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A SURVEY OF POTENTIAL POPULATION EXPOSURES TO CHEMICAL CONTAMINANTS PRESENT IN UNPROTECTED SURFACE WATER SUPPLIES IN NORTH CAROLINA

BY

Alvis G. Turner
Francis A. DiGiano
Patricia M. DeRosa

Department of Environmental Sciences & Engineering
School of Public Health
University of North Carolina
Chapel Hill, N.C. 27514

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DISCLAIMER STATEMENT

ABSTRACT

Existing data from state and federal sources were used to identify North Carolina's surface water supplies, populations served, and point-source discharges into surface waters. This information was combined to create a new computer data base which can be used to identify facilities that discharge upstream of surface water supplies. In addition, state-wide use of agricultural pesticides was estimated as a first step in assessing potential non-point source pollutants.

Currently, little organized information is available to establish a complete chemical profile of each point source of wastewater discharge. Even less is known about the chemicals contributed by non-point sources such as agricultural and urban runoff. This preliminary study suggests the need for an integrated data management system linking surface water supply systems to all potential sources of chemical contamination. The specific chemicals entering surface waters must be estimated or, better yet, measured so that potential risks may be evaluated.

As a first step, the organic chemical contaminants in raw water supplies extracted from those surface waters considered most vulnerable to upstream wastewater discharges should be identified and their removal by water treatment measured.

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RECOMMENDATIONS

1. The State should consider initiating an integrated computerized data management system that merges surface water supply and wastewater discharge information. This data base should include:

   a. Detailed, descriptive treatment and production information on each surface water supply system.

   b. Detailed, descriptive discharge volumes, and NPDES permit information for each industrial, municipal, and other discharges; and permit limitations on specified discharges.

   c. Standard Industrial Classification (SIC) codes for each permitted facility; a list of the EPA priority pollutants which might be discharged from each of the permitted facilities; and whether the facility is designated as a primary industry.

   d. Pretreatment limitation if the facility is discharging into a Publicly Owned Treatment Works (POTW) with a pretreatment program.

   This data management system should be capable of linking all the information on individual surface water supply systems and wastewater discharges.

2. The State should collect accurate and reliable information on all agricultural chemical uses, including pesticides, in the state. This information should be computerized by county and river basin and stored in a manner which will allow the data to be used:

   a. In appropriate models for estimating overland and instream migration and risk assessment.

   b. To design effective monitoring programs.

   c. To establish priorities for further study.

3. The State should establish a regular monitoring program to identify trace organic contaminants and their concentrations in those surface water supplies (before and after treatment) which have the greatest number of upstream industrial major discharges. These Public Water Systems have been identified in Table 11 of this report.

4. A long term study should be initiated, with the assistance of POTWs, to evaluate the impact of urban runoff on surface waters in the State.

INTRODUCTION

The prospect of unparalled economic growth in North Carolina raises concerns over the attendant problems of urbanization and industrialization which naturally follow. High among these concerns is the provision of safe drinking water for North Carolinians. What constitutes a "safe" drinking water supply also needs reexamination in light of the impacts of urbanization and industrialization on water quality. The National Academy of Sciences reported in 1977 (Drinking Water Committee, NAS)[1] that 298 volatile organic compounds had been identified in drinking water, and this number has increased since 1977. However, the extent to which consumers are at risk from low-level exposures to these organic substances in drinking water is still uncertain.

The impetus for reexamination of the definition of a safe water supply comes from the Safe Drinking Water Act of 1974. To date, the only organic chemicals to be regulated nationally under this Act are six pesticides and trihalomethanes. However, there are indications that more will follow as health effects studies are completed.

Organic chemicals enter surface waters through both point and non-point sources. These originate from industrial usage, municipal wastewater treatment (e.g. chlorination of wastewater effluents), and from agricultural and urban runoff. Reliable data on the identity and concentration of specific organic chemicals which enter the surface waters of North Carolina by any of these routes are not available. Biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total organic carbon (TOC) are most often used to measure gross concentrations of organics present in wastewaters, but these measurements give no indication of the composition of the organics present. Even less is known about the persistence and fate of the organic solutes in surface waters in the state. Identification of these substances requires sophisticated analytical equipment and is quite expensive. Since both economic and analytical resources are expected to be limited, it will be necessary to focus attention, at least initially, on those drinking water supplies which have the greatest potential for contamination with organic chemicals and which serve the largest number of people.

There are relatively few surface water supplies in North Carolina. Of the 2,712 public water supplies, only about ten percent (243) obtain water from surface sources. However, these systems serve roughly 50 percent of the population. Therefore chemical contamination of surface waters is a major concern. Groundwater contamination has been addressed in a companion study, Present and Potential Impacts of Toxic Substances in Municipal Groundwater

Resources in North Carolina, by Donald Huisingh and Janet R. Hatley, Water Resources Research Institute (Report No. 198)[2]. Surface waters are more vulnerable to chemical contamination than groundwaters because they are subject to upstream discharges, both point and non-point, and all downstream users may be affected. In contrast, groundwater contamination tends to involve a few specific chemicals and usually affects only those supplies in relatively close proximity to the source of contamination.

The purpose of this research was to use existing data on public water supplies, municipal and industrial wastewater discharges, and demographic information to identify those surface water supplies in North Carolina which have the greatest potential for contamination with organic chemicals and which, if contaminated, would expose the largest number of people. A new computer data base was created which should be useful to investigators and regulatory authorities interested in drinking water quality and human risk.

Computer cartography was used to provide a spatial analysis (mapping) of major NPDES point source discharges and surface water supplies by county and by river basin. These maps provide a graphic representation of the spatial relationships between point source discharges and water supply extraction sources.

The only non-point source discharges considered in this research were agricultural pesticides. There were inadequate data to predict the migration and fate of pesticides from agricultural lands and their impact on receiving streams. However, crude estimates of pesticide usage by river basin were derived. These estimates might be used to identify subbasins for further research. A methodology, Chemical Migration and Risk Assessment (CMRA), has been developed by Batelle Pacific Northwest Laboratories for the U.S. Environmental Protection Agency (1982)[3] which can be applied to large river basins when adequate data have been collected.

The research project was severely limited by the paucity of reliable information concerning the actual volumes of industrial and municipal wastewaters discharged, the types and concentrations of organic chemicals present in those discharges, and the fate of these chemicals in surface waters. No specific data are currently available on non-point source discharges of organic chemicals. This project was not intended to supply this data but to organize existing data in a manner which would provide a base for future research on surface and drinking water quality and human exposure.

METHODOLOGY

Using existing information (Table 1), a new computer data base was created. These data were used to describe North Carolina's surface water sources, wastewater discharges, and agricultural pesticide usage; to plot maps showing the distribution of these systems and discharges; and to identify those water systems which have the greatest potential for contamination.

Definitions Used in This Research

Surface Water System - a community water system that either extracts water from a surface source or purchases water from a surface source extractor for their primary permanent use.

Protected Surface Water Supply - a surface water system that has no known National Pollution Discharge Elimination System (NPDES) point-source discharges upstream of the extraction point. For the purposes of this report, a water system may be classified as protected even though there may be point-source discharges not included in the NPDES system and/or non-point discharges. There is little or no information on these sources of contamination.

Unprotected Surface Water Supply - a surface water system which has one or more known NPDES point-source discharges upstream of the extraction point.

Major Municipal NPDES Discharger - defined by EPA and the State as a Publicly-Owned Treatment Works (POTW, SIC Code 4952) which meets one or more of the following criteria:

- discharges one mgd or more, or
- serves a population of at least 10,000, or
- is determined by the State or EPA Regional Office to impact a water quality limiting stream or to receive toxic waste from an industrial user.

Minor Municipal NPDES Discharger - defined by EPA and the State as a POTW which is not a major discharger.

Major Industrial NPDES Discharger - an industrial discharger receiving 80 or more points under the NPDES Industrial Permit Rating System (IPRS). This rating is based on:

Table 1

Sources of Data

Reference	Source	Contact Person
North Carolina Public Water Supply Data (Current through January 1983)	Water Supply Branch, Environmental Health Section, Division of Health Services, N.C. Department of Human Resources	Mr. Leon Pryer
North Carolina NPDES Data (Current through April 1983)	Information Services, Division of Environmental Management, N.C. Department of Natural Resources and Community Development	Ms. Sue Gardner
SIC Code and North Carolina NPDES Permitted Facilities (Current through May 1983)	Permit Compliance System, Office of Water Enforcement and Permits, U.S. Environmental Protection Agency, Washington, D.C.	Mr. Rick Brandes
North Carolina Sub-basin Maps and NPDES Discharge Points (Current through July 1982)	Technical Services, Division of Environmental Management, N.C. Department of Natural Resources and Community Development	Mr. Vince Schneider
List of North Carolina POTWs Subject to Pretreatment	Pretreatment Section, Division of Environmental Management, N.C. Department of Natural Resources and Community Development	Mr. Doug Finan
Major Crop Acreages by County	N.C. Agricultural Statistics, 1982, N.C. Crop and Livestock Reporting Service, N.C. Department of Agriculture	
Pesticide Use Estimates	Department of Entomology, N.C. State University, Raleigh	Dr. R.L. Robertson

Table 1 (Cont'd)

Reference	Source	Contact Person
Pesticide Data	N.C. 1983 Agricultural Chemicals Manual, School of Agriculture and Life Sciences, N.C. State University, Raleigh	
County and River Basin Land Area	N.C. Water Plan Reference Manual, 1974, Division of Resource Planning and Evaluation, N.C. Department of Natural Resources and Community Development	

- toxic pollutant potential of the discharge.
- flow and/or streamflow volume.
- traditional pollutants (BOD, COD, TSS, ammonia, heat load).
- potential public health impacts (50 miles or less from a municipal water supply intake).
- water quality factors (discharging into a water quality limiting stream).

Minor Industrial NPDES Discharger - an industrial discharger receiving less than 80 points under the NPDES IPRS.

Miscellaneous NPDES Discharger - a facility defined by the State as minor NPDES discharger which is neither municipal nor industrial and generally discharges a domestic-type waste (e.g., hotels, restaurants, and gasoline stations).

Industrial Pretreatment - the reduction, elimination, or alteration of pollutants in industrial wastewater prior to their discharge into a publicly owned treatment works (POTW). The purpose of the pretreatment is "to protect POTWs and the environment from damage that may occur when hazardous or toxic wastes are discharged into community sewer systems." The EPA requires all states which administer the NPDES Program to develop a state pretreatment program consistent with the National Pretreatment regulations. In North Carolina, the pretreatment program requires some POTWs to establish local pretreatment that limits pollutants introduced by industrial users. The limitations are designed to prevent interference with the operation of the POTW, prevent pass-through of harmful pollutants which are not removed by the POTW, prevent contamination of municipal sludge, and limit the occupational exposure of treatment plant workers to chemical hazards.

New Data Base on Surface Water Supply Systems in North Carolina

Each water supply system in the State is inspected regularly by a representative from the Department of Human Resources. The information from this survey is stored in a central computer file. All public water supplies classified as community water systems (serving a population of 25 or greater) were identified from this computer file.

All community water systems that extract surface water or purchase surface water as their primary permanent source were listed. Water supply systems that use surface water only as a secondary source or only as a reserve or emergency supply were not counted as surface water supply systems.

The name, identification number, population served, average daily production, surface water source, and location of the extraction point (longitude and latitude) of each surface water system were also abstracted from the central computer file. These data were reviewed and corrected where necessary with the aid of engineers at the central and regional offices of the Water Supply Branch, Division of Health Services

All of this information was entered in a new SAS data set which covers 243 surface water supply systems throughout North Carolina, 153 systems which extract from surface waters and 90 which purchase water from the extractors.

New Data Base on Wastewater Discharges in North Carolina

Selected data on the 2,394 permitted dischargers were abstracted from the computer file of the North Carolina NPDES Permit Program (Division of Environmental Management, Department of Natural Resources and Community Development). These data included the name of the facility, type of ownership (public or private), county location, NPDES permit number, sub-basin code, classification (major or minor), design flow, and latitude and longitude of each facility.

All permitted discharges that were upstream of a water supply extraction point were also matched against the Division of Environmental Management's Pretreatment List. This list includes all publicly owned treatment facilities which are required to have a pretreatment program (design flow equal to or greater than five mgd or receives process waste from any categorical industry).[4]

This information was entered in a new Statistical Analysis System (SAS) data set that covers all the NPDES permitted dischargers in North Carolina, 2,158 of which are classified as minor and 236 as major. Together they have a design discharge volume of 3,878 mgd.

Computer Cartographic Mapping

Using the longitude and latitude data for each surface water supply source and NPDES discharge, a computer cartographic mapping program, CAM-IV-A, was used to locate each of these reference points on a base map of North Carolina. Four maps were produced to illustrate the spatial relationships between surface water supplies and NPDES point source discharges.

Identification of Protected and Unprotected Surface Water Supply Systems

The North Carolina Administrative Code does not specifically define water supply systems as being protected or unprotected. However, some degree of protection is provided to all surface water supply sources by restricting activities and discharges which may impair water quality.

Using sub-basin maps provided by the Technical Services Office of the Division of Environmental Management, upstream discharges that might impact on surface water sources were identified. These maps provide information on the longitude and latitude of each NPDES discharge, the name of the discharger, the NPDES permit number, and the name of the receiving stream. Stream classification data were consulted to check source names and the classification of receiving streams.

The type and number of NPDES discharges upstream of each surface water supply system were determined by comparing the surface water supply map with the point source discharge map. Any discharge into a waterway which eventually flowed into a surface water supply source was considered to be an upstream discharge. No attempt was made to determine the distance between any discharge and the extraction point of a water supply system.

The designations "protected" and "unprotected" are not used in regulatory programs in North Carolina. They were selected solely for purposes of this report and are related only to permitted NPDES wastewater discharges. They are not intended, either explicitly or implicitly, to imply a quantitative relationship between any discharge and any drinking water system.

Linking NPDES Data with SIC Codes and Pretreatment Data

Using SAS, a NPDES computer file was created which contains information on the 2,394 permitted discharges and their upstream locations in relation to surface water supply extraction points by NPDES permit number. This file can be used to search for information on all discharges upstream of a particular water supply, but it does not contain any information on the types of chemicals in these discharges.

Knowing the NPDES permit number, a user can determine the Standard Industrial Classification (SIC) code of the facility by searching the EPA Permit Compliance System file. The SIC code can then be used in conjunction with the EPA "Development Documents" to identify the "priority pollutants" (see Appendix) which might be discharged from that particular industrial facility. This linkage can be

used to provide some information on the potential chemical contaminants that might be present in any permitted discharge.

Using the North Carolina Pretreatment List, all POTWs that are required to have a pretreatment program were also identified and included in the same computer file.

Agricultural Pesticide Use

The methodology used to estimate the types and amounts of agricultural pesticides used in North Carolina was developed by Sheets, Jackson, and Phelps and reported in A Water Monitoring System for Pesticides in North Carolina, (Water Resources Research Institute Report #19, 1970).[5]

North Carolina Agricultural Statistics for 1982 (N.C. Crop and Livestock Reporting Service, North Carolina Department of Agriculture) were used to determine the total acreage of major crops grown in each county. Because relatively insignificant amounts of pesticides would be used on crops other than tobacco, corn, soybeans, cotton, small grains (wheat, oats, barley), Irish potatoes, peanuts, and sweet potatoes, only these crops were used in estimating pesticide usage. This is a conservative approach.

The 1983 Agricultural Chemicals Manual (School of Agriculture and Life Sciences, N.C. State University)[6] provided information on which pesticide chemicals are recommended for particular pests on each crop. This manual includes information on the common and brand name of pesticide chemicals, formulations, rate of application, and any restrictions which are in effect.

The 1974 North Carolina Water Plan Reference Manual (Division of Resource Planning and Evaluation, Department of Natural Resources and Community Development)[7] was used to convert crop acreage by county to acreage by river basin. If a county was located in two river basins, it was assumed that the relative acreage of a given crop would be proportional to the total relative land area in each basin. For example, if fifty percent of the land area in a county was in the Cape Fear basin and fifty percent in the Neuse basin, it was assumed that one-half the acreage of a given crop would be grown in each river basin.

Expert opinion (Professor R.L. Robertson, N.C. State University) was sought to determine which pesticide chemicals would likely be used on any particular crop and how many acres (percentage) of that crop would be treated each year. Using this data, the following equation was used to estimate the amount of pesticide chemical used in each river basin in the state:

$$\frac{\text{Total lbs pesticide (active ingredient)}}{\text{Acres}} \times \text{Percent of Acres Treated} \times \text{Crop Acreage in River Basin} =$$

Lbs of Agricultural Pesticide Applied in River Basin

The uncertainties in these estimates are significant. However, until reliable quantitative pesticide use data are collected, they represent the best information available.

Potential Human Exposure to Chemical Contaminants in Drinking Water

Very little information is available on specific chemicals and their concentrations in any specific water supply in North Carolina. Using existing data, the only index of human exposure available was the number of people served by a surface water supply that was downstream of one or more point source wastewater discharges. This is a very inadequate measure of consumer risk because none of the chemicals discharged or their reaction products may reach a public water supply and, even if they do, their concentrations in drinking water may not present a significant risk.

The population served by protected and unprotected surface water supplies was entered into our data base by county.

RESULTS

Synthetic chemicals have become widely distributed in surface waters as a result of industrial, municipal, and agricultural activity. They are often present in very low concentrations, usually far below the doses and dose rates causing observable effects on man and animals in toxicity studies. Information on the complete range and concentrations of organic substances in any individual drinking water supply is lacking. Consequently there is great uncertainty in estimating the magnitude of the risk to health posed by ingestion of water. This research is seen as a first step in addressing some of these uncertainties in North Carolina.

Spatial Anlaysis

A series of four maps (Figures 1-4) were prepared to illustrate the spatial relationships between surface water supplies and point sources of wastewater discharge. The latitude and longitude of each surface water supply source and major NPDES discharge in the state were obtained from existing data. These reference points were mapped by computer cartography by county and by river basin.

Figure 1 shows the location of all the surface water supply sources (153) in the state by river basin. Most of these sources are concentrated in the Catawba, Yadkin, Cape Fear, and Neuse River basins. Very few communities in the Coastal Plain depend on surface sources for drinking water. Groundwater is the major source of drinking water in this region. Even though most surface water systems are located in the urban areas of the state due primarily to the large quantities required, many small communities also rely on surface sources.

Figure 2 shows the spatial relationship of all major municipal and industrial point sources of wastewater discharges to unprotected (one or more NPDES discharges upstream) surface water systems by river basin. North Carolina and the Environmental Protection Agency classify wastewater discharges into major and minor sources. Major sources account for only 10 percent of point source discharges in the state, however, they contribute approximately ninety percent of the total volume discharged. This map depicts only the major discharges.

The numerous point source discharges in the Piedmont region reflect the intense industrialization in the river basins of this area. Figure 2 is not intended to imply a direct connection between the major wastewater discharges

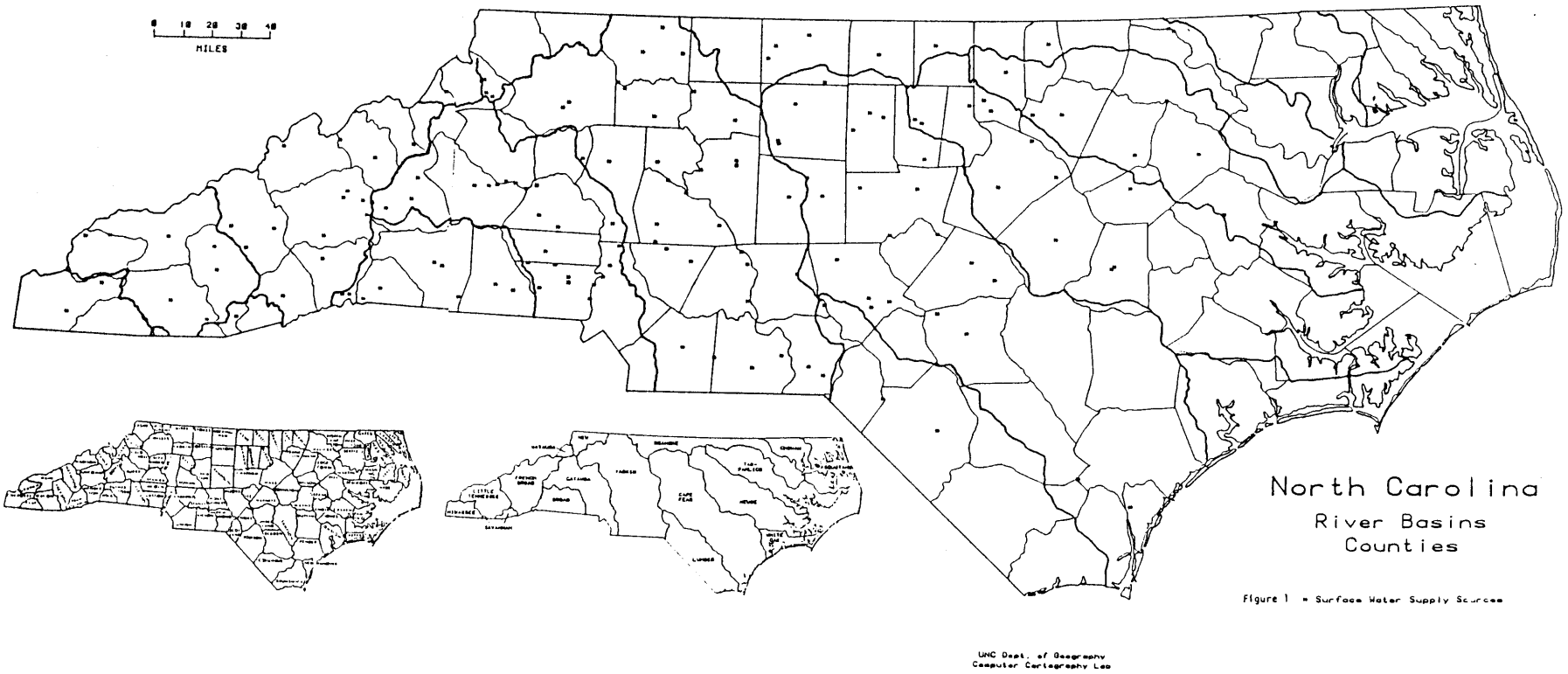
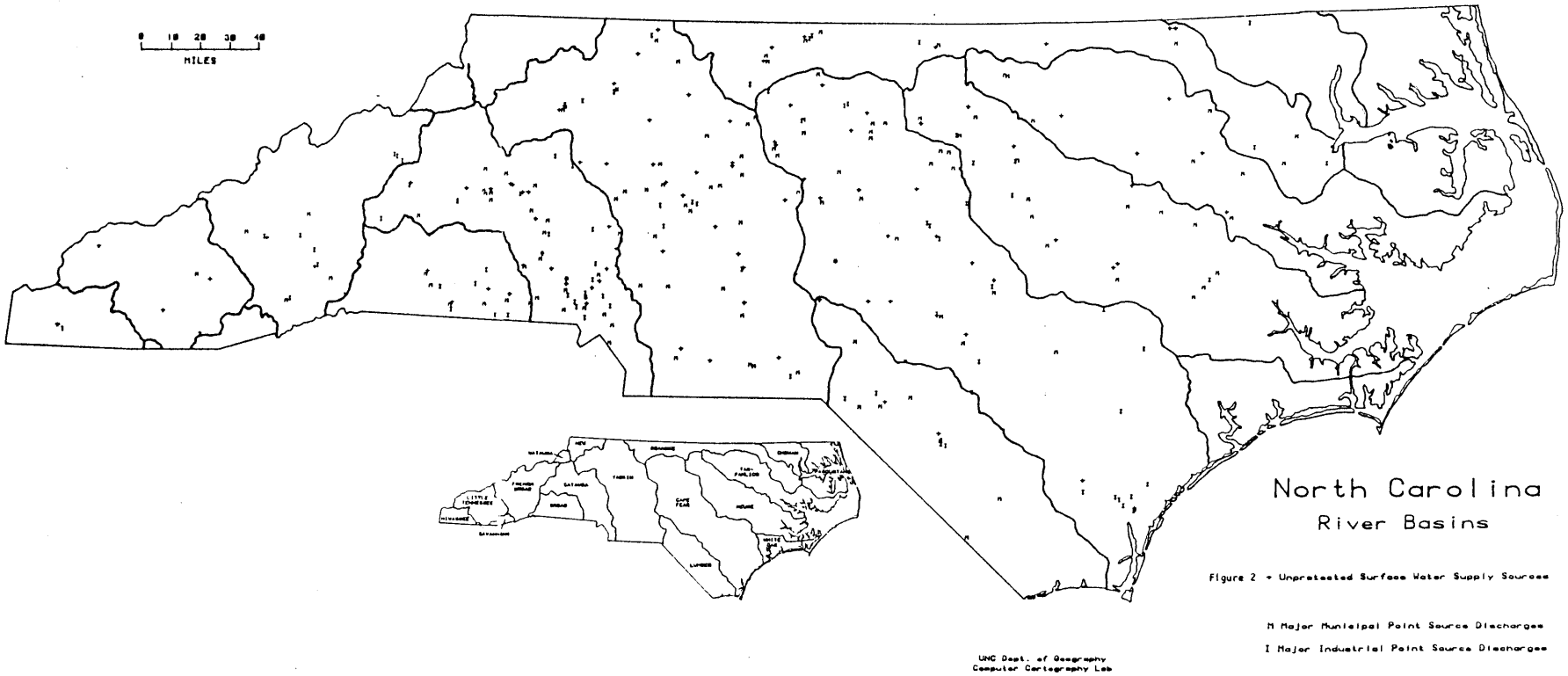


Figure 1 - Surface Water Supply Sources


0 10 20 30 40
MILES
North Carolina
River Basins
Figure 2 - Unpretested Surface Water Supply Sources
M Major Municipal Point Source Discharges
I Major Industrial Point Source Discharges
UNC Dept. of Geography
Computer Cartography Lab

shown and extraction points for water supply systems. Many of the water supplies designated as unprotected are below minor wastewater discharges which are not depicted in Figure 2. Also, we have no information on the fate, distribution, or sinks for organic substances in waterways between discharge and extraction points. Our use of the term "unprotected" refers only to the possibility that a hydraulic connection may exist between a wastewater discharge and the extraction point of a water supply system. Most of the unprotected surface water systems in the state are clustered in the lower reaches of the Catawba, the middle of the Yadkin basin, the upper reaches of the Cape Fear and Neuse, and throughout the Tar-Pamilco river basin.

Figure 3 shows the location of all unprotected surface water sources in the state by river basin. These systems should be given high priority in future investigations of organic chemical pollution in drinking water.

The last map, Figure 4, indicates the location of all surface water sources and all major municipal and industrial wastewater discharges in the state by county. This map should be useful to county officials, particularly planners, since it focuses on a much smaller spatial unit than the river basin. It is obvious that in some counties in the Piedmont there is an intense use of surface waters for both water supply and waste discharge. This suggests that closer examination be given to the potential for conflict in these uses. However, additional data will be required before the extent and magnitude of this conflict is known.

Surface Water Systems

There are 243 water systems in North Carolina that supply drinking water extracted from surface sources (Figures 1 and 5). These systems, located primarily in the Yadkin (24.7 percent) Catawba (20.2 percent) and Cape Fear (14.8 percent) River basins, supply a population of 2.9 million citizens. This is almost one-half of the total population of the state. One hundred fifty three of these systems (63 percent) extract water from surface sources, while 90 purchase treated water from one of the 153 extractors (Figure 6).

There is at least one surface water system in 69 of the state's 100 counties. Many counties, such as Gaston (13), Wake (9), and Burke (8) have multiple systems (Table 2). The 153 surface water extractors produce 531.6 million gallons of water per day, an average of 3.47 mgd per system (Figure 7). Fifty-four percent of the extractors produce less than one mgd (Table 3), while ten systems produce more than 10 mgd.

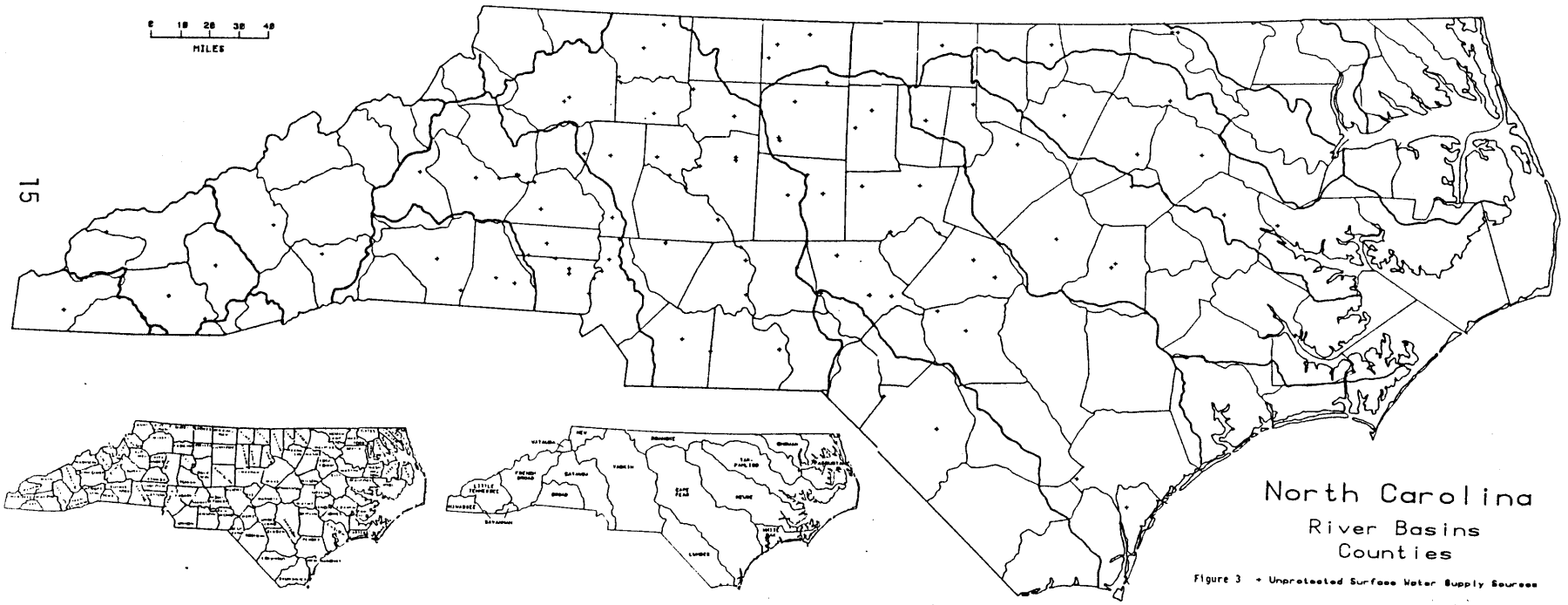


Figure 3 - Unprotected Surface Water Supply Sources

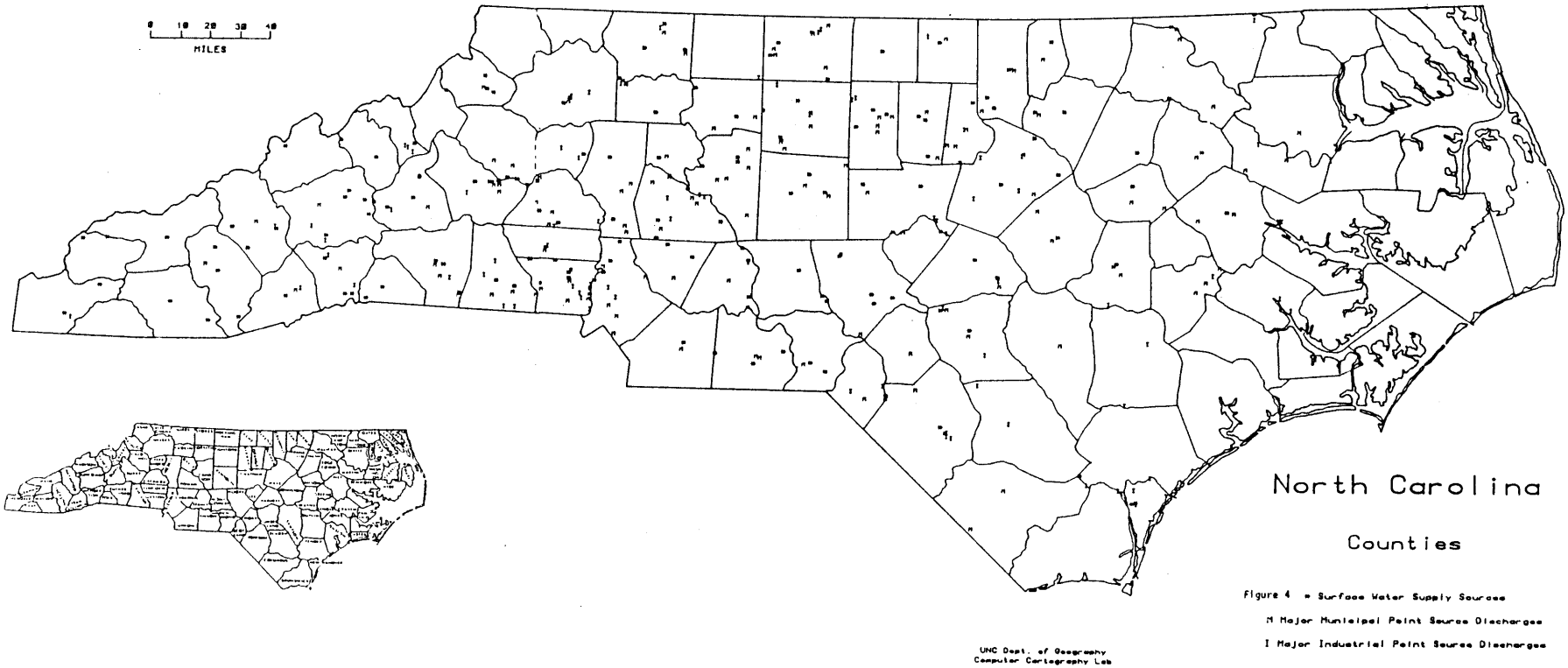

0 10 20 30 40
MILES
North Carolina
Counties
Figure 4 = Surface Water Supply Sources
M Major Municipal Point Source Discharges
I Major Industrial Point Source Discharges
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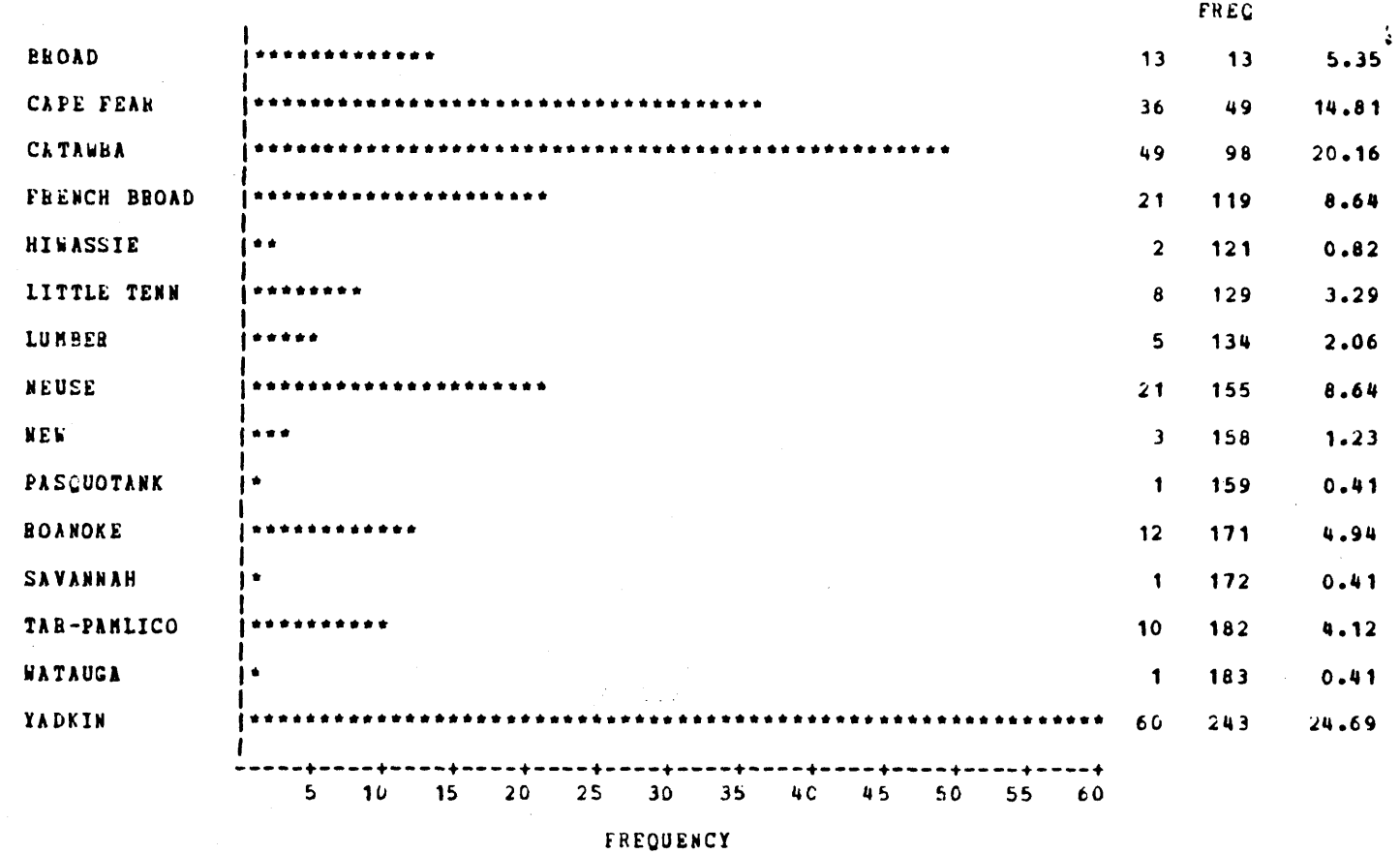
Figure 5

North Carolina Surface Water Supplies*
By River Basin



* Systems

Figure 6

North Carolina Surface Water Supply Sources
By River Basin

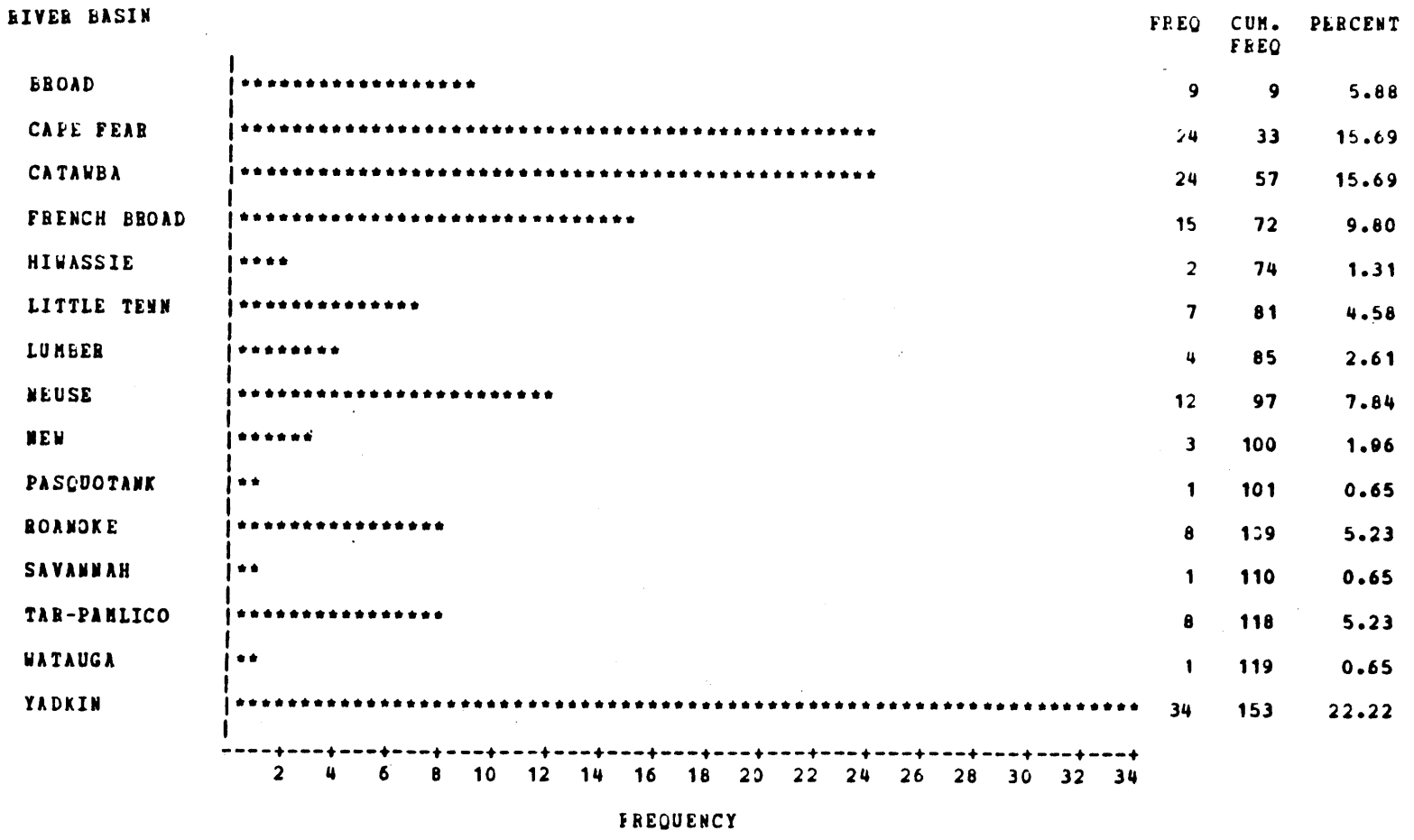


Table 2

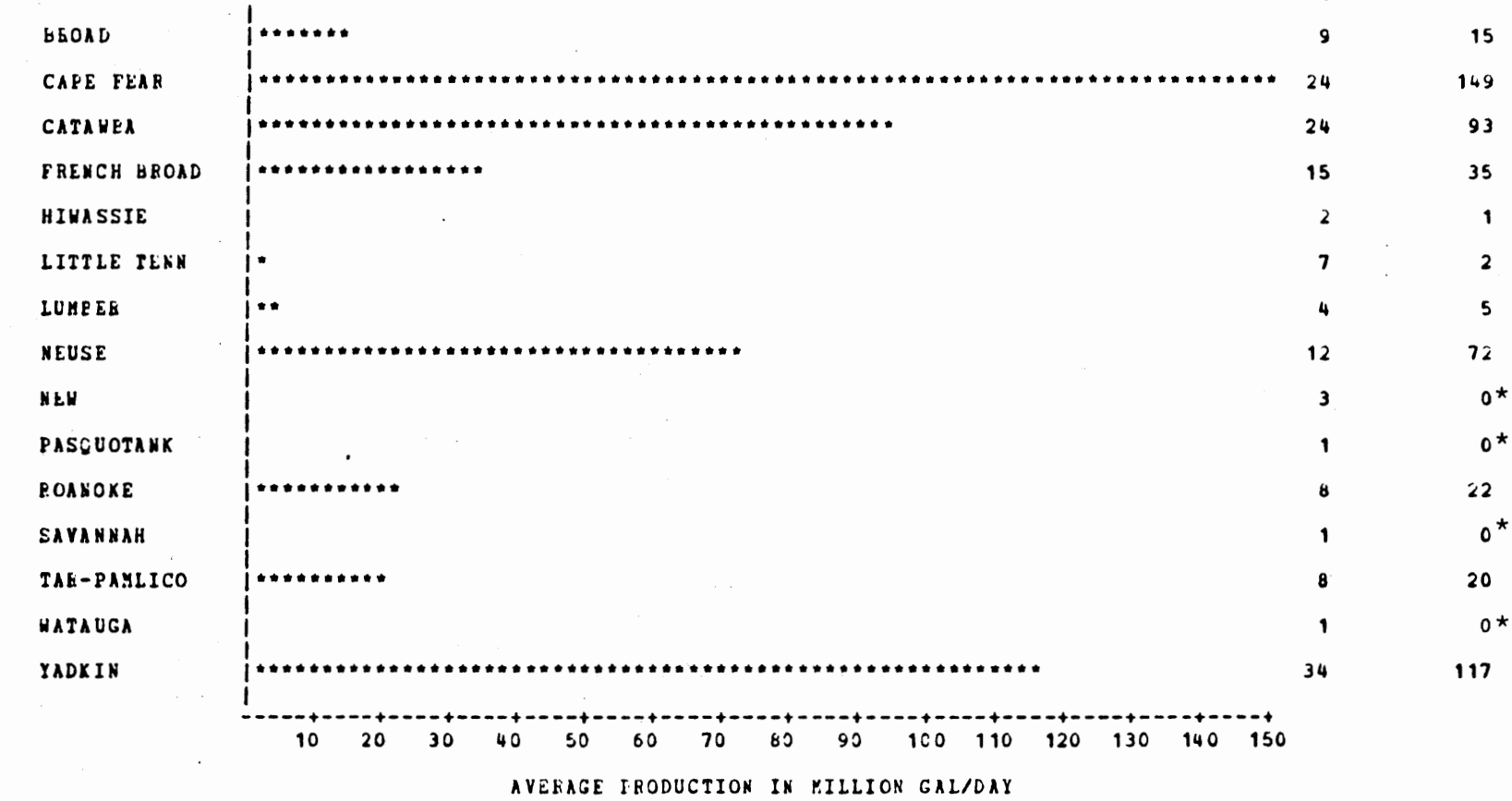
Surface Water Supplies and Population Served
by County in North Carolina

County	Number of Supplies	Population Served
Alamance	5	62,087
Alexander	2	13,000
Anson	7	35,605
Beaufort	1	9,800
Buncombe	7	137,030
Burke	8	39,045
Cabarrus	7	33,200
Caldwell	7	33,700
Caswell	1	2,400
Catawba	5	67,790
Chatham	4	8,680
Cherokee	2	5,000
Cleveland	2	38,000
Columbus	1	500
Cumberland	3	141,985
Dare	1	3,000
Davidson	4	53,025
Davie	2	13,500
Durham	1	115,000
Edgecombe	2	13,600
Forsyth	2	190,323
Franklin	2	7,100
Gaston	13	109,718
Graham	2	1,530
Granville	3	16,900
Guilford	3	237,300
Halifax	4	26,800
Harnett	7	24,886
Haywood	7	39,950
Henderson	4	26,065
Iredell	3	35,500
Jackson	4	9,450
Johnston	4	13,033
Lee	3	18,517
Lincoln	3	10,260
MacDowell	3	6,900
Macon	2	10,000
Madison	2	4,247

County	Number of Supplies	Population Served
Mecklenburg	6	341,550
Mitchell	1	5,000
Montgomery	5	9,931
Moore	5	13,449
Nash	1	45,000
New Hanover	1	51,000
Orange	3	68,362
Person	1	13,600
Pitt	2	36,000
Polk	3	3,846
Randolph	4	24,714
Richmond	4	15,919
Robeson	3	34,735
Rockingham	5	54,824
Rowan	7	78,480
Rutherford	6	18,060
Stanley	5	28,400
Stokes	1	12,800
Surry	4	16,230
Swain	1	3,200
Transylvania	1	8,000
Union	4	24,700
Vance	1	22,669
Wake	9	208,834
Warren	2	2,990
Watauga	4	28,501
Wayne	2	41,000
Wilkes	5	42,305
Wilson	1	33,000
Yadkin	2	4,700
Yancey	1	2,000
State	243	2,897,425

Figure 7

Average Daily Production of Surface Water Supply Sources
By River Basin in North Carolina



* Data values missing for river basin

Table 3

Average Daily Water Production by Surface Water Extractors in North Carolina

Daily Water Production (MGD)	Number of Extractors
Not reported	21
0.0 - 0.5	37
0.5 - 1.0	24
1.0 - 1.5	11
1.5 - 2.0	5
2.0 - 3.0	11
3.0 - 4.0	8
4.0 - 5.0	9
5.0 - 6.0	4
6.0 - 7.0	6
7.0 - 8.0	3
8.0 - 9.0	1
9.0 -10.0	3
Over 10.0	10
Total	153

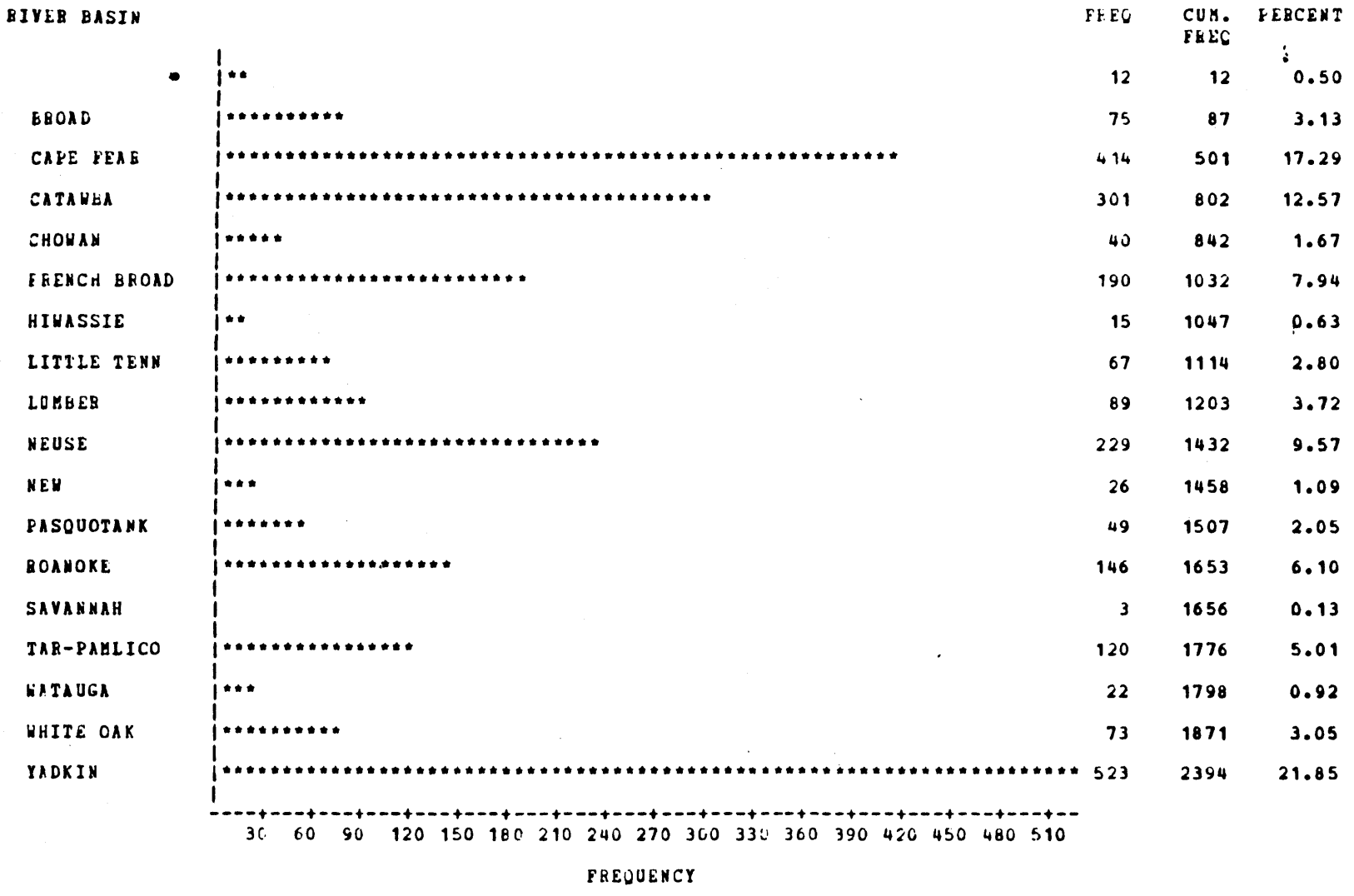
Point Source Wastewater Discharges

There are 2,394 point source permitted discharges into surface waters in North Carolina (Figure 8). Fifty-two percent of these discharges occur in the Yadkin (21.9 percent) Cape Fear (17.3 percent) and Catawba (12.8 percent) River basins. More than one-half of all surface water systems extract water from these same river basins.

The total design flow of the 2,394 discharges is 3,878 mgd, of which more than one-half (2303 mgd) is cooling water from 15 steam generating plants (Tables 4 and 5). Sixty-six percent of the state's total discharge volume enters the Cape Fear River basin (2300 mgd). Significant discharges also enter the Roanoke (401 mgd), Catawba (364 mgd), and Yadkin (199 mgd) River basins (Figure 9). More than one-half of the total major and minor point source discharges in the state enter the Yadkin, Cape Fear, and Catawba River basins (Figures 10 and 11). Even though there is major uncertainty as to the total volume and concentration of toxic organics in these discharges, the opportunity for pollution of surface water sources is significant.

Figure 8

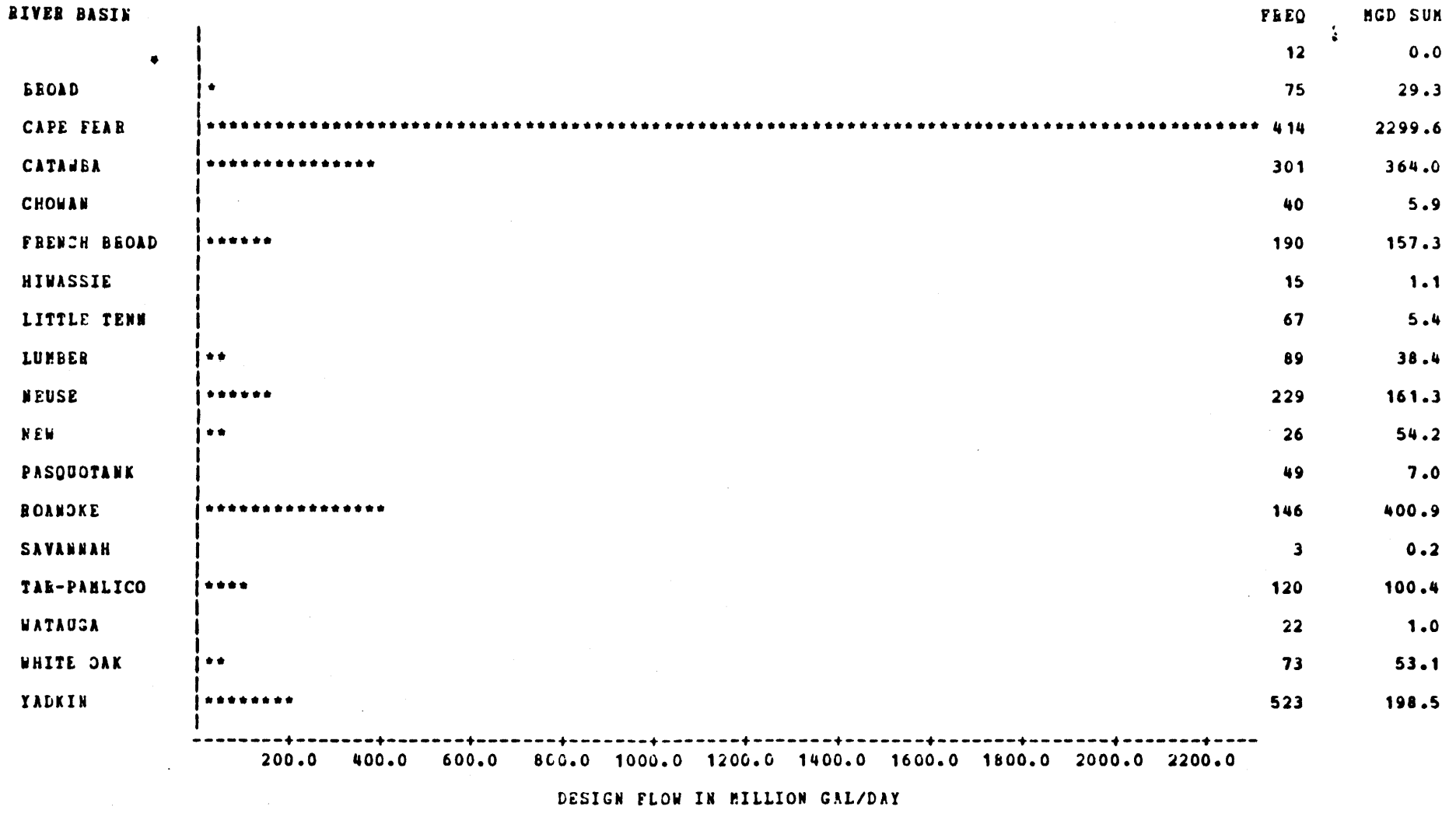
North Carolina Point Source Discharges
by River Basin



* Data values missing for river basin

Figure 9

Total Design Flow From Point Source Discharges
by River Basin in North Carolina



* Data values missing for river basin

Figure 10

Design Flow of Major Discharges
by River Basin in North Carolina

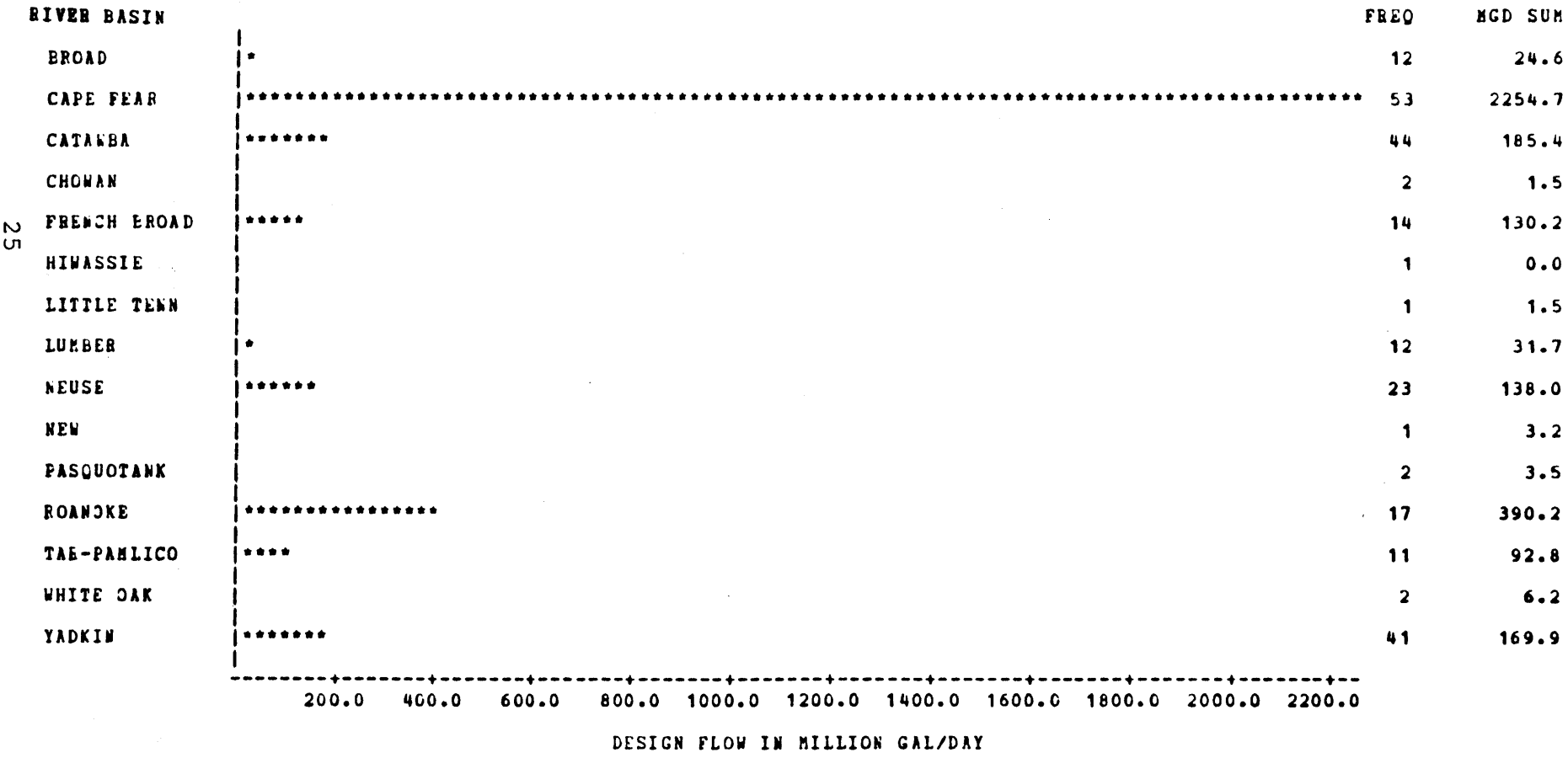
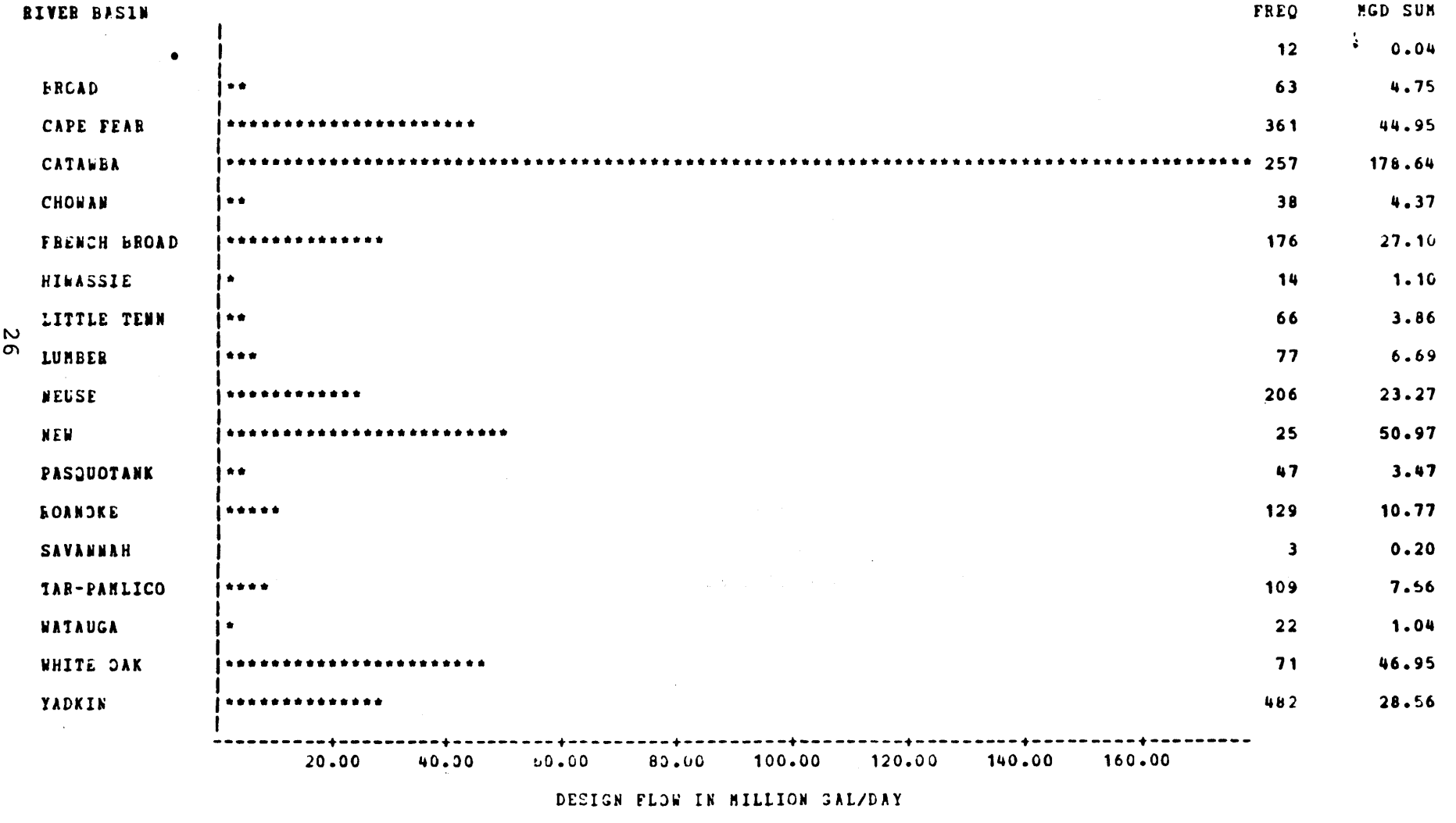


Figure 11

Design Flow of Minor Discharges
by River Basin in North Carolina



* Data values missing for river basin

Table 4

Total Number and Design Volume of Discharges by River Basin in North Carolina

River Basin	Major Discharges (mgd) Number	Design Vol.	Minor Discharges (mgd) Number[2]	Design Vol.
Broad[1]	12	24.6	63	4.75
Cape Fear[1]	53	2254.7	361	44.95
Catawba[1]	44	185.4	257	178.64
Chowan	2	1.5	38	4.37
French Broad[1]	14	130.2	176	27.10
Hiwassee	1	0.1	14	1.10
Little Tenn	1	1.5	66	3.86
Lumber[1]	12	31.7	77	6.69
Neuse	23	138.0	206	23.27
New	1	3.2	25	50.97
Pasquotank	2	3.5	47	3.47
Roanoke[1]	17	390.2	129	10.77
Savannah	0	0.0	3	0.20
Tar-Pamlico	11	92.9	109	7.57
Watauga	0	0.0	22	1.04
White Oak	2	6.2	71	46.95
Yadkin[1]	41	169.9	482	28.56
Totals	236	3433.6	2146	444.25

[1]Location of steam generating plants discharging cooling water: Broad (3), Cape Fear (4), Catawba (4), French Broad (1), Lumber (1), Roanoke (4), and Yadkin (1).

[2]Twelve minor dischargers are omitted because the river basin into which they discharged could not be ascertained. The combined discharge volume of the 12 was 0.04 mgd.

Discounting cooling water discharges from steam generating plants, wastewater treatment plants (650 mgd) and pulp and paper processing plants (228 mgd) contribute significantly (84 percent) to major discharges in the state (Table 5). Chemical and textile industries are also major wastewater dischargers. These estimates are based solely on volume since the type and concentration of organic chemical constituents in these discharges is not known.

Table 5

Major North Carolina Point Source Discharges
by Industry Type

Industry Type (SIC)	Number of Facilities	Total Design Flow (mgd)
Mining and quarrying(non-metal)	3	10.7
Food and kindred products	3	1.0
Textiles	36	62.8
Apparel	1	0.5
Lumber and wood	1	1.0
Pulp and Paper	7	228.4
Chemical	20	75.9
Stone, clay and glass	2	0.8
Primary metals	1	5.1
Fabricated metals	2	0.2
Machinery	1	0.1
Electrical products	4	4.0
Steam electric plants	15	2383.6
Wastewater treatment plants	138	650.3
National security	2	9.2
Totals	236	3433.6

A summary of the data on all surface water supply systems, populations served, and NPDES discharges for North Carolina is shown in Table 6. This table includes information on each water supply system (name, identification number, and water extraction source) by county. It also indicates the number of municipal, industrial, and miscellaneous discharges, both major and minor, upstream of each water supply extraction source. The number of municipal wastewater treatment plants subject to pre-treatment regulation is also included. This summary does not indicate the distances between discharge and extraction points (see maps) nor does it address the types and concentrations of chemicals that may be discharged.

Non-Point Source Discharges (Pesticides)

Nationally, only those pesticides regulated under the Safe Drinking Water Act are routinely monitored in drinking water (Endrin, Lindane, Methoxychlor, Toxaphene, 2,4-D and 2,4,5-TP Silvex). Some additional pesticides are monitored in North Carolina's Ambient Water Quality Monitoring Program which is administered by the Department of Natural Resources and Community Development. In addition, investigations of

Table 6

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	Industrial Major	 Minor	Misc	Primary Extraction Source
Alamance								
Alamance Village Utility	02-02-114	186	0	0	0	2	9	Alamance Creek
Burlington	02-01-010	40,000	0	0	0	1	0	Lake Burlington
Graham-Mebane	02-01-015	27,328	0	0	0	0	0	Quaker Creek Reservoir
Haw River	02-01-020	2,140	0	0	0	1	0	(P) Burlington[1]
Mebane	02-01-018	2,433	0	0	0	0	0	(P) Graham
Alexander								
Alexander County	01-02-015	10,000	0	0	0	1	0	South Yadkin River
Taylorsville	01-02-010	3,000	0	0	0	1	0	(P) Alexander Co.
Alleghany								
Anson								
Anson County	03-04-010	28,000	26(23)	24(4)	11	82	288	Yadkin-PeeDee
McFarlan	03-04-036	104	26(23)	24(4)	11	82	288	(P) Anson Co.
Morven	03-04-040	835	26(23)	24(4)	11	82	288	(P) Anson Co.
North Anson	03-04-02	1,260	26(23)	24(4)	11	82	288	(P) Anson Co.
Peachland	03-04-034	550	26(23)	24(4)	11	82	288	(P) Anson Co.
Polkton	03-04-030	770	26(23)	24(4)	11	82	288	(P) Anson Co.
Wadesboro	03-04-020	4,086	0	0	0	0	0	Jones Creek
Ashe								
Avery								
Beaufort								
Washington	04-07-010	9,800	1(1)	0	0	1	2	Tranters Creek
Bertie								
Bladen								
Brunswick								

(*) Number of waste water treatment plants subject to pre-treatment regulation

[1](P) Purchased from

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	Industrial Major	 Minor	Misc	Primary Extraction Source
Buncombe								
Asheville	01-11-010	114,900	0	0	0	0	0	N. Fork Swannao River
Biltmore Estates	01-11-103	120	0	0	0	0	0	(UT) Busbee Lake[2]
Biltmore Forest	01-11-030	2,000	0	0	0	0	0	(P) Asheville
Black Mountain	01-11-020	6,600	0	0	0	0	0	Dunsmore Creek Reservoir
Montreat	01-11-035	1,000	0	0	0	0	0	Flat Creek
Weaverville	01-11-025	4,010	0	0	0	0	0	Ox Creek
Woodfin	01-11-015	8,400	0	0	0	0	0	Sugarcamp Fork
Burke								
Brentwood	01-12-103	4,005	0	0	0	0	1	(P) Morganton
Brentwood-Jamestown	01-12-104	2,100	0	0	0	0	1	(P) Morganton
Burke County	01-12-065	1,200	4(4)	3(2)	4	14	29	(P) Valdese
Drexel	01-12-045	3,000	0	0	0	0	0	Propst Creek
Icard Township	01-12-060	2,240	4(4)	3(2)	4	14	29	(P) Valdese
Morganton	01-12-015	16,000	0	0	0	0	1	Warrior Fork
Triple Community	01-12-040	3,500	4(4)	3(2)	4	14	29	(P) Valdese
Valdese	01-12-010	7,000	4(4)	3(2)	4	14	29	Lake Rhodhiss
Cabarrus								
Concord	01-13-010	26,000	0	0	0	1	0	Coldwater Creek
Harrisburg	01-13-025	300	0	0	0	1	0	(P) Concord
Jackson Park	01-13-045	600	0	0	0	1	0	(P) Concord
Mount Pleasant	01-13-020	1,300	0	0	0	0	0	Dutch Buffalo Creek
Rockland	01-13-035	1,000	0	0	0	1	0	(P) Concord
Royal Oaks	01-13-015	2,500	0	0	0	0	0	(P) Cannon Mills, Rowan County
South Concord	01-13-040	1,500	0	0	0	1	0	(P) Concord
Caldwell								
Baton	01-14-025	4,100	7(5)	3(2)	4	16	32	(P) Lenoir
Caldwell County	01-14-047	2,400	7(5)	3(2)	4	16	32	(P) Lenoir
Granite Falls	01-14-030	3,000	7(5)	3(2)	4	16	33	Lake Rhodhiss
Hudson	01-14-020	2,800	7(5)	3(2)	4	16	32	(P) Lenoir
Lenoir	01-14-010	20,000	7(5)	3(2)	4	16	32	Lake Rhodhiss
Rhodhiss	01-14-035	800	7(5)	3(2)	4	16	33	(P) Granite Falls
Saw Mill	01-14-040	600	7(5)	3(2)	4	16	32	(P) Lenoir

[2](UT) Unnamed tributary

Table 6 (Cont'd)

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	Industrial Major	 Minor	Misc	Primary Extraction Source
Camden								
Carteret								
Caswell								
Yanceyville	02-17-010	2,400	0	0	0	0	0	Country Line Creek
Catawba								
Conover	01-18-020	3,900	7(5)	4(2)	5	18	36	(P) Hickory
Hickory	01-18-010	40,000	7(5)	4(2)	5	18	36	Catawba River
Longview	01-18-025	3,390	7(5)	4(2)	5	19	36	Lake Hickory
Maiden	01-18-030	3,000	0	0	0	0	0	Maiden Lake
Newton	01-18-015	17,500	0	0	0	0	2	Jacobs Fork
Chatham								
Goldston-Gulf	03-19-025	900	5(4)	4(3)	0	18	31	Deep River
Pittsboro	03-19-015	1,580	8(7)	0	4	22	54	Haw River
Siler City	03-19-010	6,000	1(0)	0	0	0	0	Rocky River
Saint Lukes	03-19-040	200	5(4)	4(3)	0	18	31	(P) Goldston-Gulf
Cherokee								
Andrews	01-20-020	2,500	0	0	0	0	0	Beaver Creek
Murphy	01-20-010	2,500	0	1(0)	1	1	3	Hiwassie River
Chowan								
Clay								
Cleveland								
Kings Mountain	01-23-020	15,000	0	0	0	1	1	John Henry Moss River
Shelby	01-23-010	23,000	0	0	1	1	5	First Broad River
Columbus								
Riegelwood	04-24-035	500	25(20)	10(4)	12	58	133	Cape Fear River
Craven								
Cumberland								
Fayetteville	03-26-010	78,000	23(18)	9(4)	9	54	119	Cape Fear River
Fort Bragg	03-26-344	58,000	0	0	0	1	5	Little River
Hope Mills	03-26-025	5,985	23(18)	9(4)	9	54	119	(P) Fayetteville

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	 Industrial Major	 Minor	Misc	Primary Extraction Source
Currituck								
Dare								
Nags Head	04-28-010	3,000	0	0	0	0	0	Fresh Pond
Davidson								
Davidson Water, Inc.	02-29-025	25	6(5)	7(0)	5	25	136	Yadkin River
Denton	02-29-030	6,000	18(16)	14(0)	10	57	207	Yadkin River
Lexington	02-29-010	32,000	1(0)	0	0	1	7	Abbotts Creek
Thomasville	02-29-020	15,000	1(0)	0	0	1	7	Abbotts Creek
Davie								
Davie County	02-30-015	9,500	1(1)	0	0	3	9	South Yadkin River
Mocksville	02-30-010	4,00	0	0	0	1	1	Hunting Creek
Duplin								
Durham								
Durham	03-32-010	115,000	0	0	0	0	2	Lake Michie
Edgecombe								
Princeville	04-33-045	1,600	5(5)	9(1)	0	8	37	(P) Tarboro
Tarboro	04-33-010	12,000	5(5)	9(1)	0	8	37	Tar River
Forsyth								
Kernersville	02-34-020	7,200	0	1(0)	0	0	4	(P) Winston-Salem
Winston-Salem	02-34-010	183,123	0	1(0)	0	0	4	Salem Lake
Franklin								
Franklinton	02-35-010	4,000	0	0	0	0	0	Sally Kearney Creek
Louisburg	02-35-015	3,100	2(2)	1(1)	0	1	9	Tar River
Gaston								
Belmont	01-36-015	15,000	11(9)	12(2)	12	44	67	Catawba River
Bessemer	01-36-025	6,000	0	0	0	0	0	City Lake
Catawba Heights	01-36-070	262	10(8)	12(2)	9	33	59	(P) Mout Holly
Cherryville	01-36-030	4,800	0	0	0	0	1	Indian Creek
Cramerton	01-36-040	1,842	6(4)	6(0)	2	16	17	(P) Gastonia
Dallas	01-36-065	4,170	6(4)	6(0)	2	16	17	(P) Gastonia
Gastonia	01-36-010	59,000	6(4)	6(0)	2	16	17	South Fork Catawba River
High Shoals	01-36-075	700	5(4)	2(0)	2	14	15	South Fork Catawba River
Lowell	01-36-060	3,300	6(4)	6(0)	2	16	17	(P) Gastonia
McAdenville	01-36-045	970	6(4)	6(0)	2	16	17	(P) Gastonia
Mount Holly	01-36-020	8,900	10(8)	12(2)	9	33	59	Catawba River
Ranlo	01-36-034	1,774	6(4)	6(0)	2	16	17	(P) Gastonia
Stanley	01-36-035	3,000	0	1(0)	0	0	0	Hoyle Creek
Fontana Village Resort	01-38-101	1,500	1(1)	6(0)	0	7	39	Fontana Lake
Tapoco, Inc.	01-38-104	30	0	0	0	0	0	Yellow Hammer Branch

Table 6 (Cont'd)

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	 Industrial Major	 Minor	 Misc	Primary Extraction Source
Granville								
Creedmoor	02-39-015	1,600	0	0	0	0	0	Ledge Creek
Oxford	02-39-010	7,500	0	0	0	0	0	Devin Lake
Umstead Hosp-Butner	02-39-107	7,800	0	0	0	0	0	Butner Lake
Greene								
Guilford								
Greensboro	02-41-010	170,000	1(0)	0	0	4	3	Lake Brandt
High Point	02-41-020	65,000	0	0	0	8	4	Deep River
Jamestown	02-41-030	2,300	0	0	0	8	6	Deep River
Halifax								
Enfield	04-42-025	3,600	0	2(0)	0	2	8	Fishing Creek
Halifax County	04-42-040	700	6(5)	5(0)	5	13	69	(P) Weldon
Roanoke Rapids	04-42-010	19,000	6(5)	5(0)	5	13	68	Roanoke River
Weldon	04-42-020	3,500	6(5)	5(0)	5	13	69	Roanoke River
Harnett								
Angier	03-43-015	1,856	21(18)	7(4)	7	47	110	(P) N.E. Metro
Coats	03-43-020	1,445	21(18)	7(4)	7	47	110	(P) N.E. Metro
Dunn	03-43-010	9,450	21(18)	9(4)	7	50	111	Cape Fear River
Erwin	03-43-035	3,220	21(18)	9(4)	7	50	111	(P) Dunn
Lillington	03-43-025	2,115	21(18)	7(4)	7	47	110	(P) N.E. Metro
N.E. Metro-Harnett County	03-43-045	6,000	21(18)	7(4)	7	47	110	Cape Fear River
Shawtown	03-43-040	800	21(18)	7(4)	7	47	110	(P) Lillington
Haywood								
Canton	01-44-015	7,500	0	0	0	0	3	Pigeon River
Clyde	01-44-025	1,900	0	0	0	0	3	(P) Canton
Hazelwood	01-44-030	2,300	0	0	0	0	0	(P) Waynesville
Junaluska	01-44-035	2,050	0	0	0	0	0	(P) Maggie Valley
Lake Junaluska Assembly	01-44-107	4,200	0	0	0	0	0	(P) Waynesville
Maggie Valley	01-44-040	6,000	0	0	0	0	0	Campbells Creek
Waynesville	01-44-010	16,000	0	0	0	0	0	Allens Creek
Henderson								
Hendersonville	01-45-010	25,000	0	0	0	0	2	Mills River
J.P. Stevens-Tuxedo	01-45-123	240	0	0	0	0	0	(UT) #1
Laurel Park	01-45-030	750	0	0	0	0	2	(P) Hendersonville
Mondamin	01-45-104	75	0	0	0	0	0	(UT) #2
Hertford								

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	 Industrial Major	 Minor	Misc	Primary Extraction Source
Hoke								
Hyde								
Iredell								
Mooresville	01-49-015	9,000	9(7)	12(2)	6	30	55	Lake Norman
Statesville	01-49-010	25,000	0	0	0	1	1	South Yadkin River
West Iredell	01-49-158	1,500	0	0	0	1	0	(P) Alexander County
Jackson								
Dillardtown	01-50-135	150	0	0	0	0	0	(P) Sylva
Sapphire Valley	01-50-113	800	0	0	0	0	0	Intake Branch
Sylva	01-50-010	3,500	0	0	0	0	0	Fisher Creek
West Carolina University	01-50-116	5,000	0	0	0	0	0	Tuckaseegee River
Johnson								
Four Oaks	03-51-035	1,200	5(5)	6(2)	3	18	55	(P) Smithfield
Kenly	03-51-030	1,433	5(5)	6(2)	3	18	55	(P) Smithfield
Smithfield	03-510010	7,800	5(5)	6(2)	3	18	55	Neuse River
West Smithfield	03-51-055	2,600	5(5)	6(2)	3	18	55	(P) Smithfield
Jones								
Lee								
Cumnock	03-53-025	117	5(4)	4(3)	0	18	31	(P) Goldston-Gulf Chatham County
Northview	03-53-020	400	21(18)	6(4)	6	45	108	(P) Sanford
Sanford	03-53-010	18,000	21(18)	6(4)	6	45	108	Cape Fear River
Lenoir								
Lincoln								
Boger City	01-55-025	4,000	3(2)	2(0)	2	13	14	(P) Lincolnton
Hill-N-Dale	01-55-127	300	3(2)	2(0)	2	13	14	(P) Lincolnton
Lincolnton	01-55-010	5,960	3(2)	2(0)	2	13	24	South Fork Catawba River
McDowell								
American Thread Co.	01-56-101	500	0	0	0	0	1	Armstrong Creek
Marion	01-56-010	4,000	0	0	0	0	0	Buck Creek
Old Fort	01-56-025	2,400	0	0	0	0	0	Jarett Creek

Table 6 (Cont'd)

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal		Industrial		Misc	Primary Extraction Source
			Major(*)	Minor(*)	Major	Minor		
Macon								
Franklin	01-57-010	5,000	0	0	0	0	1	Cartoogecaye Creek
Highlands	01-57-015	5,000	0	0	0	0	1	Big Creek
Madison								
Hot Springs	01-58-020	647	0	0	0	0	0	Cascade Branch
Mars Hill	01-58-010	3,600	0	0	0	0	0	Big Laurel Creek
Martin								
Mecklenburg								
Charlotte	01-60-010	330,000	10(8)	12(2)	9	32	59	Mountain Island
Cornelius	01-60-030	1,700	9(7)	12(2)	7	31	58	(P) Davidson
Davidson	01-60-020	4,400	9(7)	12(2)	7	31	58	Lake Norman
Huntersville	01-60-025	1,750	9(7)	12(2)	7	31	58	Lake Norman
Matthews	01-60-035	700	10(8)	12(2)	9	32	59	(P) Charlotte
Pineville	01-60-040	3,000	10(8)	12(2)	9	32	59	(P) Charlotte
Mitchell								
Spruce Pine	01-61-010	5,000	0	0	0	0	0	Beaver Creek
Montgomery								
Biscoe	03-62-035	1,790	0	0	0	1	2	(P) Montgomery County
Candor	03-62-030	781	0	0	0	0	0	Drowning Creek
Montgomery County	03-62-010	2,500	0	0	0	1	2	Little River
Mount Gilead	03-62-015	1,630	0	0	0	1	2	(P) Montgomery County #2
Troy	03-62-020	3,230	0	0	0	1	2	(P) Montgomery County #3
Moore								
Carthage	03-63-025	1,405	0	0	0	0	1	Nicks Creek
Robbins	03-63-015	1,544	0	2(2)	0	0	1	Mill & Cabin Creek
Samerkand Manor	03-63-127	200	0	0	0	0	1	Drowning Creek
Southern Pines	03-63-010	9,400	0	0	0	0	0	Mill Creek
Vass	03-63-045	900	0	0	0	0	2	Little River
Nash								
Rocky Mount	04-64-010	45,000	3(3)	4(1)	0	2	14	Tar River
New Hanover								
Wilmington	04-65-010	51,000	27(22)	22(4)	22	74	151	Cape Fear River
Northampton								

Table 6 (Cont'd)

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	 Industrial Major	 Minor	Misc	Primary Extraction Source
Onslow								
Orange								
Hillsborough	03-68-015	7,562	0	0	0	1	3	Eno River
Orange Water & Sewer	03-68-010	55,000	0	0	0	0	0	University Lake
Orange-Alamance	03-68-020	5,800	0	0	0	0	0	Eno River
Pamlico								
Pasquotank								
Pender								
Perquimans								
Person								
Roxboro	02-73-010	13,600	0	0	1	0	0	City Lake
Pitt								
Colonial Mobile Home Park	04-74-135	1,000	6(6)	12(1)	0	11	40	(P) Greenville
Greenville Utility	04-74-010	35,000	6(6)	12(1)	0	11	40	Tar River
Polk								
Columbus	01-75-015	1,100	0	0	0	0	0	Hore Creek
Saluda	01-75-020	950	0	0	0	0	2	(P) Hendersonville, Henderson County
Tryon	01-75-010	1,796	0	0	0	0	0	Colt Creek
Randolph								
Asheboro	02-76-010	20,000	0	0	0	1	0	Back Creek/Lucas Lake
Franklinville	02-76-035	836	0	0	0	0	1	(P) Ramseur
Ramseur	02-76-020	1,178	0	0	0	0	1	Sandy Creek
Randelman	01-76-015	2,700	0	0	0	1	2	Polecat Creek
Richmond								
Ellerbe	03-77-020	1,770	26(23)	24(4)	11	82	288	(P) Richmond County
Hamlet	03-77-010	5,090	0	0	0	0	0	Marks Creek
Richmond County	03-77-109	559	26(23)	24(4)	11	82	288	(P) Anson County
Rockingham	03-77-015	8,500	0	0	0	0	0	Falling Creek
Robeson								
Lumberton	03-78-010	20,000	3(3)	1(0)	1	2	5	Lumber River
Robeson County	03-78-055	11,235	1(1)	0	1	1	2	Lumber River
Robeson County/Lumberton	03-78-130	3,500	3(3)	1(0)	1	2	5	(P) Lumberton

Table 6 (Cont'd)

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	 Industrial Major	 Minor	Misc	Primary Extraction Source
Rockingham								
Dan River	02-79-040	7,324	2(1)	2(0)	1	7	27	(P) Eden
Eden	02-79-010	26,000	291)	2(0)	1	7	27	Dan River
Madison	02-79-030	3,000	0	1(0)	1	3	21	Dan River
Mayodan	02-79-025	2,500	0	1(0)	0	0	1	Mayo River
Reidsville	02-79-020	16,000	0	0	0	0	1	Troublesome Creek
Rowan								
Cannon Mills Co.	01-80-015	22,500	0	0	0	0	0	Irish Buffalo Creek
East Landis	01-80-176	500	0	0	0	0	0	(P) Landis
East Spencer	01-80-060	2,480	10(9)	9(0)	7	37	163	(P) Salisbury
Kannapolis	01-80-020	18,000	0	0	0	0	0	(P) Cannon Mills
Landis	01-80-038	1,500	0	0	0	0	0	Lake Wright
Salisbury	01-80-010	30,000	10(9)	9(0)	7	37	163	Yadkin River
Spencer	01-80-030	3,500	10(9)	9(0)	7	37	163	(P) Salisbury
Rutherford								
Alexander Mills	01-81-017	1,080	0	0	0	0	0	(P) Forest City
Cliffside-Cone Mills	01-81-108	300	2(2)	0	1	4	3	Second Broad River
Ellenboro	01-81-038	980	0	0	0	0	0	(P) Forest City
Forest City	01-81-010	9,500	0	0	0	0	0	Second Broad River
Rutherford-Spindale	01-81-035	3,200	0	0	0	1	1	Catheys Creek
Sandy Mush	01-81-045	3,000	0	0	0	0	0	(P) Forest City
Sampson								
Scotland								
Stanley								
Albemarle	01-84-010	17,500	19(16)	14(0)	11	59	211	Yadkin River
Badin	01-84-102	1,900	19(16)	14(0)	11	59	211	Badin Lake
Norwood	01-84-015	2,500	19(16)	16(0)	11	62	222	Lake Tillery
Oakboro	01-84-020	1,500	19(16)	14(0)	11	59	211	(P) Stanly County Utility
Stanley County Utility	01-84-035	5,000	19(16)	14(0)	11	59	211	(P) Albemarle
Stokes								
King District Water Assoc.	02-85-010	28,800	5(4)	3(0)	5	11	41	Yadkin River
Surry								
Dobson	02-86-030	1,200	0	0	0	0	1	Fisher River
Elkin	02-86-020	4,050	0	0	0	0	1	Big Elkin Creek
Mount Airy	02-86-010	8,480	0	0	0	1	0	Lovills Creek
Pilot Mountain	02-86-025	2,500	0	0	0	0	0	Toms Creek

Table 6 (Cont'd)

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	 Industrial Major	 Minor	Misc	Primary Extraction Source
Swain								
Bryson City	01-87-010	3,200	0	0	0	0	0	Lands Creek
Transylvania								
Brevard	01-88-010	8,000	0	0	0	0	0	Cathey Creek
Tyrell								
Union								
Marshville	01-90-015	3,500	0	0	0	0	1	Lanes Creek
Monroe	01-90-010	17,000	0	0	0	1	2	Lake Twitty
Waxhaw	01-90-020	1,700	0	0	0	1	2	(P) Monore
Wingate	01-90-030	2,500	0	0	0	1	2	(P) Monroe
Vance								
Henderson-Kerr Lake	02-91-010	22,669	1(1)	0	0	0	3	Nutbush Creek
Wake								
Apex	03-92-045	2,980	3(3)	3(1)	0	5	26	(P) Cary
Cary	03-92-020	23,700	3(3)	3(1)	0	5	26	(P) Raleigh
Feltonsville	03-92-060	600	3(3)	3(1)	0	5	26	(P) Apex
Ideal Mobile Home Park	03-92-146	84	3(3)	3(1)	0	5	26	(P) Raleigh
Morrisville	03-92-075	280	3(3)	3(1)	0	5	26	(P) Cary
Raleigh	03-92-010	170,000	3(3)	3(1)	0	5	26	Neuse River
Wake Forest	03-92-030	4,390	0	0	0	0	0	Smith Creek
Wendell	03-92-035	2,300	0	0	0	0	0	(P) Zebulon
Zebulon	03-92-040	4,500	0	0	0	0	0	Little River
Warren								
Norlina	02-93-020	900	1(1)	0	0	0	3	(P) Henderson-Kerr Lake, Vance County
Warrenton	02-93-010	2,000	1(1)	0	0	0	3	(P) Henderson-Kerr Lake, Vance County
Washington								
Watauga								
Appalachian State Univ.	01-95-101	10,000	0	0	0	0	0	Howards Creek
Beech Mountain	01-95-104	2,500	0	0	0	0	0	Pond Branch
Blowing Rock	01-95-020	801	0	0	0	0	0	Flattop Branch
Boone	01-95-010	15,200	0	0	0	0	0	Winkler Creek

Table 6(Cont'd)

Identification of Surface Water Systems with NPDES Upstream Discharges

County Name of Water System	I.D. Number	Pop. Served	Number of Upstream Discharges Municipal Major(*)	 Minor(*)	 Industrial Major	 Minor	Misc	Primary Extraction Source
Wayne								
Cherry Hospital	04-96-105	3,000	0	2(2)	0	2	5	Little River
Goldsboro	04-96-010	38,000	7(7)	8(3)	4	21	64	Neuse River
Wilkes								
Blue Ridge	01-97-030	4,200	0	0	0	0	1	(P) North Wilkesboro
Cricket-Millers Creek	01-97-020	7,700	0	0	0	0	1	(P) North Wilkesboro
Mulberry-Fairplains	01-97-015	7,875	0	0	0	0	1	(P) North Wilkesboro
North Wilkesboro	01-97-010	17,700	0	0	0	0	1	Reddies River
Wilkesboro	01-97-025	4,830	0	0	0	2	6	Yadkin River
Wilson								
Wilson	04-98-010	33,000	0	0	0	0	1	Toisnot Swamp
Yadkin								
Jonesville	02-99-010	1,700	2(1)	0	3	3	16	Yadkin River
Yadkinsville	02-99-015	3,000	0	0	0	0	1	South Deep Creek
Yancey								
Burnsville	01-00-010	2,000	0	0	0	0	0	Bowlens Creek

fish kills often include the analysis of fish tissue and water samples for the presence and concentrations of pesticide chemicals.

Agricultural pesticide use can be a serious non-point source water pollution problem and the use of these pesticides has increased dramatically in the last three decades. Data on pesticide usage are not collected in North Carolina and very little is known about the migration of these chemicals into surface or ground waters.

With the assistance of several experts at North Carolina State University, notably Dr. T.J. Sheets, who is director of the Pesticide Residue Research Laboratory, and Professor R.L. Robertson in the Department of Entomology, we have estimated the total annual use of major agricultural pesticides in North Carolina (Table 7). Our estimates indicate that over 26 million pounds of these chemicals (active ingredients) are used in agriculture each year. Herbicides, which generally have a very short half-life in water, account for 45 percent of the pesticides used. Plant growth regulators (19 percent), fumigants (17 percent), nematocides (7 percent), insecticides (6 percent), and fungicides (6 percent), constitute the remaining uses.

Total annual use by river basin has also been estimated (Table 8). These estimates cannot be used to predict either the types or concentrations of pesticide chemicals which may be present in surface or drinking waters. Many other factors, including the chemical properties of the pesticide, method of application, topography, and other environmental conditions will affect the ultimate fate of each pesticide.

Table 7

Estimates of Major Agricultural Pesticides
Used in North Carolina

Pesticide Type Chemical (Brand Name)	Crops	Status[1]	Estimated Annual Use (lbs)
Insecticides			
Acephate (Orthene)	Tabacco		177,583
Methomyl (Lannate, Noudrin)	Soybean, peanut, tobacco	Some R	48,753
Monocrotopnos (Azodrin)	Peanut, tobacco	Restricted	23,357
Carbaryl (Sevin)	Potato, soybean, peanut, tobacco		389,518
B. thuringensis	Tobacco		20,015
Aldicarb (Temik)	Potato, peanut	Restricted	114,650
Carbofuran (Furadan)	Corn, peanut	Some R	268,528
Phorate (Thimet)	Peanut		31,860
Disulfoton (Mocap Plus)	Peanut	Some R	5,310
Fevalerate (Pydrin)	Potato, cotton, soybean, peanut		10,404
Ethoprop (Mocap)	Peanut	Some R	21,240
Fonofos (Dyfonate)	Sweet potato, peanut	Some R	68,040
Chlorpyrifos (Lorsban)	Sweet potato, peanut		29,760
Terbufos (Counter)	Corn		317,830
Methyl parathion	Corn	Restricted	14,000
Permethrin (Ambush, Pounce)	Cotton	Restricted	8,200
Azinphos-methyl (Guthion)	Cotton, potato	Restricted	6,031
Chlordimeform	Cotton	Restricted	410
			1,555,489
Herbicides			
Diphenamid (Enide)	Tobacco, peanut, sweet potato		1,041,875
Pebulate (Tillam)	Tobacco		211,800
Isopropalin (Paarlan)	Tobacco		42,360
Napropamide (Devrinol)	Tobacco		26,475
Pendimethalin (Prowl)	Potato, soybean, peanut, tobacco		514,140
Benefin (Balan)	Peanut		55,401
Vernolate (Vernam)	Peanut		101,775
Metolachlor (Dual)	Potato, soybean, corn, peanut		1,150,800
Alachlor (Lasso)	Potato, soybean, corn, peanut		1,270,225
Naptalam (Alanap)	Soybean, peanut		670,200
Dinoseb (Premerge)	Soybean, peanut		299,700
2,4-DB	Peanut		4,071
Acifluorfen (Blazer)	Soybean, peanut		243,850
Atrazine	Corn		3,456,250
Butylate (Sutan)	Corn		345,625

Pesticide Type Chemical (Brand Name)	Crops	Status[1]	Estimated Annual Use (lbs)
2,4-D	Corn, small grains		428,300
Linuron (Lorox)	Potato, cotton, corn		268,240
Ametryn (Evik)	Corn		246,875
Paraquat	Corn	Restricted	15,800
Glyphosate (Round-up)	Corn		19,750
Trifluralin (Treflan)	Cotton, soybean		1,028,000
Bentazon (Basagran)	Soybean		470,000
Fluometuron (Cotoran)	Cotton		61,500
DSMA/MSMA	Cotton		92,250
Diclofop (Hoelon)	Small grains	Restricted	11,100
Metribuzin (Sencor)	Potato		2,163
Oryzalin (Surflan)	Sweet potato		7,800
Chloramben (Amiben)	Sweet potato		23,400
			12,109,725
Fungicides			
Metalaxyl (Ridomil)	Tobacco		204,876
Mancozeb	Tobacco, peanut		80,393
Chlorthalanil (Bravo)	Peanut		531,000
Copper fungicides	Peanut		354,000
Fentin hydroxide (Du-ter)	Peanut		17,700
Benmyl	Peanut		42,480
Fungicidal sulfurs	Peanut		265,500
			1,495,949
Nematocides			
Ethoprop (Mocap)	Peanut, tobacco	Some R	977,115
Aldicarb (Temik)	Soybean, peanut, tobacco	Restricted	226,850
Fenamiphos (Nemacur)	Peanut, tobacco	Some R	116,250
Fensulfothion (Dasanit)	Tobacco	Some R	136,463
Carbofuran (Furadan)	Peanut, tobacco	some R	255,510
Oxamyl (Vydate)	Tobacco		72,780
Disulfoton (Mocap Plus)	Tobacco	Some R	218,340
			2,003,308
Fumigants			
Dichloropropene and Chloropicrin (Telone C-17)	Tobacco	Restricted	2,139,732 534,933

Pesticide Type Chemical (Brand Name)	Crops	Status[1]	Estimated Annual Use (lbs)
Ethylene dibromide and Chloropicrin (Terr-o-cide 30)	Tobacco	Restricted	1,222,704 698,688
			4,596,057
Plant Growth Regulators			
Maleic hydrazide MH	Tobacco		818,775
Fatty alcohol	Tobacco		4,366,880
			5,185,575
	State Total		26,946,103

[1]Status: Pesticide is partially or completely restricted

Table 8

Agricultural Pesticide Use by River Basin in North Carolina

River Basin	Estimated Annual Use (lbs)	Number of Surface Water Extractors
Broad	179,625	9
Cape Fear	4,814,263	24
Catawba	348,255	24
Chowan	1,319,940	0
French Broad	324,644	15
Hiwassee	20,282	2
Little Tennessee	28,225	7
Lumber	2,416,691	4
Neuse	5,829,720	12
New	89,305	3
Pasquotank	1,287,081	1
Roanoke	3,228,685	8
Savannah	2,792	1
Tar	4,478,970	8
Watauga	15,707	1
White Oak	370,962	0
Yadkin	2,175,213	34
State Totals	26,930,360	153

Our estimates indicate that 56 percent of all the pesticide chemicals used in the state are applied to agricultural lands in the Neuse, Cape Fear, and Tar River basins. Twenty-nine percent of all the surface water systems (44) in the state extract their water from these same basins. These estimates can provide a starting point for examining the potential impact of these pesticides on North Carolina's surface water supplies.

Human Exposure

Research over the past decade has established that thousands of different compounds may be present in natural surface water systems and many of these, perhaps hundreds, may also appear in water supplied to public consumers. The number of organic compounds present and their concentrations in any one water supply are unknown.

At least two million persons in North Carolina regularly consume drinking water which is extracted from surface waters which may be contaminated with chemicals from identified upstream point-source discharges (Table 9).

Table 9

North Carolina Population Served by Surface Water Supplies by County

County	Estimated Population Served	Total County Population	Percent of Population Served
Alamance			
Protected[1]	19,761		19.9
Unprotected[2]	42,326		42.6
Total	62,087	99,319	62.5
Alexander			
Protected	none		none
Unprotected	13,000		52.0
Total	13,000	24,999	52.0
Alleghany (no surface water supplies)			
Anson			
Protected	4,086		26.0
Unprotected	21,519		84.0
Total	25,605[3]	25,605	100.0
Ashe (no surface water supplies)			
Avery (no surface water supples)			
Beaufort			
Protected	none		none
Unprotected	9,800	40,355	24.3
Total	9,800	40,355	24.3
Bertie (no surface water supplies)			
Bladen (no surface water supplies)			
Brunswick (no surface water supplies)			
Buncombe			
Protected	137,030		85.1
Unprotected	none		none
Total	137,030	160,934	85.1

[1] No point source discharges upstream of extraction point.

[2] One or more point source discharges upstream of extraction point.

[3] Population data is uncertain.

County	Estimated Population Served	Total County Population	Percent of Population Served
Burke			
Protected	3,000		4.1
Unprotected	36,045		49.8
Total	39,045	72,504	53.9
Cabarrus			
Protected	3,800		4.4
Unprotected	29,400		34.3
Total	33,200	85,895	38.7
Caldwell			
Protected	none		none
Unprotected	33,700		49.7
Total	33,700	67,746	49.7
Camden (no surface water supplies)			
Cartaret (no surface water supplies)			
Caswell			
Protected	2,400		11.6
Unprotected	none		none
Total	2,400	20,705	11.6
Catawba			
Protected	3,000		2.9
Unprotected	64,790		61.5
Total	67,790	105,208	64.4
Chatham			
Protected	none		none
Unprotected	8,680		26.0
Total	8,680	33,415	26.0
Cherokee			
Protected	2,500		13.3
Unprotected	2,500		13.3
Total	5,000	18,933	26.6
Chowan (no surface water supplies)			
Clay (no surface water supplies)			

County	Estimated Population Served	Total County Population	Percent of Population Served
Cleveland			
Protected	none		none
Unprotected	38,000		45.5
Total	38,000	83,435	45.5
Columbus			
Protected	none		none
Unprotected	500		1.0
Total	500	51,037	1.0
Craven (no surface water supplies)			
Cumberland			
Protected	none		none
Unprotected	141,985		57.4
Total	141,985	247,160	57.4
Currituck (no surface water supplies)			
Dare			
Protected	3,000		22.4
Unprotected	none		none
Total	3,000	13,377	22.4
Davidson			
Protected	none		none
Unprotected	53,025		46.9
Total	53,025	113,162	46.9
Davie			
Protected	none		none
Unprotected	13,500		54.9
Total	13,500	24,599	54.9
Duplin (no surface water supplies)			
Durham			
Protected	none		none
Unprotected	115,000		75.3
Total	115,000	152,785	75.3

County	Estimated Population Served	Total County Population	Percent of Population Served
Edgecombe			
Protected	none		none
Unprotected	13,600		24.3
Total	13,600	55,988	24.3
Forsyth			
Protected	none		none
Unprotected	190,323		78.1
Total	190,323	243,683	78.1
Franklin			
Protected	4,000		13.3
Unprotected	3,100		10.3
Total	7,100	30,055	23.6
Gaston			
Protected	6,000		3.7
Unprotected	103,718		63.8
Total	109,718	162,568	67.5
Gates (no surface water supplies)			
Graham			
Protected	30		0.4
Unprotected	1,500		20.8
Total	1,503	7,217	21.2
Granville			
Protected	16,900		49.6
Unprotected	none		none
Total	16,900	34,043	49.6
Greene (no surface water supplies)			
Guilford			
Protected	none		none
Unprotected	237,300		74.8
Total	237,300	317,154	74.8
Halifax			
Protected	none		none
Unprotected	26,800		48.5
Total	26,800	55,286	48.5

County	Estimated Population Served	Total County Population	Percent of Population Served
Haywood			
Protected	30,550		65.7
Unprotected	9,400		20.2
Total	39,950	46,495	85.9
Henderson			
Protected	315		0.5
Unprotected	25,750		44.0
Total	26,065	58,580	44.5
Hertford (no surface water supplies)			
Hoke (no surface water supplies)			
Hyde (no surface water supplies)			
Iredell			
Protected	none		none
Unprotected	35,500		43.0
Total	35,500	82,538	43.0
Jackson			
Protected	4,450		17.2
Unprotected	5,000		19.4
Total	9,450	25,811	36.6
Johnston			
Protected	none		none
Unprotected	13,033		18.5
Total	13,033	70,599	18.5
Jones (no surface water supplies)			
Lee			
Protected	none		none
Unprotected	18,517		50.4
Total	18,517	36,718	50.4
Lenior (no surface water supplies)			
Lincoln			
Protected	none		none
Unprotected	10,260		24.2
Total	10,260	42,372	24.2

County	Estimated Population Served	Total County Population	Percent of Population Served
McDowell			
Protected	6,400		18.2
Unprotected	500		1.4
Total	6,900	35,135	29.6
Macon			
Protected	none		none
Unprotected	10,000		49.6
Total	10,000	20,178	49.6
Madison			
Protected	4,247		25.2
Unprotected	none		none
Total	4,247	16,827	25.2
Martin (no surface water supplies)			
Mecklenburg			
Protected	none		none
Unprotected	341,550		84.5
Total	341,550	404,270	84.5
Mitchell			
Protected	5,000		34.7
Unprotected	none		none
Total	5,000	14,428	34.7
Montgomery			
Protected	781		3.5
Unprotected	9,150		40.7
Total	9,931	22,469	44.2
Moore			
Protected	9,400		18.6
Unprotected	4,049		8.0
Total	13,449	50,505	26.6
Nash			
Protected	none		none
Unprotected	45,000		67.0
Total	45,000	67,153	67.0

County	Estimated Population Served	Total County Population	Percent of Population Served
New Hanover			
Protected	none		none
Unprotected	51,000		49.3
Total	51,000	103,471	49.3
Northampton (no surface water supplies)			
Onslow (no surface water supplies)			
Orange			
Protected	60,800		78.9
Unprotected	7,562		9.8
Total	68,362	77,055	88.7
Pamlico (no surface water supplies)			
Pasquotank (no surface water supplies)			
Pender (no surface water supplies)			
Perquimans (no surface water supplies)			
Person			
Protected	none		none
Unprotected	13,600		46.6
Total	13,600	29,164	46.6
Pitt			
Protected	none		none
Unprotected	36,000		39.9
Total	36,000	90,146	39.9
Polk			
Protected	2,896		22.3
Unprotected	950		7.3
Total	3,846	12,984	29.6
Randolph			
Protected	none		none
Unprotected	24,714		26.9
Total	24,714	91,728	26.9

County	Estimated Population Served	Total County Population	Percent of Population Served
Richmond			
Protected	13,590		29.9
Unprotected	2,329		5.1
Total	25,919	45,481	35.0
Robeson			
Protected	none		none
Unprotected	34,735		34.2
Total	34,735	101,610	34.2
Rockingham			
Protected	none		none
Unprotected	54,824		65.7
Total	54,824	83,426	65.7
Rowan			
Protected	42,500		42,8
Unprotected	35,980		36.3
Total	78,480	99,186	79.1
Rutherford			
Protected	14,560		27.1
Unprotected	3,500		6.5
Total	18,060	53,787	33.6
Sampson (no surface water supplies)			
Scotland (no surface water supplies)			
Stanly			
Protected	none		none
Unprotected	28,400		58.5
Total	28,400	48,517	58.5
Stokes			
Protected	none		none
Unprotected	12,800		38.7
Total	12,800	33,086	38.7
Surry			
Protected	2,500		4.2
Unprotected	13,730		23.
Total	16,230	59,449	27.3

County	Estimated Population Served	Total County Population	Percent of Population Served
Swain			
Protected	3,200		31.1
Unprotected	none		one
Total	3,200	10,283	31.1
Transylvnia			
Protected	8,000		34.2
Unprotected	none		none
Total	8,000	23,417	34.2
Tyrell (no surface water supplies)			
Union			
Protected	none		none
Unprotected	24,700		35.1
Total	24,700	70,380	35.1
Vance			
Protected	none		none
Unprotected	22,669		61.7
Total	22,669	36,748	61.7
Wake			
Protected	11,190		3.7
Unprotected	197,644		65.6
Total	108,834	301,327	69.3
Warren			
Protected	none		none
Unprotected	2,990		18,4
Total	2,990	16,232	18.4
Washington (no surface water supplies)			
Watauga			
Protected	28,501		90.0
Unprotected	none		none
Total	28,501	31,666	90.0
Wayne			
Protected	none		none
Unprotected	41,000		42.2
Total	41,000	97,054	42.2

County	Estimated Population Served	Total County Population	Percent of Population Served
Wilkes			
Protected	none		none
Unprotected	42,305		72.1
Total	42,305	58,657	72.1
Wilson			
Protected	none		none
Unprotected	33,000		52.3
Total	33,000	63,132	52.3
Yadkin			
Protected	none		none
Unprotected	4,700		16.5
Total	4,700	28,439	16.5
Yancey			
Protected	2,000		13.4
Unprotected	none		none
Total	2,000	14,934	13.4
STATE			
Protected	449,301		7.7
Unprotected	2,448,124		41.6
Total	2,897,425	5,881,766	49.3

These consumers and many others may also be exposed to organic substances, such as pesticides, from non-point sources (Table 8).

Thirty-one counties in the state have no drinking water systems that extract water from surface sources. In another 10 counties -- Buncombe (137,030 consumers), Caswell (2,400), Dare (3,000), Granville (16,900), Madison (4,247), Mitchell (5,000), Swain (3,200), Transylvania (8,000), Watawga (28,501), and Yancey (2,000) -- 210,278 consumers use surface water systems that have no known point-source discharges upstream (defined as protected in our terminology).

In Mecklenberg County more than 300,000 persons consume drinking water from surface sources that have one or more point-source discharges upstream. In another five counties, Cumberland, Durham, Gaston, Guilford, and Wake, more than 100,000 persons in each county receive drinking water from unprotected sources. The number of organic substances and their concentrations in these systems is not known.

DISCUSSION

Our analysis of existing data bases has shown that a significant number of surface water supplies do not meet the definition of "protected" as used in this research. These supplies, therefore, must be considered to be vulnerable to chemical contamination to some extent. Table 6 indicates a wide range of vulnerability based on the number and type of discharges upstream of surface water supplies. In an attempt to quantify what appear to be the most serious conflicts between waste discharge and water supply, the results presented in Table 6 were analyzed further to identify those water supplies subject to the maximum number of upstream discharges. The water supply in each river basin with the most discharges upstream is shown in Table 10 while the 10 water supplies in the state with the most discharges upstream are presented in Table 11. Table 10 emphasizes the point that the intensity of conflict between uses of surface waters for wastewater discharge and water supply is highly variable form river basin to river basin. The conflict appears minimal in the Broad, French Broad, Hiwassee and Lumber. However, it is more severe in the Cape Fear, Catawba, Little Tennessee, Neuse, Roanoke, Tar, and Yadkin.

The 10 water supplies in North Carolina having the greatest number of upstream discharges are all located in the Cape Fear and Yadkin river basins (Table 11). They serve a population of about 250,000. Our method of tabulating upstream discharges and thus designating unprotected surface water supplies (see Methodology) indicates that the water supplies most likely to be affected are in the lower segments of the most highly developed river basins. Therefore, the results presented in Table 11 are not surprising. They should be useful in developing priorities for future monitoring programs.

We must re-emphasize here that the distance between wastewater discharges and water supplies has not been accounted for in this research. Not only may the discharges be some considerable distance upstream, but they may also be on tributaries to the river used as a supply source. Moreover, the mix of discharge types among the categories of municipal (major and minor), industrial (major and minor), and miscellaneous may be quite variable. Without more detailed analysis, even this categorical designation may be misinterpreted. An important consideration, for example, may be what constitutes a "major industrial" discharge. The EPA ranking system applies this designation for a number of reasons; among them are waste discharge volume, estimated

Table 10

Surface Water Supply Sources With The Greatest Number of Upstream NPDES Discharges in Each River Basin in North Carolina

River Basin	PWS Name	County	Population Served*	Upstream Discharges
Broad	Cliffside-Cone Mills	Rutherford	300	10
Cape Fear	Wilmington	New Hanover	51,000	296
Catawba	Belmont	Gaston	15,000	146
French Broad	Canton	Haywood	9,400	3
Hiwassie	Murphy	Cherokee	2,500	6
Little Tennessee	Fontana Village Resort	Graham	1,500	53
Lumber	Lumberton	Robeson	23,500	12
Neuse	Goldsboro	Wayne	38,000	104
New	- No unprotected surface water sources in basin -			
Pasquotank	- No unprotected surface water sources in basin -			
Roanoke	Weldon	Halifax	4,200	98
Savannah	- No unprotected surface water sources in basin -			
Tar	Greenville	Pitt	36,000	69
Watauga	- No unprotected surface water sources in basin -			
Yadkin	Anson County	Anson	33,843	431

* Includes purchasing populations

Table 11

The Ten Surface Water Supplies With the Greatest Number of Upstream NPDES Discharges in North Carolina

PWS Name	Total Number of Upstream Discharges	County	Population Served*	River Basins
Anson County	431	Anson	33,848	Yadkin
Norwood	330	Stanley	2,500	Yadkin
Albemarle	314	Stanley	24,000	Yadkin
Badin	314	Stanley	1,900	Yadkin
Denton	306	Davidson	6,000	Yadkin
Wilmington	296	New Hanover	51,000	Cape Fear
Riegelwood	238	Columbus	500	Cape Fear
Salisbury	226	Rowan	35,980	Yadkin
Fayetteville	214	Cumberland	83,985	Cape Fear
Dunn	198	Harnett	12,670	Cape Fear

* Includes purchasing populations

dilution in the receiving water, proximity to a water supply, concentrations of traditional pollutants (e.g., BOD), or the potential to contain toxic pollutants. Our objective, therefore, has been limited; we have linked together data bases for water supply and wastewater discharge in such a way as to bring attention to the potential for contamination which may, in fact, increase with economic development.

A further qualification is that our data base does not identify which organic chemicals may be discharged at either industrial or municipal treatment facilities. Obviously, the chemical constituents and their concentrations can only be determined by sample analysis.

It is possible to use existing data bases to arrive at some estimate of the types of chemicals which may be present in industrial effluents. The regulations pertaining to industrial discharges are the NPDES Effluent Guidelines and the Pretreatment Standards. Both of these rely on EPA Development Documents which describe the priority pollutants that may be present in various major categories of industrial effluents. Using the EPA Development Documents, it is possible to compare the industrial categories and sub-categories and their SIC codes (there is not, however, a one to one correspondence).

Our data base merges NPDES permit information, pretreatment designation for POTWs, and SIC code for each industrial discharge. Therefore, the SIC code of a particular industry can be cross-referenced with priority pollutants that may be discharged. Appendix I contains the priority pollutants potentially discharged from 34 industrial categories as developed by the EPA and compiled by the DEM Pretreatment Program.[4]

Because of the uncertainty associated with using the above procedure to identify chemical contamination, we have not attempted to analyze or present a tabular listing of industrial sources of specific chemicals. Estimating the type of pollutants likely to be discharged by a given facility would be useful, however, in establishing monitoring programs for priority pollutants. It would provide some guidance in selecting sampling location and choosing appropriate analytical techniques.

Our analysis of non point sources of chemical contaminants was limited to estimating pesticide usage in the state. Those river basins in which the greatest usage of pesticides occurs (Table 8) are the Neuse, Cape Fear, and Tar. Together, the amount of pesticides applied annually is estimated as about 15 million pounds. These same river basins contain 29 percent of the surface water supplies in

the state. However, beyond such statistics, it is impossible to speculate on the impact of pesticides on surface water quality. There are many chemical formulations for pesticides which produce varying degrees of persistence. Moreover, the amounts escaping to the soil during runoff events is very difficult to estimate; good management practices may minimize these losses. The analysis of pesticides in surface waters requires sophisticated techniques, which limit the practicability of routine surveillance. State monitoring programs thus far have not detected excessive concentrations that would require surface water suppliers to treat for removal of pesticides currently regulated by the EPA Safe Drinking Water Act. Nevertheless, this research suggests diligence in monitoring, especially in those river basins in which pesticide usage is greatest. Even more helpful in planning monitoring programs is a breakdown of specific pesticide usage by county; these more detailed estimates are available in a separate document.[8]

We have not considered non-point sources of urban runoff and their impact on downstream water supplies. This would require that a much more detailed study be undertaken to estimate the extent of urbanization in each county and to relate it in some quantitative fashion to chemical contamination. Such information is not currently available on a state-wide basis. There are some established research approaches to this problem. They require knowledge of curb miles and literature estimates of chemical contaminants discharged with storm events. The impact of urban runoff on surface water quality is a debated issue; it could be very significant and thus worthy of closer examination.

CONCLUSIONS

This research has brought together data bases from different agencies of the state and federal government to focus attention on the fact that many surface water supplies are subject to chemical contamination in a variety of forms. The traditional separation in state government of responsibilities for water supply and waste disposal becomes more difficult to reconcile when the future promises increased urbanization and industrialization. This is not to suggest that state agencies do not communicate with each other on these issues at present. However, there is a need to bring a more quantitative approach to bear on the merger of waste discharge and water supply concerns. Further, there is a need to recognize the importance of protecting water supplies to the fullest in this era when traditional measures of safety for human consumption are being challenged.

The data base developed here should serve as a model by which planners and regulatory personnel can more readily review the extent of conflict in the use of surface water for waste discharge and water supply. It contains information obtained from various sources and gives a more complete picture of water quality problems than here-to-fore was available. However, the usefulness of any data base will always be limited if not continuously updated.

Based on our definition of an unprotected water supply, there is the potential for a significant fraction of the state's population to be exposed to chemical contaminants, albeit in trace amounts. The Cape Fear and Yadkin River basins contain the 10 surface water supplies in the state with the greatest number of upstream waste discharges, ranging from 199 to 410; collectively, these supplies serve about 250,000 people. This problem is not new to North Carolina or any other state. The de facto reuse of wastewater is accepted practice so long as wastewater treatment, dilution, natural attenuation processes, and finally, water treatment provide the necessary measures of protection. The problem is that we are not sure that all of these safeguards work to remove contaminants that may have long term impacts on human health. Therefore, prudence suggests careful assessment of all contaminants entering surface waters used for water supply.

This research has shown that while significant progress has been made in organizing data bases, there are still important gaps. Accurate computerized lists of water supply

sources and NPDES permits were obtained. For most of the permits on file, effluent limitations have only been required for the traditional pollutants (i.e., BOD and suspended solids). However, a small number of permits do include limitations on specific organic chemicals which are likely to appear in the waste effluent of particular industries. There is little specific information on the presence or concentrations of these and other organic chemicals not currently regulated.

Quantifying the impact of contamination from non-point sources on surface water supplies is even more difficult than from point sources. The impact is necessarily ephemeral in nature because it only occurs during storm events. Moreover there are no convenient data bases available. We have estimated the state-wide usage of specific pesticides and total pesticide usage by river basin. However, these estimates are admittedly crude because records of pesticide use by agriculture are scant leaving only extrapolation based on land area and crop type for calculation purposes. The data suggest that the Neuse, Cape Fear, and Tar River basins should be of the greatest concern because collectively, 29 percent of the state's surface water supplies are located in these basins and nearly 60 percent of the state's pesticide usage (15 million pounds annually) occurs here. Obviously, pesticide usage does not translate directly into some measure of pesticide concentration in surface waters; nor are all pesticides necessarily harmful to human health. Therefore, this research does not answer the question of how non-point pollution from agricultural use of pesticides impacts surface water supplies. It merely provides a way of focusing attention on where potential problems may exist.

Urban non-point pollution could not be considered although it may be a significant source of contamination. Data to estimate the extent of this problem are difficult to obtain without quantifying urbanization across the state. This in itself would be a major research effort.

The new data base assembled in this research, while still flawed in many respects, should nevertheless assist planners and regulatory agencies. The data base can be used for identifying those regions in the state where the highest priority exists for more adequate information on contamination of surface water supplies. We have only highlighted its use on a county-wide or river basin-wide scale. However, individual surface water supplies can be investigated much more fully by tracking the NPDES permits upstream, matching SIC codes with lists of priority pollutants, and examining pesticide usage at the county level. These results can then help establish monitoring programs and focus attention on the degree of protection to be afforded to such supplies.

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APPENDIX

TABLE 1

MATRIX OF PRIORITY POLLUTANTS POTENTIALLY DISCHARGED FROM INDUSTRIAL CATEGORIES

● POLLUTANT FOUND IN SIGNIFICANT QUANTITY

	PRIORITY POLLUTANTS	CATEGORICAL INDUSTRY	ADHESIVES	ALUMINUM FORMING	AUTO & OTHER LAUNDRIES	BATTERY MANUFACTURING	COAL MINING	COIL COATING	COPPER FORMING	ELECTRICAL PRODUCTS	ELECTROPLATING	EXPLOSIVES MANUFACTURING
1.	acenaphthene											
2.	acrolein											
3.	acrylonitrile											
4.	benzene						●					
5.	benzidine											
6.	carbon tetrachloride		●									
7.	chlorobenzene						●					
8.	1,2,4-trichlorobenzene											
9.	hexachlorobenzene											
10.	1,2-dichloroethane						●			●		
11.	1,1,1-trichloroethane						●			●		
12.	hexachloroethane											
13.	1,1-dichloroethane											
14.	1,1,2-trichloroethane											
15.	1,1,2,2-tetrachloroethane											
16.	chloroethane											
17.	bis(chloromethyl) ether											
18.	bis(2-chloroethyl) ether											
19.	2-chloroethyl vinyl ether (mixed)											
20.	2-chloronaphthalene											
21.	2,4,6-trichlorophenol											
22.	parachlorometa cresol											
23.	chloroform (trichloromethane)		●	●			●					
24.	2-chlorophenol									●		
25.	1,2-dichlorobenzene									●		
26.	1,3-dichlorobenzene									●		
27.	1,4-dichlorobenzene									●		
28.	3,3'-dichlorobenzidine											
29.	1,1-dichloroethylene											
30.	1,2-trans-dichloroethylene						●					
31.	2,4-dichlorophenol											
32.	1,2-dichloropropane											
33.	1,2-dichloropropylene (1,3-dichloropropene)											
34.	2,4-dimethylphenol											
35.	2,4-dinitrotoluene											
36.	2,6-dinitrotoluene						●					
37.	1,2-diphenylhydrazine											
38.	ethylbenzene		●				●			●		
39.	fluoranthene											
40.	4-chlorophenyl phenyl ether											
41.	4-bromophenyl phenyl ether											
42.	bis(2-chloroisopropyl) ether											
43.	bis(2-chloroethoxy) methane											
44.	methylene chloride (dichloromethane)		●	●			●			●		
45.	methyl chloride (chloromethane)											
46.	methyl bromide (bromomethane)											
47.	bromoform (tribromomethane)											
48.	dichlorobromomethane											
49.	trichlorofluoromethane						●					
50.	dichlorodifluoromethane											
51.	chlorodibromomethane											
52.	hexachlorobutadiene											
53.	hexachlorocyclopentadiene											
54.	isophorone											
55.	naphthalene									●		
56.	nitrobenzene											
57.	nitrophenol											
58.	4-nitrophenol											
59.	2,4-dinitrophenol											
60.	4,6-dinitro-o-cresol											
61.	N-nitrosodimethylamine											
62.	N-nitrosodiphenylamine											
63.	N-nitrosodi-n-propylamine											
64.	pentachlorophenol		●									
65.	phenol		●	●						●		

TABLE 1 (Continued)

MATRIX OF PRIORITY POLLUTANTS POTENTIALLY DISCHARGED FROM INDUSTRIAL CATEGORIES

● POLLUTANT FOUND IN SIGNIFICANT QUANTITY

PRIORITY POLLUTANTS	CATEGORICAL INDUSTRY	ADHESIVES	ALUMINUM FORMING	AUTO & OTHER LAUNDRIES	BATTERY MANUFACTURING	COAL MINING	COIL COATING	COPPER FORMING	ELECTRICAL PRODUCTS	ELECTROPLATING	EXPLOSIVES MANUFACTURING
66. bis(2-ethylhexyl) phthalate		●	●			●					
67. butyl benzyl phthalate		●									
68. di-n-butyl phthalate		●	●			●					
69. di-n-octyl phthalate											
70. diethyl phthalate		●				●					
71. dimethyl phthalate		●									
72. benzo(a)anthracene (1,2-benzanthracene)											
73. benzo(a)pyrene (3,4-benzopyrene)					●						
74. 3,4-benzofluoranthene											
75. benzo(k)fluoranthane (11,12-benzofluoranthene)											
76. chrysene											
77. acenaphthylene											
78. anthracene						●					
79. benzo(ghi)perylene (1,12-benzoperylene)											
80. fluorene											
81. phenanthrene											
82. dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)											
83. indeno (1,2,3-cd)pyrene (2,3-o-phenylenepyrene)											
84. pyrene											
85. tetrachloroethylene				●				●			
86. toluene						●					
87. trichloroethylene		●	●								
88. vinyl chloride (chloroethylene)											
89. aldrin											
90. dieldrin											
91. chlordane (technical mixture & metabolites)											
92. 4,4'-DDT											
93. 4,4'-DDE (p,p'-DDX)											
94. 4,4'-DDD (p,p'-TDE)											
95. a-endosulfan-Alpha											
96. b-endosulfan-Beta											
97. endosulfant sulfate											
98. endrin											
99. endrin aldehyde											
100. heptachlor											
101. heptachlor epoxide											
102. a-BHC-Alpha											
103. b-BHC-Beta											
104. r-BHC-(lindane)-Gamma											
105. o-BHC-Delta											
106. PCB-1242 (Arochlor 1242)											
107. PCB-1254 (Arochlor 1254)											
108. PCB-1221 (Arochlor 1221)											
109. PCB-1232 (Arochlor 1232)											
110. PCB-1248 (Arochlor 1248)											
111. PCB-1260 (Arochlor 1260)											
112. PCB-1016 (Arochlor 1016)											
113. toxaphene											
114. antimony (total)		●				●					
115. arsenic (total)						●			●		
116. asbestos (fibrous)											
117. beryllium (total)											
118. cadmium (total)					●			●	●	●	
119. chromium (total)		●	●			●	●	●	●	●	
120. copper (total)		●	●	●		●		●	●	●	
121. cyanide (total)		●					●			●	
122. lead (total)		●	●	●	●	●		●	●	●	●
123. mercury (total)		●			●	●					
124. nickel (total)			●		●	●				●	
125. selenium (total)											
126. silver (total)					●						
127. thallium (total)						●					
128. zinc (total)		●	●	●	●	●	●	●	●	●	
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)											

TABLE 1 (Continued)

MATRIX OF PRIORITY POLLUTANTS POTENTIALLY DISCHARGED FROM INDUSTRIAL CATEGORIES

• POLLUTANT FOUND IN SIGNIFICANT QUANTITY

PRIORITY POLLUTANTS	CATEGORICAL INDUSTRY	FOUNDRIES	GUM AND WOOD CHEMICALS	INORGANIC CHEMICALS	IRON & STEEL	LEATHER TANNING & FINISHING	MECHANICAL PRODUCTS	NON-FERROUS METALS	ORE MINING & DRESSING	ORGANIC CHEMICALS	PAINT & INK
1. acenaphthene								•			
2. acrolein											
3. acrylonitrile											
4. benzene			•				•	•		•	•
5. benzidine											
6. carbon tetrachloride							•			•	•
7. chlorobenzene										•	
8. 1,2,4-trichlorobenzene								•			
9. hexachlorobenzene								•			
10. 1,2-dichloroethane							•	•			
11. 1,1,1-trichloroethane							•				
12. hexachloroethane											
13. 1,1-dichloroethane							•	•		•	
14. 1,1,2-trichloroethane							•				
15. 1,1,2,2-tetrachloroethane											
16. chloroethane											
17. bis(chloromethyl) ether											
18. bis(2-chloroethyl) ether											
19. 2-chloroethyl vinyl ether (mixed)											
20. 2-chloronaphthalene											
21. 2,4,6-trichlorophenol						•					
22. parachlorometa cresol											
23. chloroform (trichloromethane)						•				•	
24. 2-chlorophenol											
25. 1,2-dichlorobenzene						•					
26. 1,3-dichlorobenzene											
27. 1,4-dichlorobenzene						•					
28. 3,3'-dichlorobenzidine											
29. 1,1-dichloroethylene							•				
30. 1,2-trans-dichloroethylene							•				
31. 2,4-dichlorophenol											
32. 1,2-dichloropropane											
33. 1,2-dichloropropylene (1,3-dichloropropene)											
34. 2,4-dimethylphenol											
35. 2,4-dinitrotoluene											
36. 2,6-dinitrotoluene											
37. 1,2-diphenylhydrazine											
38. ethylbenzene			•			•	•			•	•
39. fluoranthene							•	•			
40. 4-chlorophenyl phenyl ether											
41. 4-bromophenyl phenyl ether											
42. bis(2-chloroisopropyl) ether											
43. bis(2-chloroethoxy) methane							•				
44. methylene chloride (dichloromethane)						•		•		•	•
45. methyl chloride (chloromethane)											
46. methyl bromide (bromomethane)											
47. bromoform (tribromomethane)											
48. dichlorobromomethane								•		•	
49. trichlorofluoromethane											
50. dichlorodifluoromethane											
51. chlorodibromomethane											
52. hexachlorobutadiene											
53. hexachlorocyclopentadiene											
54. isophorone											
55. naphthalene						•	•				
56. nitrobenzene											
57. nitrophenol											
58. 4-nitrophenol											
59. 2,4-dinitrophenol											
60. 4,6-dinitro-o-cresol											
61. N-nitrosodimethylamine											
62. N-nitrosodiphenylamine							•				
63. N-nitrosodi-n-propylamine											
64. pentachlorophenol						•	•				•
65. phenol		•	•		•	•	•		•	•	•

TABLE 1 (Continued)

MATRIX OF PRIORITY POLLUTANTS POTENTIALLY DISCHARGED FROM INDUSTRIAL CATEGORIES

• POLLUTANT FOUND IN SIGNIFICANT QUANTITY

PRIORITY POLLUTANTS	CATEGORICAL INDUSTRY	FOUNDRIES	GUM AND WOOD CHEMICALS	INORGANIC CHEMICALS	IRON & STEEL	LEATHER TANNING & FINISHING	MECHANICAL PRODUCTS	NON-FERROUS METALS	ORE MINING & DRESSING	ORGANIC CHEMICALS	PAINT & INK
66. bis(2-ethylhexyl) phthalate						•	•	•		•	
67. butyl benzyl phthalate							•	•			
68. di-n-butyl phthalate								•		•	
69. di-n-octyl phthalate								•			
70. diethyl phthalate							•	•			
71. dimethyl phthalate											
72. benzo(a)anthracene (1,2-benzanthracene)											
73. benzo(a)pyrene (3,4-benzopyrene)								•			
74. 3,4-benzofluoranthene											
75. benzo(k)fluoranthane (11,12-benzofluoranthene)											
76. chrysene								•			
77. acenaphthylene											
78. anthracene							•				
79. benzo(ghi)perylene (1,12-benzoperylene)											
80. fluorene								•			
81. phenanthrene										•	
82. dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)											
83. indeno (1,2,3-cd)pyrene (2,3-o-phenylenepyrene)											
84. pyrene								•			
85. tetrachloroethylene			•			•	•	•		•	•
86. toluene										•	•
87. trichloroethylene											
88. vinyl chloride (chloroethylene)											
89. aldrin											
90. dieldrin											
91. chlorgane (technical mixture & metabolites)											
92. 4,4'-DDT											
93. 4,4'-DDE (p,p'-DDX)											
94. 4,4'-DDD (p,p'-TDE)											
95. a-endosulfan-Alpha											
96. b-endosulfan-Beta											
97. endosulfant sulfate											
98. endrin											
99. endrin aldehyde											
100. heptachlor											
101. heptachlor epoxide											
102. a-BHC-Alpha											
103. b-BHC-Beta											
104. g-BHC-(lindane)-Gamma											
105. d-BHC-Delta											
106. PCB-1242 (Arochlor 1242)											
107. PCB-1254 (Arochlor 1254)								•			
108. PCB-1221 (Arochlor 1221)											
109. PCB-1232 (Arochlor 1232)											
110. PCB-1248 (Arochlor 1248)								•			
111. PCB-1260 (Arochlor 1260)											
112. PCB-1016 (Arochlor 1016)											
113. toxaphene											
114. antimony (total)				•				•			
115. arsenic (total)				•				•			
116. asbestos (fibrous				•							
117. beryllium (total)								•			
118. cadmium (total)	•			•			•	•		•	
119. chromium (total)	•	•		•	•	•	•	•		•	•
120. copper (total)	•	•		•		•	•	•	•	•	•
121. cyanide (total)				•	•	•		•	•		
122. lead (total)				•		•	•	•	•	•	•
123. mercury (total)				•				•		•	•
124. nickel (total)		•		•		•	•	•			•
125. selenium (total)				•				•			
126. silver (total)				•				•			
127. thallium (total)				•							
128. zinc (total)	•	•		•	•	•	•	•	•		•
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)											

TABLE 1 (Continued)

MATRIX OF PRIORITY POLLUTANTS POTENTIALLY DISCHARGED FROM INDUSTRIAL CATEGORIES

• POLLUTANT FOUND IN SIGNIFICANT QUANTITY

	PRIORITY POLLUTANT	CATEGORICAL INDUSTRY	PESTICIDES	PETROLEUM REFINING	PHARMACEUTICALS	PHOTOGRAPHIC SUPPLIES	PLASTICS AND SYNTHETICS	PLASTICS PROCESSING	PORCELAIN ENAMELING	PRINTING & PUBLISHING	PULP, PAPER, AND FIBERBOARD	RUBBER
1.	acenaphthene											
2.	acrolein											
3.	acrylonitrile											
4.	benzene				•	•	•					
5.	benzidine											
6.	carbon tetrachloride											
7.	chlorobenzene											
8.	1,2,4-trichlorobenzene											
9.	hexachlorobenzene											
10.	1,2-dichloroethane											
11.	1,1,1-trichloroethane											
12.	hexachloroethane											
13.	1,1-dichloroethane											
14.	1,1,2-trichloroethane											
15.	1,1,2,2-tetrachloroethane											
16.	chloroethane											
17.	bis(chloromethyl) ether											
18.	bis(2-chloroethyl) ether											
19.	2-chloroethyl vinyl ether (mixed)											
20.	2-chloronaphthalene											
21.	2,4,6-trichlorophenol											
22.	parachlorometa cresol											
23.	chloroform (trichloromethane)				•						•	
24.	2-chlorophenol											
25.	1,2-dichlorobenzene											
26.	1,3-dichlorobenzene											
27.	1,4-dichlorobenzene											
28.	3,3'-dichlorobenzidine											
29.	1,1-dichloroethylene											
30.	1,2-trans-dichloroethylene											
31.	2,4-dichlorophenol											
32.	1,2-dichloropropane											
33.	1,2-dichloropropylene (1,3-dichloropropene)											
34.	2,4-dimethylphenol											
35.	2,4-dinitrotoluene											
36.	2,6-dinitrotoluene											
37.	1,2-diphenylhydrazine											
38.	ethylbenzene						•					
39.	fluoranthene											
40.	4-chlorophenyl phenyl ether											
41.	4-bromophenyl phenyl ether											
42.	bis(2-chloroisopropyl) ether											
43.	bis(2-chloroethoxy) methane											
44.	methylene chloride (dichloromethane)				•	•						
45.	methyl chloride (chloromethane)											
46.	methyl bromide (bromomethane)											
47.	bromoform (tribromomethane)											
48.	dichlorobromomethane											
49.	trichlorofluoromethane											
50.	dichlorodifluoromethane											
51.	chlorodibromomethane											
52.	hexachlorobutadiene											
53.	hexachlorocyclopentadiene											
54.	isophorone											
55.	naphthalene											
56.	nitrobenzene											
57.	nitrophenol											
58.	4-nitrophenol											
59.	2,4-dinitrophenol											
60.	4,6-dinitro-o-cresol											
61.	n-nitrosodimethylamine											
62.	n-nitrosodiphenylamine											
63.	n-nitrosodi-n-propylamine											
64.	pentachlorophenol											
65.	phenol		•	•	•		•					

TABLE 1 (Continued)

MATRIX OF PRIORITY POLLUTANTS POTENTIALLY DISCHARGED FROM INDUSTRIAL CATEGORIES

- POLLUTANT FOUND IN SIGNIFICANT QUANTITY

PRIORITY POLLUTANT	CATEGORICAL INDUSTRY: PESTICIDES	PETROLEUM REFINING	PHARMACEUTICALS	PHOTOGRAPHIC SUPPLIES	PLASTICS AND SYNTHETICS	PLASTICS PROCESSING	PORCELAIN ENAMELING	PRINTING & PUBLISHING	PULP, PAPER, AND FIBERBOARD	RUBBER
66. bis(2-ethylhexyl) phthalate										
67. butyl benzyl phthalate										
68. di-n-butyl phthalate										
69. di-n-octyl phthalate										
70. diethyl phthalate										
71. dimethyl phthalate										
72. benzo(a)anthracene (1,2-benzanthracene)										
73. benzo(a)pyrene (3,4-benzopyrene)										
74. 3,4-benzofluoranthene										
75. benzo(k)fluoranthane (11,12-benzofluoranthene)										
76. chrysene										
77. acenaphthylene										
78. anthracene										
79. benzo(ghi)perylene (1,12-benzoperylene)										
80. fluorene										
81. phenanthrene										
82. dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)										
83. indeno (1,2,3-cd)pyrene (2,3-o-phenylenepyrene)										
84. pyrene										
85. tetrachloroethylene										
86. toluene			●	●	●					
87. trichloroethylene										
88. vinyl chloride (chloroethylene)										
89. aldrin										
90. dieldrin										
91. chlordane (technical mixture & metabolites)										
92. 4,4'-DDT										
93. 4,4'-DDE (p,p'-DDX)										
94. 4,4'-DDD (p,p'-TDE)										
95. a-endosulfan-Alpha										
96. b-endolsulfan-Beta										
97. endosulfant sulfate										
98. endrin										
99. endrin aldehyde										
100. heptachlor										
101. heptachlor epoxide										
102. a-BHC-Alpha										
103. b-BHC-Beta										
104. r-BHC-(lindane)-Gamma										
105. o-BHC-Delta										
106. PCB-1242 (Arochlor 1242)										
107. PCB-1254 (Arochlor 1254)										
108. PCB-1221 (Arochlor 1221)										
109. PCB-1232 (Arochlor 1232)										
110. PCB-1248 (Arochlor 1248)										
111. PCB-1260 (Arochlor 1260)										
112. PCB-1016 (Arochlor 1016)										
113. toxaphene										
114. antimony (total)				●						
115. arsenic (total)			●		●					
116. asbestos (fibrous)										
117. beryllium (total)										
118. cadmium (total)			●	●		●	●			
119. chromium (total)		●	●	●	●		●			
120. copper (total)					●	●	●			
121. cyanide (total)	●	●	●	●						
122. lead (total)			●	●	●	●	●			●
123. mercury (total)			●	●						
124. nickel (total)			●	●	●		●			
125. selenium (total)										
126. silver (total)				●						
127. thallium (total)										
128. zinc (total)		●	●	●	●		●			●
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	●									

TABLE 1 (Continued

MATRIX OF PRIORITY POLLUTANTS POTENTIALLY DISCHARGED FROM INDUSTRIAL CATEGORIES

• POLLUTANT FOUND IN SIGNIFICANT QUANTITY

PRIORITY POLLUTANTS	CATEGORICAL INDUSTRY	SOAPS AND DETERGENTS	STEAM ELECTRIC	TEXTILE MILLS	TIMBER PRODUCTS PROCESSING							
1. acenaphthene												
2. acrolein												
3. acrylonitrile												
4. benzene												
5. benzidine												
6. carbon tetrachloride												
7. chlorobenzene												
8. 1,2,4-trichlorobenzene												
9. hexachlorobenzene												
10. 1,2-dichloroethane												
11. 1,1,1-trichloroethane												
12. hexachloroethane												
13. 1,1-dichloroethane												
14. 1,1,2-trichloroethane												
15. 1,1,2,2-tetrachloroethane												
16. chloroethane												
17. bis(chloromethyl) ether												
18. bis(2-chloroethyl) ether												
19. 2-chloroethyl vinyl ether (mixed)												
20. 2-chloronaphthalene												
21. 2,4,6-trichlorophenol												
22. parachlorometa cresol												
23. chloroform (trichloromethane)												
24. 2-chlorophenol												
25. 1,2-dichlorobenzene												
26. 1,3-dichlorobenzene												
27. 1,4-dichlorobenzene												
28. 3,3'-dichlorobenzidine												
29. 1,1-dichloroethylene												
30. 1,2-trans-dichloroethylene												
31. 2,4-dichlorophenol												
32. 1,2-dichloropropane												
33. 1,2-dichloropropylene (1,3-dichloropropene)												
34. 2,4-dimethylphenol												
35. 2,4-dinitrotoluene												
36. 2,6-dinitrotoluene												
37. 1,2-diphenylhydrazine												
38. ethylbenzene												
39. fluoranthene												
40. 4-chlorophenyl phenyl ether												
41. 4-bromophenyl phenyl ether												
42. bis(2-chloroisopropyl) ether												
43. bis(2-chloroethoxy) methane												
44. methylene chloride (dichloromethane)												
45. methyl chloride (chloromethane)												
46. methyl bromide (bromomethane)												
47. bromoform (tribromomethane)												
48. dichlorobromomethane												
49. trichlorofluoromethane												
50. dichlorodifluoromethane												
51. chlorodibromomethane												
52. hexachlorobutadiene												
53. hexachlorocyclopentadiene												
54. isophorone												
55. naphthalene												
56. nitrobenzene												
57. nitrophenol												
58. 4-nitrophenol												
59. 2,4-dinitrophenol												
60. 4,6-dinitro-o-cresol												
61. n-nitrosodimethylamine												
62. n-nitrosodiphenylamine												
63. n-nitrosodi-n-propylamine												
64. pentachlorophenol					•		•					
65. phenol					•		•					

TABLE 1 (Continued)

MATRIX OF PRIORITY POLLUTANTS POTENTIALLY DISCHARGED FROM INDUSTRIAL CATEGORIES

- POLLUTANT FOUND IN SIGNIFICANT QUANTITY

PRIORITY POLLUTANTS	CATEGORICAL INDUSTRY	SOAPS AND DETERGENTS	STEAM ELECTRIC	TEXTILE MILLS	TIMBER PRODUCTS PROCESSING							
86. bis(2-ethylhexyl) phthalate				●								
87. butyl benzyl phthalate												
88. di-n-butyl phthalate												
89. di-n-octyl phthalate												
90. diethyl phthalate												
91. dimethyl phthalate												
92. benzo(a)anthracene (1,2-benzanthracene)												
93. benzo(a)pyrene (3,4-benzopyrene)												
94. 3,4-benzofluoranthene												
95. benzo(k)fluoranthene (11,12-benzofluoranthene)												
96. chrysene												
97. acenaphthylene												
98. anthracene												
99. benzo(ghi)perylene (1,12-benzoperylene)												
100. fluorene												
101. phenanthrene												
102. dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)												
103. indeno (1,2,3-cd)pyrene (2,3-o-phenylenepyrene)												
104. pyrene												
105. tetrachloroethylene				●								
106. toluene				●								
107. trichloroethylene				●								
108. vinyl chloride (chloroethylene)												
109. aldrin												
110. dieldrin												
111. chlordane (technical mixture & metabolites)												
112. 4,4'-DDT												
113. 4,4'-DDE (p,p'-DDX)												
114. 4,4'-DDD (p,p'-TDE)												
115. a-endosulfan-Alpha												
116. b-endolsulfan-Beta												
117. endosulfant sulfate												
118. endrin												
119. endrin aldehyde												
120. heptachlor												
121. heptachlor epoxide												
122. a-BHC-alpha												
123. b-BHC-beta												
124. r-BHC-lindane-gamma												
125. g-BHC-delta												
126. PCB-1242 (Arochlor 1242)												
127. PCB-1254 (Arochlor 1254)												
128. PCB-1221 (Arochlor 1221)												
129. PCB-1232 (Arochlor 1232)												
130. PCB-1248 (Arochlor 1248)												
131. PCB-1260 (Arochlor 1260)												
132. PCB-1016 (Arochlor 1016)												
133. toxaphene												
134. antimony (total)				●								
135. arsenic (total)				●	●							
136. asbestos (fibrous)												
137. beryllium (total)												
138. cadmium (total)				●								
139. chromium (total)	●			●	●							
140. copper (total)	●	●		●	●							
141. cyanide (total)				●								
142. lead (total)	●			●								
143. mercury (total)				●								
144. nickel (total)	●	●		●								
145. selenium (total)				●								
146. silver (total)				●								
147. thallium (total)												
148. zinc (total)	●	●		●								
149. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)												