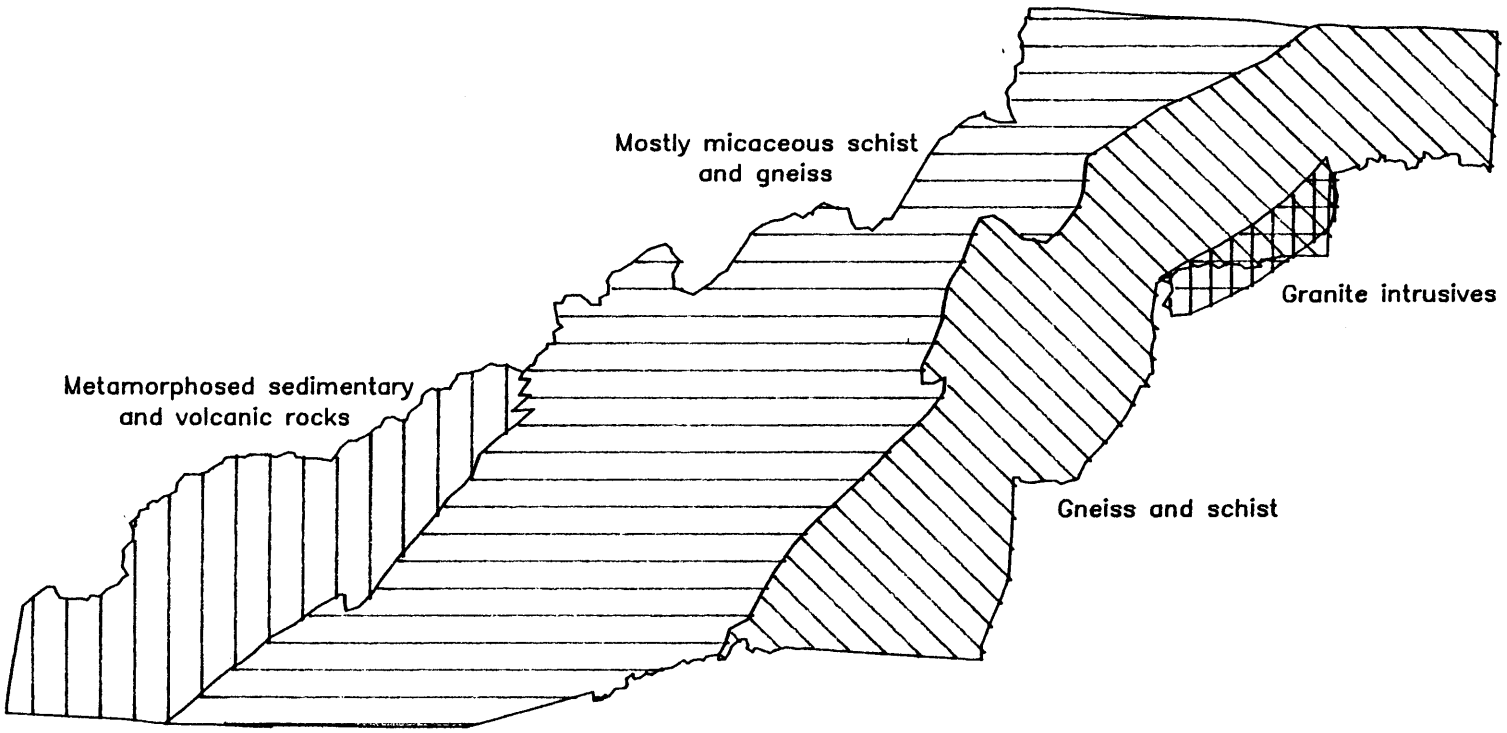


Table 5. Number and Density of Waste Discharge Permits in Western North Carolina

County	Population, 1985	No. of NPDES Permits	No. of Permits per 100,000 People
ALLEGHANY	9,692	5	52
ASHE	23,423	13	56
AVERY	14,996	22	147
BUNCOMBE	168,281	39	23
BURKE	75,548	25	33
CALDWELL	70,245	29	41
CHEROKEE	20,207	9	45
CLAY	7,026	2	28
GRAHAM	7,189	4	56
HAYWOOD	47,905	60	125
HENDERSON	66,186	49	74
JACKSON	26,967	24	89
MACON	23,072	21	91
MADISON	17,191	39	227
MCDOWELL	36,281	18	50
MITCHELL	14,559	10	69
POLK	14,388	10	70
RUTHERFORD	56,941	17	30
SURRY	60,827	36	59
SWAIN	10,699	8	75
TRANSYLVANIA	25,581	21	82
WATAUGA	34,173	30	88
WILKES	60,802	24	39
YANCEY	15,575	9	58
TOTAL	907,754	524	58

The statewide number of permits in August 1987 was 2,224 or about 22.2 per county. That is the same density as that for the western 24 counties. On a population basis, there are approximately 34 permits for every 100,000 persons for the State as a whole--58 permits per 100,000 persons in the 24-county area and 30 elsewhere. Thus, a person in one of these counties is 90 percent more likely to be served by a discharging wastewater treatment system than a person living elsewhere in the State, a much more decentralized pattern of discharges to streams.

Several of the counties within the region have an even more exaggerated decentralization of discharges. Madison, Avery, and Haywood Counties have more than 100 permits per 100,000 persons.

While many of these permits have been issued to small dischargers such as motels, schools, and even to individual residents, the degree of treatment provided in these small systems is usually far less than that provided in centralized facilities that are managed by trained operators with supporting laboratory services. Furthermore, the accumulation of discharges from several small discharges along a small stream may well lead to contraventions of standards, as is the case along Jonathan's Creek in Haywood County.

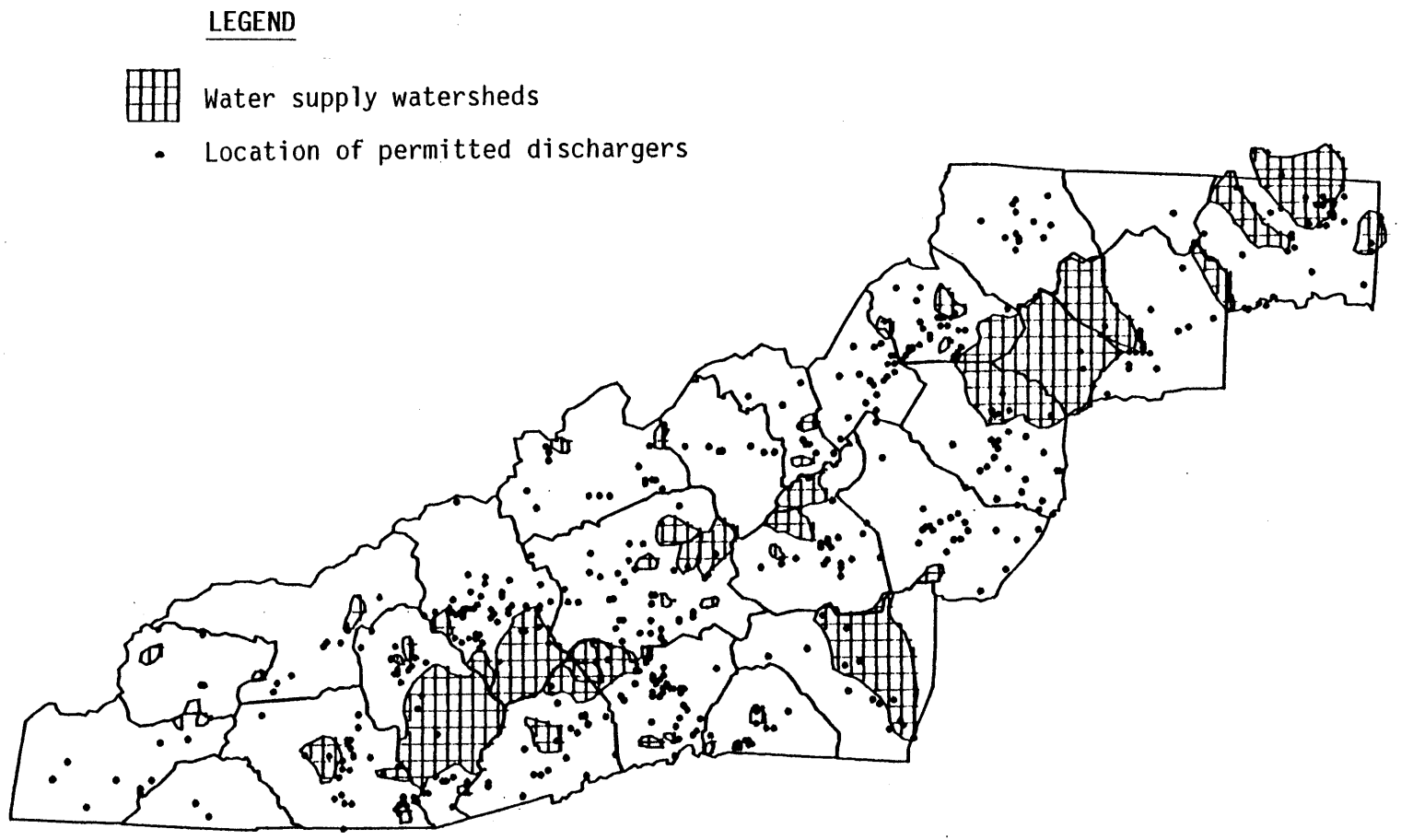
Decentralization of wastewater treatment can pose a threat to public drinking water supplies when permits are issued to activities located upstream of those supplies. As shown in Figure 4, that is the case in several supplies in western North Carolina. The largest numbers of those occur in Surry, Caldwell, and Rutherford Counties, and in the Yadkin River Basin upstream of Wilkesboro and Jonesville.

AGRICULTURE

Because of the expanded use of a wide array of pesticides and herbicides and continued soil erosion, agricultural activities in these watershed are also of concern. Although this region is not the principal agricultural center of the State, it does include a significant amount of agricultural production. Approximately 13 percent of all farmlands in the State are located in this region, and they cover about 21 percent of the total area, less than the statewide figure of 33 percent. The mountainous terrain limits the amount of land that can be cultivated. In this region only 4.7 percent of the total area was in cultivation in 1982, while the statewide level was 16.5 percent. That figure is highly

FIGURE 4.

Water Supplies and Discharge Permits



variable from county to county within the region as shown in Figure 5. Alleghany, Henderson, and Surry Counties are all above the 10 percent level.

This area is more widely used for pasturelands than is the rest of the State. Within this area, 8.7 percent of all lands are in pasture. That amount is much greater than 5.3 percent for the State. In some counties, as shown in Figure 6, as much as 25 to 30 percent of the land is in pasture.

These facts would tend to place less importance on agriculture as a source of contamination in mountain watersheds than elsewhere in the State except for the fact that the preponderance of surface water supplies are in the western half of the State. Furthermore, as shown in the discussion of Pigeon River, agricultural activities in the region are carried out in close proximity to streams.

The threat to public water supplies from agricultural chemicals should not be overstated. On the other hand, it should not be ignored as has been largely true in North Carolina to date. In a recent effort to construct a data base for national pesticide usage, North Carolina was listed as one of nine states that had no reports of agricultural usage (Gianessi, 1986). The only estimates that are available are those that are being constructed from secondary data sources that combine crop statistics with expert opinion about application rates (Turner, DiGiano, and DeRosa, 1984; Oak Hollow Watershed Study, 1982).

Specific kinds of agricultural chemicals that are used in these watersheds can be identified by agricultural experts in each county who have knowledge of both the particular types of crops that are grown in the watersheds and the types of herbicides and pesticides that are being used. The statewide estimates of the amounts of these chemicals that are used tend to focus on major crops such as tobacco, corn, and soybeans, some of which are produced in great abundance in this region.

WATERSHED PROTECTION

Public policy to protect the quality of public water supplies is not new in North Carolina, but it has received renewed attention in recent years. Initiatives have been taken at the local level, and a significant change occurred at the state level in 1985.

FIGURE 5.

Percent of Counties in Cultivated Cropland

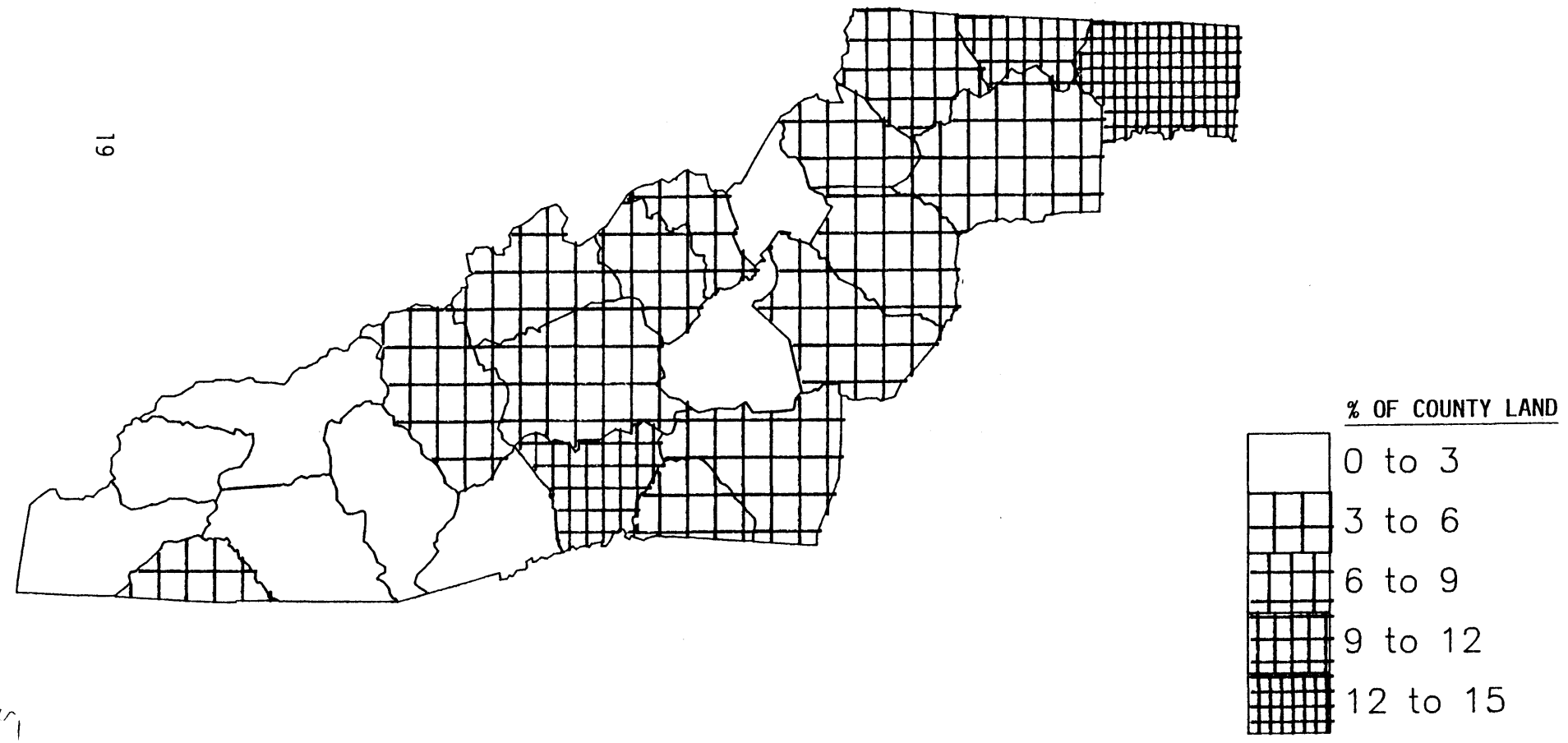
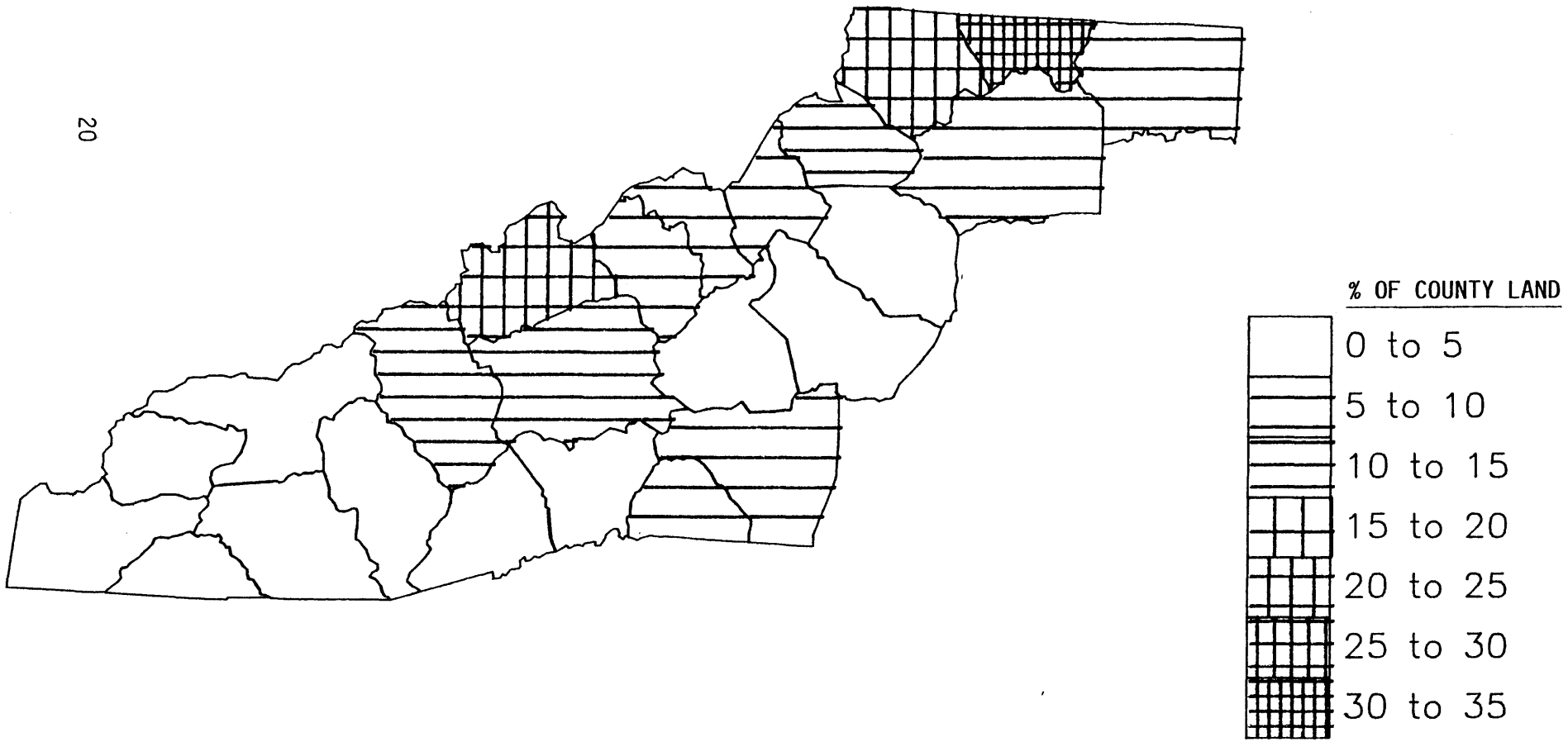


FIGURE 6.

Percent of Counties in Pastureland



Classification Status

Details of state and local programs are given in Chapter IV. To appreciate the current status of water supply protection in Western North Carolina it is sufficient at this point in the discussion to describe elements of North Carolina's stream classification system. Prior to 1985, all segments of streams that were immediately upstream of public water supplies were classified either A-I or A-II. The A-I classification was reserved for a few highly protected streams in the mountains that could be used for water supplies with minimal treatment. All other supplies fell into the A-II category.

The 1985 change in classifications brought about a three-level classification described briefly as follows:

CLASS WS-I	Water supplies which are in natural and uninhabited or predominantly undeveloped watersheds. Point source discharges are not permitted and local programs to control nonpoint source pollution are required.
CLASS WS-II	Water supplies which are in low to moderately developed watersheds. Permitted discharges are restricted to primarily domestic wastewater or industrial non-process waters specifically approved by the Commission. Local programs to control nonpoint source pollution are required.
CLASS WS-III	Water supply segments with no categorical restrictions on watershed development or discharges. A detailed evaluation of point sources including toxic substances and implementation of a non-point source control program for the portion of the watershed under the community's control is recommended.

To quality for WS-I or WS-II status, local governments having jurisdictions over the tributary watersheds must have an approved program to reduce the impact of pollution from non-point sources. In the transition from the old classification system to the new one, all A-I classifications were automatically classified WS-I, and all others were classified WS-III. To upgrade classifications from WS-III to WS-I or WS-II, a formal request must be made by a unit of local government. That request triggers a reclassification process in which the State must determine if all the required conditions have been satisfied. Unless a request of that type is made, the water supply remains in the WS-III category.

At present the 76 sources of surface water supplies in western North Carolina are classified as follows (NRCD-DEM, Dec. 1987):

Current Classification	No. of Sources
WS-I	33 (all formerly A-I)
WS-II	0
WS-III	44

Of the 44 sources currently classified as WS-III, the Division of Environmental Management, NCDNRCD, has estimated that these sources have the highest potential classifications as follows:

Highest Potential Classification	No. of Sources
WS-I	26
WS-II	9
WS-III	9

Thus, if these estimates are correct, 34 sources would have to be reclassified to achieve the level of protection that could be achieved under the State regulations.

While this program is still relatively new, there are several signs that progress toward the goal of bringing all of these supplies to their highest potential classification will be slow. County governments are the key to that progress because the watersheds lie predominantly outside the jurisdiction of cities that use them for water supplies. Cities and towns that use these supplies are more likely to act in their own interest to adopt the necessary controls on non-point sources and to restrict the location of waste dischargers to areas outside the watersheds. Counties, on the other hand, include constituents who do not benefit directly from such controls and who may resist imposition of such controls.

Of the 100 counties in North Carolina, 27 have no public water supplies that are extracted from surface sources. Watershed protection is not relevant in those counties, most of which are located in the coastal plain (protection of sole-source aquifers may be relevant, but that is another story). However, watershed protection is relevant in the other 73 counties, but, as of August 1987, only 10 of them had shown an inclination to adopt the regulations necessary to bring them into compliance with WS-I and WS-II classifications.

Of the 24 counties examined in this study, only two, Wilkes and Transylvania, are in the process of developing programs to upgrade the classifications of their

water supplies. A third, Haywood County, is awaiting publication of this report before considering further action. Four of these counties have no surface water supplies.

County governments in the region have been reluctant to adopt growth management guidelines and regulations. The nature of these regulations is discussed in greater detail in Chapter III, but the categories include: (1) land-use plans; (2) zoning; (3) subdivision regulations; (4) local sedimentation and erosion ordinances; and (5) flood-plain regulations.

The counties that have adopted these guidelines and regulations are shown in Table 6, and the statistics on them are revealing. Land-use plans have been

Table 6.

Growth Management Authority Enacted by Counties in Western North Carolina

County	Land Use Plan	Zoning	Sub-division Regs	Sediment & Erosion Ordinance	Flood Plain Regs
Alleghany	x		x		x
Ashe	x				x
Avery				x	x
Buncombe	x	x			x
Burke	x				x
Caldwell	x		x		x
Cherokee	x				x
Clay					
Graham					x
Haywood	x				
Henderson	x	x			
Jackson	x				
Macon	x				
Madison		x			x
McDowell	x				x
Mitchell					x
Polk	x	x	x		x
Rutherford	x		x		x
Surry	x	x	x		x
Swain					x
Transylvania	x				x
Watauga			x	x	x
Wilkes	x	x	x		x
Yancey	x				x

adopted by 17 of the 24 counties, but only six of them have adopted even partial zoning. Subdivision regulations have been adopted by only 7 of 24, and only two of them have enacted local sedimentation and erosion ordinances. Flood plain regulations are in force more widely.

The widespread use of land-use plans is a logical first step, but they are largely of the nature of guidelines. They are not enforceable in and of themselves. The widespread use of flood-plain regulations results in large part because of considerable financial incentives. They are a necessary prerequisite for residents of a county to qualify for federally subsidized flood insurance. The other types of growth management techniques are voluntary, they impose some restrictions on land development, and they have not been widely adopted in these counties.

CONCLUSION

The extent to which watershed protection measures of this type have been adopted in these counties may be appropriate to the levels of development that have occurred on these watersheds in the past. With a few notable exceptions, point source discharges in most of these watersheds are such that the water supplies could still be classified as either WS-I or WS-II. However, all of these counties are continuing to experience growth, and there is little public policy to manage that growth to minimize its adverse impacts on water quality. Furthermore, a significant amount of agricultural activity is occurring within the watersheds that are used for public water supplies, and the potential risk from pesticides and herbicides used in that activity has gone largely unmonitored and unassessed.

CHAPTER III

PIGEON RIVER UPSTREAM OF CANTON

Specifics of the threats to public water supplies in western North Carolina and the status of watershed protection (or the lack thereof) can be seen in detail in the case of the Pigeon River above Canton, North Carolina, in Haywood County. Although Haywood County is not growing as fast as a few of the other counties in the region, the current situation there is typical of situations that can be found in many of the other counties. Growth is occurring without the benefit of much public policy to guide it, and while existing water supplies are still in relatively good condition, change is in progress, and supplies are vulnerable to the impacts of new developments in the watershed. This particular case also illustrates the special character of watersheds in western North Carolina where urban and industrial activities are located very close to tributary streams, and where surface runoff and groundwater seepage flow directly into the supplies.

This chapter begins with a discussion of water supply related trends in Haywood County before proceeding to a detailed examination of trends in the Pigeon River watershed. It concludes with a discussion of public policies for managing growth in that watershed.

HAYWOOD COUNTY

Growth

Haywood County is growing, not explosively, but it is growing. As shown in Table 7 and Figure 7, the population followed the trends for the region as a whole. In the decade of the 1960s, Haywood County's population increased by a modest 4.8 percent from 39,700 to 41,700, but it experienced an accelerated growth in the 1970s. In that decade it increased by 10.3 percent to 46,500, and since 1980 growth has continued at a lesser pace, 2.9 percent from 1980 to 1985 when its population reached 47,900.

Water Supplies

That population is served by a combination of public and private sources. Recent data on the mix of those sources is not available, but in 1974 it was estimated that about three-fourths of the population got their water from public

Table 7.

POPULATION OF HAYWOOD COUNTY BY TOWNS AND TOWNSHIPS

Township / Town	1960	1970	1980
Beaverdam	11,969	11,468	11,997
Canton	5,068	5,158	4,631
Cataloochie	116	107	56
Cecil	426	418	355
Clyde	2,620	3,086	4,448
Clyde	680	814	1,008
Crabtree	851	794	882
East Fork	1,295	1,362	1,551
Fines Creek	905	692	764
Ivon Duff	495	645	668
Ivy Hill	1,470	1,779	2,356
Maggie Valley	-	-	202
Jonathan's Cr.	928	803	1,189
Pigeon	3,150	3,460	3,996
Waynesville	15,220	16,955	18,084
Waynesville	6,159	6,488	6,765
White Oak	266	141	149
Total	39,711	41,710	46,495

Source: US Bureau of the Census, Census of Population, 1980

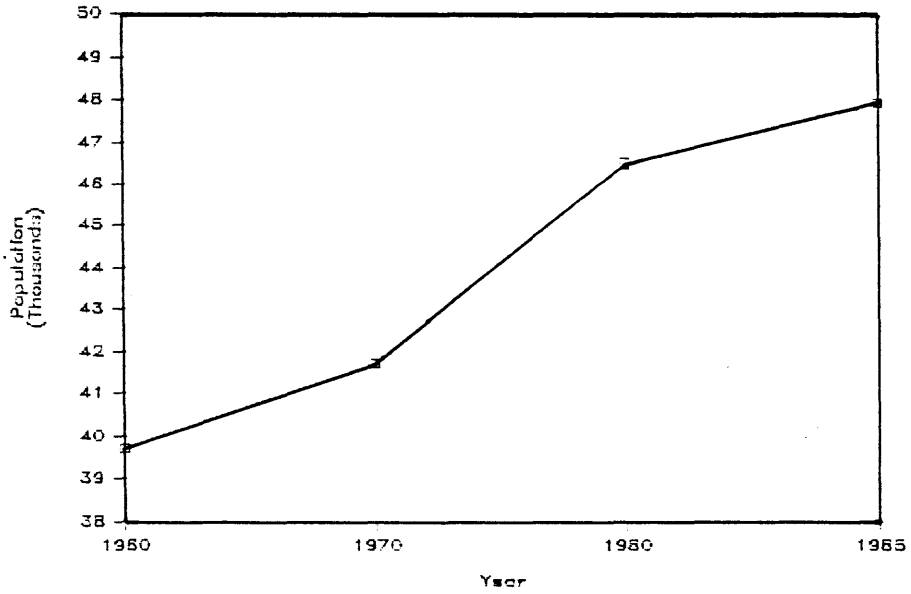


FIGURE 7. POPULATION OF HAYWOOD COUNTY

sources (Jackson, 1974, p. 115). These sources, located as shown in Figure 8, include:

Supplier	Sources	Classification
Canton	Rough Cr.	WS-I (formerly A-I)
Pigeon River	WS-III	
Maggie Valley	Campbells Cr.	WS-III
Waynesville	Allen Cr.	WS-I (formerly A-I)
	Rocky Br.	WS-I (" ")

The Town of Canton supplies not only its own customers, but it also supplies Clyde and several water associations. The Town of Waynesville also serves Hazelwood and the area around Lake Junaluska.

Spatial Patterns of Population

Although growth throughout the county has been moderate over the past 20-25 years, much of that growth has been concentrated near the water supply watersheds. As shown in Figure 9, the population of Haywood County is concentrated in the southern half of the county in Waynesville, Beaverdam (Canton), Pigeon and Clyde Townships.

Substantial growth has occurred in the Pigeon River watershed above Canton. Pigeon Township, located primarily in this watershed, experienced an increase of more than 500 people, about 15 percent, in the 1970s. East Fork Township, also located in this watershed increased by nearly 200 people in that period. It is this development trend that has caused concern among the citizens and elected officials in Canton.

Wastewater Disposal

As noted in Chapter II, the pattern of wastewater dischargers in Haywood County is highly decentralized. There are 60 permitted wastewater dischargers in the county, giving the county one of the highest number of dischargers per capita in the region and in the state. The distribution of those permits by types of generator is as follows:

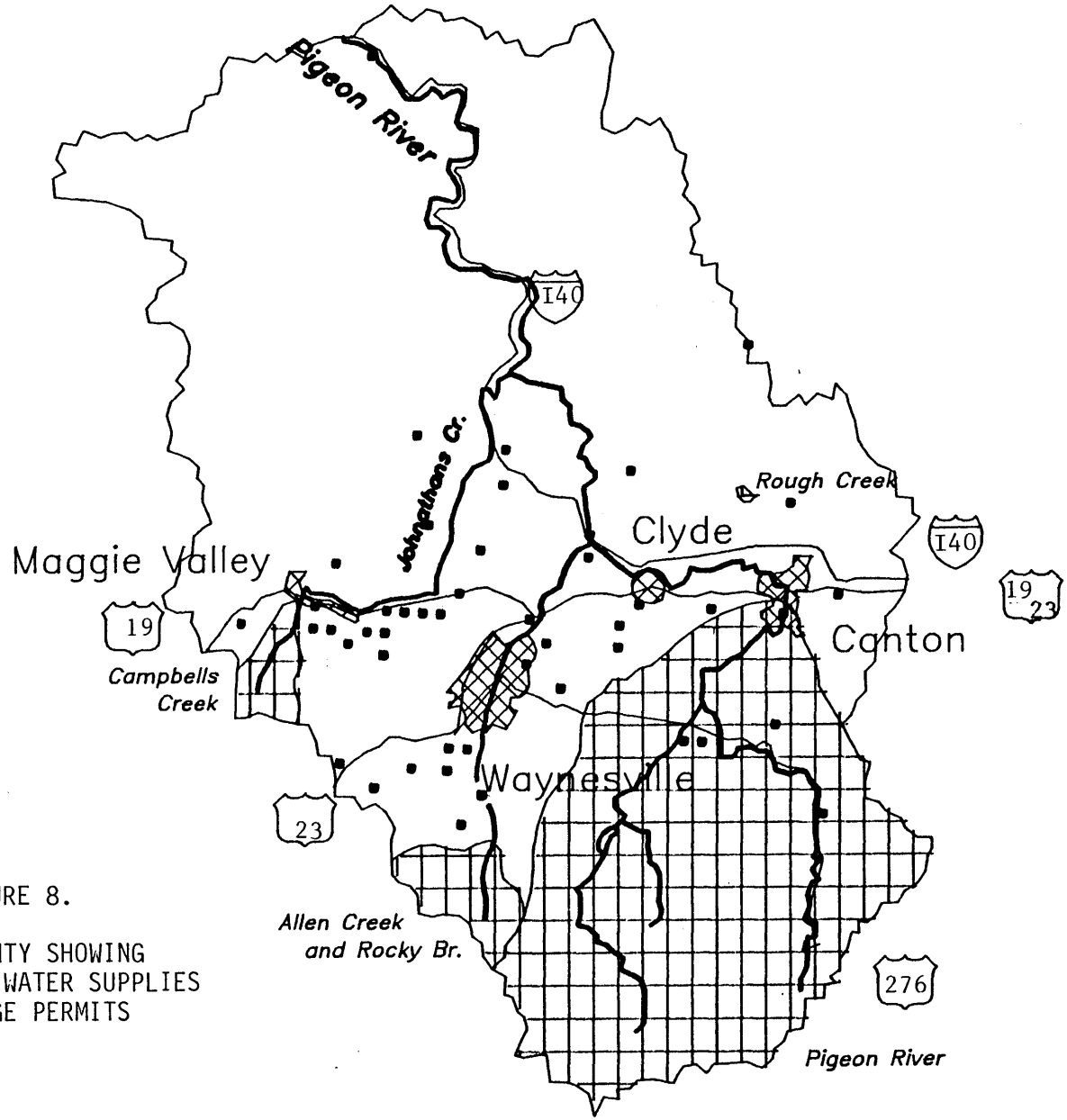


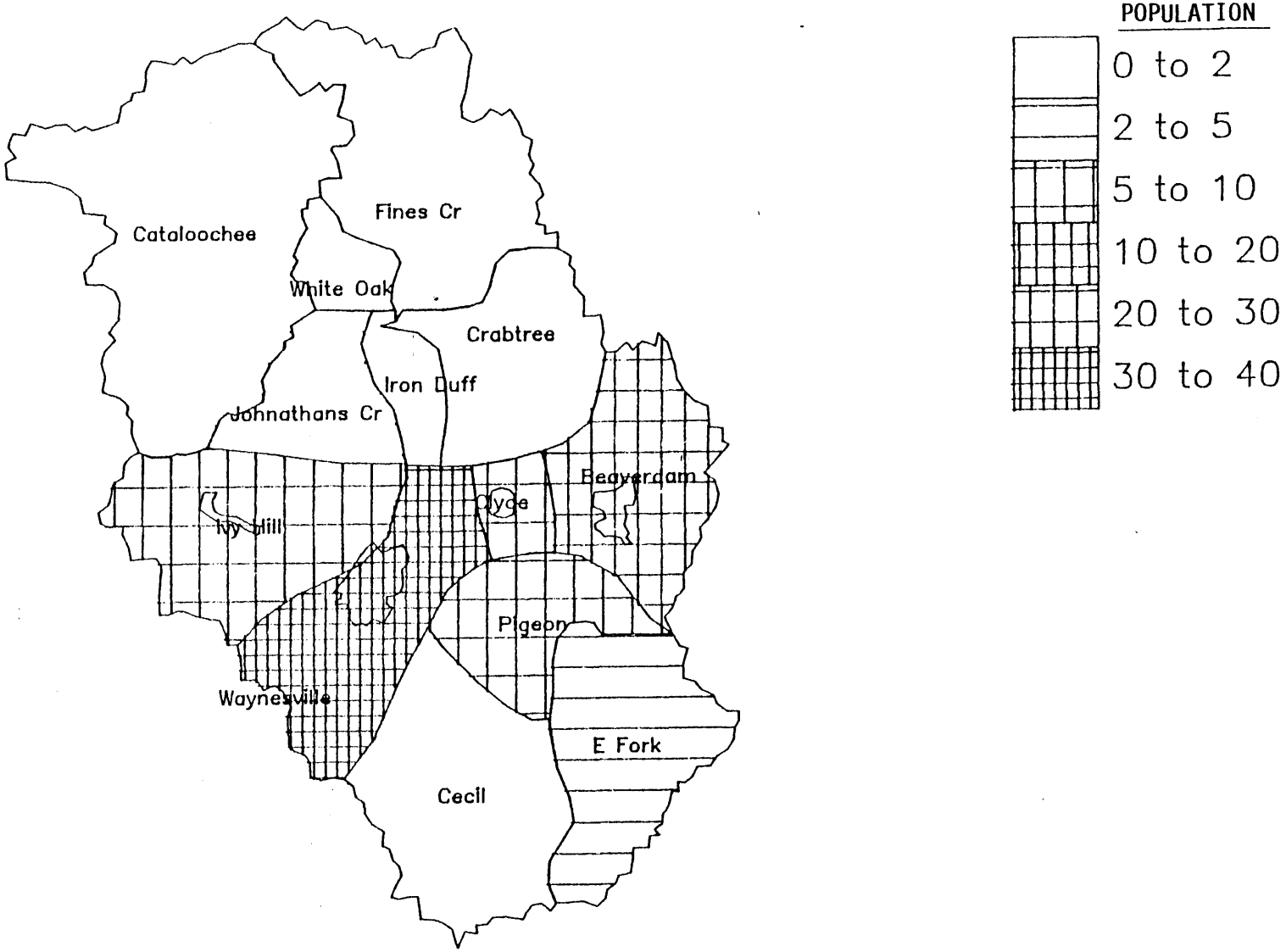
FIGURE 8.

HAYWOOD COUNTY SHOWING
LOCATION OF WATER SUPPLIES
AND DISCHARGE PERMITS

FIGURE 9.

Haywood County Population:

Distribution by Township, 1985



Type of Generator	No. of Permits
Municipal	4
Commercial and institutional	24
Industrial	6
Motels	7
Mobile home parks	1
Residential	18

Most of these dischargers are located along the urban corridor from Waynesville to Canton and along US Highway 19 between Waynesville and Maggie Valley.

This pattern of dischargers results from a combination of factors. Included among them are: (a) the failure of local governments to provide or extend sewer service to new developments; (b) the willingness of county government to issue building permits to activities not located on sewer systems; and (c) the willingness of state governments to issue discharge permits to large numbers of individual dischargers.

Fortunately, only a few discharge permits have been issued to activities located in watersheds used for public water supplies. Permits have been issued to four dischargers in the Pigeon River watershed, but another is pending. However, there is little in the way of public policy to protect the watershed from further degradation. The issuance of these permits, development trends noted earlier, and a widespread concern about industrial and agricultural chemicals led to a more detailed examination of this particular watershed.

DESCRIPTION OF THE WATERSHED

The watershed of the Pigeon River upstream of Canton, covering approximately 136 square miles, is one of the great natural resources of North Carolina. Its mountainous terrain, rimmed by the Blue Ridge Parkway on its southern border, affords spectacular views of over 50 miles. A large portion of the watershed lies within the Pisgah National Forest and the Shinning Rock Wilderness Area. It also contains a valley floor that is a highly productive agricultural area.

Topography

As shown in Figure 10, elevations in the watershed vary from 2,600 feet above mean sea level at the intake to Canton's water supply to 6,540 feet at Richland Balsam on the Parkway. Most of the urban and agricultural uses of the watershed

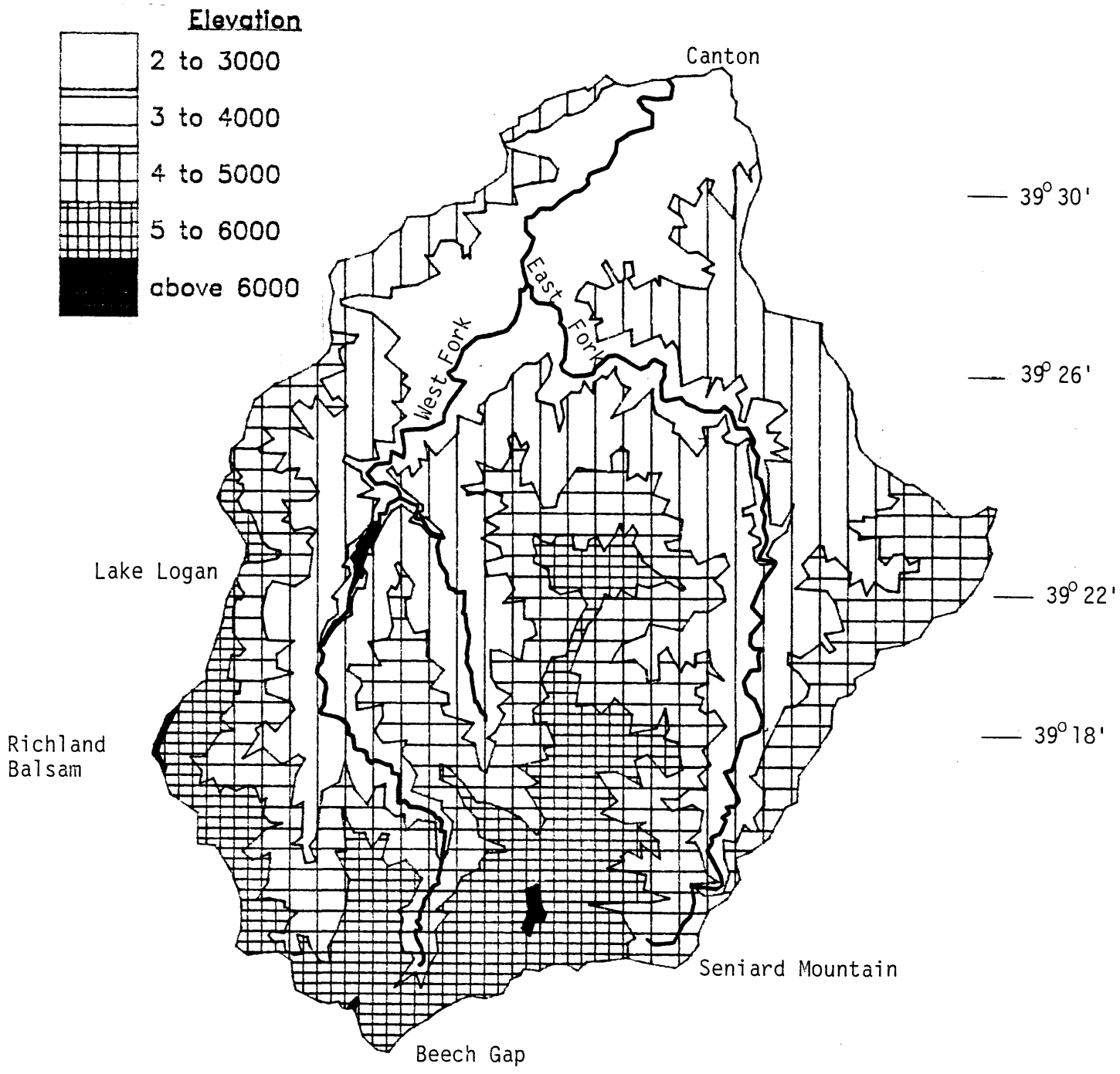


FIGURE 10.

CONTOUR MAP OF PIGEON RIVER WATERSHED UPSTREAM OF CANTON

are located below the 3,000-foot contour, an area of approximately 23 square miles or 17 percent of the watershed. The area between the 3,000 and 4,000-foot contour is about 49 square miles or 36 percent of the watershed, and between 4,000 and 5,000, 40 square miles and 29 percent of the watershed. There is approximately 23 square miles of elevations in the range 5,000-6,000, and only 0.4 square miles above 6,000 feet. Over 80 percent of the land has slopes in excess of 30 percent, and the average throughout the watershed exceeds 25 percent.

Despite the generally steep terrain, the watershed does contain a relatively broad valley floor with mild slopes. Just upstream of the intake for the Canton water supply, the flood plain extends approximately 1/2 mile to the west of the Pigeon River, and the flood plain and stream terraces extend nearly two miles to the east. Just upstream of the confluence of the West and East Forks, the flood plains and terraces are approximately three miles wide. Then, upstream of that location, the stream valleys become much more narrow, and the slopes become much steeper.

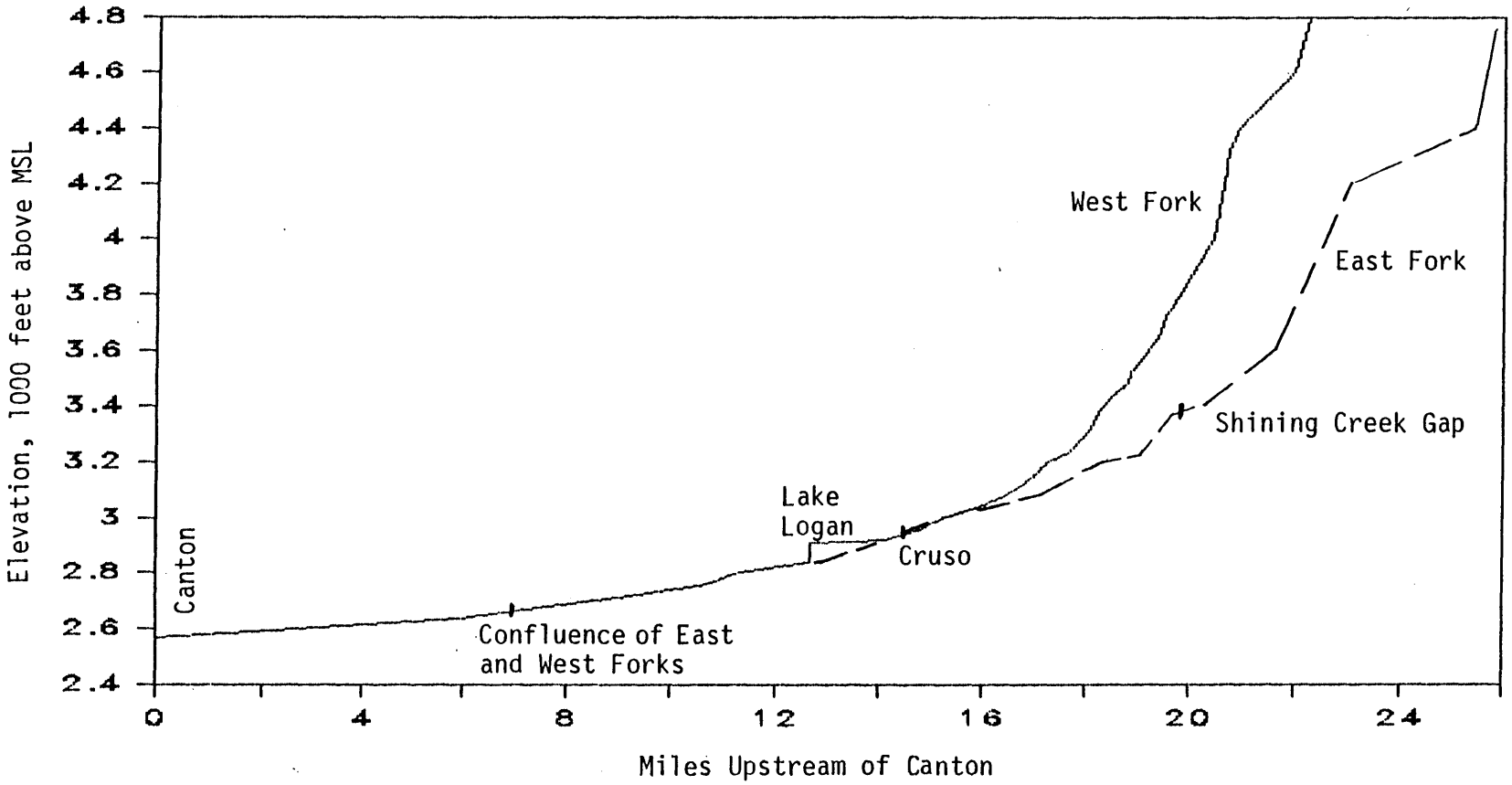
The profiles of the Pigeon River and its tributaries, in Figure 11, also illustrate the contrast in topography between the lower and upper portions of the watershed. For the first ten miles upstream of Canton, to points upstream of the confluences of the West and East Forks, the streams have an average slope of 0.37 percent. Over the next six miles to points upstream of Lake Logan on the West Fork and near Cruso on the East Fork, the slopes are still less than one percent. Then the slopes become increasingly steep as the streams approach their headwaters near the south rim of the watershed.

Soils

Soils in the watershed tend to vary with the topography. The Interim Soil Survey Report for Haywood County (1986), a portion of which is shown in Figure 12, shows that the Rosman and Dellwood series, classified as sandy loam and cobbly loamy sand, respectively, are the predominant soil types in the flood plains in the lower portion of the watershed while Saunook loam is quite common near streams in the upper part. Terraces in the lower portion are predominantly loam and clay loam in the Union and Braddock Series, while the steeper slopes represent loams from several series, including Hayesville, Plott, Edneyville, Evard-Cowee, and Wayak. More detailed descriptions of these soils are given in Appendix B, and further details are given in the soil survey report.

FIGURE 11.

PROFILE OF PIGEON RIVER



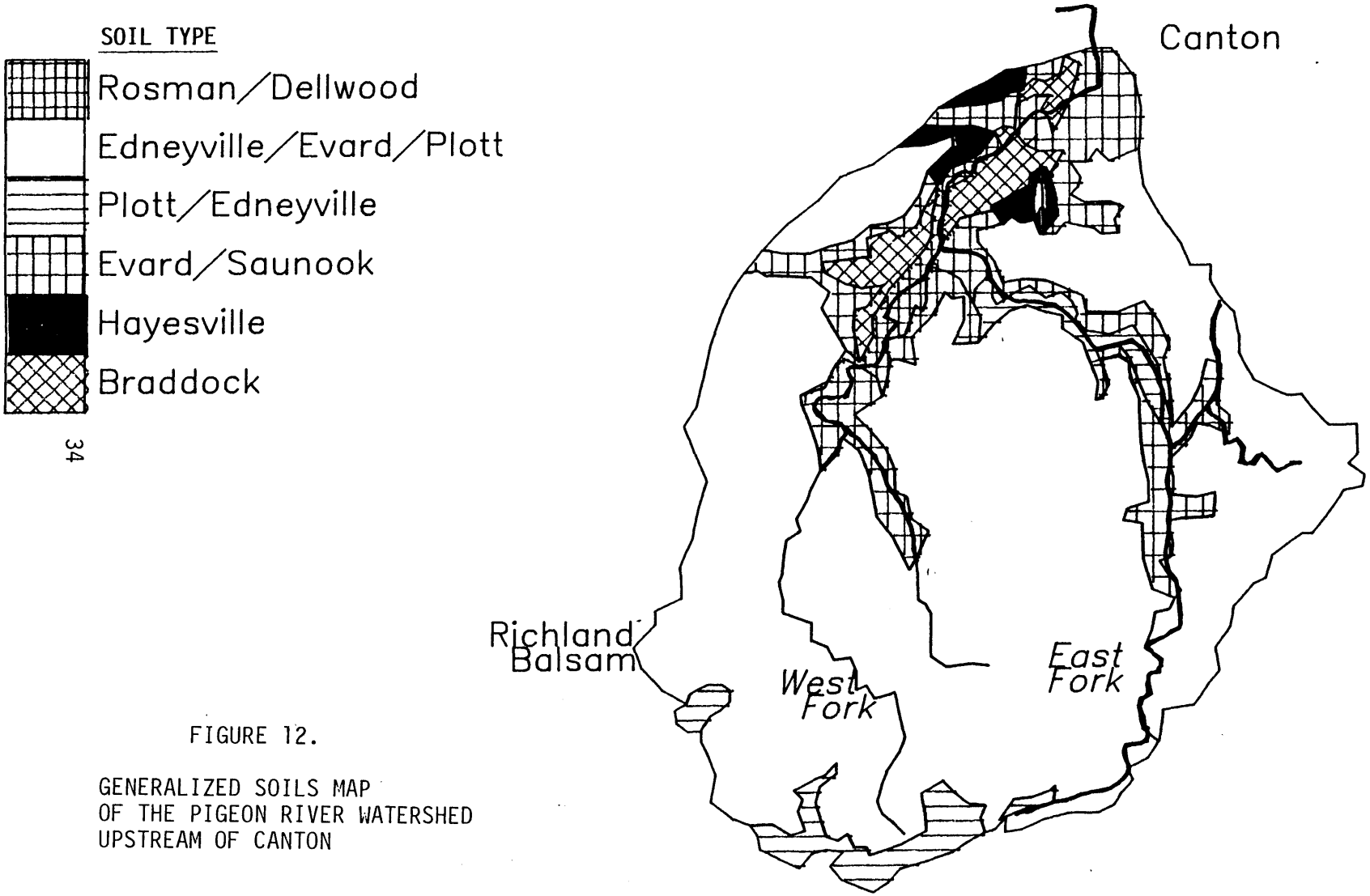


FIGURE 12.

GENERALIZED SOILS MAP
OF THE PIGEON RIVER WATERSHED
UPSTREAM OF CANTON

The characteristics of these soils have several implications for the management of water quality. First, soils in the lower portions of the basin are low in clay content, well-drained, and they are relatively deep, commonly ranging in depth from 4 to 8 feet. Thus, they have a high potential for agricultural productivity, and as noted later, they are intensively used for that purpose. Erosion and agricultural chemicals in storm runoff from these areas can be a problem if they are not managed properly. Second, the soils in the steep slopes are generally stable where vegetative covers are maintained. Construction and other land-disturbing activities will reduce the stability, however, and the combination of intense storms and steep slopes will result in avalanches of debris and soil slippage (Brovitz, p. 90). Finally, in many areas where steep slopes are dominant, the soils are fairly shallow and not well suited for on-site disposal of household and commercial wastewaters.

Land Use

The land is used for a variety of purposes. From the perspective of the watershed as a whole, the predominant category is forest. Approximately 90 percent of the 136 square miles (87,000 acres) is inside the outer boundaries of the Pisgah National Forest, but a significant portion of that land is in private ownership, much of it held by Champion International, Inc. Approximately one half of the watershed, approximately 40,000 acres in the southern part, is closed forest, while 25,000 acres in the midsection has a 50 percent forest cover, and in the lower portion, the remaining 20,000 or so acres has a forest cover of 25 percent or less (Brovitz, p. 90).

Population density over the entire watershed is quite sparse. Census tracts are not coincident with hydrologic boundaries so that exact counts of the residential population in the watershed is not possible, but they are sufficiently close to make a reliable estimate of between 5000 and 6000 persons. As shown in Table 7, there were 5,902 persons in the Cecil, East Fork, and Pigeon Townships in 1980, and those townships include some sparsely populated areas outside the watershed. A small portion of the Beaverdam Township also lies in the watershed. Regardless of the exact number, however, the density would fall in the range of 35-45 persons per square mile or one person for every 14 to 18 acres. The population did increase by 13 percent from 1970 to 1980.

Data compiled by the Haywood County Planning Department (Table 8) indicate that there were approximately 2,600 housing units and 56 commercial and industrial establishments in the watershed in 1983. The number of housing units increased substantially during the 1970s when nearly 600 units were built, and the number continues to increase at about 50 units per year. With very few exceptions, waste from these units is disposed of in septic tank systems.

If agricultural land use in the Pigeon River watershed follows the more general pattern of Haywood County, it has changed very little since 1975 as indicated in Figure 13. There were 81,000 acres of farmland in Haywood County in 1982, about 12,000 acres of which was in cultivated cropland (US Bureau of the Census). Data from the North Carolina crop statistics indicate very little change in total cropland and only moderate shifts in the mix of crops.

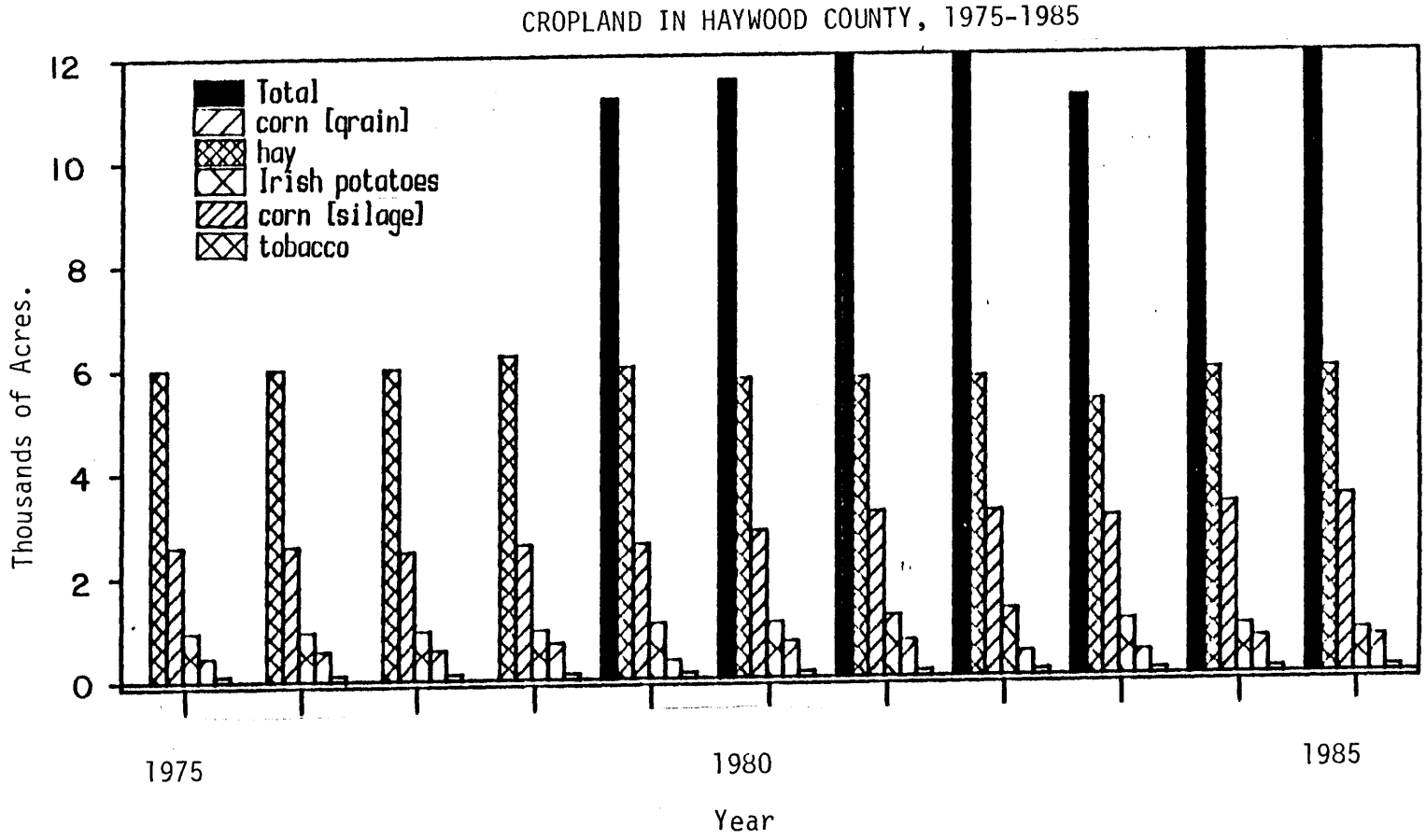
Within the Pigeon River watershed, about one-half of the land in the watershed is in farms, but a large portion of that, nearly 80 percent, is in woodlands (see Table 8). Approximately seven percent of the farmland is cultivated, and another 13 percent is in pasturelands. Thus, from the perspective of the entire watershed, there would appear to be little threat to the quality of Canton's water supply from nonpoint source discharges in the watershed.

Table 8.

Population and Land Use in
Cecil, East Fork and Pigeon Townships

	1970	1980	1983
Population	5,240	5,902	5,989
No. of Households	1,600	2,024	2,054
No. of Housing Units	1,783	2,362	2,580
Site-built	1,647	2,362	2,580
Mobile	136	348	426
Commercial & Industrial Estab.	29	48	56
Agriculture	**1974**	**1978**	**1982**
No. of Farms	622	631	641
Acreage	45,650	44,889	44,258
Woodland	36,660	36,028	35,561
Cultivated	2,600	2,549	2,522
Pasture	5,900	5,833	5,723
Idle & Other	490	479	452

FIGURE 13.


CROPLAND IN HAYWOOD COUNTY, 1975-1985
Total
corn [grain]
hay
Irish potatoes
corn [silage]
tobacco
Thousands of Acres.
0
2
4
6
8
10
12
1975
1980
1985
Year

Statistics for the entire watershed are quite deceptive in this case, however, because most of the urban development and agricultural activity is concentrated within the lower portion of the watershed just upstream of the water supply intake and near the streambanks.

A very detailed analysis of land uses was made of the 14 quad sheets shown in Figure 14. Each of those areas has been aerially mapped by an orthophotographic quad sheet covering an area of 10,000 x 10,000 feet (2,296 acres). Each of them was interpreted for this study by personnel of the Haywood County Soil and Water Conservation District. Seven attributes were identified for each quad. They are:

(1) the network of streams;
(2) woodlands;
(3) urban areas, including residential, commercial, and institutional lands;
(4) agricultural lands;
(5) steep slopes (30 percent or more);
(6) flood plain soils; and
(7) prime agricultural soils.

The interpreted quad sheets were then digitized using the MAPEDT software marketed by Resources Planning Associates, and the areas covered by each attribute was computed. Results of that analysis are shown in Table 9.

Table 9. Land Use in Pigeon River Watershed
(acres by quad sheet)*

Quad	Wood Land	Prime Farm Land	Flood Plain Soil	Steep Slope	Urban	Stream Net	Agri-culture
8632	1,970.6	144.9	234.3	1,431.7	75.6	22.1	3.2
8633	1,637.2	600.5	353.2	862.4	192.4	75.9	35.4
8634	764.1				284.8	50.9	210.1
8635	1,152.2				91.7	24.5	55.8
8644	1,028.7	500.2	253.2	834.5	269.4	66.1	181.2
8645	548.4				374.0	80.7	296.6
8646	859.0				97.6	9.2	23.8
8654	1,569.1	195.6	249.7	1,472.0	141.5	77.7	33.9
8655	951.9				258.6	48.6	49.8
8656	566.5	256.5	138.5	275.2	201.6	40.7	68.1
8662	1,835.4				97.8	36.9	8.6
8663	1,383.2				127.4	44.8	18.4
8664	331.0	11.0	44.4	392.6	84.6	23.9	8.8
8665	307.2				13.4	6.6	2.9
	14,904.5	1,708.6	1,273.2	5,268.3	2,310.4	608.6	996.4

*blank areas indicate the quad sheet's land use was not digitized.

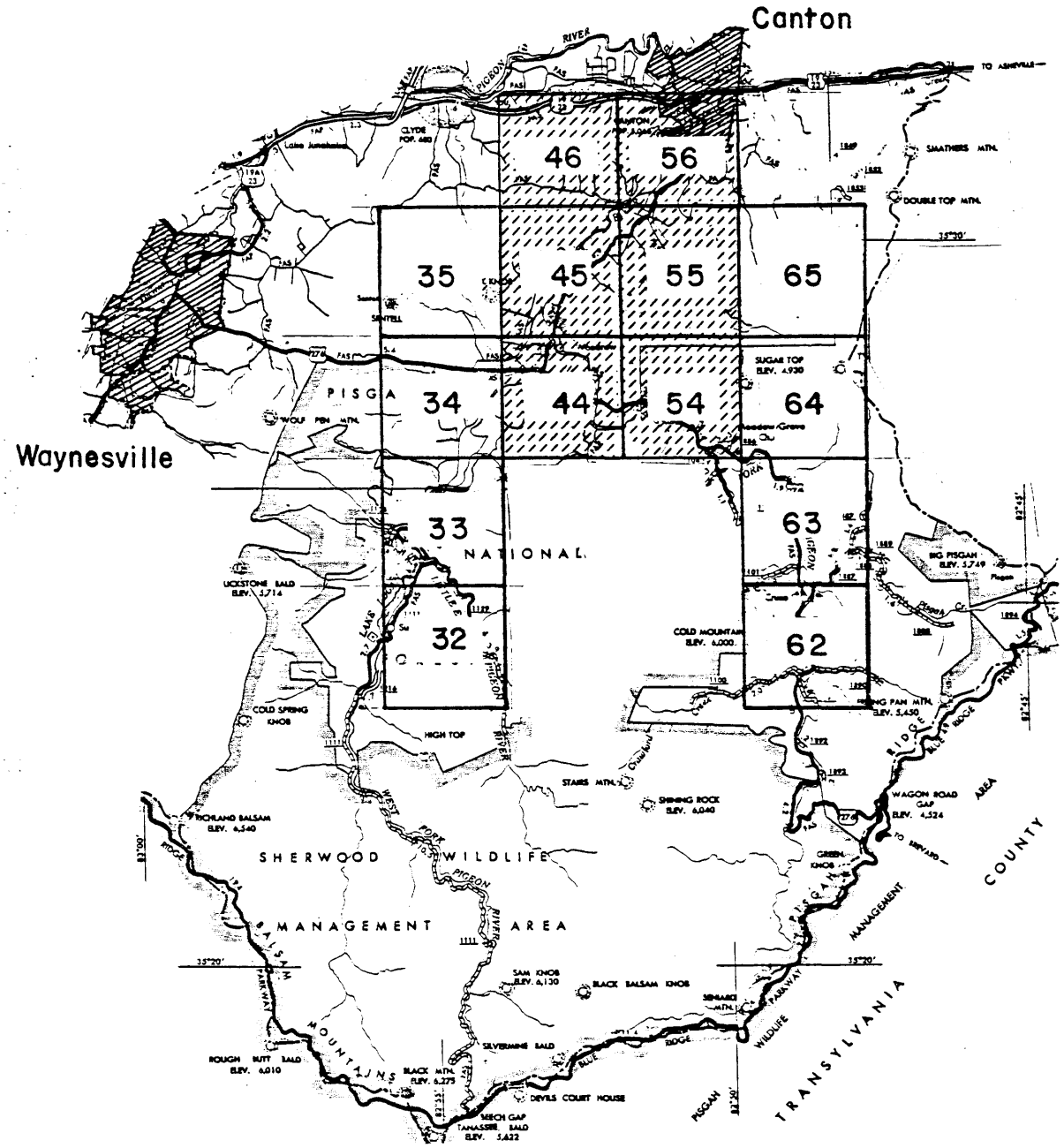


FIGURE 14. COVERAGE OF ORTHOPHOTO MAPS USED FOR LAND USE ANALYSIS

It is apparent from these results that the most intensively used portion of the watershed is that area covered by the cross-hatched quads in Figure 14. These six quads cover 13,776 acres of the watershed, including 2,580 acres of very steep slopes (30 percent or more) and 365 acres of streams. Approximately 40 percent of the area is covered by woodlands.

Urban activities cover a significant portion of the remaining lands, including 1,530 acres, and cultivated agricultural activities are also significant, accounting for 840 acres, mostly in intensive vegetable production, particularly tomatoes. Since most of the population within the watershed reside in this area, densities are in the range of 225-275 persons per square mile or one person per 2-2.5 acres.

The significance of urban development and cultivated lands in the watershed is magnified by the proximity of those activities to the mainstem of the Pigeon River. Locations of the urban activities relative to the river and its feeder streams are shown in Figure 15. Although an exact count of the housing units in that particular area has not been made, the data on housing and population in the watershed and the spatial distribution of urban development suggest that the area shown in Figure 15 contains 1500-2000 units. All of those units, except for those inside the Canton sewer service area, are served by septic tanks. The wastewater facilities plan for Haywood County, prepared by a planning engineering firm in 1984, proposed an extensive wastewater collection and treatment system for that area (William F. Freeman Co., 1984). That system, shown in Figure 16, had an estimated construction cost of near $7 million. Very little of that system has come to reality.

Locations of cultivated lands are shown in Figure 17. It can be noted that most of those lands abut the streams. Thus, stormwater runoff from these fields flow directly into the streams, and an analysis of an overlay of forested lands, cultivated lands, and the stream network revealed that in many instances there is little or no vegetative buffer between the fields and the streams. In those instances it is reasonable to expect a substantial transport of agricultural chemicals and eroded soil into the streams.

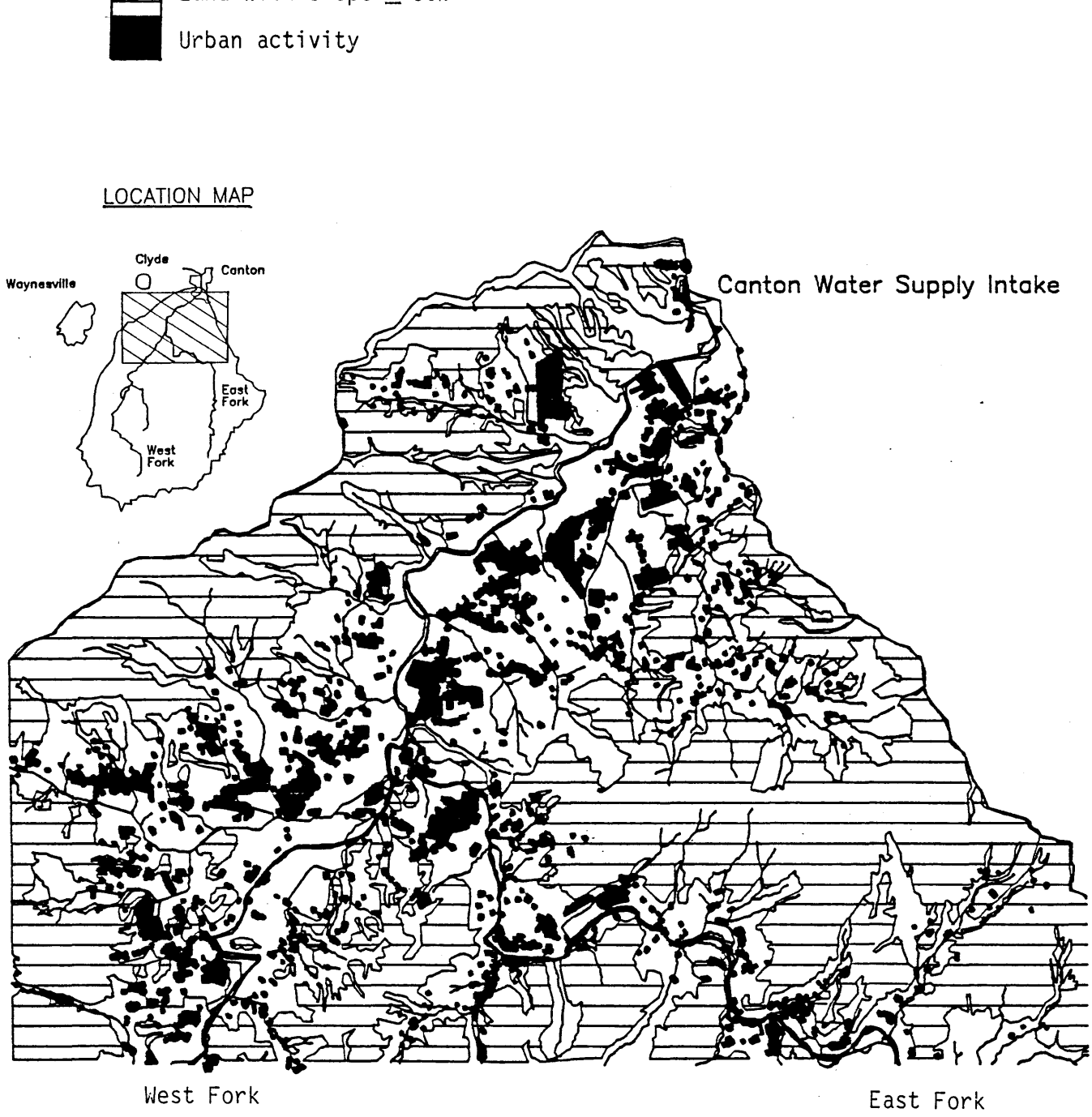


FIGURE 15.

LOCATION OF URBAN LANDS IN PIGEON RIVER WATERSHED UPSTREAM OF CANTON

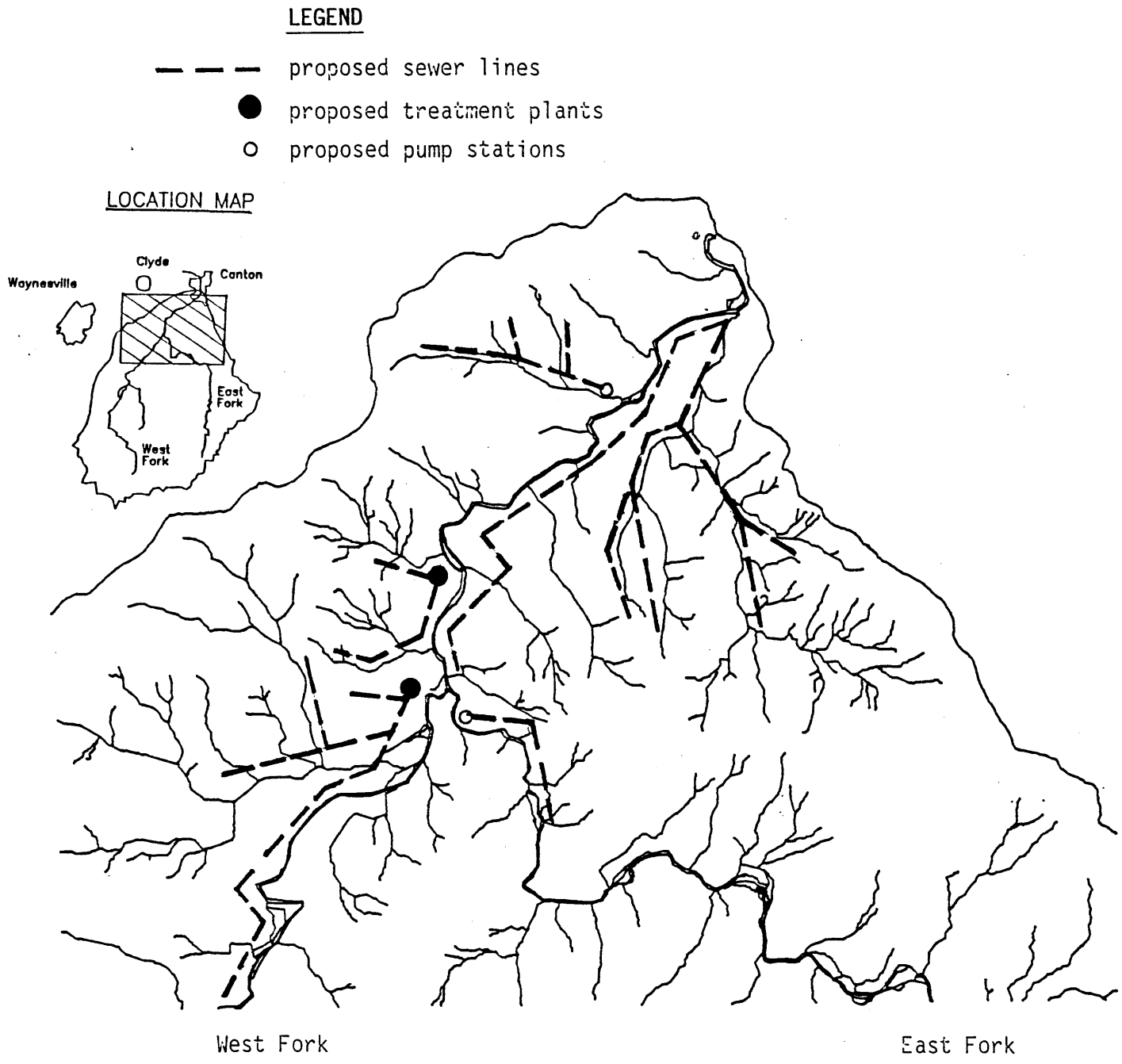


FIGURE 16

PROPOSED WASTEWATER COLLECTION AND TREATMENT FACILITIES

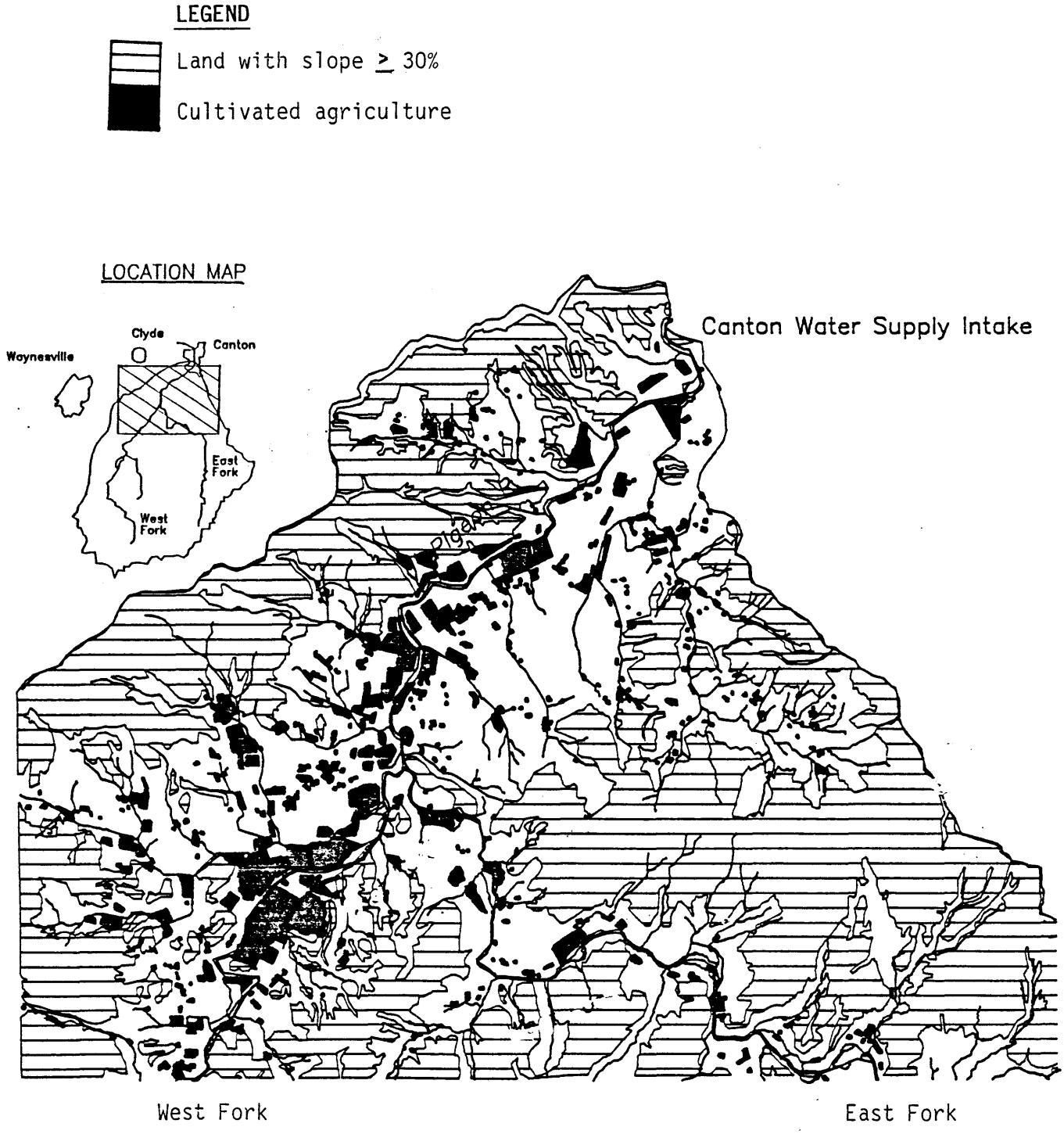


FIGURE 17.

LOCATION OF AGRICULTURAL ACTIVITIES IN PIGEON RIVER WATERSHED UPSTREAM OF CANTON

POLLUTION SURVEYS

Point Sources

In addition to the analysis of activities in the watershed presented above, two surveys of pollution sources and instream water quality conditions have been made, one by the Division of Environmental Management (DEM) of the NCDNRCD, and one by the staff of the Water Resources Research Institute during the conduct of this study. DEM conducted an investigation of the Upper Pigeon River on July 25, 1984, where ". . .particular interest centered around three dischargers--Pigeon Valley Rest Home, Royal Oaks Subdivision, and Bethal School" (DEM, 1984). A fourth permit has been granted since that study, a request has been made for a fifth one, and the Royal Oaks Subdivision has requested a modification to expand its capacity.

The permits are described as follows:

Facility	Design Flow gals/day	Receiving Stream
Bethal School	15,000	Bird Creek
Pigeon Valley Rest Home	25,000	Pigeon River
Royal Oaks Subdivision	15,000	E. Fork Pigeon River
Roy Galloway Residence	450	Garden Creek

Their approximate locations are shown in Figure 8.

In the 1984 survey, samples were taken from the effluent of the Pigeon Valley Rest Home and from the stream at those locations. The in-stream sampling points were: (a) 500 meters above the intake of Canton's water supply; (b) 100 meters below the confluence of the East Fork and West Fork of the Pigeon River; and (c) the East Fork of the Pigeon River near Cruso, a location used to establish background water quality conditions. Water quality parameters that were measured at these locations included the conventional ones relevant to bacteria, oxygen balance, solids and nutrients. They also included a fairly standard list of 7 heavy metals (Cd, Ch, Cr, Hg, Ni, Pb, and Zn). DEM found that all of the concentrations of the substances and organisms that they examined ". . .were below state water quality standards and only slightly above background

levels." They also concluded that the effects of the point sources on in-stream water quality were negligible.

These results reflect what one would expect to find during dry-weather flows when the point-source treatment facilities are being properly operated. If the effluent volumes are within the limits specified in their permits, those discharges are small in comparison with stream flow from a watershed of that size.

Pesticide Contamination

However, as stated by DEM, the survey in 1984 focused primarily on the role of point sources, and, although the report does not include rates of stream flow at the time samples were taken, the usual procedure is to make such surveys during dry-weather, warm temperature conditions. Surveys of that kind cannot be used to assess the effects of nonpoint sources, most of which are activated by storm events.

The possibility of contamination from pesticides, herbicides, and other synthetic organic chemicals was considered to be the primary threat from nonpoint sources in this watershed. Most of the land uses that would generate significant quantities of nonpoint sources are located downstream of Lake Logan. Thus, their potential for causing excessive nutrient buildup in that impoundment would be small. The proximity of agricultural and urban activities to the intake was a matter of concern, however. The facts that a significant amount of cultivated farm land is in the watershed and that much of it is located near streambanks are sufficient to cause a concern about the potential for contamination from herbicides, pesticides, and other agricultural chemicals. As noted in Table 8, there are 2,500 acres of cultivated croplands in the Pigeon River watershed upstream of Canton. Approximately 940 of those are found within the six quad areas in Figure 14 that are nearest the water supply intake for Canton.

Tabular data on the kinds of crops grown on these lands is unavailable, but agricultural experts in Haywood County have indicated that tomatoes are the principal cash crop (West, 1987). Herbicides are applied to them in May or early June and possibly again in mid-July. Typical herbicides are Lexam and Tillam. Pesticides are applied June through September. The Agricultural Extension Services advises weekly fungicide application and pesticide application as need, although most farmers will apply pesticides on a weekly or biweekly basis.

Thiodan is a popular insecticide, which is applied along with the fungicides Manzate, Dyrene, and some of the copper compounds.

Beans are also grown in the watershed. The major pesticides applied to beans are Dacthal, Jule, and Treflan. Strawberries are also cultivated. 2,4-D is applied to strawberries in March. Devrinol or Enide is applied in early July (usually July 4th weekend). Whichever of the above compounds was not used will be applied in late August or September. There are four nurseries close to the watershed which may grow between 30 to 40 crops. Various herbicides/pesticides may be used. Small amounts of tobacco are also grown in the watershed. These lands may receive applications of Devrinol.

In addition to the croplands, the watershed includes some 5,700 acres of pasture and hay which typically receive a springtime application of 2,4-D or Banvel in late March or early April. A second application is usual after the first harvest, usually around mid-June. Other organic compounds are also used at the several dairies and hog farms in the watershed.

Although a complete listing of all the chemicals used in the watershed is not possible, it would include the 31 substances listed in Table 10. That list was compiled from conversations with several agricultural experts in Haywood County.

Just as a complete listing of all chemicals used in the basin is not feasible, neither is a complete quantification of the amounts of each that are used, the amounts that leave the fields and enter the stream, the amounts that reach the water intake, and ultimately the amount that is ingested by the citizens of Canton. Nonetheless, a partial assessment of the risk was undertaken by sampling at several locations throughout the watershed and subjecting those samples to broad-based chemical analyses.

Site Selection and Sampling Procedure

A discussion with the Agricultural Extension Service suggested that any time between mid-February and mid-October would be suitable for sampling of pesticides and herbicides. The types of pesticides/herbicides found might change throughout the growing season, but no particular sampling period would result in higher concentrations.

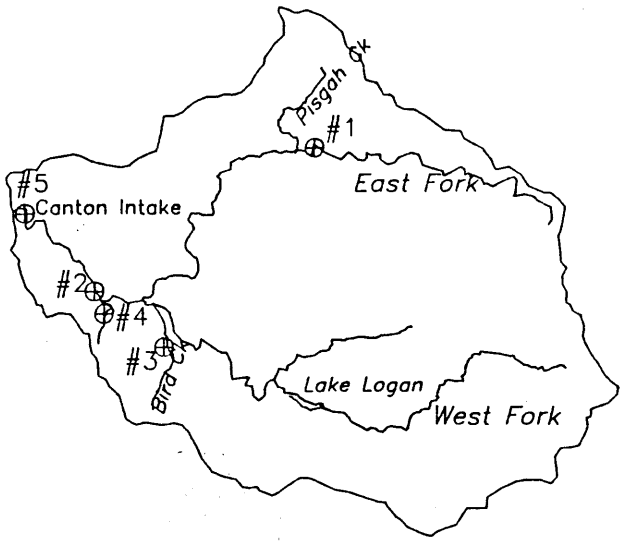
A total of five sampling locations were established along the river, running approximately from the border of the Sherwood Wildlife Management Area to the

Table 10.
Pesticides & Herbicides Used in Haywood County

Common Name	Trade Name	Use	Crops
2,4-D	2,4-D	systemic herbicide	corn, apples, hay strawberries
Anilazine	Dryene	foliar fungicide	tomatoes
Atrazine	Aatrex	selective pre/post emergence herbicide	
Bacillus thuringiensis var, kurstaki	Dipel, Bactur, Thuricide	insecticide	corn, tobacco
Benomyl	Benlate	carbamate pesticide	
BHC, gamma isomer	Lindane	insecticide	
Butylate	Sutan	selective herbicide	corn
Captan	Captan	protectant fungicide	corn, potato, apple
Carbaryl	Sevin	contact insecticide	corn, tobacco, potato, apple
Carbofuran	Furadan	contact insecticide	corn, tobacco, potato
Chlorpyrifos	Lorsban, Dursban	broad spectrum pesticide	corn, tobacco, cattle, apple
DCPA	Dacthal	selective pre-emergence herbicide	beans
Dicamba	Banvel	foliar and soil applied herbicide	corn, hay
Dichlobenil	Casoron	selective herbicide	
Diphenamid	Enide	selective pre-emergence herbicide	tobacco, potato, strawberries
Diuron	Karmex, Drexel	photosynthesis inhibition herbicide	apples
Endosulfan	Thiodan	broad spectrum non-systemic insecticide	tomatoes
EPTC+Safener	Eradicane	herbicide	corn, hay, potato
Folpet	Phaltan	protectant fungicide	
Glyphosphate	Roundup	non-selective post-emergence herbicide	corn, apple, hay, potato
Malathion	Malathion, Sumitox	non-systemic insecticide	corn, cattle
Mancozeb + dinocap	Dikar	fungicide	tobacco, potato, apple
Maneb	Manzate, Vancide	protectant fungicide	tomatoes
Methomyl	Lannate	carbamate pesticide	corn, tobacco, potato, apple
Napropamide	Devrinol	pre-emergence herbicide	tobacco, apples
Pebulate	Tillam	pre-emergence herbicide	tobacco, tomatoes
Phosphamidon	Phosphamidon, Dimecron	organophosphorus pesticide	potato
Simazine	Princep	pre-emergence herbicide	corn, apples, hay
Terbacil	Sinbar	photosynthesis inhibition herbicide	apples, hay
Trifluralin	Treflan, Trefanocide, Treficon, Treflonocide	pre-emergence herbicide	beans
Ziram	Symate, Methyl Cymate, Methasan, Zimate, Zirbeck, Karbam White, Corozate, Fuclasin, Fuklasin, Zerlate	protectant fungicide	sweet potatoes

FIGURE 18.

LOCATION OF PESTICIDE SAMPLING POINTS



water intake at Canton as shown in Figure 18. Sampling started in mid-May and ran for nearly six weeks. Every 10-12 days, a sample was collected from each of the five sites. Samples were collected on the 5th and 27th of May and the 6th and 16th of June 1987. Samples taken on May 27 were obtained during a rainfall event. For this situation, additional samples were taken approximately 8 and 16 hours later for sites #3 and #4, the sites most likely to receive agricultural runoff.

All samples were grab samples; i.e., 4 liters of river water were collected at a given time at each location. The procedure was to fill a 4-liter glass bottle with a representative sample of river water. The bottles were labeled, sealed, and stored in a cooler with ice for shipment to a commercial laboratory where the samples were analyzed for organics.

Sampling locations were chosen for two reasons. The first was to provide an overall impression of the water quality. Sites #1, #2, and #5 were chosen for this purpose. The second objective was to gain an understanding of the potential for synthetic organic chemicals (SOCs) to contaminate the drinking water supply of Canton. From the existing land uses, herbicides and pesticides appear to be the most likely SOC candidates. Thus, stations #3 and #4 were chosen because they are near agricultural areas, and they are likely to receive direct field runoff. Three sites (#1, #2, and #5) were near locations chosen by the NC Division of Environmental Management, Water Quality Section, for the July 1984 water quality evaluation of the upper Pigeon River.

Station #1: Site 1 was located about 100 feet above the bridge at Camp Hope on the East Fork of the Pigeon River, just above Cruso and above any substantial urban development or agriculture. It served as a control to provide water quality data on the river as it leaves the Sherwood Wildlife Management Area.

Station #2: Site 2 was located just upstream from a bridge on unnamed road between Routes 215 and 110, located approximately one mile below the confluence of the East and West Forks. This site provided a summary of the water quality of the East and West Forks.

Station #3: Site 3, located off a gravel road between Routes 215 and 276, was on a small feeder stream to the West Fork about one mile above the confluence of East and West Forks. This stream travels through a mostly agricultural district, and lies alongside several large unbuffered fields. It is likely to receive direct field runoff and thus provide an assessment of the potential for agricultural chemicals entering the drinking water supply downstream.

Station #4: Site 4 is located off a gravel road parallel to Route 215, below a small culvert. Site was on a small feeder stream to the Pigeon River about one mile below the confluence. This feeder stream also flows through a highly agricultural area with several unbuffered fields providing direct runoff.

Station #5: Site 5 was located on the main stem of the Pigeon River just above the pumping station at a bridge on Route 215. It was the farthest downstream point sampled and provided the best assessment of the source water quality for Canton.

Experimental Methods

Samples were analyzed for priority pollutants using EPA's Method 625 for extractable organics. This method should detect most pesticides and herbicides if present in sufficient concentrations, as well as all but the most volatile organics. This procedure used a methylene chloride extraction at a basic pH followed by a methylene chloride extraction at an acidic pH, then analysis by gas chromatography/mass spectrometry (GC/MS). Priority pollutants, if present, are identified by comparison with analytical standards. The priority pollutants are quantified to ug/l concentrations, within the limits of the analytical techniques. Non-priority pollutants can sometimes be identified by mass spectral library matching. Those compounds identified by library matching can only be approximately quantified. Standard quality control procedures, as defined by the EPA, are adhered to by Triangle Laboratories, Inc.

The GC/MS conditions were as follows: The GC column was a J&W DB-5, 30m x 0.32 mm, with a 25 micron film thickness. The GC program held at 40 C for 3 minutes, increased to 300 C at 8 C/min, and then held at 300 C for 4.5 minutes. The GC was interfaced to the MS through a heated inlet held at 230 C. For the MS,

the ion source was heated to 180 C, and a mass range of 35 to 510 amu (atomic mass units) was scanned at 1 sec/scan.

Results

Samples were analyzed for priority pollutants using EPA's Method 625 for extractable organics. Results are summarized in Table 11. Three organic compounds were identified during the analysis. Another compound was found but could not be identified. No compounds were found for dates and/or stations not shown. Two of the compounds are known pesticides/herbicides. The concentrations of the organics are quite low, generally in the low parts per billion range. None of the compounds were priority pollutants, and therefore all the compounds were identified solely by library matching. Some caution should be exercised in drawing conclusions from these results, noting in particular that the uncertainty associated with the concentration levels is high because no direct comparisons with known standards were possible.

One of the compounds, 1,3,5-Triazine-2,4-diamine, 6 chloro-N-ethyl-N' (1-methylethyl) atrazine, is better known simply as atrazine. It is a commonly used agricultural herbicide, and has been found in other surface waters in North Carolina that are adjacent to agricultural areas (Dietrich, et al. 1983). Its oral LD_{50} in mice is 1.75 g/kg and in rats is 3.08 g/kg. No apparent skin irritations or other toxic effects have been observed in humans (Merck Index, 1976).

Another compound is Bis dimethyl carbamodithioato -S,S'-(T-4)-zinc, also known as Ziram, Cymate, methyl cymate, Methasan, Zimate, Zirbeck, Karbam White, Corozate, Fuclasin, Fuklasin, and Zerlate (Merck Index, 1976, School of Agriculture and Life Sciences, 1987). Among other purposes it is used as an agricultural fungicide. Its oral LD_{50} in rats is 1.4 g/kg. This chemical causes irritation to the skin and mucous membranes (Merck, 1976).

It is not obvious what a third compound, 4,4, thiobis-2-(1,1 dimethylethyl)-(5)-methyl phenol, is used for or where it might arise in the watershed. A brief review of the Chemical Abstracts suggests that it is an industrial chemical used primarily for its insulating properties.

The apparent hydrocarbons could not be identified exactly. Likely sources for hydrocarbon contamination include road runoff or leaky underground storage tanks.

Table 11

Summary of Organics Found
During Pigeon River Monitoring

Compound	Sample Date	Sample Station	Sample Concentration (ug/L)**
1,3,5-Triazine-2,4-diamine, 6 chloro-N-ethyl-N' (1-methylethyl) atrazine	5/27/87 (4:41)	3	*
" " " " " "	5/27/87 (4:51)	4	60
" " " " " "	5/27/87(21:58)	3	*
4,4 thiobis-2(1,1 dimethylethyl-(5)-methyl phenol	5/27/87 (4:41)	3	16
" " " "	5/27/87 (4:51)	4	19
" " " "	5/27/87(22:06)	4	13
" " " "	6/06/87	1	8
" " " "	6/06/87	2	6
" " " "	6/06/87	3	6
Bis dimethyl carbamodithioato -S,S'-(T-4)-zinc	6/06/87	2	7
" " " "	6/06/87	3	4
" " " "	6/16/87	3	*
" " " "	6/16/87	4	*
unknown hydrocarbon	5/27/87 (4:41)	3	8
unknown hydrocarbon	5/27/87 (4:51)	4	10

* Peak height less than 10% of nearest internal standard. No estimate of concentration available.

** Since none of these compounds are priority pollutants, concentrations are only approximate and should be of as order of magnitude estimates.

Discussion

The first set of samples was taken on May 6, 1987, prior to the application of most pesticides/herbicides during the growing season. It is the only set of samples in which no organics were found. These results suggest that the pesticides found in later samples were from agricultural application. Further year-round sampling should be conducted to confirm this hypothesis.

The majority of positive findings occurred at stations #3 and #4, the small feeder streams to the Pigeon River. GIS mapping had indicated that these small streams drained agricultural areas and were most likely to receive agricultural runoff.

No organics were found at Station #5, just above the Canton raw water intake. The river flow is greatest here compared to all the sampling stations, and any organics would be significantly diluted. The very low concentrations found at the other sites indicate that no health hazard is currently present. However, the fact that these chemicals are found directly upstream of the drinking water supply indicates the need for caution and concern in the face of further industrial or agricultural development.

WATERSHED PROTECTION

Surveys of instream water quality conditions such as those undertaken by DEM and those undertaken by WRRI are simply snapshots of what conditions prevailed at the time they were taken. Even then they do not provide a complete picture of what was in the water. However, they do support the general conclusion that the watershed, in its present state of development, is in good condition, and there is little evidence to conclude that there is any significant and imminent threat to the consumers of Canton's water supply.

The more disturbing observation is that public policy to prevent future degradation of this supply is minimal. The watershed is affected by continued urbanization, and there are existing requests for new and modified permits for the discharge of waste waters. Current state and federal regulations for pollution control have as objectives the protection of instream water quality sufficient to make the streams fishable and swimmable.

Under the present WS-III classification, the state is obligated to issue permits to all dischargers who can satisfy generally applicable effluent limita-

tions and in-stream water quality standards. Qualifying dischargers could include industries and municipalities. Even under the more restrictive WS-II classification, the State would be obligated to issue permits to subdivisions and other non-industrial, non-municipal dischargers. The weakness in the WS-II classification is that each permit to discharge is evaluated by the N.C. Department of Natural Resources and Community Development on a case-by-case basis, and, for small to moderate-size dischargers, it is difficult to demonstrate by standard calculations that the effluent from any single discharge would have an adverse effect upon the health of those who drink from that supply. However, the cumulative effect of many small sources could be significant, not only because of their simple additive effects, but the development of new point sources also signals a change in land use and transportation activities from which significant quantities of nonpoint pollutants would be generated.

Two events have occurred during the course of this study that illustrate why that weakness is of concern. The Royal Oaks Subdivision applied for a modification to its permit to increase the amount of discharge, and the National Park Service, which leases land to a complex near Mt. Pisgah on the Blue Ridge Parkway, applied for a permit to discharge waste to a small tributary to the East Fork of the Pigeon River. In the second of these two cases, the permit would allow the owner to replace a failing subsurface disposal system with a treatment plant that discharges to a stream. An assessment of the merits of either of these actions is beyond the scope of this report, but the burden of proof to show an adverse effect on the Canton water supply would be heavy in either case. The State intends to grant both requests. However, the present guidelines for WS-II classification offer little assurance that many such sources--new ones, expansions to existing ones, and replacement of subsurface disposal with surface discharges--would not occur in the future. Each such occurrence could be processed in the same manner as these two requests. The incremental discharge of each could have only a small marginal effect; however, the aggregate effect of many dischargers could defeat the purpose of the WS-II classification.

The Town of Canton recognized that weakness early in the history of the State's watershed protection program. In August 1986 the Town requested that the East and West forks of the Pigeon River above the existing point sources be classified WS-I with the remaining portion being WS-II. The Town was advised by the state to proceed with a request for a WS-II for the entire watershed and await

the completion of the present study to act on the WS-I classification. However, the request for a discharge permit by the National Park Service in November 1987 renewed concern among town officials, and they reactivated their earlier request (Hardin, Dec. 30, 1987). The timing of that request was inopportune, however, as the community was embroiled in the interstate controversy over the renewal of a discharge permit for Champion International, the major employer in the area. A story in the The Asheville Citizen (Morrison, February 7, 1988) pointed out that the Town was in the ironical position of requesting a higher level of protection upstream while supporting lower standards downstream. The story also stated that, after being informed of the National Park Service's intentions to build a waste treatment plant, Mayor C. W. Hardin convinced town officials to drop their demands for the WS-I classification. Nonetheless, concerns remain about the weakness of present guidelines for the WS-II classification.

The emerging concerns about watershed protection and other development activity has prompted Haywood County to take several important steps that would affect development in the watershed. There are many other steps which could be taken. In one action the County adopted a Pre-Development Ordinance which became effective March 1, 1987. While that ordinance does not add any regulations affecting the kinds of development, it does require developers to demonstrate compliance with existing regulation before construction is initiated. In a second step the County adopted a Flood Damage Prevention Ordinance, effective as of January 15, 1988, which will affect new development in the watershed that is near the streambanks of the mainstem and East and West Forks of the Pigeon River. A third step was taken in March 1988 by adopting an Erosion Control Ordinance that will take effect August 1, 1988. All of these actions flow from an increased awareness of the potential damage from construction activities.

Although the steps taken in 1986 and 1987 are significant, they would not protect the watershed from being extensively developed. The watershed is not zoned; the County does not have subdivision regulations; and there are no special ordinances to protect the quality of water in watersheds that are used as sources of drinking water.

The wastewater facilities plan for Haywood County, shown earlier in Figure 16, could eliminate some of the seepage from septic tank drainage fields, but a collection system of that extent would have at least two significant adverse effects. First, it would promote greater and higher densities of development with an

attendant increase in pollution from urban stormwater runoff. Second, that particular plan calls for the concentration of residential and commercial wastes in two new wastewater treatment plants and three pumping stations, all of which would be subject to failure. Before any program for extending sewers into the watershed is undertaken, careful consideration should be given to the development of a comprehensive watershed management plan.

The powers that the county could exercise to enhance protection of the watershed are discussed in Chapter IV. While the evidence compiled to date may support the view that there has been little need for such regulations in the past, the evidence does point to changing circumstances where prudent and reasonable action is justified to preserve the quality of this valuable resource for the future.

CHAPTER IV

WATERSHED PROTECTION:

CURRENT PROGRAMS IN NORTH CAROLINA

Although there are numerous examples of good watershed management programs in other states, the experience in North Carolina may be among the better guides for cities and counties in this State who wish to initiate or improve programs to protect their public water supplies. Since 1980 state and local governments in North Carolina have adopted a variety of growth management techniques to respond to the increasing levels of urban development in watersheds that are used for public water supplies, and it is the purpose of this chapter to review the current statutory bases and current status of those activities. The review begins with a discussion of the authority of local governments to regulate land use in general. The discussion then turns to more specific programs that have been targeted at watershed protection.

MANAGEMENT TECHNIQUES

Techniques that could be used as elements of a watershed protection plan cover a broad spectrum of possibilities, but they can be conveniently grouped into four categories:

(1) regulatory measures - those involving the exercise of police powers to control offsite damage resulting from developmental activity;

(2) acquisition of property rights - those involving the exercise of compensatory powers;

(3) financial incentives; and

(4) public education.

North Carolinians have traditionally opposed the use of regulatory authority over land use decisions either at the State level or at the local level. However, as spill-over effects of private development on public and other private properties have become more widely recognized, concepts of zoning and development ordinances of various kinds have become more acceptable to a larger portion of the population.

But the tension between regulation and the "taking" of private property remains high. North Carolina, like other states, derives its police powers to

promote public health, safety, and welfare from the fourteenth amendment, and in this State, local governments can exercise that power only if there is enabling legislation at the state level. However, there are also constitutional limits to the exercise of that power, and, of particular relevance to land use management, the regulations cannot be confiscatory, meaning the they may not render the land unusable or "take" it without just compensation. Other protections must also be satisfied; namely, due process and the avoidance of discrimination whereby two pieces of land having similar characteristics are treated differently.

A court case has tended to heighten the tension between regulation and taking. In June 1987 the Supreme Court ruled (First English Evangelical Lutheran Church of Glendale v. County of Los Angeles, California) that there can be a temporary regulatory "taking" of property in cases of continued regulatory delay, and that in this instance landowners have a right to seek compensation. This ruling has had repercussions on the decisions of local planners in North Carolina. There is fear that more regulatory restrictions will be considered a taking and local governments will need to provide an avenue to pay compensation for temporary takings. At the very least, more landowners are likely to contest regulatory restrictions, leading to increased litigation. For this reason, some local governments have become hesitant in adopting additional regulatory restrictions. Opinions vary as far as the long-term effects of this case, but one knowledgeable expert states that he knows of no case in North Carolina that has held when a case resulted in a regulatory taking and just compensation (Heath, 1987).

Regulatory Programs

Regulatory programs designed to protect important resource areas often rely on zoning, subdivision, sediment and erosion control, and flood control ordinances. These ordinances define special districts, or overlay districts, which specify permitted uses, prohibited uses, and design standards for development.

Zoning Ordinances. Zoning by municipalities and counties (GS 160A, Art. 19; 153A, Art. 18) divides a political jurisdiction into districts, each with different restrictions on the type of land use allowed, and density of development. This method may be used to assign land uses to sites having the most suitable environmental characteristics.

Traditionally, zoning ordinances were set up to establish districts of varying densities and purposes in order to guide development. Typical provisions include requirements for the provision of services and reductions of hazards such as flooding. Lot sizes often vary depending on the type of water and sewer used, and if available, developments are generally required to connect to public water and sewer systems. Site drainage requirements may be specified, and additional design standards may be set for flood prone areas.

With the realization of the impact of development on public water supplies, additional provisions geared directly to controlling stormwater, erosion, and water quality are becoming more common. Watershed protection provisions include the use of natural, undisturbed buffers, low densities, limited impervious surfaces, use restrictions, cluster development, conditional-use or special-use requirements, special districts, performance standards, and public sewage restrictions.

Subdivision Regulations. Subdivision regulations (GS 160A, Art. 19; 153A, Art. 18) control the division of raw land into buildable sites. Traditionally, a subdivision ordinance included standards for public and private water and sewer, and required information concerning the location of watercourse and drainage structures. Today, the ordinance may include watershed protection requirements such as drainage easements, grading, and on-site detention of runoff. These regulations may also encourage the dedication of stream corridors to provide buffers of natural vegetation between streams and development in lieu of a mandatory dedication of neighborhood recreational land.

Sediment and Erosion (S & E) Control. Sediment and erosion control ordinances regulate the clearing, grading, excavation, filling, and other earth-moving activities to prevent increased soil erosion and sedimentation, flooding, and the obstruction of drainageways. North Carolina has a statewide S & E ordinance (GS 113A, Art. 4). Cities and counties have the option of adopting their own, more stringent version of this ordinance, but most who adopted their own ordinance have closely followed the model ordinance developed by the State. All ordinances require the preparation of S & E plans before land-disturbing activities can be initiated.

Pre-Development Review Ordinance. Special legislation allows three counties - Haywood, Henderson, and Transylvania - to implement a Pre-Development Review Ordinance. Although this ordinance may be considered a first step toward the adoption of land-use regulation, no new land-use controls are authorized. It simply requires pre-development of plans to p mote compliance with existing regulations.

Flood Control. Flood damage prevention ordinances are intended to minimize losses due to flood damage. While these provisions are not geared directly to preserving the quality of drinking waters, they may decrease densities in floodway areas around streams and water bodies, and lessen the chance of sewage contamination from public or private systems. In addition, nonpoint source pollutant loading is directly related to stormwater and flood events. Discouraging development in flood plains will help to control nonpoint source pollution.

Through these regulations, construction in areas prone to flooding must meet specific design standards, and water and sewer facilities must be placed to prevent contamination of flood waters and vice versa. Construction may be prohibited within some distance of streams, usually based on the 100-year flood level, effectively providing undisturbed buffers. In addition, the alteration of watercourses is not allowed if it will increase the chances of flooding.

Municipal and County General Ordinance-Making Power. In addition to the specific powers, municipalities and counties in North Carolina have general ordinance-making powers (GS 160A-174; 153A-121), but if ordinances adopted under those powers resemble those under specific powers, provisions of the specific powers may govern.

Extent of Use. The extent to which local governments have used their specific powers for regulating land use has been summarized by the Division of Community Assistance, North Carolina Department of Natural Resources and Community Development (1985). Among the state's 100 counties, 78% have a land-use plan, 45% have zoning and 52% utilize subdivision regulation to guide development. This inventory also revealed that 18% of the counties have their own S & E control ordinances, 37% contain mobile home provisions, and 81% of the counties participate in the flood control program. Of North Carolina's 495 cities surveyed, 328 (66%) have developed

land-use plans, 349 (71%) have zoning and 232 (47%) contain subdivision regulations. In addition, 69 (14%) have established mobile home ordinances, 37 (8%) adopt a S & E ordinance and 244 (47%) participate in the flood control program.

This survey indicates that approximately 1/2 of the state's counties have zoning and subdivision regulations. In the cities the use of zoning seems to be more popular than subdivision regulations. Cities have a lower participation rate in adopting mobile home, S & E, and flood control regulations. Currently, most water supplies are in rural areas under county jurisdiction, but as cities continue to expand due to increased development, this will change. Cities are gaining control over development decisions within the state's water supply watersheds, and it will become increasingly important that these towns ensure proper development.

Eight counties have adopted specific watershed protection regulations, and two additional counties (Wilkes, Transylvania) are in the process of establishing protection regulations (Holman, 1987). Eleven cities have, or are in the process of adopting watershed provisions. The participating towns and counties are presented in Table 12.

Table 12.

North Carolina Communities Actively Participating in the Water Supply Watershed Protection Program

COUNTY	CITY/TOWN
WAKE	RALEIGH
DURHAM	DURHAM
ORANGE	CREEDMOOR
FRANKLIN	ZEBULON
ALAMANCE	CARY
GUILFORD	GARNER
RANDOLPH	WAKE FOREST
*WILKES	*MEBANE
*CHATHAM	CARRBORO
*TRANSYLVANIA	ROLESVILLE

*Governments currently in the process of devising a protection program

**July 1987

Other Methods

Activities of these and other communities need not be limited to regulatory actions, however. Among the other options are the acquisition of some portion of the property rights in the watershed, the creation of financial incentives to encourage the adoption of improved management practices, and public education.

The practice of acquiring all of the lands in a watershed, once common in New England, is financially feasible and advisable in only a few instances, but acquisition of all rights for some lands and partial rights for others might be appropriate in many instances. In fact, it is quite common for jurisdictions to make fee simple purchases of lands adjacent to reservoirs to protect them from shoreline developments and unauthorized access.

Less-than-fee simple acquisition techniques have not been widely used in North Carolina to protect public water supplies. One particular form, negative easements, probably deserve more attention than they have gotten. A negative easement, like all easements, conveys some specific right or rights to a second party while the title and ownership of all rights are retained by the first party. Negative easements prevent certain types of uses of privately owned land that would otherwise be permitted.

Negative easements could be thought of as one form of financial incentive for watershed management because the landowner would receive compensation for not using the land in ways that would be detrimental to a water supply. Simpler forms of financial incentives are also available, the most pertinent example being North Carolina's Agricultural Cost Share Program for Nonpoint Source Pollution Control. This program provides farmers with up to 75 percent of the cost of installing conservation facilities that reduce the flow of pollutants from nonpoint sources into water bodies. The program was begun in 1985 to provide assistance to farmers in 16 counties that were affected by the reclassification of streams to a "nutrient-sensitive" category. That program has now been extended to include the coastal counties and 16 counties in western North Carolina; it now covers approximately one-half of the State's counties. Annual appropriations in 1987 reached a level of $5.4 million for grants and $825,000 for technical assistance. One water supplier, the Orange Water and Sewer Authority (OWASA), has chosen to supplement that program for farms that are located within the two watersheds from which OWASA draws its supply.

NORTH CAROLINA'S STREAM CLASSIFICATIONS AND WATER SUPPLY PROTECTION GUIDELINES

Recent changes have also been made in the state regulatory program for water pollution control to encourage watershed protection. Protection of public drinking water supplies has always been a basic tenet for North Carolina's water pollution control program, but until recently that program was limited to point source controls. For the first half of the twentieth century it was the only statutory justification for pollution control. In 1951 the state adopted a stream classification system that assigned each segment of every stream to one of several classes according to the "best and highest" use that segment was anticipated to be put. Under that system all surface water supplies were classified as either "A-I" or "A-II." The A-I category was reserved for those supplies collected from highly protected watersheds (such as national forests) for which the only treatment necessary was chlorination. Only a very small number of supplies fit that category, and all other surface water supplies were classified A-II.

In the early 1980's, however, an extended public debate over a new water supply for the Orange Water and Sewer Authority (serving Chapel Hill and Carrboro) led to the observation that the A-II category did not draw proper distinction among water supplies that were subject to different levels of protection. One alternative, B. Everett Jordan Lake, whose tributaries receive the effluents from numerous major municipal and industrial waste treatment facilities, fell into the same category as the proposed Cane Creek Reservoir into which no domestic or industrial wastes were discharged. That debate, coupled with concerns about protection of Jordan Lake and the Falls of the Neuse Reservoir, led the Environmental Management Commission to revise the classification system in 1986. The revisions establish three levels of public water supplies; WS-I, WS-II, and WS-III. Class WS-I watersheds have no point sources; WS-II watersheds allow only domestic and approved non-process (cooling) water discharges. All others automatically fall into WS-III.

The most innovative part of this process, however, is the added requirement that before any streams are classified WS-I or WS-II, local governments (counties and municipalities) must adopt protection programs for their watersheds to protect the supplies from contamination arising from nonpoint sources. All but the pristine (previously classed A-I) waters were delegated to WS-III waters. If a water supply is eligible to receive a more protective WS-I or WS-II classification,

the governing bodies affecting lands that drain to that supply must request a reclassification and develop and adopt an approved watershed protection program.

Guidelines. To provide guidance and consistency in the program, the NC Division of Environmental Management developed a set of guidelines for watershed protection. These guidelines call for one set of regulations to apply to the entire watershed and another set to apply to a "critical area" near impoundments on intakes. Development guidelines for entire watersheds include:

(1) control of the first 1/2 inch runoff where any new development has a density greater than 12% impervious surface (40,000 sq. ft. per dwelling);

(2) reservation of a 50-foot minimum undisturbed vegetative buffer along both sides of all perennial tributaries; and

(3) an inventory of hazardous materials used and stored.

The critical area includes an area adjacent to the reservoir or water intake location, and extends one mile from the reservoir's pool elevation or intake point (1/2 mile if watershed is less than 100 square miles). Recommended guidelines include:

(1) no sewer connections except to deal with specific problem areas;

(2) limit the number of small businesses;

(3) limit new development to 6% impervious coverage (80,000 sq. ft. or one dwelling per 2 acres);

(4) reservation of a 100-foot minimum vegetative buffer around all reservoirs, and around the critical area portion of streams or rivers used as an intake; vegetative buffers should remain undisturbed and have no permanent structures; and

(5) no industrial or commercial uses or their associated hazardous materials use or storage.

The guidelines also specify that:

(1) Special Use Provisions may be allowed for new developments not complying with the above requirements on a case-by-case basis, if special safeguards are in place to protect against contamination; and

(2) Development may exceed recommended impervious surface maximums (6% or 30%) as long as the first one inch of stormwater runoff is retained.

Existing and Proposed Programs

DEM has identified 157 public water supplies, mostly in the piedmont and mountains, that are eligible for classifications as either WS-I or WS-II. Some of those supplies extend over two or more political jurisdictions so that more than one local program is required to protect many of those supplies. As of August 1986, 30 local governments had inquired about the program. Of these, 18 have either adopted necessary local protection measures or are in the process of doing so.

Table 13 contains a summary of the measures adopted by each of the local programs for portions of the watersheds inside and outside of the critical areas. Details of these programs for all of the 18 local governments are given by Moubry and Moreau (1987). Because most of the watersheds lie within county jurisdictions, descriptions of the county programs are included here in the following paragraphs. They include Alamance, Chatham, Durham, Franklin, Guilford, Orange, Randolph, Wake, and Wilkes Counties.

Alamance County. A watershed protection ordinance was passed by Alamance County in May 1987. It affects lands in the watersheds of the Lake Cammack and Stony Creek Reservoir, Cane Creek, Big Alamance Creek (which feeds into the proposed Lake MacIntosh Reservoir), and Quaker and Back Creeks (which feed into the proposed Graham/Mebane Reservoir). This ordinance establishes a Water Quality Critical Area (WQCA), defined as the land located adjacent to the shoreline of a water supply reservoir at normal pool level, extending to the shorter of a mile from normal pool level or the watershed ridge line. Industry is prohibited in the WQCA. Other uses (office, institutional, etc.) are limited to a 3,000 square foot floor area and 6% impervious surface area. Bona fide farms are exempt. The Board of Adjustment may consider granting a variance if a site plan contains a maximum of 6% impervious coverage or retains/detains the first 1/2 inch of stormwater runoff falling on the property.

In the outlying watershed area, control is limited to the establishment of 50 ft. stream buffers. There are no impervious surface standards, stormwater runoff containment, or hazardous materials requirements outside the WQCA.

TABLE 13.

TECHNIQUES FOR WATERSHED MANAGEMENT IN SELECTED COUNTIES IN NORTH CAROLINA

	Controls Applicable to Critical Watershed Areas															Controls Applicable to Other Areas				
	Definition				Buffers				Development			Storage/Use of Hazardous Materials			Stormwater				
County/Comm.	1/2-1 mile from pool	1/2-1 mile from intake	No public sewerage	1 DU/2 acre	6% ISA	100 ft.- Streams	100 ft.- Reservoirs	Undisturbed Areas	Limited Small Bus.	No Commercial	No Industrial	No Commercial	No Industrial	Special Use	Control 1/2"	12% ISA	1 DU/acre	Stream Buffer	Haz Mat'l Inventory
Franklin				x				x	x	x		x	x		x		x	x	
Alamance	x		x	x			x	x	x		x	x	x					x	
Wake Co.			x	x			x								x*	*x	x	x	
Wake Forest	x			x					x	x	x						x	x	
Zebulon				x			x		x	x	x	x	x	x	x*	*x	x	x	
Rolesville	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	x*	*x	x	x	
Garner					x		x	x	x	x	x	x	x						
Raleigh			x	x	x		n/a	x	x	x	x	x	x		x	x			
Cary	x				x			x				x	x			x		x	
Durham Co.	x			x		x	x		x	x	x	x	x	x	x			x	x
Durham City	x		x	x	x			x	x		x	x	x	x	x			x	x
Orange Co.			x	x	x			x	x	x	x	x	x	x	x		x	x	x
Carrboro				x		x	x	x	x			x	x		x			x	x
Guilford Co.							x	x											
Randolph Co.	x		x	x	x		x	x	x		x	x	x				x	x	
Wilkes Co.		x	x	x	x	x		x	x		x	x	x	x		x	x	x	
Creedmoor				x	x			x				x	x	x	x	x		x	x
Chatham Co					x	*x	*x							x	x*	*x		*x	

KEY: DU = dwelling unit
SWR= storm water runoff
ISA= impervious surface area
Sewerage provision may be written or informal policy
x* *x: indicates that the first 1/2 inch must be retained if ISA>12%
*indicates proposed program or standard
Haz Mat'l = hazardous materials

Chatham County. Although the Chatham County regulations adopted in 1987 do not constitute a comprehensive watershed management program, they do contain some of the basic elements. These regulations affect development along many streams throughout the county, and they contain special provisions for certain types of developments near Jordan Lake.

The regulations contain requirements that buffers be established along the Deep River, Cape Fear River, Rocky River, Haw River, New Hope River, and B. Everett Jordan Lake (July 1987). One hundred-foot buffers are required along Deep River, Cape Fear River, Rocky River, Haw River and New Hope River, and B. Everett Jordan Lake. A 100-foot buffer must also be placed along all continuously flowing and intermittent streams for a distance of 2,500 feet upstream of their confluence with the river into which they discharge. Buffers of 50 ft. are required along streams beyond the 2,500 foot distance. In both cases, the distance may be decreased if a developer demonstrates that a smaller area will be sufficient for water protection and aesthetics.

Special provisions apply to bait and tackle shops (BATS) and industries that locate within a half mile of the Corps of Engineers property along Jordan Lake. BATS must be located on at least a one acre lot, cannot exceed 6% impervious surfaces, and must contain the first 1/2 inch of stormwater runoff from impervious surfaces. Manufacturing, warehousing, processing, and related uses must obtain Limited Industrial Conditional Use Permits. To qualify the minimum lot size is 2 acres, impervious surface areas may not exceed 6%, and the first 1/2 inch of rainfall must be contained on-site. There can be no discharge of water and any hazardous materials or wastes must be disclosed for consideration in the permit review process. For all development in the county's jurisdiction, if the mount of paved surfaces exceeds 4% of the site area, then the first 1/2 inch of stormwater must be contained (Megginson, 1987).

Durham County. Durham County first adopted watershed protection measures in its Zoning Ordinance in May 1985. This ordinance regulates the development of lands in the Lake Michie, Lake Jordan, Little River, and Neuse River watersheds. The Critical Watershed District, is an overlay district consisting of two parts, a Water Quality Basin Area (WQBA) and a Water Quality Critical Area (WQCA).

The WQCA includes land adjacent to the shoreline of a reservoir at normal pool level and extends to a point beyond either the ridge line of the reservoir water-

shed or one mile from the shoreline of the reservoir, whichever is shorter. Restrictions in the WQCA include 80,000 square foot lots and the prohibition of industrial uses. Commercial activities are permitted but the use, storage, and handling of hazardous materials is not (Suggs, 1987). Fuel storage tanks must be kept above ground.

Stormwater runoff is controlled in the critical area through impervious surface limitations or rainfall containment. For all developments the first 1/2 inch of stormwater runoff from impervious surfaces must be retained or infiltrated. Impervious surfaces may not exceed 6% of the total land area for a single development. Roof areas may be excluded from impervious surface calculations for residential developments if (a) roof runoff is directed across a vegetated surface and (b) the first one inch of storm water runoff is infiltrated. Impervious surface areas of 6-9% may be allowed through special permit. To receive a special permit in the watershed districts, a site must contain unique features to safeguard against stormwater contamination, including infiltration, retention, or detention of the first one inch of runoff from impervious surfaces. Public sewer is allowed in areas which drain into Class WS-II drinking water supplies, provided the system uses gravity flow to direct sewage outside the WQCA and the first one inch of runoff is retained or infiltrated. Public sewer is allowed in areas which do not drain into Class WS-II water supplies. Street design standards do not require curb and gutter installation.

Buffers of 100 feet are required for all perennial streams, and streams in floodplains along both stream banks. This protection ordinance does not address buffers along reservoirs in general, but the 100-foot stream buffer requirement was applied to the Little River Reservoir. The Army Corps of Engineers bought for public use an area greater than 100 feet around the Falls of the Neuse Lake. This land includes wildlife areas used for hunting and fishing and a recreation area that includes a boat ramp and marina.

In the Water Quality Basin Area (WQBA) there are no additional lot size restrictions, commercial activities are allowed, and industry is prohibited in areas which drain into Class WS-II segments of drinking water supply reservoirs. Industries which use, store, distribute, or produce hazardous substances in excess of stated threshold amounts must register the types and quantities of hazardous substances used. No facilities may recycle or dispose of toxic or hazardous wastes. Lots without public sewer require impervious surface areas of less than

15%, or 15-20% with special permit. If public sewer is provided, impervious surface areas must be less than 30%, or with a special permit 30-40%. Buffers of 50 ft. must remain along perennial streams and along streams located in flood plains. Privately owned discharging waste water treatment facilities must have the approval of the Environmental Management Commission. Industrial pre-treatment is allowed, and public sewer is to be encouraged where it is feasible.

Franklin County. Franklin County's watershed protection program was adopted in January 1987 to protect the Tar River watershed. It relies on the incorporation of control standards in its zoning ordinance. The county has designated two water supply districts, R-40 and R-80. The R-40 district provides water quality protection in the drainage basin of water supply watersheds outside the critical area. The minimum lot area is 40,000 square feet, and ground coverage by impervious surfaces is limited to 25%. The R-80 district was established to provide protection in the water supply watershed critical area. Lots must be at least 80,000 square feet and have less than 12.5% impervious surface area.

In both watershed districts, vegetative buffers of 50 ft. are required along both sides of perennial streams and on-site control of the first 1/2 inch of stormwater runoff from impervious surfaces is required. Industrial uses are permitted in the watersheds but the use, storage, and handling of hazardous chemicals or toxic substances is prohibited.

Critical areas are not defined in the zoning ordinance, but they only include R-80 districts in place around the watershed of the Franklinton City Lake (Heutz, 1987). Other sources of drinking water do not have "critical area zoning." R-40 districts are scattered throughout the county. Watershed areas do not have access to public water or sewage systems and must rely on septic tanks.

Franklin's program includes four suggested control techniques: (1) the containment of the first 1/2 inch of stormwater runoff; (2) a 50-foot minimum vegetative buffers along perennial tributaries; (3) denial of permanent structures in buffer areas; and (4) the prohibition of commercial activities. The primary drawbacks to this watershed protection program are the lack of a consistent definition of critical areas and the lack of minimal standards in those areas. The critical area does not prohibit industrial uses or public sewage systems, and impervious surface areas may exceed 6%.

Guilford County. Guilford County regulates the development of land in portions of watersheds serving Burlington, Greensboro, and High Point. Its protection program includes a Watershed Critical Area Protection District (WCA) and Watershed Management Rating System (WMRS). In 1985 the county adopted a development rating system to control the quality of development throughout their watershed areas. The WMRS presents two options to developers: (a) retain the first 1/2 inch of runoff from impervious surfaces and include 50 ft. buffers along perennial streams; or (b) submit proposals for "rating." The rating system involves a checklist and point system whereby developments must earn 100 points by meeting certain standards including its land use zone, the percent of impervious surfaces, proximity to floodways, soil type, drainage, slope, land cover, runoff control, sewage system, and road design. Additional standards for critical working areas were adopted in April 1987.

The county's watershed critical area protection district (WCA) is an overlay district, extending to the ridgeline of the reservoir basin, or in the case of major streams feeding the reservoir, to the nearest identifiable feature which crosses the stream which is at least 2,750 feet upstream of the reservoir. The critical area generally extends to the shorter of the distance of one mile landward or to the ridgeline (Jenkins, 1987).

The critical area is divided into 5 consecutive tiers, defined by their distance from the normal pool elevation. The first tier is the shoreline buffer area. Residential, commercial, and industrial uses are permitted in the WCA. Permissible densities vary between 16,000 sq. ft. lots to 200,000 sq. ft. lots over the 5 tiers depending on location and the type of sewage system used. Impervious surfaces range from 2.5% to 30%; they also depend on location and the type of sewage system present.

For all developments the first 1/2 inch of stormwater runoff must be controlled using one of the following methods: (a) on-site infiltration, (b) engineered infiltration measures (retention ponds and trenches); (c) detention structures; or (d) fee in lieu of construction where public retention structures are available. All structural designs must be approved by the County Soil Scientist, and a homeowner association must be created to own and maintain runoff control structures. Impervious surfaces may be increased by 10% in existing commercial and industrial areas if the owners control the first one inch of rainfall.

Guilford County attempts to reduce the risk of chemical spills by prohibiting certain uses within each tier. Fuel storage tanks and chemicals must be diked for the containment of spills. Dikes must be of a volume to contain 100% of the tank's contents stored in the area and should have a leakage detention system. Underground storage tanks must be approved by the planning board.

Extensive buffer area is provided in the WCA's "first tier." The first tier consists of lands within 200 feet of the normal pool elevation and lands within 1/2 to one mile upstream of the water intake structures. It is in public ownership and remains undisturbed. Buffers are not provided along streams except where slopes adjacent and parallel to natural streams and drainageways are greater than 15%.

The county's protection program contains provisions for preserving fragile areas, decreasing runoff from streets, and minimizing land disturbance. Fragile areas, including wetlands and flood plains, are protected by dedication or they may be held by a homeowners association, in a natural and undisturbed state. Drainage within developments is provided by undisturbed open channels with specified easements whose widths depend on the level of flow during a 100-year storm. Clustering of development on the best soils and terrain of a site is encouraged. To reduce land disturbance and stormwater runoff caused by street construction, block sizes may be increased, curb and gutters may be eliminated, and roads must cross natural areas or stream buffers at approximately a 90-degree angle. Erosion control plans are required for nonagricultural-related land disturbing activities if: (a) more than one acre of land is disturbed; (b) soils are highly erodible and have a "k" factor greater than .36; (c) a pond or retention structure is installed; or (d) development will take place in Tier 1 or Tier 2.

This ordinance contains many innovative techniques to provide surface water protection. It has sizable buffer (Tier 1) around reservoirs and intake structures. Street design is flexible, and wetlands and floodplains are protected. On the negative side, the tiered approach is complicated and can be confusing. Furthermore, it permits development adjacent to reservoirs, and it does not regulate hazardous substances in all tiers of the critical areas.

Orange County. Provisions for watershed protection in Orange County were first adopted in November 1984 as a part of zoning, subdivision, and sediment and erosion control ordinances. This program establishes three districts: Protected Watershed II (PW-II), Protected Watershed I (PW-I), and a Water Quality Critical Area (WQCA).

Standards for these districts apply to zoned portions of University Lake, Cane Creek, and the Upper Eno Watersheds. Bona fide farms are exempt.

The Water Quality Critical Area (WQCA) is defined topographically. It is that portion of the watershed which drains directly into an impoundment or into trunk streams leading into an impoundment. With the exception of the critical area definition and reservoir buffers, all of the state's suggested guidelines are met. The width of buffers placed along streams and rivers is calculated as 50 ft. + (slope x 4 x 100). Reservoir buffers are not addressed in the zoning ordinance. The Soil and Erosion Control Ordinance of Orange County contains additional buffer requirements which apply solely to the University Lake Watershed. Intermittent streams flowing directly into University Lake and the area directly adjacent to the lake must have a buffer width of 100 ft. + (slope x 4 x 100). New septic tanks and their nitrification fields must be 300 feet from the edge of an impoundment or perennial stream.

The Protected Watershed II (PW-II) district includes all land outside the WQCA. In this district, impervious surface areas must be less than 12%, if public sewer is unavailable and up to 30% with public sewer. Buffers along tributaries are 50 ft. + (slope x 4 x 100) with a maximum limit of 150 feet. This area includes Agricultural Residential (AR), Rural 1 (R1), Rural Buffer (RB) and PW-I zones. Residential lot sizes range from 40,000-80,000 sq. ft. Commercial and industrial uses require 80,000 and 200,000 sq. ft. lot sizes, respectively.

Light industrial uses are allowed in the PW-I district. This district provides for limited industrial activities which do not use, produce, store, consume, or discharge hazardous or toxic substances in quantities equal to or exceeding amounts specified in EPA's "Hazardous Substances and Priority Pollutants."

Randolph County. In July 1987, Randolph County's program established protection standards for critical areas of watersheds. These standards apply to all municipal water supply watersheds including Lucus Lake, Lake Bunch, Lake Reese, Sandy Creek, and the site for the future Randleman Lake. Density in the WQCAs is restricted to one dwelling unit per 80,000 square feet, and all commercial, educational, recreational, and institutional uses must have less than 3,000 square foot floor space or a limit of 6% impervious surfaces. Commercial activities cannot distribute, sell or store motor fuels or hazardous materials, and industrial uses are prohibited. No new underground fuel or chemical storage tanks are allowed. Public sewage

is prohibited unless there is a public health problem. Buffers of 50 ft. are required along all perennial streams in the watershed, and 100 foot buffers must be maintained around water supply reservoirs. Density in the outlying watershed area must be at least one dwelling unit per 40,000 square feet.

Variances may be granted if a site meets either of the following: (1) has less than a 6% impervious surface area, or (2) retains, detains, or infiltrates the first 1/2 inch of rainfall falling on the property. Bona fide farms are exempt from this ordinance.

Randolph's program could be improved by prohibiting commercial activities in their critical areas.

Wake County. Wake County has set aside R-40W and R-80W watershed districts with development standards to protect surface water quality. Critical watershed areas are zoned R-80W (80,000 sq. ft. lots) and the outlying areas are zoned R-40W (40,000 sq. ft. lots). They are applied as follows:

(1) Falls Lake Watershed has R-80W around the reservoir, and all land within 2,940 feet of the 100 year flood pool elevation. The remainder of the watershed is R-40W.

(2) Jordan Lake Watershed is the same as that in Falls Lake.

(3) In the Swift Creek Watershed R-80W applies to lands within 1,200 feet of Lakes Wheeler and Benson and all land within 600 feet of Swift Creek. The remainder is R-40W, with the exception of areas zoned for commercial, industrial, and mobile home park uses.

(4) All of the Smith Creek Watershed that lies in Wake County is zoned R-80W.

Watershed restrictions were first adopted in March 1984, but they have since been revised. Wake has requirements for Consolidated Open Space Developments and Special Uses in their R-40W and R-80W districts. Impervious surfaces are limited to 30% and any developments with impervious surface areas above 12% must contain the first 1/2 inch of rainfall. Means of control will include, in order of preference: (a) on-site infiltration; (b) retention; and (c) detention. Post-construction maintenance of stormwater control measures and facilities lie with the property owner or a homeowners association as appropriate. All buildings in these districts must be set back a minimum of 20 ft. from the edge of any undisturbed stream buffer or natural drainage area buffer. Drainage buffers of 50

feet are required along both sides of streams. Buffers along upper watershed drainageways (defined as a watercourse, channel ditch or similar physiographic feature draining less than 25 acres) must be at least 25 feet.

Wake County's program does not address issues such as commercial and industrial development, the treatment of hazardous wastes, and their watershed sewer policy. Permanent structures such as docks, boat ramps, and piers are allowed in their vegetative buffers.

Wilkes County and the Town of North Wilkesboro. Wilkes County and the Town of North Wilkesboro are in the process of creating a joint watershed protection program for the Reddies River. The proposed program includes development standards in an R-80W district in the WQCA, and R-40W district in the remaining part of their watershed areas. North Wilkesboro draws their water supply from the Reddies River. Their WQCA includes all lands adjacent to this river upstream from the water intake, and includes land from the high water mark to the ridge line or one mile point, whichever is smaller. In this area, density is restricted to one dwelling unit per 80,000 sq. ft. Industrial uses are prohibited and commercial uses must include less than 3,000 sq. ft. of floor space. Impervious surfaces are limited to 6%, unless the first 1/2 inch rainfall from impervious surfaces is contained on-site. All roads must follow the contours of the site, cross streams at a minimum of a 60 degree angle, and the first 1/2 inch of runoff from roads must be retained.

In the R-40 district, limited commercial and industrial uses are allowed, provided: (a) they do not use, handle, or store hazardous materials; (b) there is no land-application of industrial waste; and (c) pre-treatment of wastewater is not required. Density is limited to 1 dwelling unit per 40,000 sq. ft., and ISAs must be less than 12%.

Throughout the entire watershed district, facilities are prohibited which handle, store, or dispose of toxic or hazardous waste as listed on the EPA hazardous materials list or determined by the governing body. Underground storage of gasoline is allowed as an accessory use if tanks are incased in a watertight vault. Buffers are required along the Reddies River and streams. A 200 ft. buffer must be maintained along the Reddies River, and the required stream buffer width is calculated as 50 ft. + (% slope x 4). Buildings must be set back a minimum of 20

ft. from all buffers. Only septic tank systems are allowed for waste disposal in the watershed areas.

The proposed regulations appear to meet state guidelines for water quality protection in the Reddies River watershed. This ordinance is simple and easy to interpret.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Findings from both the broad scale investigations of the status of water supply protection in 24 counties in western North Carolina in Chapter II and the more detailed analysis of the Pigeon River watershed upstream of Canton in Chapter III lead to several conclusions about the need for additional protection. The review of other watershed protection programs in Chapter IV, with the findings from Chapters II and III as background, lead to recommendations for action at both the State and local levels. The purpose of this chapter is to present those conclusions and recommendations. Special attention is given to recommendations for the Pigeon River watershed upstream of Canton.

CONCLUSIONS

The data and analyses presented in Chapters II and III could lead to a number of possible conclusions, but only a few are especially relevant to the discussion of the present status of watershed protection in western North Carolina and the need for improvements. The first should be comforting to those who are concerned about the present conditions of their public water supplies. There is little evidence either in this report or in other documents reviewed by the project staff during the course of this study to suggest that water supplies in the region are subject to such widespread degradation of sufficient magnitude so as to constitute an imminent threat to public health. Despite the minimal extent to which state and local governments have adopted regulatory measures, good judgments about selections of locations for public water supplies have avoided the need for extensive controls to date. By choosing sites in areas that were not subject to intense urban developments, nearly 90 percent of the sources of drinking water in the region could qualify for either a WS-I or a WS-II classification. However, some supplies in the region do face possible contamination from upstream municipalities and industries, and more careful monitoring of upstream activities and contamination should be undertaken to maintain surveillance over the quality of those supplies.

The second conclusion is less comforting. Very few of the counties have adopted growth management strategies that will be effective in mitigating the adverse effects of upstream urban, industrial, and agricultural activities. Growth

is occurring in the region; some counties are experiencing very high rates of growth. Even in some counties that are experiencing moderate growth, such as Haywood, that growth is tending to concentrate in public water supply watersheds.

Third, very little attention has been given to monitoring for the presence of synthetic organic chemicals from agricultural and industrial activities. A wide variety of pesticides and herbicides are being applied to agricultural and silvicultural operations in the watersheds, but there is virtually no program in place to systematically identify which substances are being used, to report on the quantities of these substances that are being applied to fields and forests, or to monitor for the presence of these substances in streams and lakes that are used for drinking water.

A fourth conclusion is that the impact of urban and agricultural activities in the watersheds of western North Carolina is magnified by their relatively close proximity to feeder streams. The mountainous terrain tends to confine these activities to the flood plains and terraces of stream valleys where surface runoff and seepage from subsurface disposal of wastes travel only short distances before reaching the streams.

A fifth and final conclusion relates to the speed with which local growth management measures are adopted. Strictly voluntary regulations, including zoning, subdivision regulations, and sediment and erosion control ordinances, are not readily adopted by local governments in the region. By contrast, regulations to which financial incentives have been attached have been widely accepted over relatively short periods of time. Most notable among them are flood plain regulations and agricultural cost sharing programs.

A similar conclusion was reached in a recent assessment of the local government role in nonpoint source pollution control in Virginia (Cox and Herson, November 1987). After reviewing programs in 18 counties and municipalities in Virginia, the authors stated that at one end of the spectrum

> ". . .some localities take the minimum action necessary to comply. Where a power is discretionary, as in the case of zoning, it is unlikely to be exercised. When a program is mandatory,. . .it may consist largely of administrative formalities with little effective enforcement. . ." (p. 72). "Funding is a primary factor in local program effectiveness. Limited resources in many localities jeopardize effective implementation. While willingness and ability to fund local programs may be difficult to distinguish in some cases, funding should not be overlooked as a potential problem." (p. 79).

RECOMMENDATIONS

These conclusions lead the project staff to make several recommendations to address the shortcomings documented in this study. These recommendations are addressed to two different audiences: state government and Haywood County in particular. They are discussed in that order.

State Government

The most significant step that state government could take to enhance watershed protection is to create financial incentives for which local governments would qualify if they adopt appropriate measures. Two popular forms of financial assistance, already in place, could be used for that purpose; namely, state grants and subsidized loans for water and sewer facilities and the agricultural cost sharing program. State government should give serious consideration to adoption of criteria that requires local governments to enact appropriate regulations for watershed protection before they qualify for agricultural cost sharing and financial assistance for water supply facilities. Adoption of sedimentation and erosion control ordinances, regulations to manage surface runoff, and measures to reduce the risk of contamination from hazardous chemicals should be given high priority.

The second recommendation is that the Environmental Management Commission should remedy the inherent weakness in the present WS-II classification. Provisions should be added to place some form of limit on the number or volume of qualifying wastes that can be discharged into streams of that classification. Those limits should reflect the special concerns about public health associated with consumption of those waters.

The third recommendation is that state government should improve information about agricultural and industrial chemicals that are used in significant quantities in water supply watersheds. The lack of information on the use of herbicides and pesticides should be remedied. One step would be the creation of a reporting system for the quantities of these substances that are sold to retailers in each county. Another positive step would be to require industries and others who store or process significant quantities of hazardous chemicals that enter waste streams above public water supplies to disclose the use of those substances to managers of

those supplies. Currently available analytical methods, such as those used on the samples taken in the Pigeon River watershed, are inefficient and very costly for identifying the presence of unknown synthetic organic chemicals.

The fourth step that should be taken by state government is to revise regulations for monitoring public water supplies that are taken from surface sources. These regulations should be revised to include a periodic assessment by water suppliers of potential sources of contamination that may exist within the watersheds from which they extract their supplies as well as monitoring of the quality of water at its points of consumption.

The fifth and final recommendation for State action is to enhance understanding among the public and professional planners and engineers of the physical, chemical, and biological processes that threaten the quality of drinking water supplies and of the costs of protecting them. Public support, so vital to the success of these programs, can be sustained only if credible information about these processes and the cost-effectiveness of management programs is made more readily available to citizens and their elected officials. Some of these processes are well understood by the planners and engineers whose expertise is required to formulate and evaluate management programs. For example, watershed hydrology is reasonably well known and predictable. On the other hand, some aspects of these processes are not well understood, particularly the transport and chemical and biochemical reactions that affect the fate of synthetic organic chemicals and their effects upon public health. Furthermore, there is little information about the costs on those who own, use, or develop land that is affected by management programs.

Haywood County

Good public health policy recognizes the fact that not all of the threats and their scientific details are completely understood. Protection against the unknown and against unpredictable events is a key factor in formulating health policy, and the evidence about what is known is sufficient to warrant the adoption of reasonable steps to protect the quality of drinking water in Haywood County. The recommendations which follow recognize the fact that Haywood County does not now have zoning, subdivision regulations, erosion control ordinance, or flood plain regulations. The only controls that would affect development in the Pigeon River watershed and the other watersheds in the county are minimal statewide regulations and the Pre-Development Ordinance which provides for county review of plans.

There are several modest steps that the county and the Town of Canton should take to enhance protection of the watershed of the Pigeon River upstream of Canton, steps that would not impose excessive costs on its residents. First, the County should initiate the process of reclassifying streams in the watershed from WS-III to higher levels. The actions necessary to satisfy requirements for adequate local controls on nonpoint sources must be determined by the Environmental Management Commission in consultation with the staff of the Division of Environmental Management (DEM) of the NCDNRCD.

In concert with that activity, the Town of Canton and Haywood County should initiate the preparation of a watershed protection plan and related policies. Policies must be enacted to satisfy the guidelines for a WS-I or WS-II classification, but the plan should go beyond State guidelines. At a minimum, it should include the following elements:

(1) delineation of water quality critical areas;

(2) development of a water and sewer extension policy for the watershed;

(3) formulation of development ordinances for the water quality critical areas and remaining positions of the watershed, including:

    (a) specification of limits on densities of development;
    (b) specification of standards for the management of stormwater runoff; and
    (c) specification of waste disposal practices.

(4) identification of priority areas and techniques for the installation of Best Management Practices through the Agricultural Cost Sharing and other soil and water management programs; and

(5) development of regulations regarding the storage of hazardous substances in the watershed.

Guidelines prepared by DEM and the programs adopted by other counties, portions of which are discussed in Chapter IV, should provide useful guidance for some of the elements listed above. The policies necessary to implement the plan could be incorporated into one or more of several ordinances for which all counties in the State have enabling legislation. The most direct route is probably through a watershed protection ordinance that could be developed specifically for and applicable to the Pigeon River watershed upstream of the Canton water supply intake. Details of a proposed ordinance could be constructed with the assistance of DEM, the Institute of Government of the University of North Carolina at Chapel

Hill, and others. Examples of the provisions of these ordinances are also discussed in Chapter IV.

The Town of Canton in cooperation with Haywood County should enhance its program for monitoring the quality of its water supply. That program should include several elements. The Town should maintain an up-to-date information system on the characteristics of the watershed and activities that are occurring in it. That information should be used to periodically assess the status of possible sources of contamination in the watershed, say every three years. Information in that assessment should include: (a) the location and status of septic tanks and underground storage tanks; (b) an inventory of pesticides and herbicides with estimates of the quantities used; and (c) monitoring reports on point source discharges. That assessment should also be used to guide the selection of parameters to be measured in samples of water taken at the point of consumption.

Haywood County, through its Soil and Water Conservation District, should take an active role in promoting participation in the Agricultural Cost Sharing Program. Priority should be given to the installation of best management practices in water supply watersheds.

Finally, local officials should prepare and implement a program of public education on the nature of threats to public water supplies in the county and what steps are needed to reduce those threats. Although it is listed last in this discussion, it may be necessary to make this the first step toward implementation of more effective protection of these resources which are so vital to the continued health and prosperity of the current and future residents of Canton and Haywood County.

APPENDIX A.

Surface Water Supplies in
Western North Carolina

County	Supplier	Potential classification	Sources	Drainage area, sq. mi.
Buncombe	Asheville (2)	WS-I(A-I)	N. Fork Swannonoa-Burnett Res.	21.90
		WS-I(A-I)	Beetree Cr.-Beetree Res.	7.60
	Biltmore Est. (Asheville)	WS-I	Busbee Lake - Sweeten Cr.	0.90
	Black Mountain	WS-I(A-I)	Dunsmore Cr. Res. (Emg.)[2]	0.60
	Montreat	WS-I(A-I)	Flat Cr. (Emg)[2]	1.00
	Ridgecrest Baptist Center (Ridgecrest)	WS-I(A-I)	L. Rattlesnake Br. (Sec.)[1]	0.50
	Weaverville (2)	WS-I(A-I)	Ox. Cr.	0.40
		WS-I(A-I)	Eller Cove	0.50
	Woodfin (2) (Asheville)	WS-I(A-I)	Laurel Fork	1.20
		WS-I(A-I)	Sugar Camp Fork	1.70
Burke	Morganton (3)	WS-I(A-I)	Henry Fork	4.50
		WS-I	Warrier Fork	84.00
		WS-III	Catawba R.	510.00
	Valdese	WS-III	Catawba R. - Lake Rhodhiss	1,090.00
Caldwell	Granite Falls	WS-III	Catawba R. - Lake Rhodhiss	1,090.00
	Lenoir	WS-III	Catawba R. - Lake Rhodhiss	1,090.00
Cherokee	Andrews (2)	WS-I	Beaver Cr.	1.70
		WS-I	Dan Holland Cr.	1.50
	Murphy (3)	WS-I(A-I)	Marble Cr.	0.90
		WS-I(A-I)	Brittian Cr.	0.40
		WS-III	Hiwassee R.	420.00
Graham	Fontana Village (Fed. Govt.)	WS-III	L. Tenn. R. - Fontana Lake	1,571.00
	Robbinsville (2)	WS-I(A-I)	Burgan Cr.	0.30
		WS-I(A-I)	Rock Cr.	0.80
	Tapoco, Inc. (Tapoco)	WS-I(A-I)	Yellow Hammer Br. - Trib. of Cheoah R.	1.30

Haywood	Canton (2)	WS-I(A-I)	Rough Cr.	1.30
		WS-II	Pigeon R.	133.00
	Maggie Valley	WS-I	Campbells Cr.	5.30
	Waynesville (2)	WS-I(A-I)	Allen Cr.	13.00
		WS-I(A-I)	Rocky Br.	1.30
Henderson	Hendersonville (3)	WS-I(A-I)	N. Fork Mills River	11.70
		WS-I(A-I)	Bradley Cr.	8.80
		WS-II	Mills R.	71.10
	J.P. Stevens (Tuxedo)	WS-I(A-I)	#1 UT Lake Summit	0.29
	Camp Mondamin (Tuxedo)	WS-I(A-I)	#2 UT Lake Summit	0.60
Jackson	Sapphire	WS-I	Nix Cr. (Emg.)2	1.00
	Sylva (3)	WS-I(A-I)	Fisher Cr. (2 intake)	1.60
		WS-I(A-I)	Dills Cr.	0.90
	West Carolina Univ.(Cullowhee)	WS-II	Tuckaseegee R.	207.00
Macon	Franklin	WS-II	Cartoogechaye Cr.	44.50
	Highlands (2)	WS-I(A-I)	Houston Br. (Sec.)1	0.20
		WS-II	Big Cr.	4.90
Madison	Hot Springs	WS-I(A-I)	Cascade Br.	1.10
	Mars Hill	WS-I(A-I)	Big Laurel Cr. (North Fork)	1.00
Mitchell	Spruce Pine (2)	WS-I(A-I)	Beaver Cr.	2.20
		WS-I(A-I)	Graveyard Cr.	0.70
Polk	Columbus	WS-I	UT of Horse Cr.	0.80
	Tryon (7)	WS-I	Big Falls Cr.	1.60
		WS-I	Colt Cr.	2.70
		WS-I	Little Falls Cr.	0.50
		WS-I	Vaughn Cr. (3-intakes)	0.60
		WS-I	Fork Cr.	2.20
Rutherford	Cone Mills (Cliffside)	WS-III	Second Broad River	220.00
	Forest City	WS-I?	Second Broad River	92.00
	Rutherfordton/ Spindale	WS-III	Broad River	261.40
Surry	Dobson	WS-II	Fisher River	70.00
	Elkins	WS-II	Big Elkins Cr.	34.50
	Mount Airy (2)	WS-II	Stewarts Cr.	66.45
		WS-II	Lovills Cr.	33.05
	Pilot Mountain	WS-I	Toms Cr.	29.20

Swain	Bryson City	WS-I(A-I)	Lands Cr.	2.50
Transylvania	Brevard	WS-I	Catheys Cr.	11.40
Watauga	Appalachian State Univ. (Boone)	WS-I	Howards Cr.	0.33
	Beech Mt. (3)	WS-I	Pond Cr. (2 intake)	1.00
	(Banner Elk)	WS-I	Buckeye Cr.	2.80
	Blowing Rock	WS-I	Brick House Cr. (Flat Top Br.)	0.55
	Boone (2)	WS-I(A-I)	Winklers Cr.	0.80
		WS-I	S. Fork New R. (Emg)[2]	5.73
Wilkes	N. Wilkesboro	WS-I?	Reddies River	95.00
	Wilkesboro	WS-III	Yadkin River	370.00
Yadkin	Jonesville	WS-III	Yadkin River	832.50
	Yadkinville	WS-II	S. Deep Cr.	53.30
Yancey	Burnsville (2)	WS-I	Bowlen Cr.	1.90
		WS-I	UT Bowlen Cr.	1.20

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1. (Sec.) - indicates a secondary water supply source
2. (Emg.) - indicates an emergency water supply source
3. Extraction source that has more than one intake - latitude and longitude are for the downstream intake while the upstream intake can be from 100 feet to 10 miles upstream of this location.

APPENDIX B.

SOILS OF THE PIGEON RIVER WATERSHED UPSTREAM OF CANTON

Braddock clay loam, eroded

Description: The Braddock series consists of deep, well drained, and moderately permeable soils. They formed in alluvium or colluvium derived dominantly from a mixture of crystalline rocks. They are on high terraces, footslopes, and colluvial fans. Slopes range from 0 to 45 percent.

Drainage and Permeability: Well drained; slow to rapid surface runoff; moderate permeability.

Use and Vegetation: Most of these soils are forested. Some of the acreage is used for growing cultivated crops and pasture. Crops include corn, small grain, hay, apple and peach orchards, berries, and vegetables. Natural vegetation consists of mixed hardwoods, dominated by oaks and dogwood, with some hickory, yellow poplar, and Virginia pine.

Dellwood cobbly loamy sand, 0.3%, occasionally flooded

Description: The Dellwood series consists of somewhat excessively drained, rapidly permeable soils on flood plains in the Southern Appalachian Mountains. The soil is shallow to materials that have a high content of pebbles and cobbles. Typically the surface layer is very dark grayish brown gravelly fine sandy loam 11 inches thick. The underlying material to a depth of 62 inches is dark yellowish brown extremely gravelly and extremely cobbly sand slope ranges from 0 to 5 percent.

Drainage and Permeability: Not available

Use and Vegetation: Not available

Edneyville-Chestnut gravelly loams, stony

Description: The Edneyville series consists of well drained soils on sloping to very steep ridges and side slopes of the Southern Appalachian Mountains. Slopes are 6 to 70 percent.

Drainage and Permeability: Well drained; medium to rapid runoff; medium internal drainage; moderate permeability.

Use and Vegetation: More than one-half of the soil is in forest type of white oak, black oak, and northern red oak, hickory, maple, elm, poplar, locust, sourwood, and some white pine and hemlock are associated with this forest type. The undergrowth is laurel, dogwood, and rhododendron. Cleared areas are used for pasture, corn, small grain, hay, some fruit trees, burley tobacco, and vegetables.

Evard-Cowee gravelly loam

Description: The Evard series consists of deep, well drained, moderately permeable soils that formed in residuum from granite, gneiss, or schist. Slopes range from 2 to 80 percent.

Drainage and Permeability: Well drained, surface runoff is rapid; permeability is moderate.

Use and Vegetation: Forested to oak, hickory, white pine, and shortleaf pine.

Hayesville clay loam, eroded

Description: The Hayesville series consists of well drained soils on gentle sloping to very steep ridges and side slopes of the Southern Appalachian Mountains. They formed in residuum weathered from granite, gneiss and schists. Slopes are 2 to 50 percent.

Drainage and Permeability: Well drained; medium to rapid runoff; medium internal drainage; moderate permeability.

Use and Vegetation: About one-half of the acres of this soil is in cultivation, the remainder is in forest of yellow-poplar, eastern white pine, northern red oak, pitch pine, shortleaf pine and Virginia pine. The understory is flowering dogwood, rhododendron, mountain laurel and sourwood. Cleared areas are used for cultivated crops such as corn, small grain, pasture, hayland, burley tobacco, vegetable crops and Christmas trees.

Plott loam, stony

Description: The Plott series consists of well drained soils on sloping to very steep ridges and side slopes of the Southern Appalachian Mountains. Slopes are 6 to 70 percent.

Drainage and Permeability: Well drained. Runoff is slow under forest cover and internal drainage is medium. Permeability is moderately rapid.

Use and Vegetation: Most areas are in forest consisting of a dominant forest type of northern red oak with hickory, sugar maple, yellow-poplar, black locust, hemlock, and eastern white pine as associated. On dry sites or the higher elevations, upland oaks, hickory, blackgum, red maple, yellow birch, black birch, and pitch pine are associated. Flowering dogwood, mountain laurel, and rhododendron are the dominant understory species. Approximately 20 percent of the soil is cleared and used for pasture, hay, corn, truck crops, and burley tobacco.

Rosman, sandy loam, 0.3%, occasionally flooded

Description: The Rosman series consists of well drained soils that formed in loamy alluvium on flood plains of mountain valleys. Slopes range from 0 to 3 percent.

Drainage and Permeability: Well to moderately well drained; slow runoff; moderate internal drainage; moderately rapid permeability. These soils are subject to occasional to frequent overflow.

Use and Vegetation: Most of the acreage is cleared and in cultivation. The chief crops are corn, truck crops, hay, and pasture grasses. The remainder is in mixed hardwood and white pine.

Saunook loam

Description: The Saunook series consists of well drained soils formed in loamy alluvium and colluvium in coves, on benches, fans and toe slopes in the southern Appalachian Mountains. Slope range from 2 to 30 percent.

Drainage and Permeability: Well drained, medium runoff, and medium internal drainage; moderate permeability.

Use and Vegetation: More than 75 percent is cleared. Cleared areas are used for orchards, growing corn, tobacco, tomatoes, small grain, truck crops, ornamentals and pasture. Also, many areas are used for subdivision development. Woodland species include such species as yellow-poplar, eastern white pine, scarlet oak, red maple, white oak, northern red oak, eastern hemlock, black locust, and an understory of mountain laurel, dogwood, rhododendron, blackberries, and various ferns.

Unison loam

Description: Soils of the Unison series are deep and well drained. They are on mountain footslopes, alluvial fans, or stream terraces. Permeability of the soil is moderate. Slopes range from 0 to 45 percent. Mean annual temperature is about 55 F. Mean annual precipitation is about 40 inches.

Drainage and Permeability: Well drained, medium or rapid runoff; moderate permeability.

Use and Vegetation: About half is used for cultivated crops, pasture and orchards, such as corn, small grains, hay, fruit and vegetables. Most of the remainder is in mixed hardwoods, dominated by oaks, maple, poplar, hemlock and pine.

Wayah loam, stony

Description: The Wayah series consists of deep, well drained, moderately rapidly permeable soil on ridges and side slopes at high elevations in the Southern Appalachian Mountains. It formed in residuum weathered from acid crystalline rocks such as gneiss and granite. Slope ranges from 8 to 95 percent.

Drainage and Permeability: Well drained; very little runoff where forest litter has not been disturbed; medium to very rapid runoff where litter has been removed; moderately rapid permeability.

Use and Vegetation: Nearly all of this soil is in forest. In areas higher than about 5400 feet, red spruce and fraser fir are the dominant trees. At the lower elevations, northern red oak, black oak, American beech, yellow birch, black cherry, sugar maple, eastern hemlock, and yellow buckeye are common trees. Common understory plants are serviceberry, striped maple, American chestnut sprouts, silverbell, red maple, pin cherry, rhododendron, flame azalea, and blueberry. Common forbes are hay-scented fern, woodfern, New York fern, Soloman's seal, yellow mandarin, and trillum. In many places, the climate is so severe that ice and wind damage prevent trees from reaching commercial size. In these areas, a windswept phase is recognized. Overall, little commercial forestry is practiced on this soil. A small acreage is covered by heath balds. These balds are vegetated with rhododendron, mountain laurel, blueberry, flame azalea, hawthorn, and mountain ash. The main uses of this soil are for wildlife, and for recreational activities such as hiking, hunting, and scenic viewing.

Source: Interim Soil Survey Report, Haywood Co., NC, 1986, by SCS, USDA in coop. with Haywood Soil & Water Conservation District, Feb., 1986.

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