THE NATION'S WATER RESOURCES 1975-2000

Volume 4: Mid-Atlantic Region

Second National Water Assessment by the U.S. Water Resources Council

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Second National
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by the
U.S. Water Resources Council

December 1978

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Foreword

The Water Resources Planning Act of 1965 (Public Law 89-80) directs the U.S. Water Resources Council to maintain a continuing study of the Nation's water and related land resources and to prepare periodic assessments to determine the adequacy of these resources to meet present and future water requirements. In 1968, the Water Resources Council reported the results of its initial assessment. The Second National Water Assessment, a decade later, provides a comprehensive nationally consistent data base for the water resources of the United States. The results of the Second National Water Assessment were obtained by extensive coordination and collaboration in three phases.

Phase I: Nationwide Analysis

The Council member agencies researched, analyzed, and prepared estimates of current and projected water requirements and problems and the implications of the estimates for the future.

Phase II: Specific Problem Analysis

Regional sponsors, one for each of the 21 water resources regions, surveyed and analyzed State and regional viewpoints about (1) current and future water problems, (2) conflicts that may arise in meeting State and regional objectives, and (3) problems and conflicts needing resolution.

Phase III: National Problem Analysis

The Council conducted this final phase in three steps: (1) An evaluation of phases I and II, (2) an analysis that identified and evaluated the Nation's most serious water resources problems, and (3) the preparation of a final report entitled "The Nation's Water Resources--1975-2000."

The final report of the Second National Water Assessment consists of four separate volumes as described below. These volumes can assist Federal, State, local, and other program managers, the Administration, and the Congress in establishing and implementing water resources policies and programs.

Volume 1, Summary, gives an overview of the Nation's water supply, water use, and critical water problems for "1975," 1985, and 2000 and summarizes significant concerns.

Volume 2, Water Quantity, Quality, and Related Land Considerations, consists of one publication with five parts:

Part I, "Introduction," outlines the origin of the Second National Water Assessment, states its purpose and scope, explains the

numerous documents that are part of the assessment, and identifies the individuals and agencies that contributed to the assessment.

II, "Water-Management Problem Profiles," identifies ten general water problem issues and their implications and potential consequences.

Part III, "Water Uses," focuses on the national perspectives regarding existing ("1975") and projected (1985 and 2000) requirements for water to meet offstream, instream, and flow-management needs. State-regional and Federal perspectives are compared.

Part IV, "Water Supply and Water Quality Considerations," analyzes the adequacy of fresh-water supplies (ground and surface) to meet existing and future requirements. It contains a national water budget; quantifies surface- and ground-water supplies, reservoir storage, and transfers of water within and between subregions; describes regional requirements and compares them to supplies; evaluates water quality conditions; and discusses the legal and institutional aspects of water allocation.

Part V, "Synopses of the Water Resources Regions," covers existing conditions and future requirements for each of the 21 water resources regions. Within each regional synopsis is a discussion of functional and location-specific water-related problems; regional recommendations regarding planning, research, data, and institutional aspects of solving regional water-related problems; a problem-issue matrix; and a comparative-analysis table.

Volume 3, Analytical Data, describes the methods and procedures used to collect, analyze, and describe the data used in the assessment. National summary data are included with explanatory notes. Volume 3 is supplemented by five separately published appendixes that contain data for the regions and subregions:

Appendix I, Social, Economic, and Environmental Data, contains the socioeconomic baseline ("1975") and growth projections (1985 and 2000) on which the water-supply and water-use projections are based. This appendix presents two sets of data. One set, the National Future, represents the Federal viewpoint; the other set, the State-Regional Future, represents the regional sponsor and/or State viewpoint.

Appendix II, Annual Water Supply and Use Analysis, contains baseline water-supply data and baseline and projected water withdrawal and water-consumption data used for the assessment. Also included are a water adequacy analysis, a natural flow analysis, and a critical-month analysis.

Appendix III, Monthly Water Supply and Use Analysis, contains monthly details of the water-supply, water-withdawal, and water-consumption data contained in Appendix II and includes an analysis of monthly water adequacy.

Appendix IV, Dry-Year Conditions Water Supply and Use Analysis, contains both annual and monthly baseline and projected water-withdrawal and water-consumption data for dry conditions. Also, a dry conditions water-adequacy analysis is included.

Appendix V, Streamflow Conditions, contains detailed background information on the derivation of the baseline streamflow information. A description of streamflow gages used, correction factors applied, periods of record, and extreme flows of record, are given for each subregion. Also included is the State-Regional Future estimate of average streamflow conditions.

Volume 4, Water Resources Regional Reports, consists of separately published reports for each of the 21 regions. Synopses of these reports are given in Volume 2, Part V.

For compiling and analyzing water resources data, the Nation has been divided into 21 major water resources regions and further subdivided into 106 subregions. Eighteen of the regions are within the conterminous United States; the other three are Alaska, Hawaii, and the Caribbean area.

The 21 water resources regions are hydrologic areas that have either the drainage area of a major river, such as the Missouri Region, or the combined drainage areas of a series of rivers, such as the South Atlantic-Gulf Region, which includes a number of southeastern States that have rivers draining directly into the Atlantic Ocean and the Gulf of Mexico.

The 106 subregions, which are smaller drainage areas, were used exclusively in the Second National Water Assessment as basic data-collection units. Subregion data point up problems that are primarily basinwide in nature. Data aggregated from the subregions portray both regional and national conditions, and also show the wide contrasts in both regional and national water sources and uses.

The Second National Water Assessment and its data base constitute a major step in the identification and definition of water resources problems by the many State, regional, and Federal institutions involved. However, much of the information in this assessment is general and broad in scope; thus, its application should be viewed in that context, particularly in the area of water quality. Further, the information reflects areas of deficiencies in availability and reliability of data. For these reasons, State, regional, and Federal planners should view the information as indicative, and not the only source to be considered. When policy decisions are to be made, the effects at State, regional, and local levels should be carefully considered.

In a national study it is difficult to reflect completely the regional variations within the national aggregation. For example, several regional reviewers did not agree with the national projections made for their regions. These disagreements can be largely attributed either to different assumptions by the regional reviewers or to lack of representation of the national data at the regional level. Therefore, any regional or State resources-management planning effort should consider the State-regional reports developed during phase II and summarized in Volume 4 as well as the nationally consistent data base and the other information presented in this assessment.

Additional years of information and experience show that considerable change has occurred since the first assessment was prepared in 1968. The population has not grown at the rate anticipated, and the projections of future water requirements for this second assessment are considerably lower than those made for the first assessment. Also, greater awareness of environmental values, water quality, ground-water overdraft, limitations of available water supplies, and energy concerns are having a dramatic effect on water-resources management. Conservation, reuse, recycling, and weather modification are considerations toward making better use of, or expanding, available supplies.

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Physiography

Description

The Mid-Atlantic Region (Figure 2-1) includes the several independent drainage basins flowing into the Atlantic Ocean from the Hudson River Basin in the north near the Connecticut-New York boundary to the James River Basin in the south near the Virginia-North Carolina boundary. It embraces the States of Delaware (2 percent of the region's area) and New Jersey (8 percent); the District of Columbia (0.1 percent); major portions of New York (23 percent), Pennsylvania (29 percent), Maryland (10.2 percent), and Virginia (23 percent), and small parts of Vermont, Massachusetts, Connecticut, and West Virginia (4.7 percent). The total area is about 66.1 million acres (or about 103,342 square miles), of which two million acres are large inland water surface in streams, lakes, and bays.[1] An additional 24 million acres of bays and estuaries constitute about 40 percent of the Atlantic Coast estuaries.

The region extends about 420 miles from northern New York State to southern Virginia, and about 250 miles from the Atlantic Ocean and the eastern tip of Long Island to the headwaters in the Appalachian Mountains on the west. The topography of the region varies from flat coastal plains through undulating hill country with elevations of 200 to 800 feet, to mountains up to 5,000 feet in elevation. Within the region the major river systems are the Hudson, Delaware, Susquehanna, Potomac, Rappahannock, York, and James. Major estuaries include the Hudson River, Delaware Bay, and Chesapeake Bay. The northerly streams follow generally a north-to-south pattern, while the southerly flow is generally west to east. A unique feature of the headwater streams in the region is the abrupt changes from paths parallel to the mountains to cuts through the mountain ranges to join the main stems. Stream patterns and watershed boundaries are shown in Figure 2-1. The region was divided into six subregions (201-206) and 27 areas for analysis and discussion. The fresh surface- and groundwater resources of the Mid-Atlantic Region, supplemented by use of brackish waters from the bays and tidal portions of the streams, combine to provide an abundant supply of water for man and for the natural ecosystems of the region. The supply, however, is somewhat unevenly distributed seasonally and geographically with regard to quantity, and is degraded in quality in some locations, particularly in metropolitan areas.

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[1] This is the sum of the areas of counties used to approximate the hydrologic area of the region. Land use and other socioeconomic data are related to this area. The drainage area within the hydrologic boundary is 104,910 square miles.

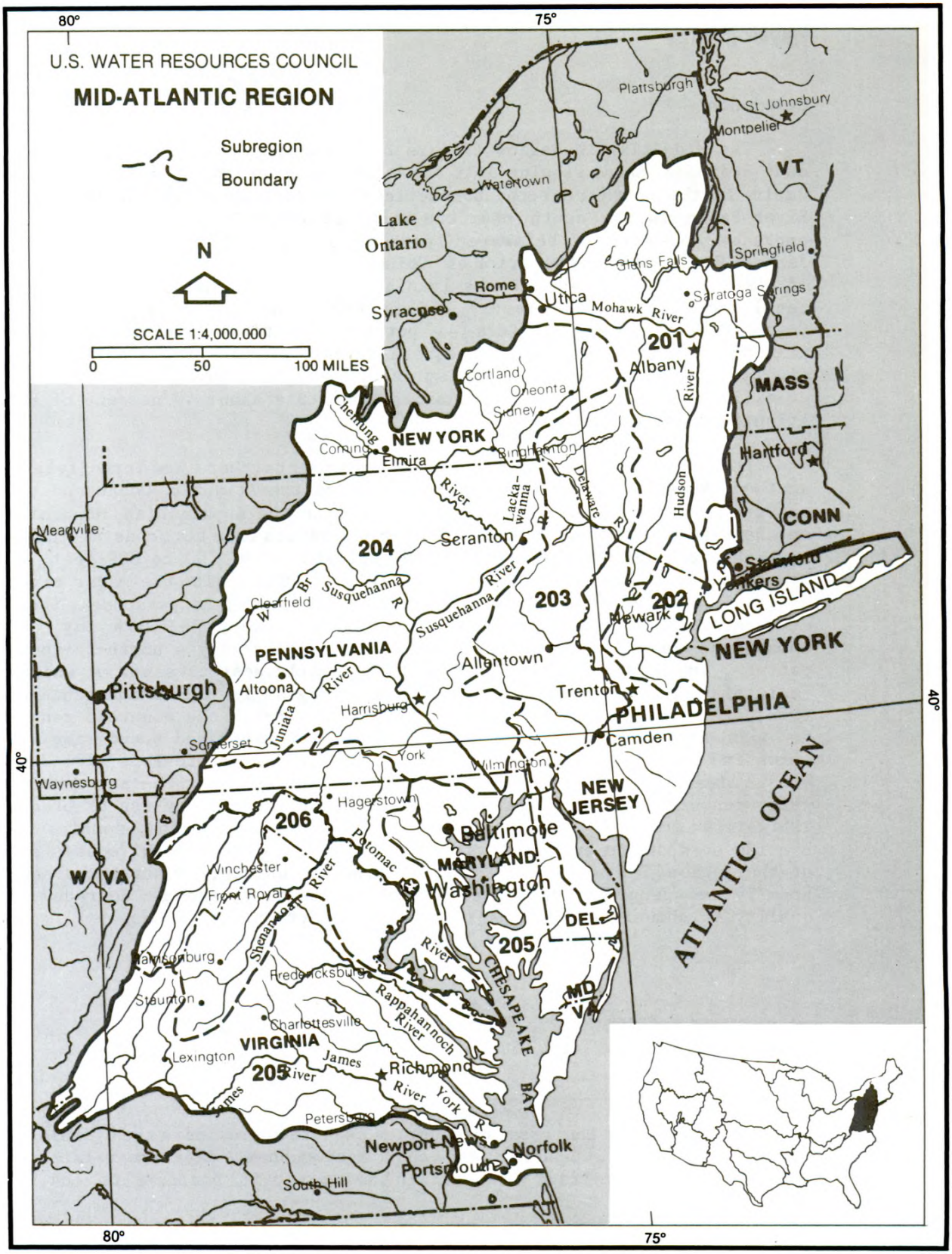


Figure 2-1. Region Map

Approximately 54 percent of the total surface area in the region is forest; 25 percent is cropland and pastureland; 7 percent is urban and built-up; 11 percent is in other classes of use; and 3 percent of the total regional area is fresh-water surface. Most of the virgin forestlands have been cut and are now in well-developed second growth. Conservation and political measures have established preserves and parks throughout the region. Farming practices are well-adapted to soil and climate and include fruit, truck, dairy, and general farming as well as livestock and poultry production (see Figure 2-2). The major cities along the coast in overall effect constitute a megalopolis embracing New York City, northern New Jersey, Philadelphia, Baltimore, Washington, Richmond, Norfolk, and intervening communities.

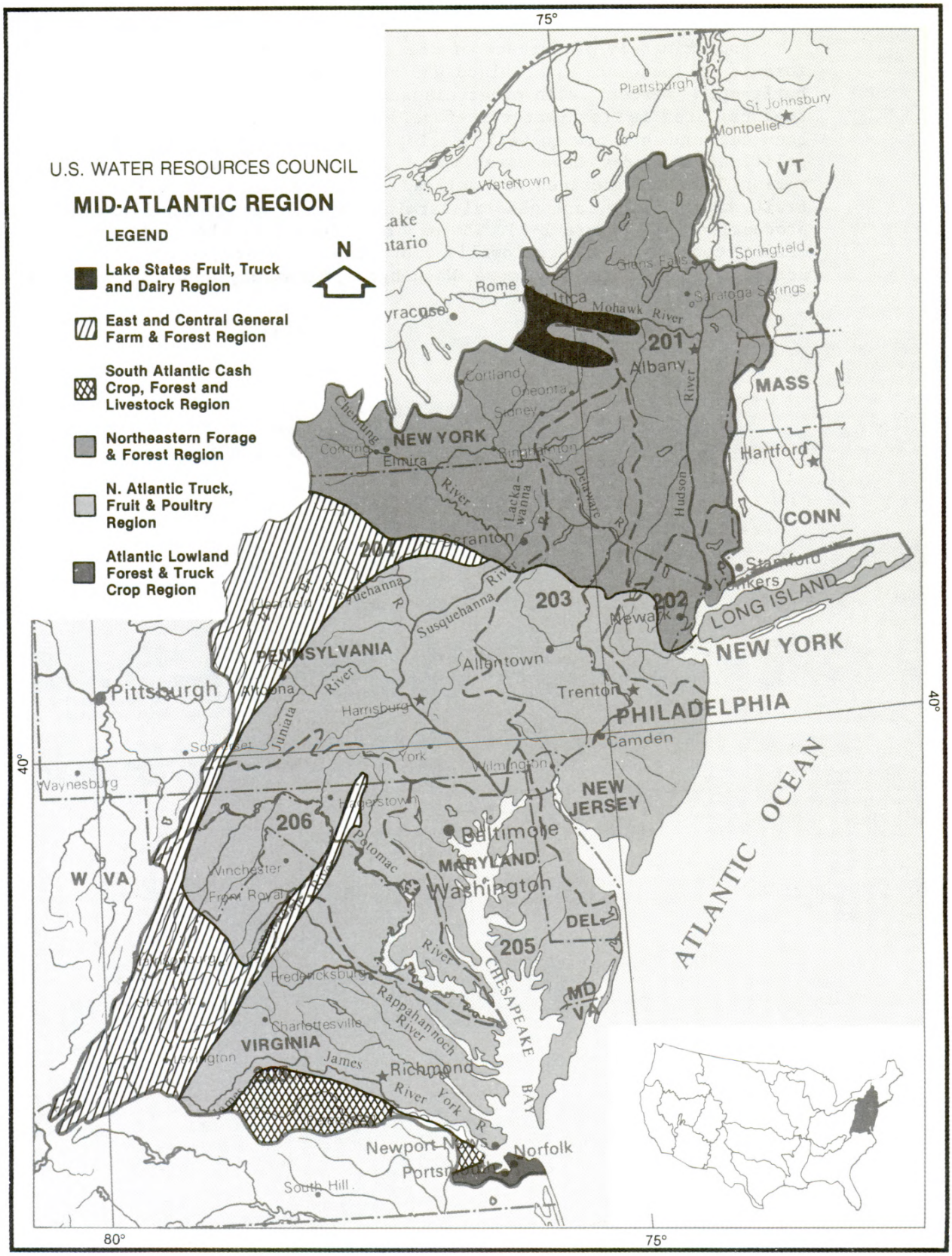


Figure 2-2. Present Land Use

Geology

The Mid-Atlantic Region varies geologically from the Atlantic Coastal Plain through the Adirondack, Piedmont, and Blue Ridge physiographic provinces. During the Ice Age, glaciers up to several thousand feet thick covered an area of the region that extended as far south as a line from southernmost Long Island through Pennsylvania. The consolidated rocks in the glaciated areas are masked to varying extents by water-lain sand and gravel deposits.

Crystalline and metamorphic rocks (granite, schist, gneiss, slate, quartzite, and marble), largely Precambrian in age, underlie the Adirondack, Piedmont, and Blue Ridge Provinces. Sandstone, shale, and minor volcanics underlie the Triassic lowlands, which lie within the Piedmont crystalline rock provinces. Highly folded and faulted Paleozoic limestone, sandstone, and shale underlie the Valley and Ridge Provinces. Similar rocks are present in the Appalachian Plateau and the Taconic Highlands.

The Coastal Plain embraces about 25,000 square miles of the region, including Long Island and part of the mainland east of the "fall line," which passes through Philadelphia, Baltimore, Washington, and Richmond. The Coastal Plain is an area of low relief, made up of sands and clays dipping gently seaward with underlying beds of sedimentary rock, many of which are excellent sources of large quantities of ground water.

Topography

The region's major topographical features are the results of marked differences in geological processes over millions of years. Among these were (1) compression and uplifting of the earth's crust which formed the Appalachian Mountains; (2) glacial erosion and deposition as far south as Pennsylvania and Long Island, which left a mantle of till in upland areas and stratified drift in lowlands; and (3) accumulation of materials eroded from these and other uplifted rocks forming a seaward thickening wedge of generally unconsolidated sedimentary rocks (the coastal plain).

The highest elevations are in the Adirondack Mountains of New York with peaks of over 5,000 feet, and in the Catskills of New York and the Blue Ridge of Virginia, rising to about 4,000 feet. Most of southern New York is in the Appalachian Plateau, lowering to the Hudson Valley to the east. The Appalachian highlands cover most of interior Pennsylvania, extending into New Jersey where there is a fairly sharp transition at the fall line to the Atlantic Coastal Plain. The fall line is where fairly steep stream slopes and waterfalls flatten out somewhat abruptly as the streams enter the Coastal Plain. The fall line marks the head of navigation on the principal streams. The Coastal Plain includes Long Island, the southern three-fifths of New Jersey, all of Delaware, and eastern Maryland and Virginia. The Piedmont, Blue Ridge, and Appalachian Plateaus, in the southern part of the Mid-Atlantic Region west of the Coastal Plain, cover the western portions of Maryland and Virginia, and that part of West Virginia included in the region.

Climate

The Mid-Atlantic Region lies between 37° and 44° north latitude, in the global zone of westerly winds and in the normal path of tropical air masses from the Gulf of Mexico. The interaction of these forces is conducive to rapid climatic changes and major storms; the climate is also significantly affected by the mountains on the west and the ocean on the east. The climate in the region is humid, with four distinct seasons, and in coastal areas is tempered in both winter and summer by the Atlantic Ocean and the large bays. Inland, the mountain ranges induce a lowering of temperature, shortening the frost-free season and increasing the amount of rain and snow.

Normal annual precipitation varies from 40 to 48 inches. Precipitation in various localities, however, ranges from 32 to 60 inches. It is distributed relatively uniformly throughout the year, but has a complex geographical distribution. Wide fluctuations in precipitation from the annual average occur frequently, from season to season and from one location to another, resulting in extremely high or low streamflows and runoff from the land. Prolonged deficiencies for months or even years, as in the droughts of the 1930's and 1960's, affect large portions of the Mid-Atlantic Region. Average annual snowfall varies from about 5 inches in the extreme southern portion of the Coastal Plain to over 100 inches in northern New York State.

The average annual temperature varies from slightly less than 40°F in the north to about 60°F in southern Virginia. Northern winters are long and rather severe, and the growing seasons average less than 100 days in some areas. Farther south, the growing seasons average up to 200 days, and the summers are long and hot.

Evapotranspiration, which includes all water losses to the atmosphere from land and water surfaces and from plants, varies from 15 to 30 inches per year, increasing generally from north to south.

Runoff is roughly equivalent to 40 percent of the precipitation. Generally, the lowest streamflows are in September and October, and the highest flows occur during the period from February to April. Surface-water temperature rises into the 70's during July and August.

People and the Resources

Identification of the problems faced by society in making economically, socially, and environmentally sound uses of water and related land resources must be based on a sound analysis of current activities and future trends. Estimates and projections of population, economic characteristics, magnitude of water and land resources, and other parameters were made as explained elsewhere in the national assessment report. These data, for 1975, 1985, and 2000, have been developed for the Nation, the regions, and the subregions and are referred to as the National Future (NF). The NF represents the Federal view of the most probable future through the end of the century. State, regional, and River Basin Commission representatives, organized in a coordinating committee with Federal agency representation, were encouraged to prepare alternative estimates. The alternative projections, called the State/Regional Future (SRF), were generally based in the Mid-Atlantic Region on the NF for 1975. The estimates for 1985 and 2000, in some areas, departed significantly from the NF where the NF did not reflect non-Federal views. A discussion of the differences between these sets of data and projections and the implications of the variations is included at the end of this section. All data presented herein are consistent with national data (NF) unless identified as SRF.

Population

More people and wealth are concentrated in the Mid-Atlantic Region than in any other region of the United States. Within this region lies the lower portion of the urbanized and urbanizing megalopolis which stretches from Boston, Massachusetts, to Norfolk, Virginia. This area of large population centers, spreading suburbs, and intense economic activity has reached its present level as a result of abundant natural resources, past immigration from abroad and from other regions of the country, a productive labor force, and a strategic location between sources of materials and markets. Much of the urban growth has been stimulated by economic and educational opportunities and ease of transportation.

The population of the Mid-Atlantic Region was 39.6 million in 1975, about 18 percent of the national total. By the year 2000, it is projected to reach about 49.9 million, an increase of about 26 percent, of which about 43.9 million, or about 88 percent, are expected to live and work in metropolitan areas. Population densities vary widely, from about 137 persons per square mile in the Susquehanna River Basin (subregion 204) to 3,863 in the New York-New Jersey metropolitan area (subregion 202). The rural areas of the region contain many small towns and cities, and many counties have less population than those usually found within a square mile of inner-city neighborhoods in large metropolitan areas.

Economy

About 17.1 million persons were employed in the region in 1975. The 1975 total personal income, measured in 1975 dollars, was estimated to be about $283 billion, over 20 percent of the national total, and averaged about $7,133 per capita. Per capita income in the region is projected to reach about $13,864 by the year 2000.

Table 2-1 shows 1975 and projected 2000 earnings for the major categories. Manufacturing, concentrated in and around the cities, accounted for 24 percent of total earnings in 1975 and is projected to constitute about 20 percent of regional earnings by 2000. Agricultural earnings in 1975 were estimated to be about $1.9 billion, about 0.9 percent of the regional total, and are projected to rise to $2.3 billion in 2000, but then will comprise only about 0.4 percent of the regional total. Other categories of economic activity are projected to increase from $167.8 billion in 1975 to about $431.7 billion in 2000.

Table 2-1.--Mid-Atlantic Region earnings - 1975, 1985, 2000
(million 1975 dollars)

Earnings sector	1975	1985	2000
Manufacturing	52,528	71,293	105,598
Agriculture	1,938	1,935	2,258
Mining	396	447	560
Other	167,771	249,413	431,723
Total	222,633	323,088	540,139

The "other" category includes the following earnings in 1975 which constituted about 75 percent of total regional earnings:

Wholesale and retail trade	16 percent
Government	19 percent
Services	19 percent
Transportation, communications, and utilities	8 percent
Contract construction	6 percent
Finance, insurance, real estate	7 percent

About one-eighth of the manufacturing earnings came from those industries categorized as textile mill products, apparel, and other mill products. Another eighth came from primary metals, fabricated metals, and ord-

nance; and chemicals and allied products, machinery, and electrical machinery and supplies contributed about one-tenth each. The remaining 45 percent of manufacturing industries earnings were spread over many categories.

All categories of economic activity will have increased earnings in 2000. Manufacturing, however, will make up only about 20 percent of the total regional earnings, compared with about 24 percent in 1975. The general or "other" category is expected to increase its share in the total regional earnings from 75 percent in 1975 to about 80 percent in 2000.

Natural Resources

The immense natural resources of the region and the productivity of its people have combined to provide a high standard of living and enhanced use of leisure time. The land presents an extensive range of uses. While supporting a large population, only 7 percent of the land in 1975 was occupied by urban and built-up developments. About 54 percent remained forested and 28 percent was devoted to crops, pasture, and other agriculture. Three percent of the region, exclusive of Chesapeake Bay, is water surface, and 8 percent of the land area serves other functions. Less than 1 percent of the region is irrigated cropland.

Table 2-2 shows the 1975 distribution of land use. Increased urbanization is projected to require about 5.8 million acres by 2000, about 9 percent of the regional area, or an increase of about 32 percent.

Table 2-2.--Mid-Atlantic Region surface area and 1975 land use

Surface area or land use type	1,000 acres	Percentage of total surface area
Surface area		
Total	66,139	100.0
Water	1,977	3.0
Land	64,162	97.0
Land use		
Cropland	11,688	17.7
Pasture and range	4,939	7.5
Forest and woodland	35,466	53.6
Other agriculture	2,059	3.1
Urban	4,418	6.7
Other	5,592	8.4

Small amounts of bituminous coal are produced in the mountainous portions of the region. The once productive anthracite mines of the Lackawanna Valley in the Susquehanna River Basin are now largely flooded because of abandonment of operations, reduced pumping, and substitution of other fuels for heating. The estuaries of the region are important

breeding areas for much of the adjacent Atlantic fisheries and provide a source of fish and shellfish for the Nation's food supply and employment for the regional population.

Agriculture

Acreage in crops is projected to decrease by about 509,000 acres or about 4.4 percent by the year 2000. The present relatively small acreage in irrigated farmland is expected to almost double, from about 264,000 acres to about 476,000 acres. Some 77,000 acres of pasture will probably be converted to cropland between 1975 and 2000. Approximately 78 percent of the total cropland is now harvested; this is expected to increase to about 94 percent in 2000. Crops include forage for cattle, fruit, vegetables, and truck crops. Forests and woodlots produce lumber, pulpwood, and Christmas trees.

Table 2-3.--Projected changes in cropland and irrigated farmland in the Mid-Atlantic Region - 1975, 1985, 2000
(1,000 acres)

Land category	1975	1985	2000
Total cropland ----------	11,688	11,590	11,179
Cropland harvested ------	9,171	10,902	10,534
Irrigated farmland ------	264	362	476

Energy

The 87 steam electric plants in the region in 1975 generated 97 percent of the total electrical energy produced or about 195,000 gigawatt-hours (gWh); conventional hydropower produced the remaining 3 percent or about 5,300 gWh. About 82 percent of the steam electric plants use a once-through cooling system. Eighty-two of these plants are fossil-fueled and five are nuclear. Electricity generation in 2000 is projected to reach about 903,000 gWh, of which about 72 percent may be nuclear (Table 2-4).

Table 2-4.--Mid-Atlantic Region electric power generation - 1975, 1985, 2000
(gigawatt-hours)

Fuel Source	1975	1985	2000
Fossil ----------	157,809	190,995	248,745
Nuclear----------	37,258	210,625	649,598
Conventional hydropower--	5,269	4,063	4,191
Total generation-------	200,336	405,683	902,534

Many of the steam electric generating plants are located on or within reach of tidal streams, bays, and estuaries and can use saline water for cooling. In 1975, such plants in the region withdrew about 17 billion gallons per day for this purpose, compared with annual requirements of about seven billion gallons of fresh water per day for other plants in the region. The need for withdrawal of fresh water will decline with increased use of cooling towers, but it is expected that a large increase in use of brackish water will occur.

The generation of electricity in 1975 produced about 1.4 quadrillion (1.4×10^{15}) Btu's of waste heat, of which about 23 percent was discharged to fresh water. By 2000, total waste heat produced by energy generation in the region is projected to be about 5.9 quadrillion Btu's, of which about 3 percent will be discharged to fresh water and about 17 percent to salt-water bodies. During dry years, heat discharge increases over normal or wet years because of the increased load assumed by steam electric plants in systems having hydroelectric plants. The expected relative reduction in heat discharge will depend on increased use of cooling towers and the degree of achievement of the objectives of Public Law 92-500.

Navigation

The volume of flow in the rivers of the Mid-Atlantic Region is not a critical consideration for navigation. Vessels are, instead, affected primarily by controlling natural or dredged depths and by the diurnal fluctuations of the tides in bays, estuaries, and upstream in rivers to the head of navigation.

The harbors and waterways of the Mid-Atlantic Region are an integral part of the national system of water and land transportation. Deep-draft commerce is served by several natural and improved channels. These include the channel between the Atlantic Ocean and the coastal and inland ports of New York-New Jersey on the Hudson River and estuary; the Delaware River to Philadelphia and Trenton; the sea-level Chesapeake and Delaware Canal which connects lower Delaware Bay with the head of Chesapeake Bay and the port of Baltimore; the Potomac River from Chesapeake Bay to Washington; the James River to Richmond; the Port of Norfolk; and the lower reaches of other streams, including the York River. Light-draft channels and harbors, with depths generally of 12 feet or less, serve barge traffic, commercial fishermen, and recreational craft. Barge traffic between the Hudson River and the Great Lakes is served by connection with the New York State Barge Canal at Waterford near Albany, New York. Shallow-draft channels, used mostly by recreational craft and small commercial fishing vessels, run along part of the southern coast of Long Island and the coasts of New Jersey south of Manasquan, and through the coastal bays of Delaware, Maryland, and Virginia to form the northern part of the Atlantic Intracoastal Waterway. The waterway provides a largely protected waterway for small craft and barges traveling between mid-Atlantic ports and Miami and Key West.

Commercial navigation facilities in the Mid-Atlantic Region at the major ports of New York, Philadelphia, Baltimore, and Norfolk handled over 332 million tons of commodities in 1975, including imports and exports of raw materials, manufactured goods, petroleum products, and miscellaneous commodities essential to the economic activity of the region and the Nation. The immense volume of waterborne petroleum traffic in the region poses the hazard of spills and potential critial environmental problems which affect the quality of the waters of the coastal areas and the adjacent areas of the Atlantic Ocean and the Continental Shelf. National energy needs, involving both offshore oil well drilling and petroleum imports via supertankers and offshore deep-draft transfer facilities, will affect the future navigation characteristics of the region. Disposal of dredged material in streams and the ocean are major problems in the maintenance of navigation channels.

Recreational watercraft use the water surfaces of the region in increasingly great numbers. The total number of such craft is unknown since only some are registered. However, the number is expected to increase with the population and the availability of leisure time. Small craft harbors, public and private, can be found in almost every stream mouth and baylet along the protected inland shores. The quality of the recreational navigation experience is primarily related to congestion and the environmental quality of the water body. Figure 2-3 shows the location of major harbors and improved rivers and waterways in the Mid-Atlantic Region.

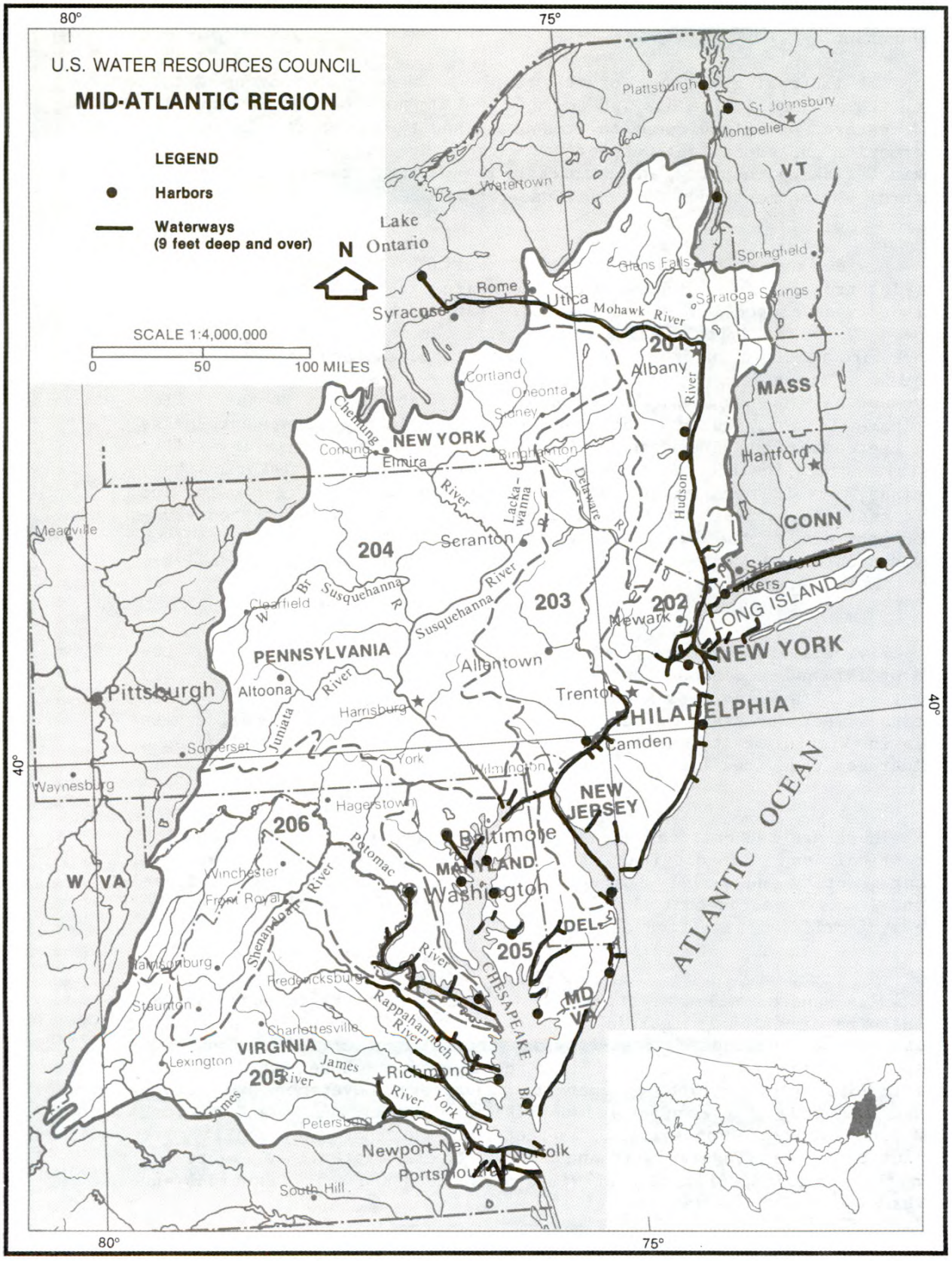


Figure 2-3. Navigation System

Environment

The increasing concern of the people of the region and the Nation with the quality of life has led to increased emphasis on the preservation and restoration of environmental resources and their intelligent use for recreation and education. Outdoor recreation involving boating, camping, hiking, fishing, hunting, and picnicking is putting increased stress on the natural environment open to public use.

A wide range of outdoor resources is available for use by the public, varying from the ruggedness of wilderness areas to the sophistication of privately developed lodges and resorts. Many of those related to or enhanced by the proximity of water bodies serve the large urban populations. Other more remote outdoor resources depend on access and transportation. The lakes, forests, mountains, bays, and beaches of the Mid-Atlantic Region have not only been made available and accessible at low cost to the public, but have also contributed to development and service by private enterprise and the consequent enhancement of economic activity. Public investment in this regard includes State parks and forests, monuments, historic sites, marinas, wayside and urban parks and preservation of free-flowing and wild and scenic rivers and ocean beaches. The fish and wildlife conservation programs of the Federal and State governments have also preserved environmental resources and, under controls, have made them available for fishing and hunting.

Five wilderness areas have been designated in the region as of the end of 1974 and encompass about 110,000 acres. They are the Lye Brook and Bristol Cliffs Wilderness Areas in Vermont, the Great Swamp and the Brigantine Wilderness Areas in New Jersey, and the James River Face Wilderness Area in Virginia. At least one other area is likely to be designated a wilderness under the law in the near future.

There are 156 critical areas for outdoor recreation, and 65 scenic, historical, and archeological sites. These areas depend upon continued water quantity and quality for the maintenance of their special designation. It is expected that the 4.8 million acres of natural and historic areas of critical significance will remain in such use.

Nine hundred miles of streams and rivers in the region are considered to be of national significance for fish and wildlife. The States are preserving 20 sections as free-flowing streams; another 18 sections have been identified as potential wild or scenic rivers. Under the Wild and Scenic Rivers Act of 1968, as amended, the Federal Government has authorized the study of the upper Delaware River in Pennsylvania and New York and Pine Creek in Pennsylvania to determine whether they qualify for inclusion in the Federal Wild and Scenic Rivers System. See Figure 2-4 for the general distribution of wilderness areas and critical areas and streams.

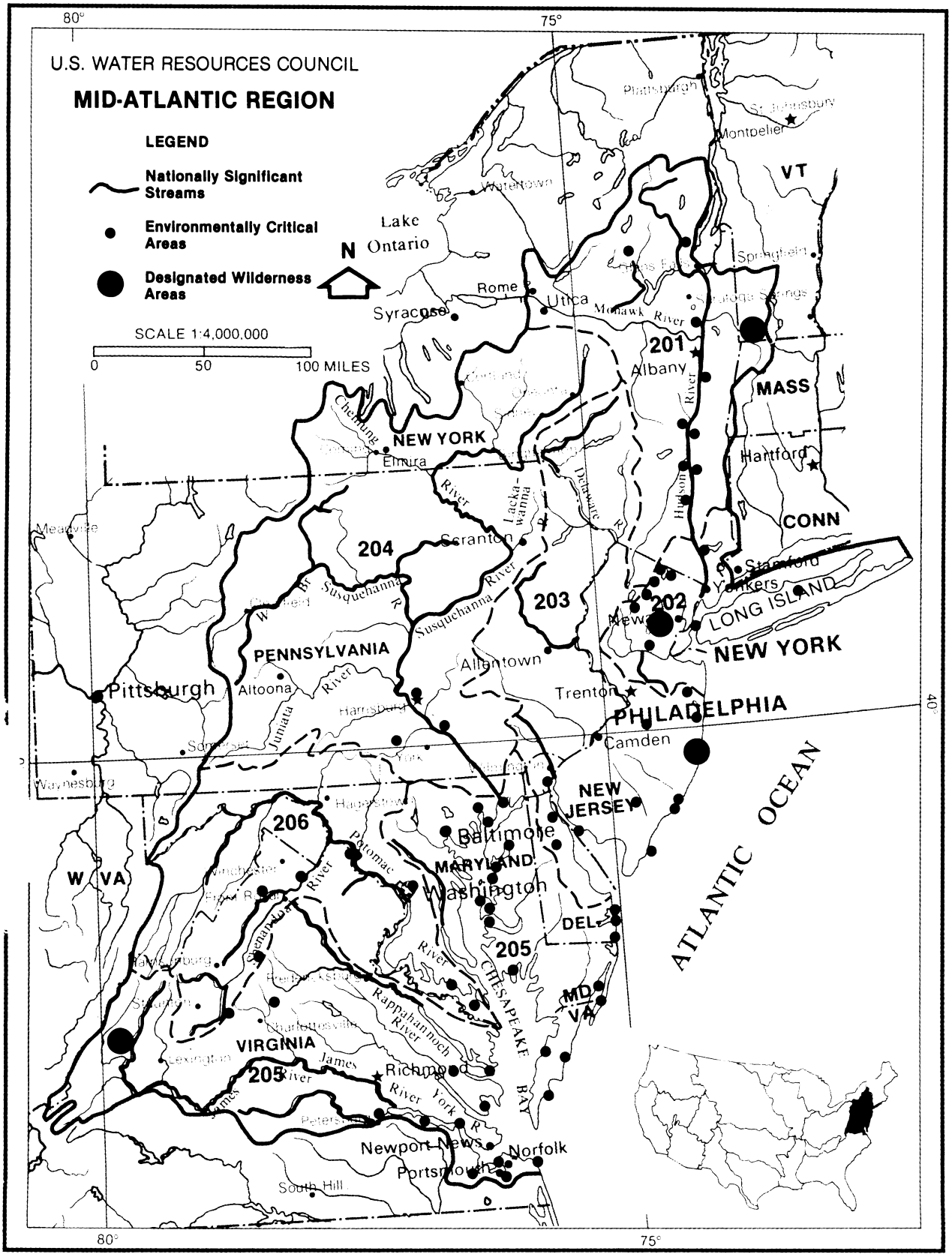


Figure 2-4. Environmental Resources

Wetlands, the incubator of many species of fish and wildlife, are an essential element in providing a viable habitat for the members of the food chain. Coastal marshes and wetlands and land areas in the flood plains of major streams, rivers, and estuaries total about 10.2 million acres in the Mid-Atlantic Region, distributed as follows:

Hudson River Basin	1,283,000 acres
Long Island - northern New Jersey	460,000 acres
Delaware River Basin and southern New Jersey	1,750,000 acres
Susquehanna River Basin	1,750,000 acres
Chesapeake Bay Drainage including, Rappahannock, York, and James Rivers	3,870,000 acres
Potomac River Basin	1,127,000 acres

At least five animal species indigenous to the region are considered in danger of extinction. These are the osprey of the Delaware and New Jersey coasts, the Pine Barrens tree frog of southern New Jersey, the bog turtle, the shortnose sturgeon, and the Maryland darter. The habitat of the peninsula fox squirrel in the Chesapeake area is threatened. Other endangered species which range throughout the region but are also distributed elsewhere are the Arctic peregrine falcon, American peregrine falcon, southern bald eagle, brown pelican, Eskimo curlew, red-cockaded woodpecker, and Bachman's warbler. Continued existence of these species hinges on preservation of the ecosystems and habitats upon which they depend under Public Law 93-205.

Water-dependent outdoor recreation activities approximated 218 million activity occasions[1] in the region in 1975, and are expected to increase by about 33 percent by 2000. Water-enhanced activities may grow from the 1975 level of 115 million by about 36 percent. The additional water and land areas required for 2000 are estimated to be about 61 and 52 percent respectively over current resources. This is an increase for the region as a whole from about 1.7 million acres to about 2.7 million acres of water area and from 63,400 acres of developed land to about 96,300 acres. Only the Hudson River Basin and the Chesapeake Bay subregions (201 and 205) are estimated to have sufficient water areas to meet the growth of demand. However, surpluses in one subregion cannot be expected to effectively serve deficiencies in others.

[1]An activity occasion is defined as the participation by one person in a recreation activity without relation to the duration of the activity.

Water

This section seeks to assess the current and potential problems related to use of water and related land resources in the Mid-Atlantic Region. Relevant quantitative data on the current supply and demand for water are the basis for the projections of probable future demands in 1985 and 2000. Data on supply withdrawals and consumption are for base year conditions unless otherwise stated.

The Mid-Atlantic Region is not a hydrologic entity as are the inland regions. Most of the major streams flow independently to the ocean and do not join in a common main stem for the final outlet. Nor are the water resources of the subregions available to each other. Accordingly, regional totals have statistical meaning only to give a broad view of the regional use of water. Subregional problems must be identified and resolved with recognition of their hydrologically isolated character.

Subregions 201, 204, and 206, representing the Hudson, Susquehanna, and Potomac river basins, are hydrologically integrated. Subregion 203 is primarily the Delaware River Basin, but for statistical convenience and because the Philadelphia area draws on the environmental resources of the coastal area of New Jersey, south of Monmouth County, it may be treated as an entity. Subregion 202 is primarily a geographic and demographic grouping of the various drainage areas entering the ocean and its embayments in the New York-New Jersey metropolitan area. Subregion 205 is a convenient statistical grouping of the Chesapeake Bay drainage and coastal areas and the several smaller river basins directly tributary to the bay south of the Potomac River Basin.

Surface Flows

The average surface flow of the streams in the region is about 79 billion gallons per day (bgd) (Figure 2-5). This includes the residual after-use of ground water withdrawals, but does not include the remainder of imports which are discharged through waste facilities to tidal areas or the sea. In a dry year, available surface flow would be reduced to about 61 bgd. The smaller streams with less natural or artificial regulation would suffer more reduction of flows in dry years than indicated by the overall average. Extremely low flows generally occur in midsummer and fall, but flow in northern streams may be reduced by freezing or extremely cold winters. Higher-than-average flows usually occur during the late winter and spring.

Withdrawal and consumption of surface and ground water do not differ markedly in average and dry years throughout the region when considered as subregional totals.

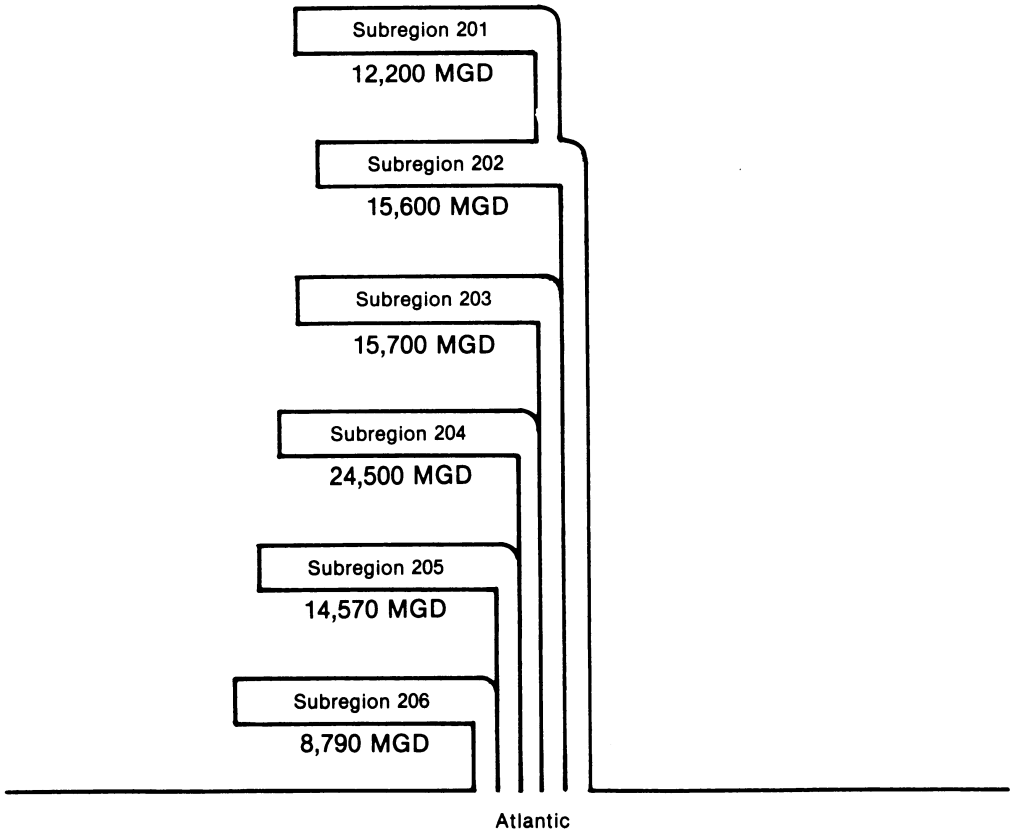


Figure 2-5. Streamflow

Ground Water

Large quantities of fresh water are available from the extensive aquifers that underlie the coastal plain, but exploitation is limited by the encroachment of saline water as fresh-water levels are drawn down and by contamination introduced by disposal of domestic and industrial wastes. The major aquifers of the Mid-Atlantic Region (see Figure 2-6) are the unconsolidated and semiconsolidated areas of the coastal plain, including Long Island and the Delmarva Peninsula, and the consolidated strata of the Appalachian range within the region. In addition, water-bearing aquifers of narrow extent underlie the river valleys. The NF estimates 1975 ground-water withdrawals to be about 2,661 mgd.

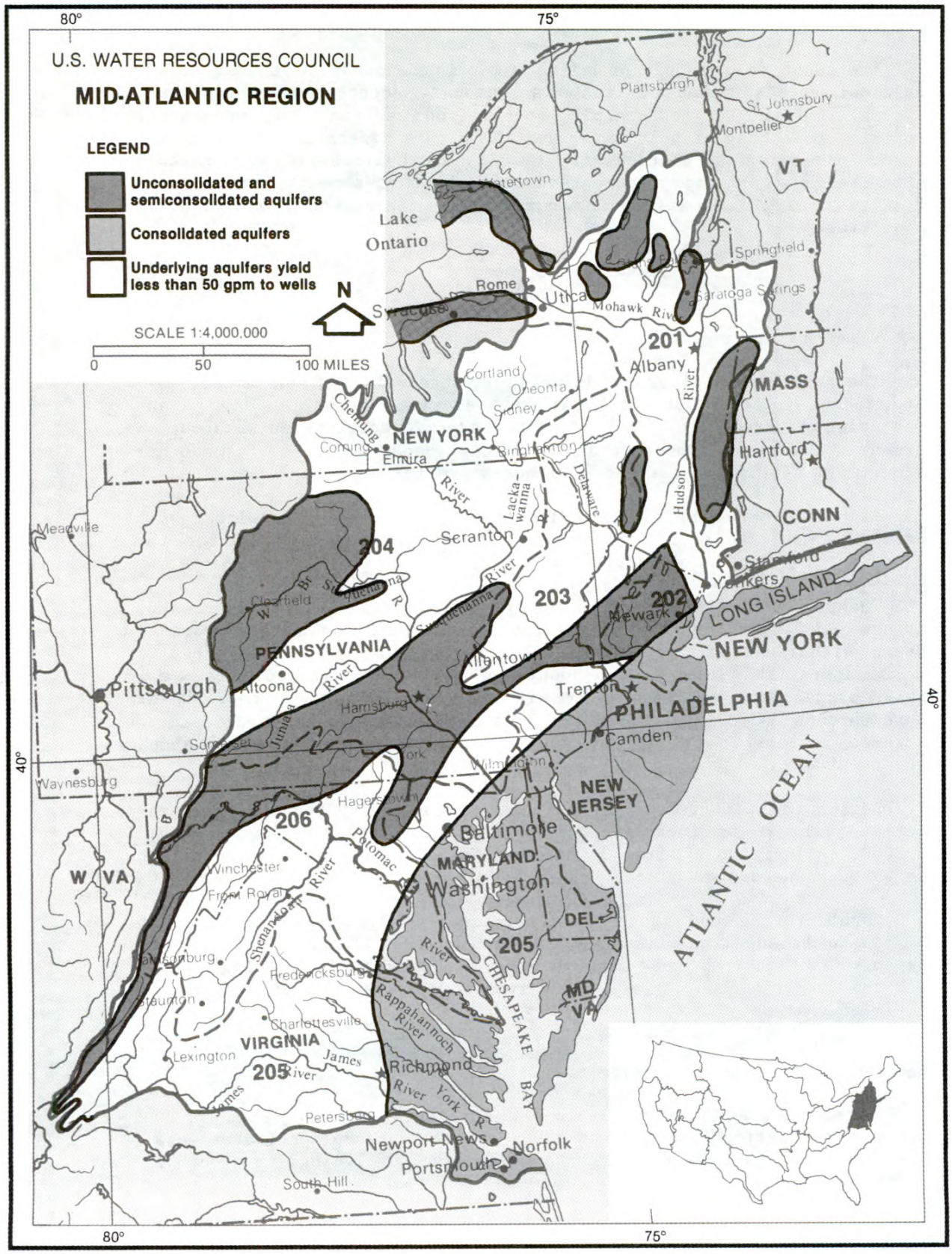


Figure 2-6. Major Aquifers

Saline Water

The quantity of supply of saline water in the ocean, bays, estuaries, and tidal reaches of coastal streams is abundant. Acceptable limits of use, however, are subject to economic, social, and environmental standards. Proximity to a body of salt water and the nature of the use are limiting factors on economical withdrawal. Quality and availability are factors in instream use affecting recreational and visual enjoyment. Primary uses of saline or brackish water are in manufacturing, mining, and steam electric industries.

Water Withdrawals

The total fresh-water withdrawals from streams and ground-water aquifers in the Mid-Atlantic Region in 1975 averaged about 18.3 bgd. Manufacturing withdrew about 30.0 percent and steam electric plants, about 41 percent of the total. Domestic and commercial needs accounted for another 25 percent. Irrigated farmlands withdrew 1.4 percent.

Figure 2-7 shows the relative distribution of fresh-water withdrawals for 1975, and withdrawals for projected (NF) demands in 2000 for the major sectors of economic activity.

The present magnitude of demand by steam electric plants is caused, for the most part, by the once-through nature of the cooling process. Future withdrawals for this and other industrial uses are expected to decline appreciably as industry adapts to more water-efficient processes. The NF projections of fresh-water withdrawal in 2000 assume major water reuse through recycling. Total fresh-water withdrawals are projected to decrease regionwide by 2000 to about 14 bgd, or a reduction of about 24 percent.

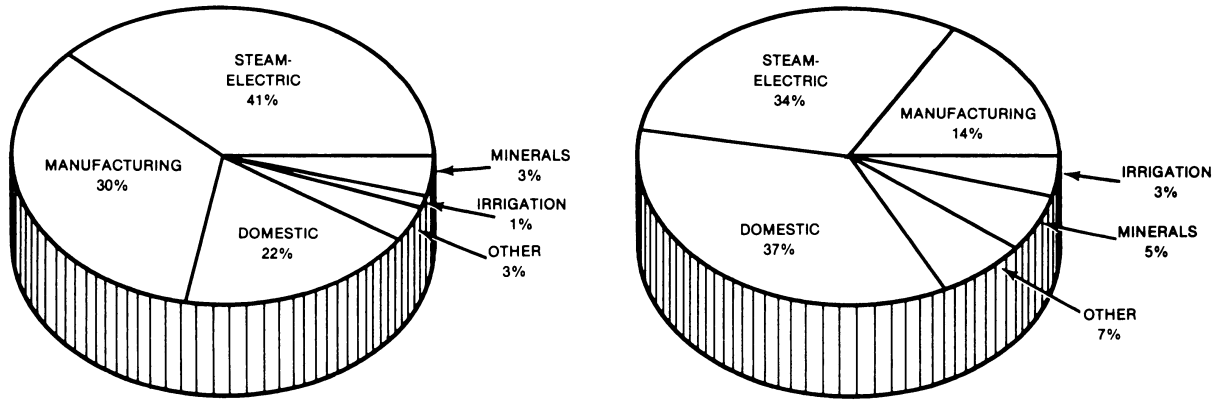
Regionwide withdrawal of saline water in an average year is projected by the NF to increase from 19.6 bgd in 1975 to about 26.2 bgd in 2000, an increase of about 34 percent. No saline water is available in the Susquehanna Basin.

Manufacturing and steam electric plants in 1975 made the largest demands on the supplies of subregions 201, 203, 204, 205, and 206. Domestic use and manufacturing took most of the withdrawals in subregion 202, with the former accounting for about two-thirds of the withdrawals.

Water Consumption

Although water withdrawals in all subregions are projected to decrease in the period from 1975 to 2000, overall consumption (water loss) is expected to about double from the 1975 level of 1.8 bgd to about 3.5 bgd in 2000.

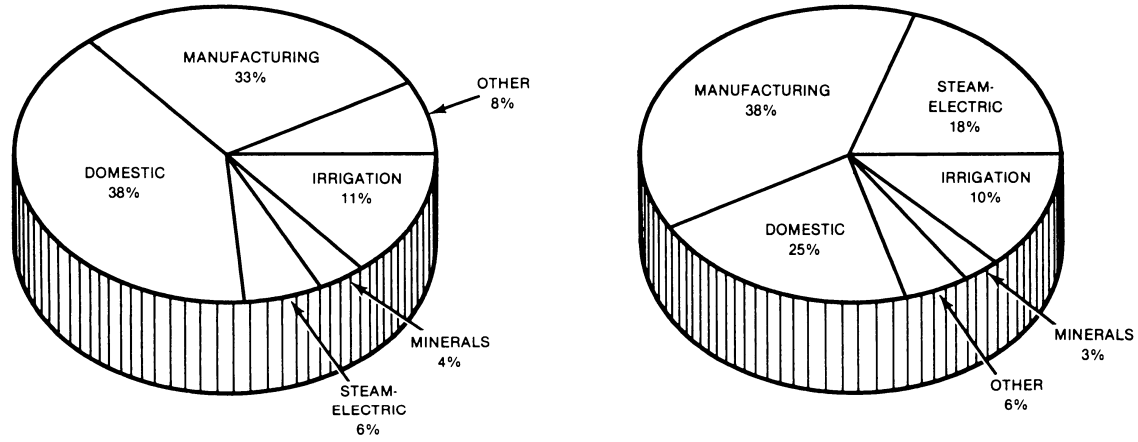
ANNUAL FRESHWATER WITHDRAWALS



1975
Total Withdrawals — 18,300 MGD

2000
Total Withdrawals — 13,873 MGD

ANNUAL FRESHWATER CONSUMPTION



1975
Total Consumption — 1,843 MGD

2000
Total Consumption — 3,548 MGD

Figure 2-7. Withdrawals and Consumption

Water consumed by evaporation, transpiration, and incorporation into products or diverted as waste is not returned to the stream. In 1975, domestic, commercial, manufacturing, and irrigation uses accounted for about 87 percent of the total consumption in the region. While all categories of use will show increased consumption by 2000, domestic consumption will consume about 29 percent, and manufacturing and steam electric plants, about 56 percent of the total. Although irrigated farms withdraw a relatively small part of total withdrawals, they consume about 74 percent of what water they do withdraw, a proportion which is not expected to change. The distribution of consumption among categories of use in the region is shown for 1975 and 2000 on Figure 2-7.

Total consumption averages about 2.3 percent of total streamflow, regionwide, and varies from about 1 percent in the Hudson (201) and Susquehanna (204) River Basins to between 3 and 4 percent in the New York-New Jersey metropolitan subregion (202) and the Delaware River Basin (203). Estimates of consumption of saline water have not been made.

Instream Uses

Instream flow needs are those uses of the stream which do not require the actual withdrawal or consumption of the water. The principal instream uses are recreation, navigation, fish and wildlife habitat, waste disposal, and production of hydroelectric power. In this assessment, instream flow estimates of need for the National Future (NF) are approximations by informed judgment of the quantity of flow at the outlets of the basin deemed sufficient to maintain the habitat of aquatic life forms. The NF estimates the instream flow approximation for fish and wildlife to be 68,840 mgd in the Mid-Atlantic Region as a whole. The State/Regional Future (SRF) considered that estimates could be made of the instream needs not only for fish but also for hydroelectric power, water quality, and environmental and other uses. Using the Federal definition, the SRF estimated the total and minimum instream flow needs for 1975. These are expected to remain constant through 2000. They vary regionally from about 71 to 79 percent of the present fresh-water supply for dry years.

Water Supply and Demand

The Mid-Atlantic Region shares the good fortune of many other regions of the Nation in having both developed and undeveloped water resources for municipal and industrial use broadly distributed throughout the region. Generally, the total regional water supply is well in excess of the total projected regional needs through the end of the century. However, seasonal and annual variations in precipitation and runoff can engender grave deficiencies in terms of supply and demand. Currently, total withdrawals for base year conditions are about 11 to 12 percent of the subregional total streamflow in the Hudson and Susquehanna River Basins; about 15 to 20 percent in the New York-New Jersey metropolitan area, the Potomac Basin, and the Chesapeake Bay; and over 40 percent in the Delaware Basin.

However, for extraordinary conditions that could be expected about every 20 years, water would not be sufficient to meet the withdrawals and other needs in many parts of the region. These estimates assume no large change in the rate of ground-water withdrawals.

Estimated consumption (NF) in the year 2000 varies from about 2 percent of subregional total streamflow in the Susquehanna Basin to about 6 percent in the Delaware subregion, approximately double the 1975 consumption. Accordingly, there should be little difficulty in meeting the quantitative demands for water for the expected needs of the several subregions. In the individual subbasins, as discussed later, more complicated intraregional problems arise. These problems range over perplexing issues involving environmental quality, economic and investment decisionmaking, and regional and national priorities in both financing and political objectives.

Comparative Analysis

Table 2-5 compares the National Future (NF) and State-Regional Future (SRF) estimates of streamflows and water use in the Mid-Atlantic Region. The differences in data are relevant to future planning since they affect estimates of water supplies, withdrawals, consumption, and instream uses. The NF makes no projections for current downstream water rights; the SRF assumes no changes in these matters. Differences in NF and SRF withdrawal projections result from the different estimates adopted by the States of New York, New Jersey, Virginia, and Pennsylvania and from varying rates of per capita needs. Estimates of water needs for various manufacturing industries and for steam electric power generation also differ. The larger SRF projections for irrigation withdrawals stem from the Pennsylvania projections for its portions of subregions 203, 204, and 206.

Whether the NF or SRF projections materialize depends on the resolution of national policy, which will affect the economy, technological development, and public desires in energy development, implementation of environmental programs, and related matters. During the projected period, all views of the future must be considered and adapted as policy is resolved and as decisions and future plans are made concerning water and related problems. The gross amount of water available on a regionwide level is much greater than either the NF or the SRF projections of withdrawal would require. In some cases, decisions on use will be made locally, e.g., in the category of irrigation. In other cases such as needs of energy production, decisions on use will depend on national and international events, on production and use of fossil and nuclear fuels, and on the alternative and still experimental means of fuel and energy production that presented problems of uncertainty in the early projections for the assessment.

Table 2-5.--Socioeconomic and volumetric data summary: the Mid-Atlantic Region

Category	1975		1985		2000	
	NF	SRF	NF	SRF	NF	SRF
SOCIOECONOMIC DATA (1000)						
Total population	39,612	38,933	43,873	42,265	49,939	46,709
Total employment	17,097	17,108	19,730	19,730	23,307	23,307
VOLUMETRIC DATA (mgd)						
-Base conditions-						
Total streamflow	81,001	NE	81,001	NE	81,001	NE
Streamflow at outflow point(s)	79,190	78,984	78,529	NE	77,453	NE
Fresh-water withdrawals	18,300	18,909	15,857	17,032	13,873	16,122
Agriculture	333	529	435	779	552	1,025
Steam electric	7,463	7,872	7,130	7,734	4,657	5,947
Manufacturing	5,416	5,918	2,526	3,245	1,942	2,869
Domestic	3,954	4,155	4,467	4,740	5,168	5,598
Commercial	650	[a]	726	[a]	826	[a]
Minerals	459	421	548	516	700	663
Public lands	4	14	4	18	7	20
Fish hatcheries	21	NE	21	NE	21	NE
Other	0	0	0	0	0	0
Fresh-water consumption	1,843	1,994	2,472	2,791	3,548	4,164
Agriculture	264	439	338	658	425	864
Steam electric	103	78	224	162	644	489
Manufacturing	607	678	934	1,073	1,361	1,773
Domestic	705	742	790	826	896	947
Commercial	91	[a]	101	[a]	114	[a]
Minerals	70	52	82	65	102	82
Public lands	3	5	3	7	6	9
Fish hatcheries	0	NE	0	NE	0	NE
Other	0	0	0	0	0	0
Ground-water withdrawals	2,661	2,811	NE	2,891	NE	3,011
Evaporation	0	0	0	0	0	0
Instream approximation						
Fish and wildlife	68,840	68,840	68,840	68,840	68,840	68,840

NE - Not estimated.

[a] SRF domestic water use includes commercial and institutional requirements.

Problems

The developed and undeveloped water resources of the Mid-Atlantic Region are sufficient in total quantity to meet foreseeable demands into the twenty-first century. However, during a drought equivalent to that of the 1960's there would be severe problems of quantity distribution and quality affecting the use of water and related land resources. Resolution of these problems is critical to the welfare of the large population of the region. Competition among uses has delayed necessary development.

As indicated in Figure 2-8b (following the recommendations), Federal and State/regional representatives find severe fresh-water quantity and quality problems in nearly all 27 areas of the six subregions and saline water problems in several. Related land resources problems also are widespread, with flooding, erosion and sedimentation, and water-related use conflicts the most common, followed by dredging and filling, and conflict in water and land uses. Resolution of these water problems requires proper study, resolution of institutional and legal arrangements, and changes in national policy on water resources and programs. Changes in the Federal role in helping the regions and the States to resolve high priority problems, and in pursuing further research and data collection activities are also required.

Water Quantity

Using the NF instream flow approximations for fish and wildlife, all subregions show streamflow deficits under dry-year conditions. The use of the flows for domestic and industrial water supplies, the consequent losses through consumption, and the effects of pollution conflict with instream needs for fish and wildlife and for recreation. Commercial navigation in the region is not dependent upon streamflows or water quality. Recreational boating, however, needs clean water and is enhanced by a pleasant natural environment in all parts of the region. The pressure of increasing use lowers the value of the recreation experience.

Water supply shortages and conflicts among users are increasingly severe problems in parts of all subregions. Headwater subbasins, estuaries and bays, and the lower tidal reaches of rivers will become particularly severe problem areas in some sections of the region, as population increases in the former and saline intrusion affects water uses in the latter.

The effects in less densely populated areas will be loss of economic productivity to industry and agriculture and limited or restricted use of water to area residents. In the more densely populated areas, the impacts will be greater in proportion to the larger number of people affected. In most of the large metropolitan areas of the region, the gap between demand and safe yield is projected to widen appreciably.

Northeast Water Supply

Metropolitan New York City is the major consumer of subregion 202's domestic water supply; water demand almost equals the total domestic demand in the rest of the region. The drainage basin of subregion 202 is the smallest in the region, and surface water available has been severely degraded by municipal and industrial discharges. The major river, the Hudson, is brackish for its entire length within the subregion. The subregion must therefore import about half of its required water because available freshwater supplies are so limited.

The existing safe supply for the New York City system is 1,300 mgd for the drought of record. The average use in 1974 was 1,479 mgd. Monthly demand in the city has already exceeded 1,670 mgd for a peak summer month and has exceeded 2,000 mgd on a peak day. In 1976 the New York City system had an average consumption that was approximately 170 mgd higher than its safe yield. It is estimated that without a conservation program the deficit for the New York metropolitan area could reach about 520 mgd in 2000. (Survey Report, Northeastern United States Water Supply Study [NEWS], July 1977.)

There is a critical inadequacy of water supply in the northern New Jersey area; 100 mgd is currently imported from the Delaware River Basin. The upper Hudson and the Delaware River Basins have exported 801 mgd and 620 mgd on the average, respectively, to the New York City systems. This has caused serious water quality problems for the exporting regions. Freshwater withdrawals from subregions 201 and 203 have allowed salt water to extend farther up the Hudson and Delaware Rivers. The problem was especially acute during the long drought of the 1960's when the flow was dangerously low in the Delaware River, which supplied water to Philadelphia. The saline interface came within a mile of Philadelphia's water supply intake. The conflict among subregions 201, 202, and 203 over freshwater supply will probably intensify in the future as the metropolitan populations of the Northeast grow larger.

Arranging imports from adjacent basins is complex and costly. Fragmented governments and many small suppliers with limited authorities make dealing for equitable compensation and large supplies difficult. Arrangements are further complicated by riparian rights of owners downstream from the points of export and by the need for additional storage sites.

Long Island Ground-water Supply

Long Island is currently facing a crisis of excessive ground-water use and resultant salt-water intrusion. Much of the 860 mgd of ground-water withdrawal in subregion 202 occurs on Long Island. Some of the pumped water returns to the ground-water system via septic tank drain fields and cesspools. However, sewer systems are collecting most of the used water and diverting it to the ocean. This water would have otherwise served to recharge the ground-water system. Increased pumping and reduced quantities of returned water permit saline water to encroach even more on ground-water supplies. These problems are receiving attention in the current

208 study and recharge pilot program. Other problems of major significance which are emerging on Long Island are the degradation of aquifer water quality. Nitrate pollution and more recent discoveries of organics and trace metals are causing new techniques for waste-water and ground-water management to be tested. Nassau County, for example, will construct a tertiary treatment pilot plant at its Wantagh treatment plant and experiment with recharge of tertiary treated water.

Many of the problems facing New York City and Long Island are beginning to emerge in other metropolitan areas. South Jersey and Norfolk, Virginia, for example, are confronted with the possibility of their potable ground-water supplies being contaminated by salt-water intrusion.

Washington, D.C., Water Supply

Average annual demands in 1970 for the Washington metropolitan area were about 390 mgd, while the minimum daily flow in the Potomac River at Little Falls above Washington, D.C., has been recorded at 388 mgd. With increasing demands from estimated population growth and per capita use, deficits in daily and weekly supply are anticipated by about 1980, and weekly and monthly deficits are expected shortly after 1990. Effects will be curtailment of use, degraded esthetic appearance of residential and public land, increased fire hazard, and possible health hazards. Very low inflows to the Potomac estuary will interfere with fish life, prevent adequate assimilation of wastes, trigger algae blooms, reduce dissolved oxygen, and allow disease-causing organisms to thrive.

Chesapeake Bay Water Supply

There is the necessity of maintaining fresh-water flows of the Susquehanna River Basin into Chesapeake Bay. A Chesapeake Bay Model Testing Program is currently investigating the fresh-water low flows into the bay.

Other Water Supply Problems

Increased demands in the York and Rappahannock River Basins will result in conflicts among uses, nonsatisfaction of environmental needs, and are already resulting in overpumping of ground-water aquifers. Demands exceed safe yield for public supply in the Norfolk area, and the gap between supply and demand is expected to increase significantly. In 1980, deficits are estimated at about 10 mgd, and the deficits in 2000 will be on the order of 50 mgd (North East Water Supply (NEWS) Study of Long Range Water Supply Problems, November 1973). Continued or increased pumping from wells may cause salt-water intrusion of ground-water supplies and potential land subsidence over the area of extensive pumping. Many requirements will not be met even with severe curtailment and, as a consequence, economic growth will be hindered. Fredericksburg also faces a potential water supply problem.

Effects of Drought

A severe drought in the subregions supplying water to the New York City, Philadelphia, or Washington areas, possibly exceeding that of the 1960's, could have catastrophic consequences locally and repercussions throughout the Nation. The economic effects of a major and prolonged drought on manufacturers using large quantities of water, such as food, textile, chemical, and primary metals manufacturers, would cause water-intensive industries to experience a discontinuation of growth. Lack of growth in water-intensive industries would affect other industries in the region and might adversely affect industries in other regions doing business with those in the Mid-Atlantic Region. Losses to the overall economy would be very large. Other regions could not readily absorb the manufacturers leaving the region under the implicit assumption of full employment since their own products, services, and manpower are expected to be fully utilized. Therefore, the economic losses to the Nation as a whole would be at least as great as the losses to the region. Preliminary estimates have shown that these losses could be on the order of $1 billion annually if the problem remains unsolved. In the event of a drought as severe as the 1960's drought in the Mid-Atlantic Region, short-term economic effects on the national economy would push this figure higher as this lack of growth, or decline, in the economy of the region would cause curtailment of growth or declines in those industries around the Nation dependent upon the Mid-Atlantic Region as a market or supplier.

Lack of supply for such uses as drinking and firefighting would have dire consequences to health and safety. Effects in the heavily populated northern New Jersey area would include overall losses environmentally, socially, and economically. Loss of recreational activity, the impairment of environmental values, and the curtailment or regression of industrial growth would occur. There would be detrimental effects on farming and on the income of area residents. Conflicts over limited water sources will occur in several areas throughout the region and are expected to increase significantly with the higher projected consumptive losses. Simultaneous withdrawal and instream use for domestic supply, agricultural irrigation, livestock, recreation, and hydroelectric needs will become more limited.

Water Quality

Water pollution problems impair the quality of most of the streams, bays, estuaries, and adjacent areas of the Atlantic Ocean in the Mid-Atlantic Region. Priority quality problems are severe and will continue, particularly in the Hudson, the Delaware, and the Potomac Rivers; the New York City and northern New Jersey area; and the Hudson River estuary area.

Sources of Pollution

Pollution includes wastes from domestic, industrial, mineral, organic, chemical, and agricultural sources; heat from manufacturing and electric

generating plants; and acid mine drainage. Recycling of use of waters withdrawn by industry and use of cooling towers by steam electric plants should reduce the heat pollution problem appreciably. The magnitude of increased heat waste in 2000 is an indication of both the magnitude of the problem and the threat to water quality. Domestic, manufacturing, mining, and agricultural activities also produce large quantities of pollutants in the form of biochemical oxygen demand (BOD) and total suspended solids (TSS). Further increases in discharge of such wastes to the waters of the region will endanger the delicate ecosystems of the streams, wetlands, bays, and estuaries.

A further contaminant is dredged material from construction activities onshore and from the deepening and maintenance of harbors and navigation channels. The prospect of offshore oil drilling and offshore deep ports for transfer of petroleum carried from abroad by supertankers poses a further threat to the quality of the ocean and its ecosystems and to recreational use of the waters and beaches of the coastal areas. Habitat changes in the estuaries would have profound economic effects on the commercial fish industry of the region, which in 1972 harvested over 850 million pounds of fish, the second largest catch of any coastal region in the country.

Acid Mine Drainage

Acid mine drainage from the western and eastern parts of subregion 204 and the western parts of subregions 203 and 206 contaminate downstream waters. It is estimated that over one million pounds of acid per day are discharged into the water bodies adjacent to subregion 203 alone. The drainage from abandoned and inactive mines contributes significantly more pollutants than the active, operating mines. These "orphan" mines are a particularly difficult problem because no one assumes responsibility for them. Acid mine drainage interferes with downstream use and causes health hazards, corrosion to shoreline structures and vessels, land scars, and increased treatment costs. The pollutants adversely affect fish and wildlife and their habitats, limit recreational use, lower overall pH (increase acidity), render water useless in some areas, and contaminate ground water, effectively limiting the availability of this source of supply.

Effects of Pollution

Risk to public health from the hazards of such contaminants as heavy metals, PCB's, bacteria, and carcinogens is serious. Liquid wastes, some of which are imported from other areas, have closed beaches to recreationists in many areas, such as the James River estuary and adjacent waters of the Chesapeake Bay, and have resulted in shellfishing restrictions. Nitrogen input has caused oxygen depletion in some areas. Pollution from waste discharges upstream of water supply intakes results in increased costs to water supply users for further treatment. Pollution from heavy urbanization in densely populated areas has caused imposition of building limitations, resulting in the curtailment of economic and social growth.

Inadequately treated waste water threatens municipal water supplies, poses health hazards, and threatens the overall environment.

Flooding

Flooding from overflow of streams and rivers is considered a priority problem in northern New Jersey, the lower Delaware River, the entire Susquehanna River, and, in the long-term, the upper Susquehanna River. Coastal damage due to flooding and erosion from storm tides, waves, and littoral currents is particularly severe in the southern New Jersey area. The National Future assumes that structural flood damage prevention measures will continue to be installed as justified, but at a slower rate than in the past, and that the present trend to apply land-use regulatory measures in the flood plains, adapting land use to the flood hazard, will continue at a faster rate.

Floods cause loss of life -- potentially major losses in some areas -- property damage, destruction of roads and railroads, interruptions to communications, and contamination of public water supplies. Flood runoff from urban and rural lands, carrying sediments, covers or washes out and destroys valuable fish and wildlife habitats, fills in channels, and adds to water treatment and dredging costs.

Flood Losses

Monetary values cannot be assigned to the effects of floods and the flood hazard on human life and social well-being. However, physical and direct monetary losses are extensive. Indirect and secondary losses are more difficult to evaluate, and many intangible effects are not susceptible to valid evaluation in monetary terms.

Based on the assumptions for the NF, the total average annual losses in the region for 1975 conditions projected to the year 2000 are expected to increase about 61 percent from about $183 million to $296 million, roughly 7.0 percent of the national toll. About 71.0 percent of current damages are urban and this proportion is projected to increase to about 77 percent of the regional total by 2000. Urban flood damages in the Mid-Atlantic Region are the second highest of any region in the country and will about double to $229 million by 2000. Average annual agricultural flood damages ($28.5 million in 1975) are projected to remain about constant in dollars during the interval, and will constitute about 9 percent of the regional total in 2000, compared with 15.5 percent in 1975. The remainder of all other kinds of economic losses is expected to increase by about 57 percent. These changes will depend on the extent to which development, provision of structural protection, and adaptation of land use in the flood plains recognizes the flood hazard.

Flood-plain Land-use Management

A consideration to be resolved is the part the Federal Government takes in bringing about changes in Federal policy and participation in

the flood-plain management and damage reduction program. Past emphasis in resolving the flood problem has been to control flood flows or flood runoff and to protect developed areas from overflow by the use of structural or land treatment measures such as dams, levees and channels, and watershed and soil treatment. The Corps of Engineers and the Soil Conservation Service, the principal flood agencies, have expended approximately $600 million per year nationally for the past ten years. However, a rising trend in public acceptance of flood-plain land-use regulations is taking place, and has received congressional endorsement in the Water Resources Development and Preservation Act of 1974 (Public Law 93-251), Section 73(a) which reads: "In the survey, planning or design of any project involving flood protection, consideration will be given to non-structural alternatives to prevent or reduce flood damages including, but not limited to, flood-proofing of structures; flood-plain regulations; acquisition of flood-plain lands for recreational fish and wildlife, and other public purposes; and relocation with a view towards formulating the most economically, socially and environmentally acceptable means of reducing or preventing flood damages." The NF projections as stated recognize this policy. Executive Order No. 11988, May 24, 1977, on flood-plain management, states that each Federal agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains.

Flood damage insurance, which had not been financially feasible nor available from the private insurance industry, became an operating reality with Federal subsidization through the Flood Insurance Act of 1968. As of August 1977, nearly 16,000 communities were participating in the program, and coverage has been rapidly increasing. The Federal Disaster Assistance Act of 1974 incorporated new Federal assistance and cost-sharing policies that are being tested. The Flood Insurance Act provided financial incentives to encourage increased land-use regulation by local agencies, and State agencies have been given additional authority to deal with flood problems. Section 73 of the 1974 Water Resources Development Act awaits implementation of the Federal role in financial participation in nonstructural measures. Under earlier authorities, information and feasibility reports have been prepared at non-Federal request on flood hazards, and protection and prevention, for over 5,800 communities.

Erosion and Sedimentation

Erosion and sedimentation are problems in large ports of subregions 201, 202, 204, 205, and 206 and affect the shores of the Chesapeake Bay and the upper reaches of the James River in subregion 205. Erosion reduces agricultural productivity, increases costs of construction, and destroys property values. In addition, sedimentation is detrimental to aquatic habitat, recreational resources, water storage reservoirs, and navigation channels.

Erosion is the dominant soil hazard on about 28 million acres of land in the region, with rates of sheet erosion from cropland harvested

varying from about 7 tons per acre annually in subregion 202 to 20 tons in subregion 206. NF projections suggest regionwide averages of about three tons per acre per year by 2000 for harvested cropland. The NF 1975 rate of erosion from forests and rangelands in the region was estimated to be about 0.2 ton per acre per year. State/regional data indicate that about 4,700 bank-miles on streams are undergoing severe erosion, and about 1,220 miles of shoreline are in a critical state.

Commercial Navigation

Existing and authorized navigation facilities in the region have been provided or proposed by the Corps of Engineers under congressional authorization since 1824 to meet the developing needs of waterborne commerce. In calendar year 1975, over 332 million tons of cargo were received or shipped from harbors of the region. This traffic will continue to affect future uses of the estuaries and bays for other purposes. The shallowness of the Atlantic Continental Shelf and the long distances of harbors and port facilities in the region from navigable depths in the ocean make adaptation to the needs of the new generation of deep-draft tankers and bulk carriers economically prohibitive by reason of the great depths and volumes of dredging that would be required. In addition, dredged material and sewage sludge disposal, offshore oil well drilling, and transfer of petroleum products from the wells or from supertankers create problems of preservation of ocean water quality and ecosystems, as well as of related land uses of the shores.

Impacts of offshore oil well drilling and petroleum transfer by vessel or pipeline could benefit economic activity, but could be costly if such activities interfere with recreation, fishing, and environmental values.

Impacts and conflicts in uses of the Continental Shelf, such as for offshore dumping, powerplant siting, deep-water port development, oil and gas development, and commercial fishing, are being principally addressed through the Coastal Zone Management Act (CZMA) (Public Law 92-583) and its 1976 amendments, particularly the Coastal Energy Impact Program (CEIP) (Section 308 of Public Law 94-370) and by already developed State coastal zone plans, such as CAFRA of New Jersey. In addition, the Federal Government is sponsoring a planning methodology study of the onshore impacts of offshore oil and gas development. Resolution of onshore problems may depend on the States developing acceptable plans under Section 305 of the CZMA, as amended. In addition, funding under Section 306 or the CEIP must be adequate to address the conflicts.

Water Surface

Water-related recreation is dependent upon adequate access and sufficient water area in a pleasant environment to provide satisfactory and safe enjoyment of outdoor recreational activities. Only the Hudson River Basin and the Chesapeake Bay subregions are considered to have sufficient water surfaces for present and anticipated levels of demand. The surplus

in neither of these is considered available to satisfy demands in the other subregions. Subregion 202, which contains the New York-New Jersey metropolitan area, faces increased recreational demands by 2000 that would require over 716,000 acres of additional water surface, an increase of about 45 percent. The needed increase in usable water surface in the other three subregions is projected to total about 986,000 acres by 2000. Some of the needed area presently is not accessible for reasons of shore development, private ownership, and other restrictions. Coastal and estuarine waters pose questions of safety to small craft even under the most favorable weather conditions. Inland streams and lakes are limited by area, currents, access, and potential for construction of artificial lakes.

River and Land Management

The conflicting desires and uses of water and related land areas within the region arise from the nature of the goals of economic enterprise, conservation and environmental preservation, property rights, and pressures of an expanding population for access to and use of water areas and adjacent lands for recreation. The region as a whole is probably not susceptible to management by a single entity. River basin commissions for the Delaware, Susquehanna, and Potomac Rivers have been established and have participated in this assessment under the regional sponsor. The first two of these have management prerogatives through interstate-Federal compact arrangements. Such management entities have not been deemed necessary up to now in the other large river basins.[1] The Water Resources Council can be a focal point for Federal involvement and coordination of the regional or subregional commissions, the States, and the Federal agencies. In addition to the obvious need for such institutional improvements to resolve the above conflicts, pressures, and diversity, existing Federal policy on water resources preservation and development needs reconsideration and revision to meet the problems to the end of the century. A reasoned and consistent resolution of the proper Federal role in planning, financing, and implementing sound solutions to the physical problems is essential.

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[1] Six river basin commissions, established under the Water Resources Planning Act of 1965, in other parts of the Nation have only planning, not management, responsibilities.

Individual Problem Areas

The Regional Coordinating Committee for the Mid-Atlantic Region, with representatives from the States, the several river basin organizations, and the concerned Federal agencies, identified sets of priority problems for the near and far terms (1975-1985 and 1985-2000) in each of the 27 subareas. Figure 2-8a shows the Mid-Atlantic Region and the general location of problem areas. The sets of priority problems are discussed in terms of selected categories of water and related land resources problems, as tabulated in Figure 2-8b and summarized in the following pages. The Mid-Atlantic Region differs from the inland regions in that the Hudson (subregions 201 and 202) and the Delaware (subregion 203) basins drain directly to the ocean; the others drain to the Chesapeake Bay and are not additive for total regional flow. Streamflow data for the subareas have been disaggregated from subregion values and represent only incremental drainage. Thus, subareas related to each other by continuity of the natural drainage systems can be summed to determine total flow at the outlets of the most downstream subareas. The data shown attempt to indicate the resources and uses indigenous to the subregions.

Problem Area 1: Mohawk River Above Little Falls, New York

Description

The Mohawk River is a principal tributary of the Hudson River in Herkimer, Oneida, and Hamilton counties in central New York. The drainage area above Little Falls, west of Albany, is 1,348 square miles, about 10 percent of the entire basin and subregion.

Most of the area is a nearly level rolling glacial drift plain. Long, narrow, steep-sided oval hills (drumlins) are prominent in the area. Local relief varies from a few feet to tens of feet, but the larger drumlins range from about 100 to 200 feet above the adjacent lowlands. Approximately 80 percent of the area is in farms, 40 percent in croplands, and 20 percent in pasture. The principal crops include feed and forage for dairy cattle, winter wheat, fruits, canning, and fruit crops. Forest comprises 20 percent of the remaining lands, mostly in farm woodlots.

Average annual runoff is about 1,675 mgd. The existing minimum monthly flow (95 percent exceedance) is 643 mgd. The addition of 13 mgd as an allowance for consumptive use and the subtraction of 18 mgd for ground-water withdrawals result in a natural modified flow of 638 mgd or 38 percent of the average runoff. Consumptive use is projected to increase to 31 mgd in 2000 with ground-water withdrawals remaining the same, resulting in a future modified flow of 625 mgd for the critical month. Supplies appear ample.

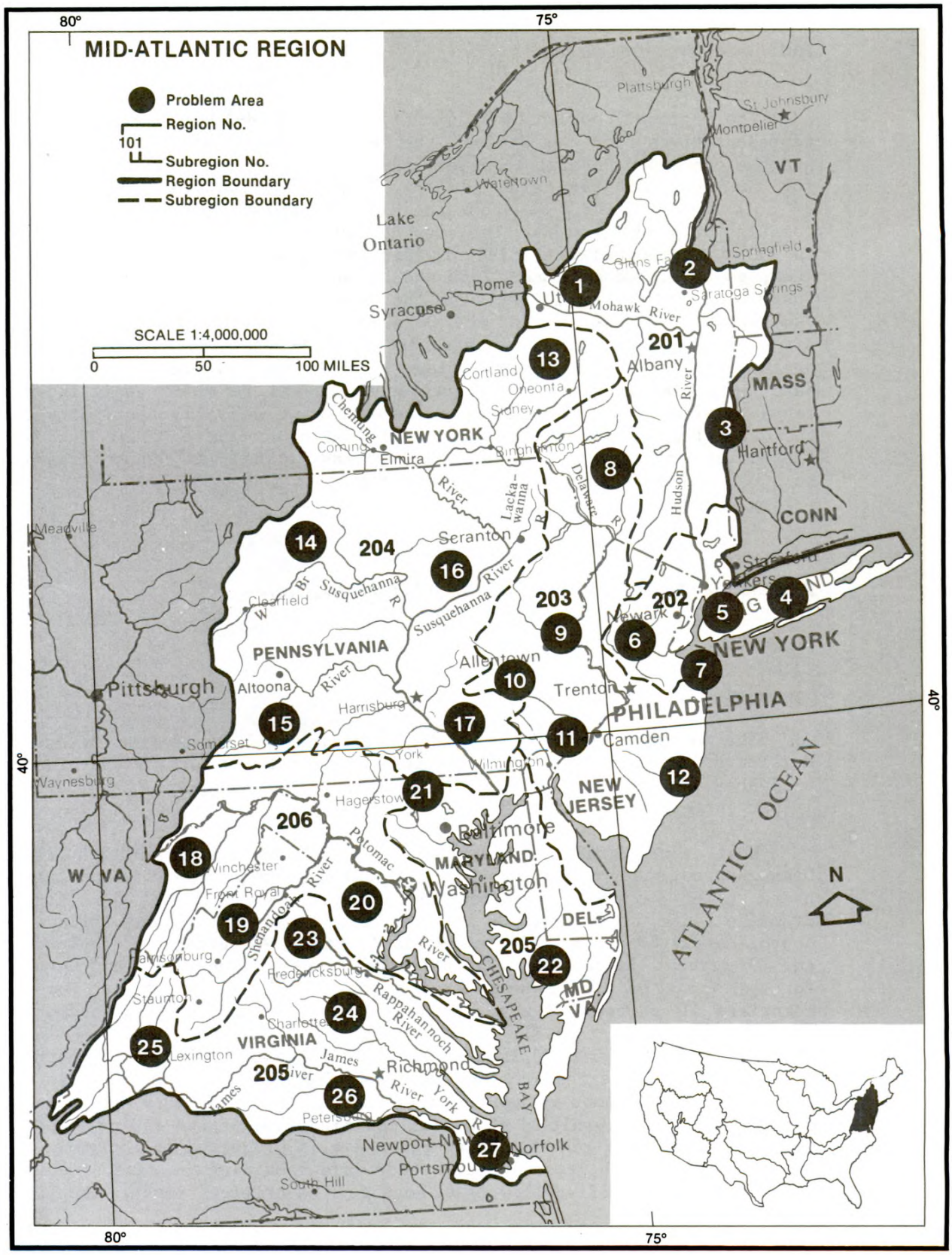

Figure 2-8a. Problem Map

MID-ATLANTIC REGION (2)

PROBLEM MATRIX

Problem area		Problem issues O= Identified by Federal Agency Representatives X= Identified by State-Regional Representative													
		Water quantity				Water quality				Related lands					
No. on map	Name	Fresh surface	Ground	Marine and estuarine	Surface/depth	Fresh surface	Ground	Marine and estuarine	Surface/depth	Flooding	Drainage	Erosion and sedimentation	Dredge and fill	Water related use conflicts	Other
Subregion 201	Upper Hudson	O	O			O						O	O	O	O
Area 1	Mohawk River above Little Falls, N.Y.	X				X				X				X	X
2	Hudson River above Albany, N.Y.	X				X									
3	Hudson River Basin — Remainder	X				X		X				X	X	X	X
Subregion 202	Lower Hudson-Long Island-North New Jersey	O	O			O	O	O	O	O		O	O	O	O
Area 4	Nassau and Suffolk Counties, N.Y.	X	X			X	X	X		X		X		X	
5	New York City and Westchester Co.	X		X		X	X	X		X		X	X	X	
6	Passaic & Raritan Rivers & No. New Jersey Streams	X	X			X	X	X		X	X			X	
7	Atlantic Ocean Drainage, Monmouth Co., N.J.	X		X			X	X		X		X	X	X	
Subregion 203	Delaware	O	O			O	O	O	O	O	O	O	O	O	O
Area 8	Delaware River above Montague, N.J.	X	X			X	X			X		X		X	
9	Delaware River above Trenton, N.J.	X	X			X	X			X			X	X	X
10	Schuylkill River above Pottstown, Pa.	X	X			X	X			X				X	
11	Lower Schuylkill River & Delaware Estuary	X	X			X	X	X		X	X		X	X	
12	Atlantic Ocean Drainage, Remainder of N.J.	X	X	X		X	X	X		X		X	X	X	
Subregion 204	Susquehanna	O		O	O	O		O		O	O	O	O	O	O
Area 13	Susquehanna River above Towanda, Pa.	X	X			X	X			X		X		X	
14	W. Branch, Susquehanna Riv. above Williamsport, Pa.	X	X			X				X		X			
15	Juniata River above Newport, Pa.	X	X			X				X		X			
16	Susquehanna River above Harrisburg, Pa.	X	X			X				X	X	X	X		
17	Susquehanna River Basin — Remainder	X	X			X	X			X		X			
Subregion 206	Potomac	O	O	O		O	O	O		O		O	O	O	O
Area 18	Potomac River above Hancock, Md.		X			X	X					X		X	
19	Shenandoah River above Millville, W.Va.		X			X	X					X			
20	Potomac River Basin — Remainder	X	X			X	X	X		X		X		X	
Subregion 205	Upper and Lower Chesapeake	O	O		O	O	O	O	O	O	O	O	O	O	
Area 21	Patuxent River & Western Shore of Chesapeake Bay					X	X	X	X	X	X	X	X	X	
22	Delmarva Peninsula & Eastern Shore of Chesapeake Bay					X	X	X		X	X	X	X	X	
23	Rappahannock River Basin, Va.		X			X		X						X	
24	York River Basin, Va.		X			X		X		X			X	X	
25	James River above Scottsville, Va.					X				X				X	
26	James River above Hopewell, Va.					X	X			X		X	X	X	
27	James River Basin — Remainder	X	X				X	X		X		X	X	X	

Figure 2-8b. Problem Matrix

The population in 1975 was 342,000 and is projected to decrease to 331,000 by 2000. The economic activities of the Utica-Rome Standard Metropolitan Statistical Area (SMSA), an industrial corridor along the Mohawk River and its tributaries, dominate in the subareas. Rail lines, canals, and highways are concentrated here. The 1975 per capita income of $6,046 is about equal to the national average and is projected to reach $12,260 by 2000. Total employment was 140,000 in 1975 and is projected to increase to 154,000 in 2000.

Water Issues

The basin's waters receive a variety of domestic and industrial waste inputs, including raw sewage from many small communities and most major cities. Urban and rural sources of nonpoint pollution are creating water quality problems accentuated by the impairment to normal flow and flushing due to locks and dams. Water quality problems are further aggravated by solid waste dumping and toxic industrial discharges, such as PCB's.

Related Land Issues

Average annual flood damages in the Mohawk Basin average about $4.1 million, approximately 25 percent of the total in the Hudson River Basin. A Federal flood protection project is in operation at Herkimer, and a project has been authorized for Rome. Rural areas are subject to overflow. The expectation of some population decline in Area 1 promises some relief from development pressures. Land-use planning with a view toward balanced economic and environmental goals is a necessity.

Institutional and Financial Issues

No high institutional or financial priority problems have been identified in this assessment for the Mohawk Basin above Little Falls, N.Y. However, limitations in financing non-Federal costs of projects in New York State need resolution.

Adverse Effects

Resolution of the foregoing problems is necessary to avoid the consequences of unwise development and use of water and land resources. In general, the slight expected drop in population will not completely alleviate the identified problems. Inadequate administrative overview, management, and coordination with adjacent areas will jeopardize accomplishment and implementation of sound planning.

Problem Area 2: Hudson River Basin Above Albany, New York

Description

The area consists of parts of New York State and Bennington County, Vermont, and a small section of the northwest corner of Berkshire County, Massachusetts. It includes the Hudson River above Albany, New York, and the remainder of the Mohawk below Little Falls, and has a total drainage area of 7,212 square miles. The terrain is mountainous, but also has one of the three most significant farm landscape valleys in the basin.

The elevations of the valley floor are about 100 feet. The Adirondack Mountains may rise to about 5,000 feet; granite, schists, and slate underlie these mountains, which are thinly mantled by glacial till. The broadened valleys are deeply filled with outwash and contain many swamps and lakes. Forests comprise a large part of the mountain area. Most of the Adirondacks are in a New York State park. Forest products include lumber, Christmas trees, and maple syrup. The area is widely used for recreation and many summer and winter sports. Farming is mostly a part-time occupation.

The Hudson River is presently regulated by over 2 million acre-feet of storage. Several large reservoirs in the upper basin, such as Sacandaga and Indian Lake, are multiple purpose. Uses include flood control, navigation, municipal water supply, recreation, and power.

The average annual runoff is about 6,650 mgd. The existing minimum monthly flow at 95 percent exceedance is 1,530 mgd (present modified flow). The addition of 68 mgd as an allowance for consumptive use and 230 mgd developed for export and the subtraction of 95 mgd for ground-water withdrawals result in a natural modified flow of 1,733 mgd or about 26 percent of the average flow. Consumptive use is projected to increase to 168 mgd by 2000 and ground-water withdrawals to 108 mgd, resulting in a future modified flow of 1,443 mgd for the critical month.

The subarea contained 43 percent of the population of the entire Hudson River Basin in 1975, or 1,033,000 people, and total employment reached 393,000. The population is expected to increase to 1,265,000 in 2000, while total employment is expected to increase to 516,000. With an overall population density of 143 persons per square mile, this subarea includes the Albany-Schenectady-Troy SMSA which is located at the confluence of the Hudson and Mohawk rivers. The area is a manufacturing, distribution, service, and State government center. Manufacturing is diversified among the food, chemical, clay, glass, printing, publishing, primary metals, and electrical machinery sectors. Nonmanufacturing employment was distributed among wholesale and retail trade, public administration, transportation, communications, and public utilities. The 1975 per capita income in the subarea was approximately $6,130, about equal to the national average, and should reach $12,260 in 2000.

Water Issues

The basin's waters receive a variety of domestic and industrial waste inputs, including raw sewage from many small communities and most major cities, thus conflicting with fishing and recreational uses. Urban and rural nonpoint sources of pollution are creating water quality problems, which are accentuated by the impairment to normal flow and flushing due to locks and dams. These will increasingly affect downstream uses. Water quality problems are further aggravated by solid waste dumping and toxic industrial discharges, such as PCB's. Restricted use of water supply for fishing and recreation will affect these activities. An insufficient number of rivers and river reaches are set aside for preservation for recreational and esthetic purposes.

Accelerated lake eutrophication in many Adirondack lakes is a problem as a result of second-home shoreline development, thus affecting fishing, recreation, and fish and wildlife habitats. Control of lake eutrophication will eventually be needed.

Excessive acid precipitation has caused fish kills and affected 11,500 acres of Adirondack lakes and ponds.

Related Land Issues

An existing Federal flood protection project for South Amsterdam and an authorized project for Schenectady will reduce major urban damages on the Mohawk. The regulating effects of Sacandaga and other reservoirs ameliorate the problem on the main stem. Projects on the Hoosic are effective. Population growth will put increasing pressures on floodplain use, and will make increased demands on land and water for recreational uses. Sound land-use planning is needed. Watershed and erosion protection are required to reduce sedimentation as well as to preserve environmental amenities. State policy gives local entities the option of combining structural flood protection and land-use regulation. Available water storage sites will become increasingly expensive and such use will face conflicts with other economic and environmental needs.

Institutional and Financial Problems

The current Hudson Level B Study is addressing these issues to develop and manage water resources in the basin, to explore interbasin transfer issues, and to coordinate financing of water-related programs and projects. Funding arrangements are lacking for small-scale immediate financial assistance to repair flood damaged facilities that do not qualify for emergency Federal flood disaster assistance.

Adverse Effects

Failure to develop a basinwide planning entity and to resolve problems of Federal and State funding will retard solution of the problems,

with consequent aggravation of economic losses, increases in eventual costs, and deterioration of environmental values. Such developments will further affect on downstream users.

Problem Area 3: Hudson River Basin — Remainder Below Albany, New York

Description

This area includes the part of the Hudson River Basin which lies below Albany to the north and above Westchester County to the south in New York State. It contains 4,805 square miles of drainage and is a major navigation, railroad, and highway thoroughfare. The total Hudson River drainage area above New York City is 13,365 square miles.

The lowlands rise from sea level through hilly terrain to elevations of about 2,000 to 3,000 feet. Soils in the Hudson River Valley developed largely from glacial till and are deep, medium-textured, and moderately well drained. Forest covers over 60 percent of the area, producing lumber, maple syrup, and Christmas trees. About 20 percent of the land is in cropland and pasture. Much of the farming is part-time and produces forage, potatoes, vegetables, and apples. About 10 percent of the land is in urban use, and this percentage is increasing rapidly in the south.

The Hudson River is navigable from New York City (the Battery) to Troy Lock, near Albany, with a minimum depth of 32 feet. It provides access from the interior to New York harbor and connecting waterways and the Atlantic Ocean. Ice closes the upper portion for several months each year, but the channel can be opened to traffic to Albany with ice breakers.

Average annual runoff is about 3,900 mgd. The existing minimum monthly flow at 95 percent exceedance is 154 mgd. The addition of 49 mgd for consumptive use and 710 mgd developed for export to subarea 13b, and the subtraction of 63 mgd for ground-water withdrawals, result in a natural modified flow of 850 mgd or about 18 percent of the average flow. Consumptive use is expected to increase to 107 mgd and ground-water withdrawals to 76 mgd in 2000, resulting in a future modified flow of 109 mgd for the critical month.

The area contained 43 percent of the population of the entire Hudson River Basin in 1975, or 1,051,000 people, with a population density of 219 people per square mile. Total population is expected to increase to 1,674,000 in 2000. Total employment, which measured approximately 360,000 in 1975, is expected to rise to 470,000 in 2000. Service industries constitute the largest portion of total employment in the area. The 1975 per capita income was above the national average at $6,544 and is expected to reach about $13,180 in 2000.

Water Issues

Priority near-term problems in the area are the complex water quality problem, disposition of dredge spoils, and an allocation of water supplies. The area water quality problem is similar in nature to the near-term problems in the upper Hudson (area 2), except that lake eutrophication and acid precipitation are not considered major. Organic and inorganic chemical pollution in area 3 is largely caused by the paper and primary metals industries. In addition, many industries, particularly the power industry, use the Hudson River as a heat sink. Allocation of available water resources for various uses such as waste disposal, water supply, and power generation is a major need.

Related Land Issues

Erosion and drainage are severe problems associated with land-use changes in the area. Adequate land-use planning is lacking. There are large visual and cultural needs, including maintenance of agricultural and high quality landscapes and preservation and development of metropolitan amenities.

Flooding is a major basinwide problem in many communities, with increasing average annual flood damages. Management and protection of flood plains is inadequate. Flooding is significant in many rural stream reaches. Wise flood-plain land-use management is critical in the solution of flood problems, and, with State encouragement, is finding increased acceptance. Disposition of dredged materials from the Hudson River navigation channel conflicts with competing demands on land areas and on environmental considerations in the undredged parts of the river channel.

Institutional and Financial Issues

The current Level B study is addressing institutional and financial issues. Funding arrangements to provide small-scale immediate financial assistance to repair flood-damaged facilities that do not qualify for emergency Federal flood disaster assistance are lacking. Lack of a regional or basinwide water and land entity to plan, implement, and finance water resource developments handicaps resolution of the issues.

Adverse Effects

Failure to develop a basinwide or regional entity to implement water resource plans will not only be detrimental to solution of the area's problems, but will also have a particular impact on the water supply problems of the New York metropolitan area. Any retardation of sound land-use planning and implementation will aggravate the growth of flood damages and will impede resolution of conflicts in demand for land for urban development, environmental conservation, and outdoor recreation.

Problem Area 4: Nassau and Suffolk Counties, New York (Long Island)

Description

Area 4 consists of Nassau and Suffolk counties on Long Island, east of New York City. It has a total drainage area of 1,397 square miles on the Atlantic Coastal Plain and is underlain by an extensive fresh-water aquifer. The island extends east about 80 miles to Montauk Point and is bounded on the north by Long Island Sound and on the south by the Atlantic Ocean. Much of Nassau County, once largely agricultural, is now urbanized, and the trend of development extends eastward into Suffolk County, a region of farms and estates. The shores and bays are sought by recreationists for bathing, boating, and fishing. About one-fifth of the area is farm-forest.

Average annual streamflow is about 990 mgd. The existing minimum monthly streamflow is 51 mgd. The addition of 30 mgd for consumptive use and also an addition of about 820 mgd as an allowance for ground water, which in this subarea is not generally reflected in surface outflow measurements, result in a natural modified flow of about 900 mgd. Consumptive use is projected to increase to 48 mgd in 2000 and ground-water withdrawals to about 850 mgd during the critical month, resulting in a future modified flow of 13 mgd for the critical month.

In 1975 the total population of area 4 was 2,650,000. This produced a population density of approximately 1,900 people per square mile. Total population is expected to reach 3.2 million in 2000.

Approximately two-thirds of the total 1975 employment of 1,042,400 was employed in transportation, communications, medical, and other professional services, wholesale and retail trade, public administration, finance, insurance, and real estate. Total employment is expected to rise to 1,411,300 in 2000. Per capita income here is well above the national average. In 1975, it was about $8,244 and is projected to reach $15,330 in 2000.

Water Issues

Nassau County is in great need of new sources of public water supply. There is a need for comprehensive water supply management and waste disposal plans and implementing systems, which include interbasin transfers.

Long Island's present ground-water resources are in need of protection from contamination such as excess nitrate input. Salt-water intrusion has been a major problem in the southeast corner of Nassau County because of intensive pumping, relatively high permeability, and changing natural conditions. In the Nassau-Suffolk region the rate of intrusion has been estimated at about 10 feet per year.

Water quality maintenance and upgrading is vital to fulfillment of beach and related water and land activities.

Earlier chemical and thermal pollution control programs in Long Island Sound will require maintenance and implementation. Many existing shoreline facilities have already become obsolete, thus precipitating a need for new, more modern facilities as well as channel enlargement in order to counter water quality and navigation problems.

The public water supply near-term problem, including imports for Nassau County, will continue into the long term, spreading over into Suffolk County as well. Fragmentation of authority will cause a near-term need to implement regional water supply management, coastal zone management, regional waste-water management, and land-use planning.

Nonagricultural and agricultural irrigation water needs are both large at the present but only nonagricultural needs will remain large. Golf courses and other nonagricultural irrigation needs will continue to grow, but the large amount of irrigated cropland is expected to be gone entirely by 2000. The offshore development of oil and gas, the construction of nuclear plants, and the drilling of deep-water wells will conflict with existing recreational developments, land-use patterns, transportation systems, social and economic structures, and with visual, cultural, environmental, and wetland uses.

Related Land Issues

Coastal erosion control and tidal flood damage reduction are major problems, particularly along the barrier beaches and islands of the southern shore. Land-use regulation conflicts with the desire to be on the beach or near the water. Urbanization and the needs of the urban population for recreational space and opportunities put increasing pressures on use of the water and related land resources of the area.

Institutional and Financial Issues

A regional water supply and waste disposal management entity is needed, particularly for Nassau County. Fragmentation of authority will, in the long term, aggravate the needs for implementing a regional water supply, land-use planning, and regional waste-water and coastal zone management. The problem of general public access to the recreational resources of the area needs attention.

Adverse Effects

Unless foresight leads to the solution of the aforementioned problems, the quality of life in the area will deteriorate with increased economic, social, and environmental costs. Lack of adequate high-quality water supplies will result in restricted human use, increased costs of

industrial production, adverse effects on health, and lowered quality of recreational opportunities. Inadequate land-use planning and implementation will aggravate flood and property losses, particularly along the shore, where increased development will expose larger investments and numbers of people to damaging storms. The lack of a coordinating and managing entity will prevent a satisfactory approach to the area's problems on an integrated basis. However, the ongoing 208 study is considering an implementing agency for the area.

Problem Area 5: New York City and Westchester County (Southeastern New York Metropolitan Area)

Description

Area 5 includes five New York City counties and Westchester County. These counties constitute a large portion of the New York Standard Metropolitian Statistical Area. Area 5 has a drainage area of 504 square miles. The land form in this urbanized area is undulating. The landscape quality in the area is low and is limited to portions of Westchester County's riverfront and coastline.

Area 5 is the Nation's largest port, railroad terminal, air transportation center, and foreign trade center and contains the Nation's largest concentration of financial, trade, professional, education, business, and communication services. Industries with the largest employment include services; wholesale and retail trade; transportation, communication and public utilities; and finance, insurance, and real estate.

Average annual runoff is about 357 mgd. The existing minimum monthly flow at 95 percent exceedance is 11 mgd. This does not include about 1,640 mgd, which can be imported into the area for New York City.

The total population of area 5 was 8,494,000 in 1975. The density per square mile was 16,850 persons. Total population is expected to decrease gradually to 7,750,000 in 2000. The total employment in 1975 was 4,020,800. This figure is projected to increase to 5,443,400 in 2000. Subarea 13b enjoys a high level of per capita income. In 1975, it reached $8,080 and is projected to be $15,020 in 2000.

Water Issues

Water is not generally available in area 5, except for imports from the lower Hudson and the upper Delaware River basins. Currently, the New York City system faces a deficit of about 170 mgd, given a recurrence of the 1960's drought. Without a conservation program, the New York metropolitan area deficit could reach 520 mgd in the year 2000 (Northeastern United States Water Supply (NEWS) Study Survey Report, July 1977). Municipal, industrial, and storm-water pollution seriously degrade the

area's surface waters. The area faces major problems of public water supply and water quality maintenance and upgrading in the near term. Disposal of dredged materials affects both water areas, including the New York Bight (the adjacent area of the Atlantic Ocean) and adjacent land areas. The water quality of the bight is also adversely affected by nitrogen input from disposal of sewage sludge and other wastes, with detrimental effects on fish and wildlife habitat. Programs of waste-heat treatment of thermal discharges may not be within the heat-dissipating capacity of the Hudson estuary. Data are inadequate on the impact of thermal and chemical pollution on fish and wildlife. The degree of use of cooling towers and the implementation of Public Law 92-500 will greatly affect these problems.

Related Land Issues

Municipal policy largely determines and controls the use of land with relation to water. Public parks often include small artificial water bodies and are oriented to enhanced use of the waterfront. Access to the waterfront is otherwise highly restricted by private ownership. Abandoned and deteriorating waterfront structures presently place much of the shore beyond use for public recreation. Portions of Riverside Drive facing the Hudson River are separated by such reaches. Jamaica Bay and its immediate shore areas offer a potential for environmental restoration. The beaches and shores of the area are inadequate for the demands placed on them for recreation by the dense population. Preservation and sound management are essential to the health and well-being of the populace. Property damages and loss of life from hurricane-driven floods and tides could be very large.

Institutional and Financial Issues

There is a need for maintenance and implementation of earlier programs addressing chemical and thermal pollution in Long Island Sound. With increases in vessel size, particularly overseas vessels, channel enlargement and increased facilities will be necessary. Many piers and shoreline facilities have become obsolete, affect water quality, and create hazards to navigation.

Adverse Effects

Failure to meet the needs of the concentrated population and to solve the identified problems will result in restricted and lower quality water supplies for domestic use, increased costs of industrial production, lessened visual quality of landscapes and parks, and increased wear and tear on available recreational areas. Lack of improved and more extensive waste treatment and disposal facilities and practices will further depreciate the water resources of the estuary and the ocean, with detrimental impacts on the adjacent land areas and their human usages. Deterioration of the shoreline structures will continue to endanger commercial and recreational navigation.

Problem Area 6: Northern New Jersey Streams

Description

Area 6 consists of 2,376 square miles of drainages in Newark Bay and the west side of Arthur Kill and Raritan Bay. Area 6 includes the drainage of the Passaic, Raritan, Elizabeth, and Hackensack rivers. This area covers 157 square miles in New York State's Orange and Rockland counties and 2,219 square miles in nine northeastern New Jersey counties. Nearly two-thirds of the area consists of rolling hills with the balance in undulating hills. Over one-half of the area consists of city landscape and the remainder consists mostly of town-farm and some forest-town landscape. The Great Swamp, a national natural landmark and designated national wilderness area of 3,700 acres, is dedicated to migratory waterfowl management. Twothirds of the town-farm and forest-town landscapes have low visual quality and the rest of the area is of medial visual quality. Small truck, dairy, and poultry farming are prevalent.

Average annual runoff is about 2,580 mgd. The existing minimum monthly flow at 95 percent exceedance is 707 mgd. Subtraction of 115 mgd for ground-water withdrawals results in a natural modified flow of 592 mgd. The future modified flow in 2000, based on a slight increase in ground-water use and an increase in consumptive use from 336 to 538 mgd, is 512 mgd, or about 20 percent of the average flow.

Total population in the area in 1975 was 4.8 million and is projected to reach 6.2 million by 2000. Population density for 1975 was approximately 2,000 persons per square mile. Per capita income was above the national average at $8,082 in 1975 and should reach $15,020 in 2000. The area contains three SMSA's, Newark, Jersey City, and Paterson-Clifton-Passaic. In these SMSA's, manufacturing employment is distributed among machinery and electrical products, primary and fabricated metal products, chemical and allied products, and food and kindred products. Total employment was 2,159,000 in 1975 and should reach 2,923,000 by 2000.

Water Issues

The water supply situation in the near term is critical in area 6 for virtually all users: municipal, self-supplied industrial, agricultural, recreational, and environmental. In the two main river basins in the northern part of area 6, the Passaic and Hackensack, surface supplies are approaching optimum development. Intra-regional development (Raritan River) will be required in the near term in order to service the 5 million people and the bulk of New Jersey's industries. Emergency planning for water supply crises due to system breakdown or drought conditions is presently inadequate.

The severe water quality problems of area 6 are due largely to location of supply intakes downstream from major waste discharge locations.

These intakes are inadequately protected, particularly at low flow. Water withdrawals have adversely affected quality downstream, and regionwide waste treatment is presently inadequate. Pollution from nonpoint sources caused by both heavy urbanization and rural sources is contributing to poor water quality and reduced recreational opportunities. An insufficient number of interconnections exist between major utilities supplying the area.

Related Land Issues

Extensive flood-plain development and heavy pressures for further development provide the basis for mounting flood damages. Estimated average annual flood damages exceed $29.1 million. Damages are especially severe on the main stems and major tributaries of the Passaic, Raritan, and Rahway rivers. Water control will be needed increasingly as the Hackensack Meadows are developed. Flood damage reduction by both structural and nonstructural measures is essential.

Institutional and Financial Issues

Emergency planning for the eventuality of a water supply crisis due to system breakdown or to drought conditions is both a near-term and far-term problem. A regional entity to coordinate and manage these problems needs consideration.

Adverse Effects

Failure to resolve the fragmented regional water supply could result in catastrophic losses in case of breakdown or drought. Lack of adequate domestic supplies of acceptable quality would endanger health and detrimentally affect industrial use. Lack of assured quantity leaves the highly developed area susceptible to extensive fire hazards. Delay in wise and coordinated flood-plain use in the face of the flood hazard will aggravate property losses and hazards to human life and safety. Deterioration of water and related land resources will detrimentally affect the human and ecological environment and lower the quality of outdoor recreation available to the people.

Problem Area 7: Atlantic Ocean Drainage, Monmouth County, New Jersey

Description

Area 7 consists of that portion of New Jersey which drains directly into the Atlantic Ocean by way of the streams in Monmouth County. It

contains a drainage area of 372 square miles, and has a forest-town landscape with the topography of a typical plain. The soils are rich and fertile. Urban growth was stimulated early by the proximity of the densely populated areas of northern New Jersey and New York City.

Average annual flow is about 260 mgd. The existing minimum monthly flow is 52 mgd. The addition of 7 mgd for consumptive use and subtraction of 6 mgd for ground-water withdrawals result in a natural modified flow of 53 mgd. Consumptive losses are projected to increase to 11 mgd in 2000 and ground-water withdrawals are expected to be about 7 mgd, resulting in a future flow of 50 mgd or about 19 percent of average flow.

The 1975 population of area 7 was 481,000. The population density was 1,300 persons per square mile. In 2000 this is expected to reach nearly 2,000 persons per square mile with a total population of 738,000. The greatest single segment of the 1975 employment total of 223,400 was in the service industries. By 2000, total employment is expected to reach 302,400. The $7,660 per capita income level of 1975 was above the national average by 25 percent. By 2000, average per capita income is expected to reach $14,260.

Water Issues

Detrimental effects to the ecosystems, streams, and the ocean, and to recreational areas result from sewer outfalls and waste disposal at sea. Offshore disposal of solid sludge and liquid wastes is creating adverse ecological effects on marine life and is adversely affecting recreation, wetlands, and fish and wildlife resources on shore. Imports of waste from other areas complicate this problem. Many areas along the coast have shellfishing restrictions, a problem that will continue even with full implementation of Public Law 92-500. Major water supply problems involve overpumping of ground water, which has resulted in serious salt-water intrusion. Drilling to deepen salt-free aquifers, moving wells inland, and development of the surface water of the Manasquan River Basin may be needed to alleviate this critical situation.

The area is one of the most intensively developed recreation areas in the Nation with ready access to major urban centers. The proximity of a large share of major East Coast refineries and major market areas for petroleum products will have an extremely high onshore impact from offshore oil exploration and development. Land-use patterns, transportation systems, social and economic structures, and visual, cultural and environmental uses will conflict with each other and with use and preservation of the area's water resources, due to heavy population density.

Related Land Issues

Land-use patterns, transportation systems, social and economic structures, and visual, cultural, and environmental uses will experience near-term conflicts as a result of the proximity of many large oil refineries and major market areas for petroleum products. Preservation of many areas

of natural beauty will conflict with recreation and industrial uses. There will continue to be near-term conflicts between land development and agricultural uses. Deep port development will produce major onshore impacts similar in nature to that caused by offshore oil exploration.

Institutional and Financial Issues

Area 7 has a further near-term institutional issue in the impacts of and conflicts over resources and uses of the Continental Shelf, such as offshore dumping, powerplant siting, deep port siting, and fishing interests.

Adverse Effects

Failure to resolve the problems and conflicts in the use of water and land resources of the area is accompanied by failure to anticipate and meet the strains of economic and environmental needs. Lack of management and control of land-use development, public access, and use of recreational and environmental areas, and coordination with public and private entities involved with industrial onshore and offshore activities will see the unnecessary depreciation of water and land resources. Adverse effects will extend well beyond the geographical boundaries of the area to the neighboring urban populations.

Problem Area 8: Delaware River Above Montague, New Jersey

Description

Area 8 includes the Delaware River Basin above Montague, New Jersey. With a total drainage area of 3,480 square miles, it encompasses the New York counties of Delaware and Sullivan, and Pike and Wayne counties in Pennsylvania. The area is generally mountainous and embraces parts of the Catskills and the Appalachians. A section of the upper Delaware River has been designated as a Wild and Scenic River.

Average annual streamflow is about 3,700 mgd. The existing minimum monthly flow at 95 percent exceedance is 476 mgd. The addition of 5 mgd for consumptive losses and 680 mgd developed for export to area 5 and the subtraction of 246 mgd for ground-water withdrawals result in a natural modified flow of 915 mgd. Consumptive losses are projected to increase to 8 mgd and exports to 800 mgd by 2000. Ground-water withdrawals are expected to decrease to 223 mgd, resulting in a future modified flow of 330 mgd, or about 10 percent of the average flow.

The population density in 1975 was 45 persons per square mile with a total population of 155,000. By 2000 population is expected to rise to 202,000. Total 1975 employment in area 8 was 66,500. The largest single category is the service industries, and manufacturing is also an important industry. Total employment is expected to reach 87,000 in 2000. The per capita income in 1975 of $5,805 was below the national average. In 2000, it is projected to be about $11,344.

Water Issues

The major water problem in area 8 is that of low-flow water conditions. Priority issues include the need for improved management of releases from New York City reservoirs and the development of a drought response strategy for the basin. Local pollutions are caused by nonpoint sources which are being investigated in the ongoing Delaware Level B Study.

Related Land Issues

Erosion and sedimentation are high priority problems. While not classified as a high priority problem, flood-plain land-use regulation should ensure that further development takes place with adequate recognition of flood hazards. Continued concern for preservation of environmental quality and maintenance of high water quality should preserve the recreational resource base and fish and wildlife habitat.

Institutional and Financial Issues

The near-term institutional issues, interwoven with water quality problems, center around the presently inadequate conservation releases from the New York City water supply reservoirs. Supreme Court decrees in 1931 and 1954 have prescribed compensating releases from reservoirs and other conditions for diversions out of the basin. Reservoirs under the decree include Neversink, Cannonsville, and Pepacton. Water resource development has recently been guided by the recommendations and project authorizations resulting from the Type II comprehensive study completed in 1960. The study is revised yearly and carried out under the guidance of the Delaware River Basin Commission. Institutional aspects relating to the 1954 Supreme Court decree and interstate matters relating to interbasin transfers need reexamination.

Adverse Effects

Failure to resolve the water-quality problems developing in the area will be detrimental to the maintenance of the quality of the water supplies of New York City and of the communities in the lower Delaware Basin. Such deterioration of quality downstream may require increased releases from the upstream reservoirs with consequent impact on their ability to meet

the demands of increasing populations. Neglect of or inadequate flood-plain land-use planning will provide the basis for increased property damages and hazards to life and health. Deterioration of environmental quality will lower the value of outdoor recreational experiences and endanger fish and wildlife habitat.

Problem Area 9: Delaware River Above Trenton, New Jersey

Description

Area 9 consists of the Delaware River Basin above Trenton and below Montague. With a drainage area of 3,533 square miles, the area contains two SMSA's, the Allentown-Bethlehem-Easton area and the Trenton area. The land usage is quite diversified throughout the basin.

Chief agricultural products include forage for dairy cattle, fruit and vegetable truck farming, tobacco, and some poultry. Forest products include cut lumber and pulpwood.

Average annual streamflow is about 3,750 mgd. The existing minimum monthly flow at 95 percent exceedance is 577 mgd. The addition of 129 mgd for consumptive losses and 100 mgd for export to area 6 and the subtraction of 250 mgd for ground-water withdrawals result in a natural modified flow of 556 mgd. Consumptive losses are expected increase to 222 mgd by 2000 and ground-water withdrawals are projected to be 236 mgd. The resulting future modified flow is 470 mgd or about 12 percent of the average flow.

In 1975, the population was 1,436,000 resulting in a population density of 406 persons per square mile. Population is expected to increase to 1,764,000 in 2000. Total 1975 employment was 665,000 with the largest percentage in manufacturing and another significant portion in the service-oriented industries. In 2000, the employment in area 9 is expected to increase to 870,000. The 1975 per capita income of $6,740 was above the national average. It is projected to increase to $13,337 by 2000.

Water Issues

Public, commercial, power cooling, and rural water supply withdrawal needs are increasing. Consumptive uses from cooling and irrigation requirements will constitute a near-term problem, as they will increasingly affect critical minimum flows, thus reducing pollution assimila-

tion capacities, and reduce the volume of fresh water entering the Delaware estuary.

Conflicts for limited water resources will significantly increase. Greater quantities of water are needed at times of low flow to meet simultaneous uses. Insufficient time exists to alleviate the conflicts if current authorized projects are not completed since alternative plans will take additional time.

Related Land Issues

Reservoir regulation providing flood control as an incidental to water supply has modified the natural flood threat. However, unusual storm patterns, such as those of August 1955, cause extremely high flows on the main stem as well as on the tributaries. Federal local protection projects have been completed at Allentown and Bethlehem on the Lehigh River. Other local protection, coupled with nonstructural measures, is needed. Conflicts in planned land use exist. Further reservoir construction for storage of excess flows and for other purposes is opposed by environmental interests.

Institutional and Financial Issues

Review of aspects of the Supreme Court decision of 1954 on releases from upstream reservoirs and interbasin and interstate transfers provide near-term issues as on the upper Delaware.

Adverse Effects

Resolution of water quality problems is needed to avoid further deterioration of supplies for the people of this middle section of the Delaware River Basin. If diversions were increased, inadequate releases provided during low-flow periods and decreased dilution of waste effluents downstream would endanger the quality of downstream withdrawals. This would also permit the advance upstream of the salinity front in the lower Delaware, with adverse effects at water intakes and on possible infiltration into the fresh-water aquifers that underlie coastal plain portions of the lower Valley. Lack of coordinated land-use planning can be expected to aggravate the flood damage potential as population growth extends developments on the flood plains. Failure to preserve environmental resources will decrease the value of outdoor recreational experiences and adversely affect fish and wildlife habitat. The degree to which acid mine drainage is controlled, paticularly from culmpiles, and the extent of use of cooling towers to reduce thermal pollution, will be appreciable factors in ensuring desirable levels of water quality.

Problem Area 10: Schuylkill River Above Pottstown, Pennsylvania

Description

Area 10 consists of the Schuylkill River above Pottstown, Pennsylvania. With a drainage area of 1,147 square miles, it embraces the Pennsylvania counties of Berks and Schuylkill. Area 10 includes the Reading SMSA.

Average annual flow is approximately 1,220 mgd. The existing minimum monthly flow is 152 mgd. The addition of 28 mgd for consumptive losses and the subtraction of 51 mgd for ground-water withdrawals result in a natural modified flow of 129 mgd. Consumptive use is projected to increase to 48 mgd by 2000 and ground-water withdrawals to decrease to about 47 mgd resulting in a future modified flow of 128 mgd or about 10 percent of average flow.

Total 1975 population was 374,000 or a density of 326 persons per square mile. In 2000 the population is projected to be 463,000.

The 1975 total employment was 233,000. The largest percentage of employment is found in manufacturing, with the service industries also providing a significant portion of jobs. Total employment is expected to reach 305,000 in 2000. In 1975, the per capita income was at about the national average at $6,000. It is projected to average $11,730 in 2000.

Water Issues

Degradation of water quality due to acid drainage from abandoned mines in the Schuylkill has limited the uses of streams for fish and wildlife habitat, aquatic life, recreation, and water supply. The Schuylkill River from its head to Maiden Creek has some mine drainage and organic pollution problems. Some efforts for controlling acid mine drainage are now being made in the area. These efforts include new treatment plants for acid streams and elimination of land scars by past mining practices.

Related Land Issues

Control of surface-water access to abandoned mine openings, a cause of acid production and resulting pollution, is a major problem.

Institutional and Financial Issues

Funds for acid mine drainage abatement are inadequate. There is a lack of local programs acting in concert with Federal and State authorities to meet pollution abatement requirements. A regional entity to plan and manage the area's water resources, as in application of Section 208 (Public Law 92-500) studies, would be of assistance.

Adverse Effects

Failure to resolve the technological, institutional, and financial problems attendant upon control of acid mine drainage, particularly from abandoned mines, will prolong the detrimental effects of such pollution. This and other forms of pollution will continue to limit the use of the Schuylkill for aquatic life, water supply, and recreational use.

Problem Area 11: Lower Schuylkill and Delaware Rivers and the Delaware Estuary

Description

Area 11 consists of the Schuylkill River below Pottstown and the Delaware River Basin below Trenton. The drainage area is 4,605 square miles, embracing the SMSA's of Philadelphia, Pennsylvania, and Wilmington, Delaware. The basin contains all forms of landscape, the most extensive of which are rolling hills and undulating plains. The New Jersey area east of the Delaware and the lower basin are largely on the coastal plain. The port of Philadelphia is the second largest on the East Coast. The river is navigable for deep-draft vessels to Trenton. The lower 45 miles of the Schuylkill are also navigable, but continuous passage is interrupted by Fairmont Dam, about 5 miles above the confluence with the Delaware. Philadelphia is a transportation center with railroads, highways, and pipelines connecting with water transportation on the river.

Average annual flow is about 4,890 mgd. The existing minimum monthly flow is 791 mgd. The addition of 299 mgd for consumptive losses and the subtraction of 325 mgd for ground-water withdrawals result in a natural modified flow of 765 mgd. This does not include about 35 mgd imported from the Susquehanna River Basin. Consumptive use is projected to increase to 515 mgd by 2000 and ground-water withdrawals to decrease to about 294 mgd, resulting in a future modified flow in that year of 544 mgd or about 11 percent of average flow.

The 1975 population was 5,052,000 resulting in a population density of 1,100 persons per square mile. The population is expected to increase to 5,760,000 in 2000.

Total 1975 employment was 2.2 million, with the largest percentage in manufacturing and another significant portion in the service related industries. In 2000 the employment in area 11 is expected to increase to 2.9 million. The 1975 per capita income averaged $7,070, just above the national average. It should reach $13,790 in 2000.

Water Issues

Water quality deterioration is a problem. From Norristown, Pennsylvania, to its mouth, the Schuylkill is polluted from both municipal and

industrial sources. Thermal pollution is affecting aquatic life. The Delaware Estuary from Trenton, New Jersey, to New Castle, Delaware, is polluted from municipal and industrial wastes causing low dissolved oxygen (D.O.) levels, high bacteria counts, and some toxicity to aquatic life. Additional pollution is derived from nonpoint sources, such as sediment, agricultural chemicals, oil spills, and urban runoff.

Conflicts for limited water resources will significantly increase as greater quantities of water are needed at time of low flow to meet simultaneous competing uses. Time is short to resolve the conflicts if current authorized projects are not completed, since preparation of and agreement on alternate plans will take additional time.

Public, commercial, power cooling, and rural withdrawal needs will increase. Consumptive uses, such as cooling and irrigation requirements, will affect fresh-water inflow to the estuary and Delaware Bay, thus changing the areal distribution of salinity. Ground-water quantity and quality are affected by salinity intrusion and recharge interference.

Related Land Issues

Flooding is a major near-term problem in many communities with increasing average annual flood damages and inadequate management and protection of flood plains. There is very heavy development in flood-prone areas. Federal local flood protection projects are in operation at Chester, Pennsylvania, on Chester Creek, and at Mount Holly, New Jersey, on Rancocas Creek. Other projects have been authorized on the East Branch of the Delaware and on Newton Creek.

Institutional and Financial Issues

Conflicts will arise over the development of offshore oil and gas drilling and of nuclear plants and deep-water ports versus the existing recreation developments, land-use patterns, transportation systems, social and economic structure, visual, cultural, and environmental values, and wetland uses. Review of the court decision of 1954 on upstream reservoir releases and interbasin transfers is needed in relation to in-basin water supplies, the salinity front, and surface- and ground-water quality.

Adverse Effects

Failure to anticipate and prepare for the increasing stress put on water quality by industrial development, waterborne petroleum traffic, and possible offshore oil production, which would be transported to or refined in the lower Delaware River area, will lead to further depreciation of water and environmental quality. Lack of flood-plain land-use management will allow increased potential for flood damages. Resolution of the problems involving petroleum products transport and transfer will depend on the practicability of deepening the rock channel of the Delaware for deep-draft tankers, with its attendant threat to ground-water aquifers,

and on the alternative of land and water transfer from offshore deep ports. Increased releases from upstream reservoirs for water quality and salinity control in the middle and lower Delaware will adversely affect the quantity and quality of water supplies for urban areas elsewhere; any decrease in releases or increase in out-of-basin transfers will have opposite impacts. Resolution of the conflicts will determine the nature and incidence of adverse effects in a major section of the Mid-Atlantic Region.

Problem Area 12: Atlantic Ocean Drainage, Remainder of New Jersey (South of Monmouth County)

Description

Area 12 consists of the remainder of that portion of New Jersey which drains directly into the Atlantic Ocean (excluding Monmouth County). Within the area's 2,021 square miles, the topography is typical of a coastal plain, generally flat with marshland in the low-lying areas along the coast. Its most outstanding feature is a wide barrier beach which fronts most of the coast and which has been extensively developed for recreation. The majority of the subbasin is forest-town landscape pattern of medial quality. It contains the New Jersey Pine Barrens, a unique wild area of 1.66 million acres, providing wilderness, recreation, and an excellent source of vegetation and natural habitat for scientific study. The designated Brigantine Wilderness Area of the Atlantic Migratory Fowl Flyway is located north of Atlantic City. Predominant farm products are truck, dairy, and poultry.

Average annual streamflow is about 2,150 mgd. The existing minimum flow for the critical month at 95 percent exceedance is 524 mgd. The addition of 40 mgd for consumptive losses and subtraction of 143 mgd for ground-water withdrawals result in a natural modified flow of 421 mgd. Consumptive use is projected to increase to 68 mgd by 2000 and ground-water withdrawals will be about 129 mgd. This will result in a future modified flow of 482 mgd, representing about 22 percent of average flow.

The 1975 population of area 12 was 503,000. This subarea embraces the Atlantic City SMSA, and had a population density of about 250 persons per square mile. Population is expected to rise to 777,000 in 2000. The 1975 employment in subarea 12 was 166,000, with the greatest percentage being employed in the service industries. Employment is expected to rise to 218,000 in 2000. The per capita income here of $6,590 in 1975 was about average for the Nation. It should reach $12,720 in 2000.

Water Issues

Detrimental effects to the ecosystems, stream, and ocean and to recreational areas result from sewer outfalls and waste disposal at sea.

Offshore disposal of solid sludge and liquid wastes is creating adverse ecological effects on marine life and is adversely affecting recreation, wetlands, and fish and wildlife resources on shore. Imports of waste from other areas complicate this problem. Many areas along the coast have shellfishing restrictions, a problem that will continue even with full implementation of Public Law 92-500.

The area is one of the most intensively developed recreation areas in the Nation with ready access to major urban centers. The proximity of a large share of major East Coast refineries and major market areas for petroleum products will cause an extremely high concentration of onshore impacts from offshore oil exploration and development. Land-use patterns, transportation systems, social and economic structure, visual, cultural, and environmental uses will conflict with each other and with use and preservation of the area's water resources, due to heavy population density.

Related Land Issues

Land-use patterns, transportation systems, social and economic structure, visual, cultural, and environmental uses will experience near-term conflicts as a result of the proximity of many large oil refineries and major market areas for petroleum products. Preservation of many areas of natural beauty will conflict with recreation and industrial uses. There will continue to be near-term conflicts between land development and agricultural uses. Deep port development will produce major onshore impacts similar to those caused by offshore oil exploration.

In addition, area 12 has an extremely high storm damage potential due to the intensive recreational development on the barrier beaches and the summer concentrations of population during the hurricane season. Intense offshore exploration for the production of oil and the possible offshore siting of nuclear power facilities pose the possibility of major onshore impacts on such unique land resources as the wetlands and pine barrens, as well as on recreational developments, especially if transport facilities are placed near these areas.

Institutional and Financial Issues

No high priority institutional or financial problems have been identified in this assessment for the Atlantic Ocean drainage in the remainder of New Jersey. However, limitations in financing non-Federal costs of projects in New Jersey need to be resolved.

Adverse Effects

Failure to resolve the problems and conflicts in use of the water and land resources of the area will be failure also to anticipate and meet the strains of economic and environmental needs. Lack of management and control of land-use development, public access, and use of recreational and environmental areas, and coordination with public and private entities in-

volved with industrial onshore and offshore activities will see the unnecessary depreciation of water and land resources. Adverse effects will extend well beyond the geographical boundaries of the area to the neighboring urban populations.

Problem Area 13: Susquehanna River Above Towanda, Pennsylvania

Description

Area 13 consists of the Susquehanna River Basin above Towanda, Pennsylvania. Its topography is generally rugged and mountainous. The drainage area is 7,797 square miles. It contains the Binghamton SMSA and the cities of Corning and Elmira, New York, important centers of economic activity, and part of the "Southern Tier" of counties in New York State. Manufacturing in the basin is well diversified and is represented by electrical and nonelectrical machinery manufacturing; textiles, shoes, wearing apparel, and furniture production; glass and photographic supplies; as well as coal mining.

In the northeast portion of the area is Otsego Lake, from which the Susquehanna River flows south and then west to the center of the area. The Chemung River forms the western part of the area flowing east and joins the upper Susquehanna at Athens, Pennsylvania. The area has nearly level to moderately sloping plateaus and narrow valleys with steep walls. Farms and cutover mixed hardwood forests cover the area. The area was glaciated during the Ice Age, and ground-water supplies occur along the stream bottoms. The Tioga and Cowanesque rivers are the principal tributaries of the Chemung in Pennsylvania, and their headwaters contain some bituminous coal workings.

Average annual streamflow is about 6,950 mgd. The existing minimum monthly flow is 361 mgd. The addition of 30 mgd for consumptive losses and the subtraction of 40 mgd for ground-water withdrawals result in a natural modified flow of 351 mgd. Consumptive losses are expected to increase to 120 mgd in 2000 and ground-water withdrawals to 60 mgd, resulting in a future modified flow of 291 mgd or about 4 percent of average flow.

The 1975 population of area 13 was 757,000. This resulted in a population density of approximately 100 per square mile. Population is forecasted at 820,000 for 2000.

The 1975 employment in area 13 was 337,000, with the service industries and manufacturing together accounting for the vast majority of employment. Employment is expected to rise to 430,000 in 2000. Average per capita income in 1975 for the subarea was $5,950, slightly below the national average. It is expected to be about $12,260 in 2000.

Water Issues

In both the near and long terms, generally low ground-water yields in some areas face increasing demand. A significant need exists to determine the relationship between surface and ground water, such as the lag time between pumping and base flow depletion. Further development of ground-water sources could result if relationships are more specifically determined, especially in and around Elmira, New York. Combined withdrawals of ground water for Elmira's municipal and industrial supply and for irrigation, exceed recharge and pose a threat to both surface- and ground-water supplies. Protection of recharge areas and management of withdrawals are required in the upper Canisteo and Cohocton River valleys, and in the Cortland and Binghamton urban areas. Water supply problems are under investigation in the current 208 study.

Near-term surface-water problems in area 13 include local and inter-basin flow additions and depletions which are conflicting with environmental, water supply, and other competing uses, and proposed increases in consumptive use, which will decrease water available for competitive uses in addition to decreasing fresh-water supply to the Chesapeake Bay. Regulation should insure that the historical pattern of fresh-water inflow to the Chesapeake Bay is not changed, thereby assuring that the present salinity gradients and circulation patterns of the bay are maintained. More effective use of resources and the development of a basin by basin systems analysis is needed to determine beneficial and adverse effects. Full implementation of Public Law 92-500 will increase consumptive losses, but less than complete compliance will add thermal waste to water pollution problems.

Serious flooding occurs in both the east Susquehanna and the Chemung River basins. Binghamton is seriously threatened by major floods such as that of June 1972 which damaged the Corning-Elmira area. The Corning-Elmira problem will be considerably lessened after completion of the Tioga-Hammond Cowanesque reservoirs now under construction. Numerous other flooding problems exist in the area. A comprehensive flood-plain management program, with Federal financial assistance, is needed.

Related Land Issues

Local flooding problems exist throughout area 13, along rural reaches, and in small communities. Flood damages are particularly high in the Elmira, Binghamton, and Corning vicinities, although Federal local protection projects protect the urban centers, and upstream reservoir regulation modifies flood flows. Local flood protection has been provided at 15 other localities in the subbasin. Four flood control reservoirs provide partial control of the design flood, but further construction of authorized reservoirs conflicts with land-use objectives of agriculture and the preservation of the natural valley environments. Effective combinations of structural and nonstructural or management measures do not exist.

Institutional and Financial Issues

Project studies of comprehensive flood-plain management (structural and nonstructural) are urgently needed in New York State in the Binghamton area and along the Tioughnioga, lower Cohocton and lower Chemung rivers. Funding and administrative guidelines have not yet been provided for implementation of the 1974 Water Resources Development Act, which authorized inclusion of nonstructural measures in Federal flood control projects.

Adverse Effects

Failure to resolve technical problems related to the optimum yield of the ground-water reservoir will result in increased deterioration of the quantity and quality of supply, with the necessity of restricting domestic and industrial uses. Increased consumption, expected as a result of conversion of industrial and electric generating processes to recycling of water, will decrease streamflows downstream and will contribute to the salinity problem in the Chesapeake Bay. Delays in coordinating land uses in the flood plain with practical combinations of structural and nonstructural measures will produce unnecessary increases in flood damage potentials. While the area is not intensively populated compared with others in the region, except for the industrial Southern Tier, demands for development of water and land resources pose threats to the quality of the environment and of natural habitats.

Problem Area 14: West Branch, Susquehanna River Above Williamsport, Pennsylvania

Description

Area 14 consists of the West Branch of the Susquehanna River above Williamsport, Pennsylvania. The topography is generally rugged and mountainous. The drainage area is 5,682 square miles. The West Branch rises in the Appalachian Plateau, and flows easterly through mountainous forest-wildland landscape to its junction with the Susquehanna River at Sunbury, Pennsylvania. Coal mines above Lock Haven are critical sources of pollution.

Average annual streamflow is about 5,050 mgd. The existing minimum flow for the critical month at 95 percent exceedance is 356 mgd. The addition of 15 mgd for consumptive loss and the subtraction of 60 mgd for ground-water withdrawals result in a natural modified flow of 311 mgd. Consumptive use is projected to increase to 60 mgd by 2000 and ground-water use to 90 mgd, resulting in a future modified flow of 341 mgd or about 7 percent of average flow.

The 1975 population of area 14 was 293,000. With a present population density of 52 persons per square mile, population is expected to rise to 359,000 in 2000.

The 1975 employment was 153,000 with services the leading category. Employment in 2000 is forecast at 200,000. The projected per capita income of $11,500 for 2000 is more than double the 1975 level of $5,600. However, it will remain slightly below the national average.

Water Issues

In the near and long terms, degradation of water quality due to acid drainage from abandoned mines in the West Branch Susquehanna River upstream from Lock Haven will limit the uses of the streams for fish and wildlife habitat, aquatic life, recreation, and water supply. Technical measures and funding for the control and treatment of acid mine drainage are needed. Regulation should insure that the historical pattern of fresh-water inflow to the Chesapeake Bay is not changed, thereby assuring that the present salinity gradients and circulation patterns of the bay are maintained.

Related Land Issues

Local flooding problems exist through the West Branch basin. A Federal local flood protection project has been completed for Williamsport-South Williamsport. Flood control reservoirs are in operation on the upper West Branch above Clearfield, and on Kettle Creek and Bald Eagle Creek, above Lock Haven. Further reservoir construction is opposed by environmental interests. Coordination of flood-plain land-use regulation with practical structural measures is essential.

Institutional and Financial Issues

Acid mine drainage abatement funds are insufficient for resolution of the problem. Rural and urban municipalities will have increasing financial difficulties in constructing water supply and waste treatment facilities. Lack of guidelines on funding and administering the 1974 Water Resources Development Act in regard to inclusion of nonstructural alternatives in Federal flood control projects prevents consideration and accomplishment of balanced plans for flood damage reduction.

Adverse Effects

If not solved in the near term, degradation of water quality due to acid mine drainage from abandoned mines will continue to have adverse effects on water and land resources and their best use and preservation. Resolution of the Federal role in nonstructural flood damage reduction measures would establish a basis for determining the financing of combined plans and adjustment to the flood hazard. Without public accept-

ance of the concepts of such adjustment, and probably some degree of Federal aid in identifying all beneficiaries of flood damage reduction, the damage potential will continue to grow. Unless water quality, mine drainage, and flood plain adjustment problems are resolved, the quality of the natural and the human environments will continue to deteriorate in the subbasin.

Problem Area 15: Juniata River Above Newport, Pennsylvania

Description

Area 15 consists of the Juniata River above Newport, Pennsylvania, with a drainage area of 3,354 square miles. The Juniata River flows easterly through undulating and rolling valleys with hilly slopes and through steep Appalachian mountain ridges to join with the Susquehanna River 38 miles below the West Branch, a few miles above Harrisburg. Altoona is the only large town and is the nucleus of the Altoona SMSA. The area consists primarily of forest-wildlife landscape.

Average annual streamflow is about 2,990 mgd. The existing minimum monthly flow at 95 percent exceedance is 275 mgd. The addition of 18 mgd for comsumptive losses and the subtraction of 41 mgd for ground-water withdrawals result in a natural modified flow of 252 mgd. Consumptive use will be 70 mgd and ground-water withdrawals 61 mgd by 2000 resulting in a future modified flow of 243 mgd, or 8 percent of average flow.

The 1975 population of subarea 15 was 295,000, with a present population density of approximately 90 persons per square mile. Population is expected to rise to 337,000 in 2000.

The 1975 employment in subarea 15 was 123,000, with the service industries providing the largest percentage of jobs. Employment in 2000 is expected to be close to 160,000. The 1975 per capita income was $5,315. It is expected to reach $10,884 in 2000.

Water Issues

Area 15 has water problems of low ground-water yields, as in the upper Susquehanna Basin (area 13), and local flooding. The relationship between surface and ground water is not known, and detailed data and analyses are not available. Vigorous compliance with established water quality standards is essential to meet standards for municipal and industrial water supplies, outdoor recreation, and fish and wildlife habitat. Use of cooling facilities for steam electric plants will increase consumption of water, with consequent decrease in net supplies and a corresponding effect on salinity in the Chesapeake Bay. Regulation should insure that the historical pattern of fresh-water inflow to the Chesapeake Bay is not changed, thereby assuring that the present salinity gradients and circulation patterns of the bay are maintained.

Related Land Issues

Local flooding occurs throughout the Juniata Basin, and damages are particularly high in the upper sections. Effective combinations of structural and nonstructural measures do not exist in the basin. A Federal local flood protection project has been authorized for Tyrone, but is not yet constructed. Public knowledge of flood hazards and the need to adjust land use to these hazards is fundamental to resolution of the problem in the area.

Institutional and Financial Issues

Rural and urban public entities have increasing difficulty in constructing water supply and waste treatment facilities. Funding and administrative guidelines for implementation of the 1974 Water Resources Development Act, which authorized consideration of nonstructural alternatives in Federal flood-control projects, have not been promulgated.

Adverse Effects

Failure to resolve technical problems related to the optimum yield of the ground-water reservoir will result in increased deterioration of the quantity and quality of supply, with the necessity of restricting domestic and industrial uses. Increased consumption, expected as a result of conversion of industrial and electric generating processes to recycling of water, will decrease streamflows downstream and will contribute to the salinity problem in the Chesapeake Bay. Delays in coordinating land uses in the flood plain with practical combinations of structural and nonstructural measures will produce unnecessary increases in flood damage potential. While the area is not intensively populated compared with others in the region, demands for development of water and land resources pose threats to the quality of the environment and of natural habitats.

Problem Area 16: Susquehanna River Above Harrisburg, Pennsylvania

Description

Area 16 consists of the Susquehanna River above Harrisburg, the State Capital, and below Towanda; the West Branch below Williamsport; and the Juniata below Newport. The Susquehanna River in this area flows through forest-town and town-farm landscapes, by the Dutch Amish country, and through Harrisburg. The drainage area of the subbasin is 7,267 square miles and is generally rugged and mountainous. The subbasin also includes the Lackawanna River and the "Wyoming Valley" portion which contains the city of Scranton, the largest city in the subbasin, a major manufacturing

center and SMSA. The valley was the scene of once highly productive anthracite coal mines, now largely flooded due to abandonment of operations or reduced production and pumping. The decline of anthracite, the "clean coal," was the result of increased use of oil and gas for home heating.

Average annual streamflow is about 6,470 mgd. The existing minimum monthly flow at 95 percent exceedance is 930 mgd. The addition of 100 mgd for consumptive use and the deduction of 196 mgd for ground-water withdrawals result in a natural modified flow of 834 mgd. Consumptive use will increase to 400 mgd and ground-water withdrawals to 294 mgd in 2000, resulting in a future modified flow of 728 mgd or about 11 percent of average flow.

Over one-third of the Susquehanna River basin's residents live in area 16. Scranton, Wilkes-Barre-Hazletown, and Harrisburg are the three large SMSA's in the area. The 1975 population of subarea 16 was 1,564,000, with a present population density of 215 persons per square mile. Population is expected to rise to 1,825,000 in 2000. The 1975 employment in subarea 16 was 582,000, with manufacturing and services of about equal importance. Employment in 2000 is expected to reach about 750,000. Per capita income in 1975 of $5,670 was below the national average. It is projected to reach $11,500 by 2000.

Water Issues

Near- and long-term water issues in this middle section of the Susquehanna River basin concern low ground-water yields with increasing demand, interbasin flows, and probable increases in consumptive use. The relationship between surface and ground water is not known and needs to be determined.

Acid mine drainage from abandoned mines in the Lackawanna River Basin from Carbondale, above Scranton, to the mouth; the main stem of the Susquehanna near Wilkes-Barre; and in the Mahantango, Nescopeck, Catawissa, and Wiconisco Creek watersheds, has degraded the quality of those streams and has limited the uses of the streams for fish and wildlife habitat, aquatic life, recreation, and water supply. Technical improvements are needed in the methods of effectively treating acid drainage from abandoned mines.

Local and interbasin flow additions and depletions conflict with environmental, water supply, low flow, and other competing uses. Expected increases in consumptive uses, due to industrial and steam electric water recycling processes, will decrease the amount of instream water available for competitive uses, as well as decrease the fresh-water flow to the Chesapeake Bay, with consequent effect on the salinity of bay waters. Full implementation of Public Law 92-500 will increase consumptive losses, while less than complete compliance will add thermal pollution problems to the streams. Regulation should insure that the historical pattern of fresh-water inflow to the Chesapeake Bay is not changed, thereby assuring that the present salinity gradients and circulation patterns of the bay are maintained.

Related Land Issues

Local flood problems exist throughout the subbasin. Flood damages are particularly high on the main stem above Harrisburg. Effective combinations of structural and nonstructural flood damage reduction measures do not exist. Federal flood protection projects have been completed at Scranton on the Lackawanna, and at Kingston-Edwardsville, Plymouth, Swoyersville-Forty Fort, Wilkes-Barre-Hanover Township, and Sunbury on the main stem. Upstream reservoir reduction of flood flows attenuates in this reach.

Institutional and Financial Issues

Acid mine drainage abatement funds are insufficient to control the problem. Rural and municipal entities will have increasing financial difficulties in constructing water supply and waste treatment facilities. Flood-plain management programs need to be developed and implemented. Guidelines on application of the 1974 Water Resources Development Act to this problem are needed.

Adverse Effects

Failure to resolve technical problems related to the optimum yield of the ground-water reservoir will result in increased deterioration of the quantity and quality of supply, with the necessity of restricting domestic and industrial uses. Increased consumption, expected as a result of conversion of industrial and electric generating processes to recycling of water, will decrease streamflows downstream, and will contribute to the salinity problem in the Chesapeake Bay. Delays in coordinating land uses in flood plains with practical combinations of structural and nonstructural measures will produce unnecessary increases in flood damage potential. While the area is not intensively populated compared with others in the region, demands for development of water and land resources pose threats to the quality of the environment and of natural habitats.

Problem Area 17: Susquehanna River Basin Below Harrisburg, Pennsylvania

Description

Area 17 consists of the lower portion of the Susquehanna River Basin, below Harrisburg, Pennsylvania. Embracing the Pennsylvania counties of Lancaster, Lebanon, York, and about one-third of Dauphin County, it also includes the northern part of Harford County, Maryland, where it enters the northern end of Chesapeake Bay. The drainage of the subbasin is 3,410

square miles, while the entire Susquehanna River Basin above the Chesapeake Bay is about 27,510 square miles. A principal tributary of the lower main stem is Codorus Creek, which joins the river from the west below Harrisburg. The area consists of the gently to strongly rolling piedmont which is evenly divided between farm and suburban landscapes. The Dutch Amish country is located east of Lancaster. A major private hydroelectric power dam (Conowingo) on the lower main stem prevents commercial navigation above Havre de Grace, Maryland, but part of the river upstream has been improved to a 5-foot depth to accommodate recreational craft.

Average annual streamflow is about 3,040 mgd. The existing minimum flow for the critical month at 95 percent exceedance is 275 mgd. The addition of 87 mgd for consumptive losses and 81 mgd developed for export to areas 11 and 21 and the subtraction of 64 mgd for ground-water withdrawals result in a natural modified flow of 379 mgd. Consumptive losses are projected to increase to 350 mgd in 2000, exports to 100 mgd, and ground-water withdrawals to 95 mgd, resulting in a future modified flow of 24 mgd, about 1 percent of the present average flow.

The 1975 population of subarea 17 was 680,000, with a present population density of about 200 people per square mile. Population is expected to rise to 904,000 in 2000.

The 1975 employment in area 17 was about 340,000, with a per capita income of about $6,740. Manufacturing provided the largest number of jobs. Employment in 2000 is expected to reach 430,000 and the average per capita income should be approximately $13,800.

Water Issues

Low ground-water yields occur in areas with increasing demands. There is a significant need to determine the relationship between surface and ground water. Reliable surface and ground water and related data and analyses are not available.

Diversions to Chester County, Pennsylvania, and to Baltimore City, Harford and Cecil counties, Maryland, deplete flow, thereby conflicting with environmental, water supply, low flow, and other competing uses. If not solved in the near term, proposed consumptive use of water for electric power generation near Conowingo Reservoir and several energy parks, agricultural irrigation, and municipal and industrial purposes would, if unregulated, decrease the quantity of water available for instream purposes and for inflow to Chesapeake Bay. However, to assure that present salinity gradients and circulation patterns of the bay are maintained, water use should be regulated so that the historical pattern of fresh-water inflow to the Chesapeake Bay is not changed. Implementation of the requirement for cooling towers for all new powerplants (Public Law 92-500) will increase the amount of consumptive loss; partial compliance with the requirement may cause thermal pollution problems.

Related Land Issues

Local flood problems occur in the entire subbasin, and include Port Deposit, Perryville, and Havre de Grace, Maryland. A need for improved combinations of structural and nonstructural measures and sound land use is needed.

Institutional and Financial Isues

The 1974 Water Resources Development Act allowed nonstructural solutions on Federal flood-control projects; however, funding or administrative guidelines have not been provided. Rural and urban municipalities will have increasing financial difficulties in constructing water supply and waste treatment facilities.

Adverse Effects

Failure to resolve technical problems related to the optimum yield of the ground-water reservoir will result in increased deterioration of the quantity and quality of supply, with the necessity of restricting domestic and industrial uses. Increased consumption, expected as a result of conversion of industrial and electric generating processes to recycling of water, will decrease streamflows downstream and will contribute to the salinity problem in the Chesapeake Bay. Delays in coordinating land uses in the flood plain with practical combinations of structural and nonstructural measures will produce unnecessary increases in flood damage potentials. While the water supply seems generally adequate, the demands for water induced by growth within the area and in other areas, unless reconciled with competing uses, will increase the cost of maintenance of water quality in the streams, affect the quality of recreation and fish and wildlife habitat, and adversely impact on the fulfillment of irrigation water needs. Failure to plan sufficiently in advance for quality control and water storage facilities will retard economic development, and the preservation of environmental quality.

Problem Area 18: Potomac River above Hancock, Maryland

Description

Area 18 consists of the 4,073 square miles drained by the upper portion of the Potomac River above Hancock, Maryland, including the north and south branches. The area is largely in West Virginia, with small parts in Maryland and Virginia. The terrain is heavily forested mountains and rolling foothills, with both farmland and wildland landscapes. Bituminous coal mining is a major activity in the basin.

Average annual streamflow is 2,440 mgd. The minimum flow during the critical month at 95 percent exceedance is 227 mgd. The addition of 43 mgd for consumptive losses and subtraction of 46 mgd for ground-water withdrawals results in a natural modified flow of 224 mgd. Consumptive losses are projected to increase to 160 mgd, and ground-water withdrawals to 47 mgd by 2000, resulting in a future modified flow of 111 mgd, or about 4.5 percent of average flow.

The total population in 1975 was 160,000, with a present population density of approximately 40 persons per square mile. Population is expected to decrease to 151,000 in the subarea by 2000.

Total employment in area 18 in 1975 amounted to 85,000. The service industries provided the largest single source of employment. In 2000, total employment is forecasted to drop to 63,000. Per capita income reached $5,750 in 1975, which is below the average for the Nation. It is projected to reach $9,810 in 2000, still substantially below the national average. Seven local flood protection projects (Public Law 566) are in operation or under construction, and the Bloomington Dam is under construction for flood control, water quality control, and recreation.

Water Issues

Water quality is a major issue in area 18, for both the near and long term. Acid mine drainage from active mines in Georges Creek and the north branch of the Potomac River, industrial discharges from pulp and paper mills, and fiber industries, and municipal discharges below Moorfield, West Virginia, and particularly at Cumberland, Maryland, are creating conflicts with recreation, fish and wildlife, and municipal water supply withdrawals. Sediments and nutrients from agricultural and silvicultural sources are also creating conflicts with these uses, as well as creating problems in the estuary, increasing the cost of water treatment for municipal supplies, and possibly diminishing the productivity of agricultural land.

Related Land Issues

Estimated average annual flood damages in the basin approximate $3 million. A Federal local flood protection project is in operation at Kitzmiller on the north branch. Flood-plain management is needed to reduce potentials. Agricultural erosion is contributing to sediment and nutrient problems in the estuary, increasing the cost of water treatment for municipal supplies, and possibly diminishing the productivity of agricultural land.

Institutional and Financial Issues

No financial or institutional issues of high priority have been identified for area 18. However, abatement of acid mine drainage and provision of municipal water supplies and adequate waste disposal facilities on

a regional basis may be beyond the authoritative and financial capabilities of local governments and agencies.

Adverse Effects

Failure to resolve the treatment and financing of acid mine drainage abatement and the polluting effects of industrial and agricultural activities will result in continued deterioration of streamflows, impairment of downstream water supplies, and harm to fish and wildlife habitat and to the quality of outdoor recreation.

Problem Area 19: Shenandoah River above Millville, West Virginia

Description

Area 19 includes the 3,040 square mile drainage of the Shenandoah River above Millville, West Virginia, and includes the north and south forks. The terrain is characterized by an alternating band of ridges and rich fertile valleys. Shenandoah National Park is in area 19. The diverse characteristics of miles of free-flowing streams, scenic vistas, and historic sites are readily available from the Washington, D.C., metropolitan area. Agriculture provides diversified production of dairy, poultry, orchard, grain, and livestock products.

Average annual streamflow is about 1,820 mgd. The existing minimum flow for the critical month at 95 percent exceedance is 314 mgd. The addition of 32 mgd for consumptive losses and the subtraction of 34 mgd for ground-water withdrawals result in a natural modified flow of 312 mgd. Consumptive use is projected to increase to 120 mgd by 2000 and ground-water withdrawals to 35 mgd, resulting in a future modified flow of 227 mgd, about 12 percent of average flow.

The total population in 1975 was 221,000 with a density of 73 persons per square mile. Population is expected to reach 381,000 in the area in 2000.

Total employment in area 19 in 1975 was 114,000. The largest single source of employment was provided by the service industries, with about one-third in manufacturing. In 2000 total employment is expected to be 190,000. In 1975, the area's per capita income was above the national average at $6,670. It should reach $12,720 in 2000.

Water Issues

Food processing and municipal waste discharges in the vicinity of Front Royal are creating near-term problems and conflicts with downstream

uses. Sediment and nutrients from urban, industrial, and agricultural sources are creating water quality problems and affecting the estuary. Mercury in the South River and south fork of the Shenandoah has resulted in a long-term fishing ban.

In the long term, sediment from upstream sources (stone quarries) and nutrients will adversely affect commercial and sport fishing, wildlife, recreation needs, visual and cultural values, and water supply. Increased water treatment costs will result.

Related Land Issues

Flooding on the Shenandoah accounts for about 4 percent (about $0.3 million) of the estimated average annual damages for the entire Potomac Basin under natural conditions. Sound flood-plain land use should prevent this from increasing. However, agricultural erosion is contributing to sediment and nutrient problems in the estuary, is increasing the cost of water treatment for municipal supplies, and might be diminishing the productivity of agricultural land.

Institutional and Financial Issues

No high priority institutional or financial problems have been identified in this assessment for this subbasin. However, limitations in financing non-Federal costs of projects in Virginia need resolution.

Adverse Effects

Failure to control erosion and the production of sediment will cause depreciation of instream values to fish and wildlife, public recreation, and environmental quality, as well as increase the costs of water supply treatment. Nutrients from farms will further lower the water quality of the Potomac estuary.

Problem Area 20: Potomac River Basin — Remainder

Description

Area 20 consists of the Potomac River basin exclusive of the upper Potomac above Hancock (area 18) and the Shenandoah above Millville (area 19). This portion, constituting the middle and lower Potomac, contains a drainage area of 7,557 square miles. The area of the entire Potomac basin is 14,760 square miles. The terrain is characterized by the gentle topography of the coastal plain. The area embraces parts of the States of Maryland, Pennsylvania, Virginia, and West Virginia, and all of the District of Columbia. Scenic, historic, and recreational facilities contri-

bute to employment in the area, which is also attracting establishment of headquarters by large corporations and financial and professional activities. Manufacturing is increasing in the area as economic activities diversify from and provide services to government. While the river is navigable to Washington (where the controlling depth is about 20 feet), relatively little commerce moves by water. Upstream progress is blocked by the rapids immediately downstream from the Great Falls of the Potomac on the Fall Line.

Average annual flow is about 4,530 mgd. The existing minimum flow for the critical month at 95 percent exceedence is 622 mgd. The addition of 80 mgd as an allowance for consumptive losses and the subtraction of 85 mgd for ground-water withdrawals result in a natural modified flow of 617 mgd. Consumptive losses are expected to increase to 298 mgd and ground-water withdrawals to 88 mgd by 2000, resulting in a future modified flow of 407 mgd or about 9 percent of average flow. This does not include 20 mgd imported from area 21.

The total 1975 population of area 20 was 3,466,000 with a population density of about 460 persons per square mile. In the year 2000, the population is projected to reach 6,014,000.

Total employment in area 20 in 1975 amounted to 1.7 million. The area contains the Washington, D.C. SMSA. By far the largest segment of employment is found in the service industries; the next largest single source of jobs relates to public administration. In 2000, total employment in area 20 is estimated to reach 2.8 million. This area averaged well above the national average per capita income in 1975 at $8,120. In 2000, it should be slightly less than double the 1975 level reaching $15,480.

Water Issues

Seasonal demands for the Washington metropolitan area during summer months have exceeded the historic minimum flow of the Potomac River, and domestic demands are expected to increase causing impacts on this presently inadequate downstream supply. Inadequately treated waste water and untreated combined sewer overflows are adversely affecting fish, wildlife, and recreation in the estuary. Increasing consumptive use upstream of Dickerson will adversely affect the estuary, fish, and wildlife needs, and municipal water supply capability, especially for the Washington, D.C., metropolitan area.

Related Land Issues

Construction activities are the major contributors of sediment to streams and the estuary in this area. In addition, agricultural erosion, such as that occurring in the highly erodible soils of the Monacacy subbasin and Montgomery County, Maryland, is a significant source of sediment and nutrients. Agricultural erosion diminishes productivity of agricultural

land and, together with construction-caused erosion, contributes to sediment and nutrient problems in the estuary and increases the costs of water treatment for municipal supplies.

Institutional and Financial Issues

Financing for regional water supply systems will require increasingly larger capital investments, possibly beyond the means of local governments.

Washington's seasonal demands and financing for regional water supply systems will carry over from the near-term into the far-term.

Adverse Effects

Failure to achieve a safe and adequate water supply for essential uses in the Washington metropolitan area would result in socioeconomic losses during extremely low flows. Other problems involving pollution and maintenance of water quality involve increased economic costs and endangered public health. Unregulated discharge of untreated domestic and stormwater wastes will degrade further water quality, fish and wildlife habitat, and the recreational value of the lower river and the estuary. Possible future use of the estuary as a source of water supply will hinge, in part, on success in meeting and resolving water quality problems.

Problem Area 21: Patuxent River and Western Shore of the Chesapeake Bay

Description

Area 21 is comprised of small drainage basins in Maryland that flow into the Chesapeake Bay. It includes the 2,705 square miles drained by the Patuxent River and small streams on the west shore of the bay and lies in the coastal plain and the low hills of the Piedmont Plateau. Baltimore is the major population and transportation center of the area. The Chesapeake Bay shoreline is a unique ecological resource. Land types includes farm-forest, farm, and forest-town landscapes along the bay's shorelines.

Employment is centered around the Baltimore industrial port complex in the processing of imported raw materials such as primary metals (iron and copper), and in the handling of export items, including coal, grain, spices, and brewery products. Other significant economic activities are food processing, and manufacturing of electrical equipment and transportation equipment. The relatively flat coastal plain provides some farming activity, chiefly in vegetables, fruits, poultry, and dairy products.

The bay is a major producer of nursery fish for commercial and recreational fishing along the Atlantic seaboard. The bay also provides a major wintering area for migratory waterfowl and is a part of the Atlantic flyway.

Average annual streamflow is about 1,570 mgd. The existing minimum monthly flow at 95 percent exceedance is 274 mgd. The addition of 100 mgd for consumptive use and 20 mgd for export to area 20 and the subtraction of 23 mgd for ground-water withdrawals result in a natural modified flow of 371 mgd. Consumptive use is projected to increase to 278 mgd by 2000, and ground-water withdrawals, to 28 mgd. Exports are projected to remain constant, resulting in a natural modified flow of 101 mgd or 6 percent of average flow.

The 1975 population of area 21 was 2,091,000, with a population density of 773 persons per square mile. Total population is expected to rise to 2,303,000 in 2000.

The 1975 employment was about 960,000 with the service industries providing the largest group of jobs. One SMSA, Baltimore, is in area 21. Substantial employment increases in chemicals, paper, and metals are projected by 2000. Total employment in 2000 is expected to reach 1.2 million. This area enjoys a relatively high rate of per capita income. In 1975, it averaged $7,890 and is expected to reach $15,480 in 2000.

Water Issues

A major near- and long-term problem in area 21 is the pollution problems in Baltimore harbor and nearby areas in the Chesapeake Bay which may result from the deepening of navigation channels, thus conflicting with other uses.

The bay is also being adversely affected by pollution in its tributaries. Large loads of nutrients and pesticide residues from agricultural activities enter the bay from the Susquehanna River and are detrimental to shellfish and other forms of aquatic life.

Increased diversions from the Susquehanna River and other major tributaries for powerplants and other industrial uses and enlargement of the Chesapeake and Delaware Canal may increase adverse effects on recreation, commercial and sport fisheries, and other elements of the bay ecosystem.

Related Land Issues

Large sediment loads from the tributaries to the Chesapeake Bay, particularly the Susquehanna River, are conflicting with fish and wildlife needs, commercial navigation, visual and cultural values, and recreation. These also intensify the problem of identifying dredge spoil disposal sites adjacent to Baltimore harbor and the Chesapeake and Delaware Canal.

Institutional and Financial Issues

A coordinated approach is needed for reducing urban and recreational flood damages on the Patuxent and Patapsco rivers. Local funds may be inadequate to accomplish Federal and State programs for water quality control. Funding is required to continue and reevaluate studies of the bay ecosystem.

Adverse Effects

Failure to resolve effects of changes in fresh-water supply to the head of the Chesapeake Bay from the Susquehanna, Patuxent, and other streams will affect the salt-water regimen of the bay's waters, with possible detrimental changes in the ecosystem and the natural food chain. Decreases in fish productivity will induce economic troubles for the commercial fishermen of the area. Changes in wetlands and marsh characteristics will be damaging to local fish and wildlife and to recreational values, but will also damage the migratory waterfowl that winter or pass over the bay, and the extensive fisheries production of the adjacent Atlantic Ocean, for which the bay is a natural incubator. Preservation of the bay's ecology and environment is essential to avoid deterioration of the natural, economic, and social structures that have developed around it.

Problem Area 22: Delmarva Peninsula and Eastern Shore of the Chesapeake Bay

Description

Area 22 consists of the drainage of the small streams on the Delaware-Maryland-Virginia peninsula located between the Chesapeake Bay and the Atlantic Ocean. The Delmarva peninsula includes a drainage area of about 5,440 square miles, including the southern half of Delaware. The area is of low relief, is underlain by the Atlantic coastal plain fresh-water aquifer, and contains one of the major areas of salt-water marshes in the East. The Chesapeake Bay and its eastern shoreline is a unique ecological resource, and its waters and wetlands provide essential support to the aquatic life of the region and the Atlantic fisheries. Land use includes farm-forest and farm and forest-town landscapes. The ocean beaches attract large summer and migratory populations for bathing and fishing, and the bay is a major resource for commercial and recreational fishing. A portion of the seashore has been designated as the Assateague National Seashore and extends from the Ocean City Inlet some 30 miles to Chincoteague.

Average annual streamflow is about 3,150 mgd. The existing minimum monthly flow is 470 mgd. The addition of 202 mgd for consumptive losses and the subtraction of 47 mgd for ground-water withdrawals result in a

natural modified flow of 625 mgd. Consumptive use is projected to increase to 561 mgd by 2000 and ground-water withdrawals to 56 mgd, resulting in a future modified flow of 120 mgd.

The 1975 population of area 22 was 382,000, with a population density of 70 persons per square mile. Total population is expected to rise to 572,000 by 2000.

The 1975 employment was 163,000 with the services industry providing the largest group of jobs. A portion of the Wilmington, Delaware, SMSA lies within the area. Total employment in 2000 is expected to reach 210,000. Per capita income was at the national average in 1975 reaching $6,130. It is projected to be $11,960 in 2000.

Water Issues

The Chesapeake Bay is being adversely affected in its upper reaches and in shellfish, sport, and commercial fishing areas by pollution in tributaries and streams, particularly from livestock wastes and septic tank systems. Large loads of nutrients particularly detrimental to shellfish and pesticide residues from agricultural activities enter the bay from the Susquehanna River. Fresh-water inflows that will protect shellfishing, commercial fishing, and the general ecosystems of the bay through preservation of natural seasonal patterns, must be maintained.

Increased diversions from the Susquehanna River and other major tributaries, for powerplants and other industrial uses and possible enlargement of the Chesapeake and Delaware Canal, may increase adverse effects on recreation, commercial and sport fisheries, and other elements of the bay ecosystem. Overpumping of ground water adversely affects supplies.

The Chesapeake Bay is particularly affected by pollution in its tributaries and streams, which particularly affect commercial shellfishing and sport fishing. Full implementation of Public Law 92-500 would alleviate this problem.

Related Land Issues

Large sediment loads from the Chester and Choptank rivers are conflicting with fish and wildlife needs, commercial navigation, visual and cultural values, and recreation, and intensify the problem of locating dredged material disposal sites.

While identified as only moderate problems in this assessment, the possibility of severe storms during the recreation season with hazards to life and property on the barrier beaches, shoreline erosion, the growing conflicts of second home and suburban developments with other land uses on the Eastern Shore, and the possibility of offshore petroleum exploration and production pose problems for the future.

Adverse Effects

Failure to resolve the effects of changes in fresh-water supply to the head of the Chesapeake Bay from the Susquehanna, Patuxent, and other streams will affect the salt-water regimen of the bay's waters, with detrimental changes in the ecosystem and the natural food chain. Decreases in fish productivity will induce economic troubles for the commercial fishermen of the area. Changes in wetlands and marsh characteristics will be damaging to both local fish and wildlife and to recreational values. Such changes will also damage the migratory fowl that winter or pass over the bay and the extensive fisheries production of the adjacent Atlantic Ocean. Preservation of the bay's ecology and environment is essential to avoid deterioration of the natural, economic, and social structures that have developed around it.

Problem Area 23: Rappahannock River Basin, Virginia

Description

Area 23 consists of the Rappahannock River Basin, all in Virginia, with a drainage area of 2,700 square miles. It extends from the Blue Ridge Mountains and Shenandoah National Park to the Chesapeake Bay. The topography is varied, ranging from mountains, through the Piedmont Plateau which is divided by many valleys and streams, to the coastal plain, a low area intersected by the deltas of rivers and streams flowing into the Chesapeake Bay. Sloping lowlands, tidal rivers, marshes, and swamplands are prevalent. A scientifically unique wildlife habitat takes up about 1,500 square miles around the mouth of the Rappahannock. The landscape is dominantly farm and forest. Major crops are grain and tobacco; the forests provide lumber and potash.

Average annual streamflow is about 1,565 mgd. The existing minimum flow for the critical month at 95 percent exceedance is 33 mgd. The addition of 11 mgd for consumptive losses and the subtraction of 23 mgd for ground-water withdrawals result in a natural modified flow of 21 mgd. Consumption is expected to increase to 29 mgd by 2000, resulting in a future modified flow of 20 mgd, or about 1 percent of the average flow.

The total 1975 population of the area was 123,900, with a density of 46 people per square mile. Total population in 2000 is projected to reach about 168,000.

Employment in 1975 was 61,000 and is projected to reach 79,000 in 2000, with the largest increases expected in the service industries (including wholesale and retail trade) and manufacturing. Per capita income in 1975 was $5,520, about 12 percent below the national average, and is projected at $10,880 in the year 2000.

Water Issues

Degraded water quality, due in part to failing septic tanks and livestock pollution, has closed various shellfish areas in the estuary from time to time. Increased irrigation needs will conflict with competing water supply demands and fish and wildlife. Municipal and industrial discharges and urban runoff from Fredericksburg, Port Royal, Urbana, and Tappahannock affect water quality and recreational and commercial uses of the streams. Potential water supply shortages at Fredericksburg and overpumping of ground water are emerging problems.

Related Land Issues

Conflicts between industrial, suburban, and second-home development and the preservation of wetlands will affect shellfish production. Implementation of Public Law 92-500 may alleviate the problem. Urban areas, particularly Fredericksburg, are subject to flood damages. Sound land use policies are needed.

Institutional and Financial Issues

Financing for regional water supply systems will require increasingly large capital investments, particularly for distribution, possibly beyond the means of local governments. Local funds to implement water quality control projects to complete Federal and State plans may also be beyond local governments' fiscal ability.

Adverse Effects

Failure to ameliorate the water quality problem will result in further losses of shellfish habitat and production. The conflicts between suburban development pressures and the goals of wetlands and fish and wildlife preservation will be satisfactorily resolved only if both conservation and development policies are reconciled. Losses of important water and land natural resources will otherwise result and will have important impact on the economic and social welfare of the people in the areas concerned. Lack of planning and funding to meet water supply and waste disposal needs will be detrimental to health and safety and to economic development.

Problem Area 24: York River Basin, Virginia

Description

Area 24, with a drainage of 3,300 square miles, consists of the York River Basin. The area extends from the Blue Ridge Mountains and Shenandoah

National Park to the Chesapeake Bay. The topography is varied, ranging from the mountains to the Piedmont Plateau, which is divided by many valleys and streams, to the coastal plain, a low area intersected by deltas of rivers and creeks flowing into the Chesapeake Bay. Sloping lowlands, tidal rivers, marshes, and swamplands are prevalent in this area.

Five types of cultural landscapes are represented in the basin with farm and forest types predominating. Most of this diversity is concentrated in the northern portion of the basin.

Average annual steamflow is about 1,915 mgd. The existing minimum flow for the critical month at 95 percent exceedance is 45 mgd. The addition of 13 mgd for consumptive use and the subtraction of 29 mgd for ground-water withdrawals result in a natural modified flow of 29 mgd. Consumptive use is projected to increase to 36 mgd and ground-water withdrawals to 34 mgd by 2000, resulting in a future modified flow of 27 mgd, about 1.5 percent of average flow.

The total 1975 population of area 24 was 109,604, resulting in a population density of 33 persons per square mile. The population is projected to reach 186,130 in 2000.

Employment in 1975 in the area was approximately 89,000. With the area embracing a portion of th Richmond and Newport News-Hampton SMSA's, total employment is projected at 131,000 in 2000. The largest increases are projected in the service industries (including the wholesale and retail trades) and manufacturing. Per capita income was equal to the national average at $6,130 in 1975. By 2000, it should reach $12,110.

Water Issues

Increased irrigation needs will cause local conflict with increased demands for water supply. The competition for the limited water resources between fish and wildlife, public and industrial supply, and rural uses will intensify.

Degraded water quality, due in part to failing septic tanks and livestock pollution, has closed some shellfishing areas and adversely affects recreation needs and wetlands protection. Public Law 92-500 implementation will improve water quality and alleviate the problem.

Pulp and paper industries and seafood processing plants pollute the stream below West Point, and overpumping of ground water may cause salinity intrusion and contamination in the York-James peninsula.

Related Land Issues

Development of second-home subdivisions may degrade water quality in the estuary, affecting the wetlands and shellfish areas. Virginia wetlands law and restrictions on shellfish taking work against development.

Other land-use conflicts are developing in relation to proposed channel widening for tankers in the York River, development pressures on wetlands in York and Gloucester counties, oil refinery expansion, and the prospect of offshore petroleum production with its impacts on adjacent land areas.

Institutional and Financial Issues

Improved land-use policy is indicated. Financing for regional water supply systems will require increasingly large capital investments, possibly beyond the means of local governments. Local funds to implement water quality control projects to complete Federal and State plans may also be beyond the fiscal ability of local governments.

Adverse Effects

Failure to ameliorate the water quality problem will result in further losses of shellfish habitat and production. The conflicts between suburban development pressures and the goals of wetlands, fish, and wildlife preservation will be satisfactorily resolved only if both conservation and development policies are reconciled. Losses of important water and land natural resources will otherwise result, and will have important impacts on the economic and social welfare of the people in the areas concerned. Lack of planning and funding to meet water supply and waste disposal needs will be detrimental to health and safety and to economic development.

Problem Area 25: James River above Scottsville, Virginia

Description

Area 25 consists of the James River Basin above Scottsville, Virginia. The area consists primarily of the rugged Appalachian Mountain Ranges, through the Blue Ridge. With a drainage area of 4,571 square miles, the area contains one SMSA, Lynchburg.

Average annual streamflow is about 2,650 mgd. The existing minimum monthly flow at 95 percent exceedance is 270 mgd. The addition of 77 mgd for consumptive use and the subtraction of about 40 mgd for ground-water withdrawals result in a natural modified flow of 307 mgd. Consumptive use is projected to increase to 214 mgd and ground-water withdrawals to 47 mgd by 2000, resulting in a future modified flow of 140 mgd for that year, representing about 5 percent of average flow.

Total population in 1975 was 176,000, resulting in a population density of nearly 40 persons per square mile. Population for the year 2000 is projected at 212,000.

Total employment in area 25 in 1975 was 82,000. The largest source of employment was the service industries. Manufacturing was the second most important source. Total employment is expected to reach 105,000 in 2000. A per capita income of $5,630 was reported for this area in 1975. It is expected that it will reach $11,070. On the average, it is below the national level by about 10 percent.

Water Issues

The present assessment has not identified any near- or long-term water issues for this area. Water supply and waste disposal needs will, of course, grow with the population. Flash flooding on the tributaries is and causes local damages and hazards.

Related Land Problems

As second-home developments take place, conflicts can be expected with competitive uses for the available water supply.

Institutional and Financial Issues

The only near-term problem for area 25 is that financing and repayment arrangements for regional water supply facilities may be inadequate. Financing for continuation of water quality programs in connection with meeting deadlines under Public Law 92-500 may be inadequate.

Adverse Effects

Failure to plan for, fund, and provide timely, safe, and adequate water supplies for the developing area will endanger public health and safety, retard economic development, and affect the general quality of life in the area.

Problem Area 26: James River above Hopewell, Virginia

Description

Area 26 consists of the James River Basin above Hopewell, Virginia, including the Chickahominy River. The area consists of the rugged Appal-

achian Mountain ranges and rolling hills of the piedmont. With a drainage area of 4,949 square miles, the subarea contains a large part of the Richmond, Virginia, SMSA.

Average annual streamflow is approximately 2,870 mgd. The existing minimum flow for the critical month is 192 mgd. The addition of 82 mgd as an allowance for consumptive use and the subtraction of 43 mgd for ground-water withdrawals result in a natural modified flow of 231 mgd. Consumptive use is projected to increase to 229 mgd and ground-water withdrawals to 51 mgd by 2000, resulting in a future modified flow of 53 mgd or about 2 percent average flow.

Total population in 1975 was 646,000, resulting in a population density of about 130 persons per square mile. Population for the year 2000 is projected at 841,000. Total employment in area 26 in 1975 was 36,000. The largest source of employment was the service industries. Manufacturing was the second most important source, though significantly below the service industries. Total employment is expected to reach 472,000 in 2000. The per capita income was $5,980 in 1975 and should reach $11,800 in 2000. These figures are just slightly below the national average.

Water Issues

Municipal and industrial pollution seriously degrade water quality and cause low dissolved oxygen in the James River below Richmond. Water is generally plentiful in the upper reaches of the James, but diversion may be necessary to meet the water supply needs of the heavily populated and industrial regions near the coast. Richmond low areas are flooded as a result of severe storms.

Related Land Issues

Second-home development conflicts with other uses for available water supply.

Institutional and Financial Issues

Present financing and repayment arrangements for regional water supply facilities are inadequate. Meeting deadlines under Public Law 92-500 is also difficult at present funding levels.

Adverse Effects

Failure to plan for, fund, and provide timely, safe, and adequate water supplies for the developing area will endanger public health and safety, retard economic development, and affect the general quality of life in the area.

Problem Area 27: James River below Hopewell, Virginia, and Atlantic Coastal Drainage

Description

Area 27 consists of the lower reaches of the James River below the confluence with the Chickahominy River and the Atlantic Coastal Drainage from Old Point Comfort to Virginia Beach, Virginia. The main stem is tidal throughout this length. The area consists largely of a flat, sprawling coastal plain.

With a drainage area of 1,080 square miles, the area contains the two SMSA's of Newport News-Hampton and Norfolk-Portsmouth. The total drainage area is 10,600 square miles. Some high quality but unpreserved coastline exists in the area. The high concentration of historic sites and the seashore and water provide diverse recreational opportunities. Hampton Roads-Newport News is a major shipbuilding and port facility. The military and public administration are both significant factors in the area's economy.

Average annual streamflow is about 625 mgd. The existing minimum flow for the critical month at 95 percent exceedance is about 72 mgd. The addition of 18 mgd for consumptive use and subtraction of 11 mgd for ground-water withdrawals result in a natural modified flow of 79 mgd. Consumptive use is projected to increase to 49 mgd by 2000, with ground-water withdrawals remaining the same, resulting in a future modified flow of 41 mgd, or about 7 percent of average flow.

Total population in 1975 was 731,000, with a density of 677 persons per square mile. Population for the year 2000 is projected at 953,000. Total 1975 employment in the area was 306,000, with the largest part in service industries. Total employment is expected to reach 400,000 in 2000. Per capita income is just above average, amounting to $4,234 in 1975, and projected to approximately $8,300.

Water Issues

Demands are expected to exceed safe yields for public water supply in the near term for Norfolk and Virginia Beach. Continued or increased pumping from wells may cause salt-water intrusion into ground-water supplies and potential land subsidence over the area of extensive pumping. The deficit between public water supply demands and safe yields may increase in the long term. Rapid industrial growth will mean large withdrawals for process and cooling uses. Development might impose excessive ground-water demands by lowering the aquifer levels. The persistent effects of past discharge of Kepone and frequent oil spills are continuing water quality problems.

Related Land Issues

Second-home and residential development conflicts with competitive uses for the available water supply.

Institutional and Financial Issues

Present financing and repayment arrangements for regional water supply facilities are inadequate. Financing for continuation of water quality programs is also inadequate and makes it difficult to meet deadlines under Public Law 92-500.

Adverse Effects

Failure to plan for, fund, and provide timely, safe, and adequate water supplies for the developing area will endanger public health and safety, retard economic development, and affect the general quality of life in the area.

Summary

Assuming average conditions, the Mid-Atlantic Region as a whole has adequate developed and undeveloped water resources in total quantity to meet the anticipated needs of an expanding population and economy through the end of the century. However, with only 3 percent of the Nation's land area, and 18 percent of its population in 1975, most of which is densely concentrated in the urban and urbanizing megalopolis along the coast, both land and water resources are already subject to a number of severe local stresses that will increase, unless sound measures are taken, as the population grows another 26 percent, from 39.6 million in 1975 to about 50.0 in the year 2000.

The region offers a range of topography from the flat coastal plain, with its beaches, barrier islands, bays and estuaries, through the rolling hills and plateaus of the foothills, to the rugged Appalachian Mountains which reach up to 4,000 feet in elevation and form the boundary with the northeasterly tributaries of the Mississippi River system. The northern part of the region was glaciated during the Pleistocene period, with geological and topographical changes that affect surface- and ground-water characteristics. The climate is temperate and humid, but ranges from severe cold winters in the north to hot summers in the south. Extremes of heat and cold occur less frequently near the ocean and the large bays than in the inland mountainous areas. The growing season varies from less than 100 days in northern New York to about 200 days in southern Virginia. Rich soils and generally adequate rainfall, supplemented by some sprinkling irrigation, encourage truck and fruit farming; and forested areas of large and small extent are spread through the region. Bituminous coal is mined at several points in the western mountainous sections. Fin and shell fish are exploited extensively in the adjacent ocean and the coastal bays and add appreciably to the Nation's food supply and the region's employment. Fish and wildlife and the outdoors constitute major enhancement to and provide extensive opportunities for healthful recreation.

The region exhibits great contrasts between the dense concentration of people in the cities along the coast and the thin distribution inland. From the early days of settlement, the region has been the gateway for much of the immigration to the Nation and to the West, and it exhibits all the diversity of the varied origins of its people and their adaptation to changing times and technology. Agriculture is a relatively small component of economic activity in the region, and is likely to grow only a moderate amount. Manufacturing produces almost a quarter of the earnings at present, but this proportion is expected to decline as business, services, and trade for an urban population become more dominant. Manufacturing is varied, including food, textiles, lumber, chemicals, petroleum, metals, machinery, and other manufactured products; it places a large demand on water and impacts on its quantity and quality. Nonmanufacturing activities include contract construction, finance, insurance, real estate,

transportation, communications, utilities, wholesale and retail trade, and government. In this group, electrical power generation places major demands on water, and its consumptive uses will increase as recycling of cooling water is employed to reduce heat pollution of water bodies.

The hydrological pattern of the region is varied, and the subregions, each embracing large and medium river basins, are separate hydrological entities. Except for established interbasin transfers, little additional exchange of water between subregions is considered likely. The northerly rivers flow generally southward to the ocean; the southerly rivers flow east. The headwaters in the Appalachian highlands follow northerly courses between the mountains until they abruptly break through the mountains to join the lower main streams. The Hudson and the Delaware rivers flow to the Atlantic Ocean directly. The Susquehanna, Potomac, Rappahannock, York, and James rivers flow to the Chesapeake Bay, an arm of the ocean.

The rivers of the region drain large portions of New York, Pennsylvania, Maryland, and Virginia, all of New Jersey and Delaware, and small parts of Vermont, Massachusetts, Connecticut, and West Virginia. Long Island, much of New Jersey, and the Delmarva Peninsula embrace the freshwater aquifers of the coastal sedimentary deposits, a bountiful source of ground water. The brackish waters of the bays and estuaries are the incubators of aquatic life and also the source of supply for industries and electric generating plants that can tolerate such water. The streams, lakes, bays, beaches, and forests are important ecological and social resources for fish and wildlife conservation and for human use in fishing, hunting, boating, contemplation of nature, and other outdoor renewal of the quality of life.

The greatest amounts of water (about 71 percent) withdrawn from streams and ground water in the region at present are by manufacturing and steam electric plants. About 10 percent of this water withdrawn is consumed and not returned to the streams or the ground. Domestic and commercial demands account for about 25 percent of the total withdrawals, and consumed about 17 percent of them in 1975. Because of changes in manufacturing and cooling processes, the amount of water consumed in 2000 is expected to be about 1.9 times that in 1975, although the quantity of withdrawals is projected to decrease by about 24 percent. Implementation of the requirements of water pollution control and environmental quality legislation will bring about many changes in municipal and industrial water-use patterns and technology, and water withdrawn from surface streams and from the ground-water reservoir will be recycled, treated, and reused a number of times. As a result, the natural supply of water, which presently exceeds both present and anticipated demands most of the time, but lacks some desirable aspects of distribution and quality, will be ample for the needs of the Mid-Atlantic Region.

Despite the overall abundance of water supplies and the extent of the land resource, the region faces a number of severe water and related land problems. Most of these problems can be segregated by the subregion because of their hydrologic independence, and some problems are also localized by subbasins or areas. However, the impacts of meeting these problems,

and the degree to which they will be solved or neglected, will extend to the social, economic, and environmental welfare of the people beyond the localities to the States, the region, and the Nation.

There are several severe and widespread problems: those affecting withdrawal and consumption of fresh ground and surface water, the quality of fresh and saline water, and salt-water intrusion into fresh-water aquifers; flooding of urban and developed lands, the pressures of encroachments on flood plains, and the erosion of soils from construction and agricultural areas; the effects of sedimentation on water courses, reservoirs, navigation channels, and wetlands; disposal of excavated and dredged materials and sewage sludge; and conflicts of land use by land developers, urban expansion, industry, conservationists, and recreationists. Activities associated with commerical navigation have potential impacts which could adversely affect the ecosystems of estuaries and the ocean. Measures to minimize such impacts are desirable.

In the region, minimal progress has been made in developing institutional mechanisms for analyzing, resolving, and managing water resources problems except for the Interstate-Federal compacts in subregions 203 and 204 (Delaware and Susquehanna Compact Commissions). While each subregion may be an entity in water problems, political areas overlap and coordination at times faces State and Federal constitutional issues. The Federal role in both the political and the financial aspects of water resources development and conservation, and in cooperation with the States and localities, is under review by the Administration.

Water quantity and quality problems in the Mid-Atlantic Region are most severe in the densely populated urban areas. New York City imports water from both the Hudson and Delaware River basins and faces shortages in dry years. There is a need for rehabilitation of the existing New York City system and expansion thereof to meet foreseeable water supply deficits. New York City withdrawals impact on the cities of Trenton and Philadelphia and the salt front in the lower Delaware River. The city of Washington and its suburbs have already seen midsummer rates of withdrawals that, except for the time of occurrence, would have simultaneously exceeded the lowest flow of the Potomac at the point of withdrawal. Controversy continues between water utilities and upstream and downstream interests on use of land with the potential for storage reservoirs and other water supply projects. The suitability of the water of the upper Potomac estuary for human consumption, while under investigation, is uncertain and is being evaluated.

Flood damages continue to rise as the flood hazard is ignored in many places by builders or is unknown to home buyers. The encouragement of publication of flood hazard information by the Federal Government since 1960, and the initiation of a federally subsidized flood insurance program with incentives for sound flood-plain land-use management, have only lately begun to see public acceptance, but they depend on continuing Federal, State, and local governmental support. A national trend is evident toward the sound combination of structural and nonstructural flood damage reduction measures, and should reduce future increases in flood loss potential.

Federal policy, now under review, should encourage sound flood-plain management. Land-use regulations and construction codes are non-Federal responsibilities and have varying degrees of acceptance and use. To the extent applied, they may help prevent any appreciable increase in the rates of land erosion and resultant sedimentation.

Under existing legislation, improved management should be expected of the problem of disposal of dredged materials from Federal improvements for navigation and from private construction, mining, and solid waste disposal.

Major decisions to be made and programs still to be formulated regarding energy production and conservation and petroleum-products transportation will affect not only the offshore ocean environment but also the ecology and use of the shores, estuaries, connecting water courses, and adjacent lands.

Conclusions and Recommendations

The objective of a periodic national water assessment is to maintain and identify on a current basis existing and emerging problems in the use and preservation of water and related land resources. Identification of problems, however, is futile without seeking resolution. The priority problems of water supply and water quality, energy development, flood damage reduction, commercial navigation, and related needs in the region must be evaluated in recognition of the size and density of the population and the urgency of agreeing on solutions. The pervasiveness of the variety of problems which exist throughout the region can be described in terms of several encompassing issues. The following conclusions and recommendations have been made with reference to the Federal role, planning and implementation, data collection and research, and institutional arrangements.

Federal Role

The Federal Government has long participated in the planning, the implementation, and the financial support of water and related resources preservation and development. Its role in defining national policy in the fields of navigation, irrigation, flood control, fish and wildlife preservation, outdoor recreation, and water and environmental quality has varied from a high degree of involvement in planning, to a somewhat lesser degree in financing and construction, and to a point leaving cooperation and maintenance responsibilities largely to non-Federal sponsors.

A strong national and Federal interest exists in effecting solutions to the region's water problems. Federal cost-sharing, in some instances, is needed because of the inability of non-Federal entities to finance projects such as flood control, water supply, and upgrading of sanitary and combined sewer systems, particularly those on a regional scale or where the beneficiaries are so widespread that direct and equitable assessment of costs is not practicable. A more important and not so obvious reason for Federal support is the essential need to provide a catalyst and a focal point for coordination and cooperation among a diversity of interests and organizations to secure implementation of plans. In some cases which have clearly defined user benefits, partial or full repayments over time of the costs of initial Federal involvement may be appropriate, but this does not necessarily lessen the need for Federal financial assistance at the beginning.

The Water Resources Council should therefore explore means to improve leadership and cooperation among entities to provide adequate financing and sharing of costs for water and related land resources programs and projects in the region and in the Nation.

Planning

Many current and authorized studies in each analytical problem area are addressing the identified problems, including those involving flood control, domestic and industrial water supply, energy development, commercial navigation, and related water quantity and water quality needs. Such studies, if adequately supported at the Federal level and expeditiously carried out, would provide solutions to the identified problems. Additional Level B[1] studies not presently under consideration in the region are not considered warranted at this time. Any additional Level B studies needed should be undertaken without undue delay. However, this does not preclude the need for or the desirability of any planned or programmed studies such as under Section 208 of Public Law 92-500, or other studies thereunder, which are still necessary, nor does it eliminate the possibility of need for new Level B proposals at some future date. There will, of course, be a need for Level C (implementation) studies throughout the region. Implementation studies should receive strong institutional and financial support to ensure that high priority problems in the region are given full and timely attention.

It is essential, further, that the numerous studies underway and to be undertaken lead to constructive action. Therefore, the conclusions and recommendations in studies in the region should emphasize implementation and support of proposed solutions at the Federal level.

Data and Research

Expanded data collection and research activities should be undertaken regarding flow requirements for water quality, including seasonal distribution needs to bays and estuaries; instream requirements for fish, wildlife, recreation, hydropower, and salt-front balance; and regarding the role of combined surface and ground waters in providing these instream flows.

During the course of the assessment, quantitative means for describing problems of water quality for each basin, or on a unit flow basis, were not readily available. Knowledge concerning the physical, chemical, and biological interactions with flow quantities is either lacking or too scarce to permit the use of numerical parameters to assess the problems causing pollution. Instream flow criteria are key elements in the planning and management of water and related resources. More specific techniques for deriving quantitative values in these categories would aid greatly in describing and resolving the problems, as well as in making future assessments more meaningful.

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[1]Level B study is a preliminary or reconnaissance type of interdisciplinary study of sufficient complexity to warrant an intermediate study between framework (Level A) and implementation (Level C) studies.

Therefore, data collection and research activities should be extended to areawide values of water quality with respect to the quantity of flow and other instream needs.

Institutional Requirements

There is a need to examine the many interrelationships between the Federal and non-Federal organizations that are involved in the policy and planning of water resources studies. Research is needed to analyze the purposes and efficiency of existing laws and institutions that affect water and related land resource policy. The Water Resources Council should establish and fund a continuing coordinating organization with more diverse representation, including State and River Basin Commission representatives. It should develop a permanent user awareness plan to insure widespread and continuing concern in resolution of water problems.

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NATIONAL PROGRAMS AND ASSESSMENT TASK GROUP

s Council, Chairman of Task Group

cies[1] and Council Staff

Department of Agriculture:
Karl Klingelhofer
Arthur Flickinger
David K. Bowen
Adrian Haught
Roger Strohbehn
Marlin Hanson
Roy M. Gray

Department of the Army:
William T. Whitman
Theodore Hillyer
George Phippen
Walter Schilling
Jack Lane

Department of Commerce:
Konstantine Kollar
Robert Brewer
Patrick MacAuley

Department of Commerce—Con.
Henry L. DeGraff
Edward A. Trott, Jr.
Lyle Spatz
David Cartwright

Department of Energy:
Ernest E. Sligh
Robert Restall
John Mathur
Louis A. Schuppin

Department of Housing and Urban Development
Truman Goins
Theodore H. Levin

Environmental Protection Agency:
Robert F. Powell

Department of the Interior:
Thomas Bond

Department of the Interior—Con.
Keith Bayha
Robert Bergman
Jerry Verstraete
Irene Murphy
Mortimer Dreamer
Hal Langford
Bruce Gilbert
Robert May
Henry Gerke
Don Willen
Ralph Baumer
Brent Paul
Dick Nash

Water Resources Council:
Jack R. Pickett
W. James Berry
Kerie Hitt

Water Resources Council—Con.
Raymond E. Barsch (IPA, California)
Edith B. Chase (Detail, USGS)
Art Garrett (Detail, USGS)
Clive Walker (Detail, SCS)
Frank Davenport
James Evans
Joel Frisch
Charles Meyers
Peter Ramatowski
Arden Weiss
William Clark
Ted Ifft
Della Laura
Ward Hickman
Greg Gajewski
Robert Mathisen
Albert Spector
Judith B. Smith

Regional Sponsors and Regional Study Directors

Region	*Sponsor*	*Study Director*
New England	New England River Basins Commission	Jane Carlson, Dave Holmes
Mid-Atlantic	U.S. Army Corps of Engineers	Robert Meiklejohn, Kyle Schilling
South Atlantic-Gulf	Southeast Basins Inter-Agency Committee	Douglas Belcher
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Rio Grande	U.S. Bureau of Reclamation	Kenneth Schroeder, Paul Willmore
Upper Colorado	U.S. Bureau of Reclamation	Ival Goslin
Lower Colorado	U.S. Bureau of Reclamation	Dean Johanson
Great Basin	States of Nevada and Utah	Vic Hill, Barry Saunders
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Hawaii	Hawaii Department of Land and Natural Resources	Walter Watson
Caribbean	Puerto Rico Department of Natural Resources	Greg Morris

State and Other Representatives[2]

Alabama:
Walter Stevenson

Alaska:
Katherine Allred

Arizona:
David A. Gerke

Arkansas:
Jonathan Sweeney

California:
James U. McDaniel
Vernon E. Valantine

Colorado:
Fred E. Daubert

Connecticut:
Carolyn Grimbrone

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District of Columbia:
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Florida:
Pratt Finlayson

Georgia:
James R. Wilson

Hawaii:
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Manuel Monzie, Jr.

Idaho:
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Ohio:
William G. Mattox

Oklahoma:
Mike Melton

Oregon:
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William N. Frazier

Rhode Island:
Frank Gerema

South Carolina:
Christopher Brooks
Clair P. Guess, Jr.

South Dakota:
Keith Harner

Tennessee:
Frank M. Alexander

Texas:
Herbert W. Grubb

Utah:
Lloyd H. Austin

Vermont:
Elizabeth Humstone

Virginia:
Dale F. Jones

Washington:
Fred Hahn

West Virginia:
M. S. Baloch

Wisconsin:
Rahim Oghalai

Wyoming:
Clem Lord

Puerto Rico:
Guillermo Barreto

Virgin Islands:
Albert E. Pratt
Terri Vaughan

Principal Advisors and Reviewers

Jack Gladwell, University of Idaho
Ronald M. North, University of Georgia
Warren Viessman, Jr., Library of Congress
James Wade, University of Arizona
Mark Hughes, Consultant
Lance Marston, Consultant
H. James Owen, Consultant
Harry A. Steele, Consultant
Pat Waldo, Consultant
Francis M. Warnick, Consultant
Bernard J. Witzig, Consultant
Leo R. Beard, University of Texas

[1] The Washington staff of the Federal agencies was augmented by field office staff who participated with Washington offices or through the Regional Study Teams.
[2] Several States had representatives on more than one Regional Study Team. Contributions of those not named were greatly appreciated.

THE NATION'S WATER RESOURCES — 1975-2000

Volume 4: Mid-Atlantic Region

Authorization

The United States Water Resources Council was established by the Water Resources Planning Act of 1965 (Public Law 89-80).
The purpose of the Council is to encourage the conservation, development, and utilization of water and related land resources on a comprehensive and coordinated basis by the Federal government, States, localities, and private enterprises with the cooperation of all affected Federal agencies, States, local government, individual corporations, business enterprises, and others concerned.