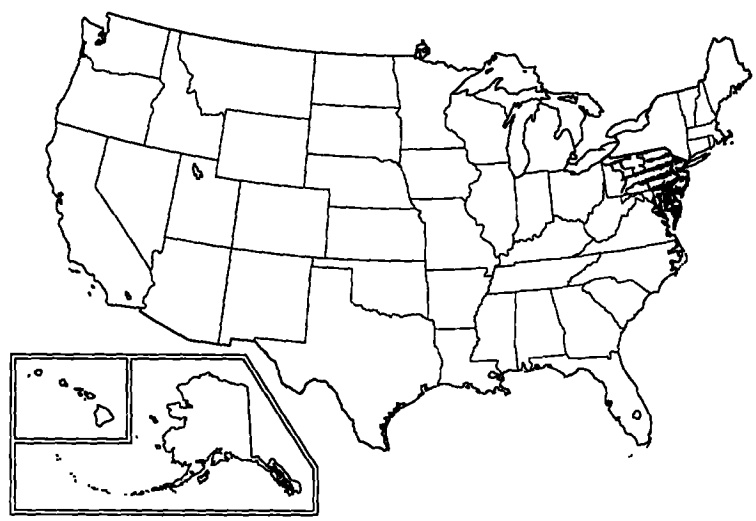
US Army Corps
of Engineers

National Hydroelectric Power Resources Study

Volume XV
September 1981

Regional Assessment: Mid Atlantic Area Electric Reliability Council



SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
Volume XV

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
National Hydroelectric Power Resources Study: Regional Assessment; Mid-Atlantic Area Electric Reliability Council (MAAC)

5. TYPE OF REPORT & PERIOD COVERED
Final

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
U.S. Army Engineer Division, North Atlantic
90 Church Street
New York, NY 10007

8. CONTRACT OR GRANT NUMBER(s)
N/A

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Same as No. 7 above

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
U.S. Army Engineer Institute for Water Resources
Kingman Building
Fort Belvoir, VA 22060

12. REPORT DATE
September 1981

13. NUMBER OF PAGES
136

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)
Same as No. 11 above

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Hydroelectric power potential; electric power supply and demand; hydroelectric project evaluation; electric power projections

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This volume briefly describes existing conditions (physical, social, economic) affecting electric supply and demand in the Mid-Atlantic Area Council. It discusses the existing electric energy system and the role of hydroelectric power therein. Projections of electrical supply and demand through the year 2000 are discussed. The hydropower resources, developed and undeveloped, of the region are evaluated and a regional ranking of specific projects and sites which are recommended to be studied in further detail is presented. The public involvement in the planning process is described.

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

U.S. ARMY CORPS OF ENGINEERS

NATIONAL HYDROELECTRIC POWER RESOURCES STUDY

REGIONAL REPORT: VOLUME XV

MID ATLANTIC AREA ELECTRIC RELIABILITY COUNCIL

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September 1981

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

PREFACE

The economic success and standard of living in this country have been achieved, in part, at the expense of abundant supplies of low cost, non-renewable, energy sources. In recent years however, diminishing reserves of the preferred non-renewable energy sources, i.e. oil and natural gas, have prompted a national energy policy which emphasizes conservation and the development of new and renewable sources of energy. This report is a direct result of the national energy policy as it focuses on our major existing renewable energy resource, hydroelectric power.

Congress, in the Water Resources Development Act of 1976 (P. L. 94-587), authorized and directed the Secretary of the Army, acting through the Chief of Engineers, to undertake a National Hydroelectric Power Resources Study (NHS). The primary objectives of the NHS were (1) to determine the amount and the feasibility of increasing hydroelectric capacity by development of new sites, by the addition of generation facilities to existing water resources projects, and by increasing the efficiency and reliability of existing hydroelectric power systems; and (2) to recommend to Congress a national hydroelectric power development program.

The final NHS report consists of 23 volumes. Volumes I and II are the Executive Summary and National Reports respectively. Volumes III and IV evaluate the existing and projected electric supply and demand in the United States. Volumes V through XI discuss various generic policy and technical issues associated with hydroelectric power development and operation. Volumes XII and XIII describe the procedures used to develop the data base and include a complete listing of all sites. Volumes XIV through XXII are regional reports defined by Electric Reliability Council (ERC) regions. The index map at the inside back cover defines the ERC regions. Alaska and Hawaii are presented in Volume XXIII.

This volume, number XV, describes the hydroelectric power potential in the Mid-Atlantic Area Electric Reliability Council (MAAC) region. A map depicting all sites described in the text is located in the jacket, inside back cover.

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Chapter 1
REGIONAL OBJECTIVES

The current economy and standard of living have been achieved largely as a result of abundant supplies of low-cost energy. Diminishing reserves of traditional primary energy sources, oil and natural gas, have prompted a national energy policy which emphasizes both conservation and the development of new sources of energy. Hydroelectric power is one of the nation's sources of primary energy, and in many parts of the country provides a valuable increment of our electrical generating capacity. The potential for developing new hydroelectric power sources still exists as well as opportunities for more efficient utilization of hydroelectric power and other water resources projects. The National Hydroelectric Power Resources Study analyzed this potential and the physical, economic, environmental and social constraints associated with hydroelectric power development to assess the contribution that could be made to meet the nation's growing electric energy requirements.

Within the general objectives of the National Study, an assessment of the potential for hydroelectric power development within the Mid-Atlantic Area Electric Reliability Council Region is presented. A regional plan to meet future demand for hydroelectric power to the year 2000 is outlined. It consists of the identification of specific existing and undeveloped sites that warrant further study and the time frame in which studies should be undertaken to achieve the most efficient utilization of tne nation's hydroelectric power resources. This plan is considered to be responsive to six regional objectives which relate to the problems, needs, concerns and opportunities in the region.

- Identify all hydroelectric power potential which is economically viable and acceptable in terms of social, environmental and institutional impacts.

- Assess the physical potential for increasing hydroelectric power capacity and generation in the form of a current and updated inventory of potential hydroelectric power sites.

- Determine the technical and economic and environmental potential of increasing hydroelectric power, short and long term at existing dams and undeveloped sites.

- Contribute to the national goal of energy independence and reduction of the region's dependence on foreign oil and other nonrenewable fossil fuels.

- Emphasize early development of hydroelectric additions to existing projects where such facilities can be developed and operated to curtail use of scarce and expensive fossil fuels.

- Promote and encourage the development of projects and programs which provide for the development of new electric energy and more efficient use of existing energy sources.

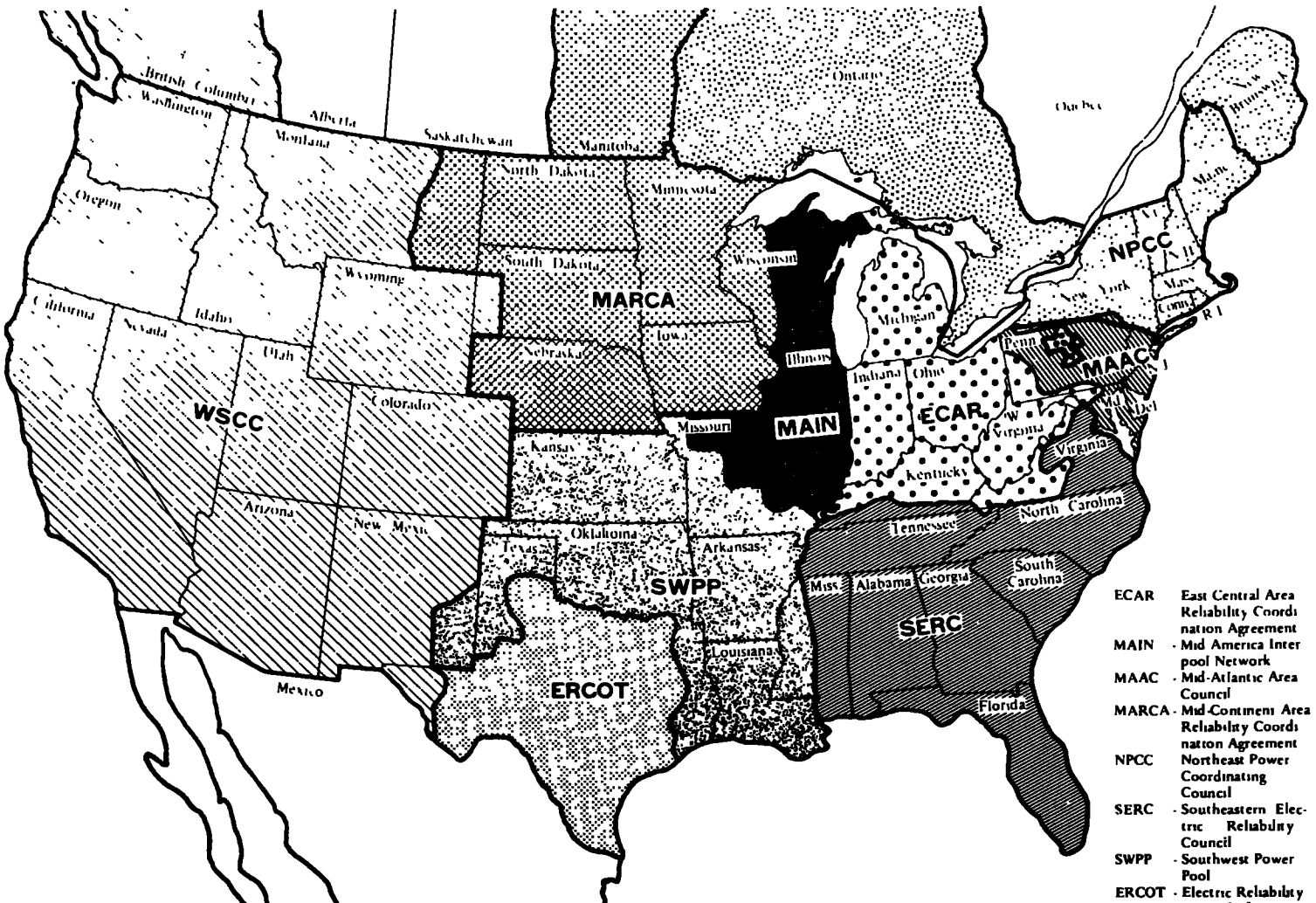
Chapter 2
EXISTING CONDITIONS

The utility systems comprising the Mid-Atlantic Electric Reliability Council (MAAC) encompass a service area of approximately 48,700 square miles in the central east coast portion of the United States extending east from the Ohio-Pennsylvania border and Lake Erie to the New Jersey coast and south from the New York-Pennsylvania border to south of Washington, D.C. This area includes all of the State of Delaware and the District of Columbia, and portions of four States: 97 percent of New Jersey, 75 percent of Pennsylvania, 60 percent of Maryland and one percent of Virginia. It is the smallest of the nine National Electric Reliability Council Regions as shown in Figure 2-1. The MAAC Region is bounded on the north by the Northeast Power Coordinating Council (NPCC), on the south by the Southeastern Electric Reliability Council (SERC), and on west by the East Central Area Reliability Council (ECAR). Its geographic location is such that it is the bridge between the coal-burning utilities of the West and the imported oil-dependent utilities of the Northeast. A delineation of the geographical boundary of the MAAC Region is shown on Figure 2-2.

2.1 TOPOGRAPHY

The topography of the MAAC Region varies from mountainous terrain with elevations over 4,000 feet to flat and undulating coastal plains with their beaches, barrier islands, bays and estuaries. Its diverse features are the result of marked differences in the geological process over millions of years. The two major physical features of the region are the areas of crystalline rocks in the Piedmont Plateau, which is part of the foothills of the Appalachian Mountains, and the Coastal Plain which is a wide belt of sand, clay and gravel covering the coastal areas and extending seaward beneath the Atlantic Ocean for 100 miles or more. Topography of the region, along with cultural development adjacent to major streams generally limits the development of hydroelectric power resources. It is such that most tributary streams have relatively steep profiles and narrow flood plains. The profiles of the major streams are generally somewhat flatter than those of the tributaries, but their flood plains are also relatively narrower.

The Appalachian Highlands covers most of the interior of the Commonwealth of Pennsylvania. They extend into the State of New Jersey, where there is a fairly sharp transition at the Fall Line to the Coastal Plain. The Fall Line which passes through Trenton, New Jersey; Philadelphia, Pennsylvania; Wilmington, Delaware; Baltimore, Maryland; and Washington, DC is the boundary between the Piedmont and the Coastal Zones. It marks the zone of rapids and waterfalls where streams running off the hard crystalline rock of the Piedmont physiographic province descend into the Coastal Plain. The Fall Line coincides with many of the older and larger cities primarily because it is the inland limit of navigation as well as having been a source of water power. It acts as a tidal barrier separating the estuary of the rivers from their headwaters.



Source: Inventory of Power Plants in the United States, Energy Information Administration, DOE, April 1979.

Figure 2-1
REGIONAL ELECTRIC RELIABILITY COUNCIL AREAS

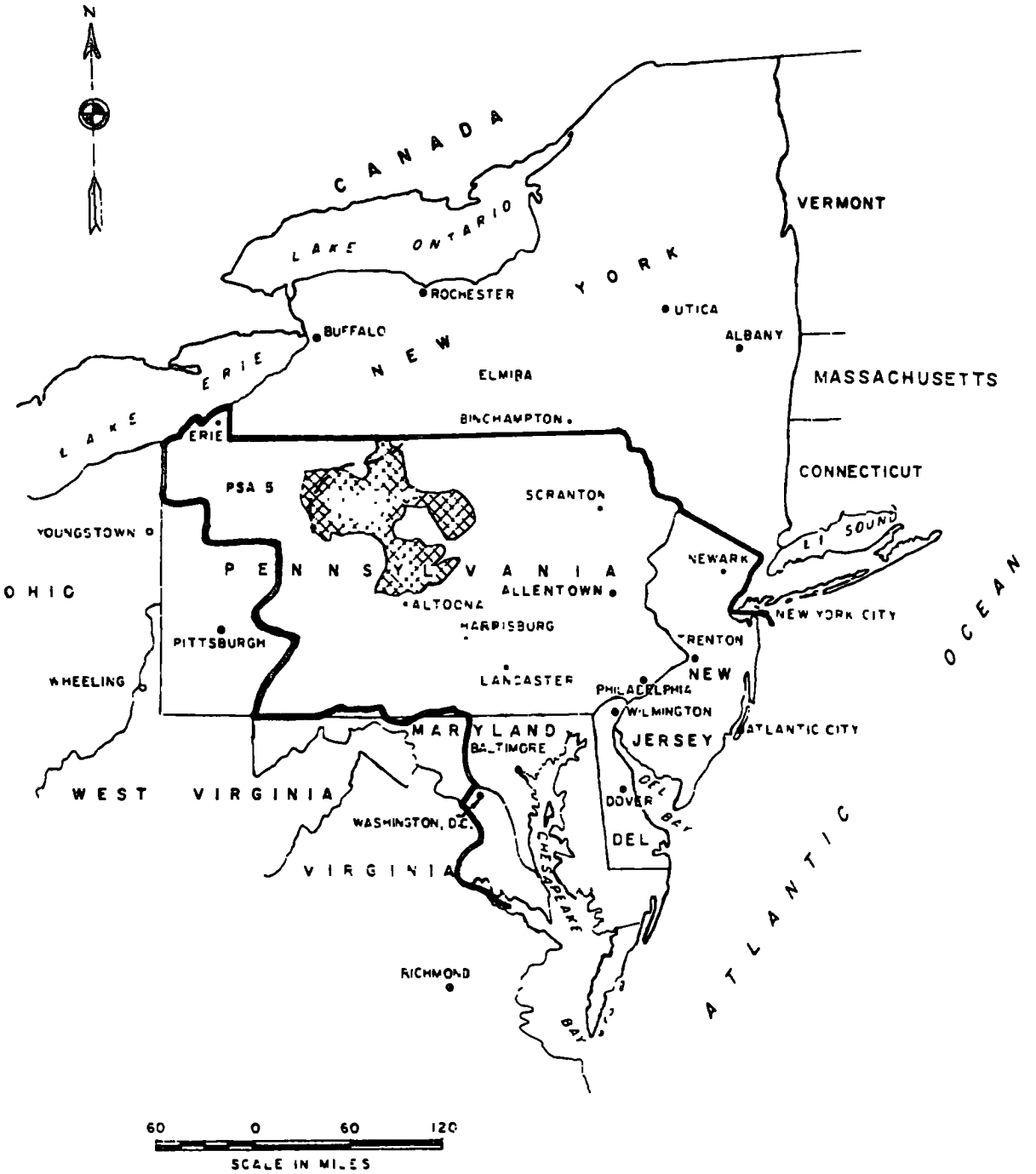


Figure 2-2
MID-ATLANTIC AREA ELECTRIC RELIABILITY COUNCIL REGION

In the MAAC Region, the Coastal Plain which is an area of low relief includes that part of the mainland east of the Fall Line. It extends southward from the southern three-fifths of New Jersey to eastern Maryland and Virginia encompassing all of the State of Delaware.

2.2 HYDROLOGIC CONDITIONS

There is a wide range of climatic conditions in the MAAC Region. The region is situated in the global zone of westerly winds and 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 to the west and the ocean to the east. Generally, three types of weather patterns influence the region; cold, dry air flowing down from the Arctic; warm moist air from the Gulf States; and cool moist air moving in from the ocean. The climate is humid, with four distinct seasons, and in the coastal lowlands, which include the most densely populated areas in the region, 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. The average annual temperature in the region varies from about 50 degrees (Farenheit) in the north to about 58 degrees in the south. Northern winters are fairly long and severe, with growing seasons averaging less than 100 days in some areas. In the southern portion of the region, growing seasons average up to 200 frost-free days and the summers are long and hot. The Atlantic Coastal influence on temperature is greatest in the fall, delaying the first killing frost. This results in a coastal frost-free season averaging from 20 to 40 days longer than in areas a short distance inland.

Average annual precipitation in the region varies from about 44 to 48 inches. It is distributed fairly evenly throughout the year, and ranges from slightly less than 40 inches in the northwestern portion in Pennsylvania, to more than 45 inches in the southern portion in Delaware, Maryland and Virginia. Precipitation is generally about four inches greater along the coast than in nearby inland areas. Most of this difference is accounted for by the greater coastal precipitation in the fall. 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 runoff and streamflows. Low flows occur on a yearly cyclical basis and generally have a duration of three or four months in late summer and early fall. The lowest streamflows generally are in September and October and the highest flows occur during the period from February to April. Occasionally, prolonged periods of low flow extends beyond seasonal limits for months or even years, as in the droughts of the 1930's and 1960's, which affected large portions of the region. During the drought of the 1960's, many gaging stations recorded annual flows for several consecutive years that were on the order of 50 percent or less of the long-term average. The long-term average flow is about 1.5 cfs per square mile.

Average annual snowfall is predominantly a function of latitude, however, some high altitude areas in the southern portion of the region

receive much more snow than more northerly coastal lowlands. Snowfall in the extreme southern portion of the region, in Maryland and Virginia, averages about 10 inches, while it averages more than 60 inches in northwestern Pennsylvania.

Three major river systems; the Delaware, Susquehanna and the Potomac traverse the MAAC Region. Major estuaries include the Delaware and Chesapeake Bays. These systems are generally separate hydrological entities in that most of the major streams flow independently to the ocean and do not join in a common main stem for the final outlet. The northerly streams generally flow southward to the ocean, while the southerly streams flow generally in a west to east pattern. An 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 lower main streams. The Delaware River flows directly to the Atlantic Ocean and the Susquehanna and the Potomac Rivers flow to the Chesapeake Bay, an arm of the ocean. Stream patterns and watershed boundaries are shown on Figure 2-3.

The river systems in the MAAC Region drain large portions of Pennsylvania and Maryland, all of New Jersey and Delaware and a very small portion of Virginia. Average runoff varies from 2.0 cfs per square mile at stations in the Delaware and Susquehanna Basins to less than 1.0 cfs per square mile at stations in the Potomac Basin. A major portion of New Jersey and the Delmarva Peninsula embrace the freshwater aquifers of the coastal sedimentary deposits, a bountiful source of groundwater. The fresh surface and groundwater resources of the region, supplemented by use of brackish waters from the bays and tidal portions of the streams, combine to provide an abundant source of supply for industries and electric generating plants that can tolerate such water. However, wide seasonal and annual streamflow fluctuations impose a significant constraint on the development of new large scale multi-purpose hydroelectric power projects in the region. 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.

2.3 ECONOMICS OF AREA

The service area of the Mid-Atlantic Area Reliability Council plays an important role in the Nation's economy. It overlaps all or portions of nine Bureau of Economic Analysis Economic Areas (BEA) encompassing about 103 counties in the multi-state region. Figure 2-4 shows the delineation of the area by counties and BEA Economic Areas. Generally, the region lies within the lower half of the urbanized and urbanizing megalopolis which stretches from Boston, Massachusetts to Norfolk, Virginia. More people and wealth are concentrated in this megalopolis than in any other region of the United States. 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

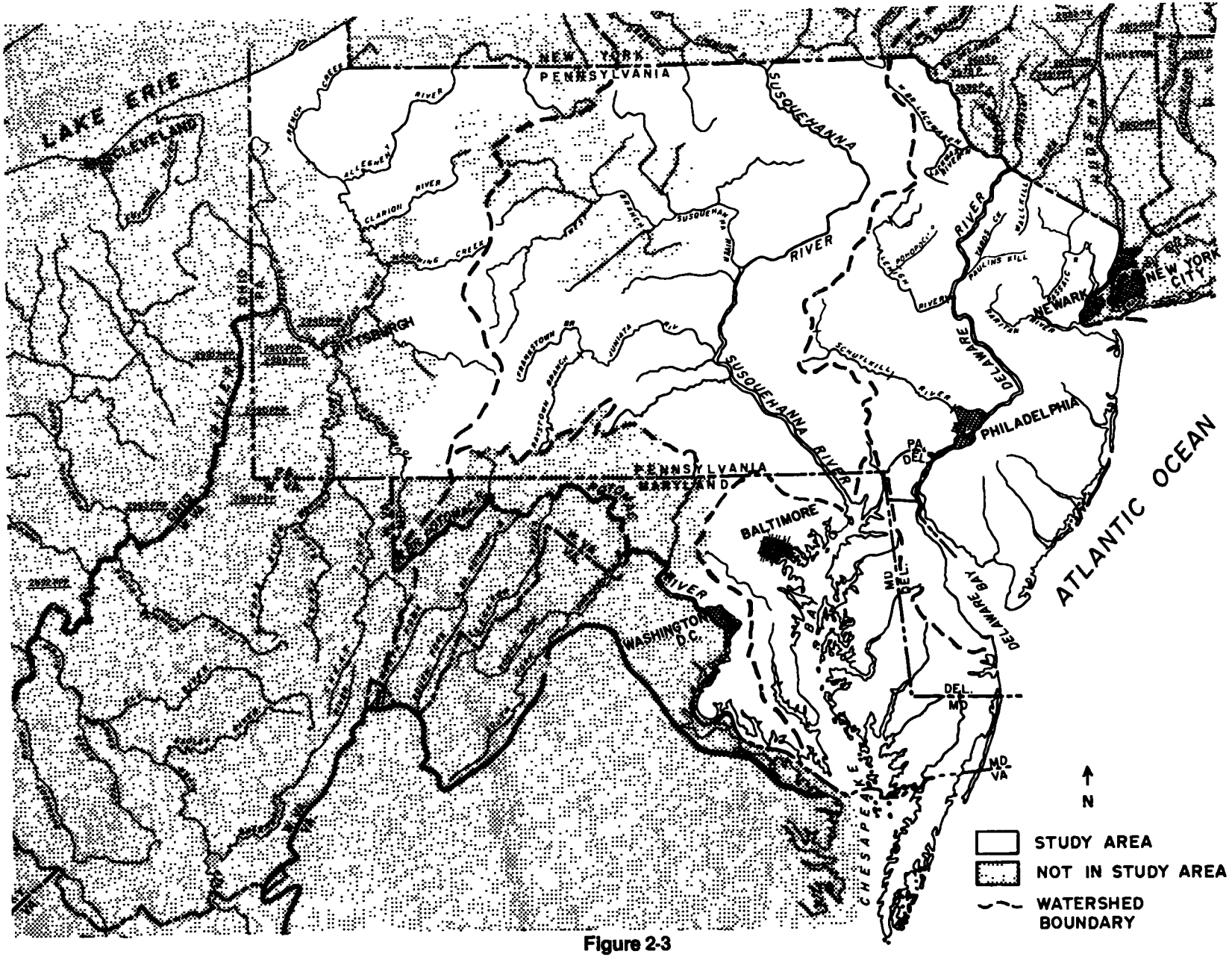


Figure 2-3
STREAM PATTERNS AND WATERSHED BOUNDARIES

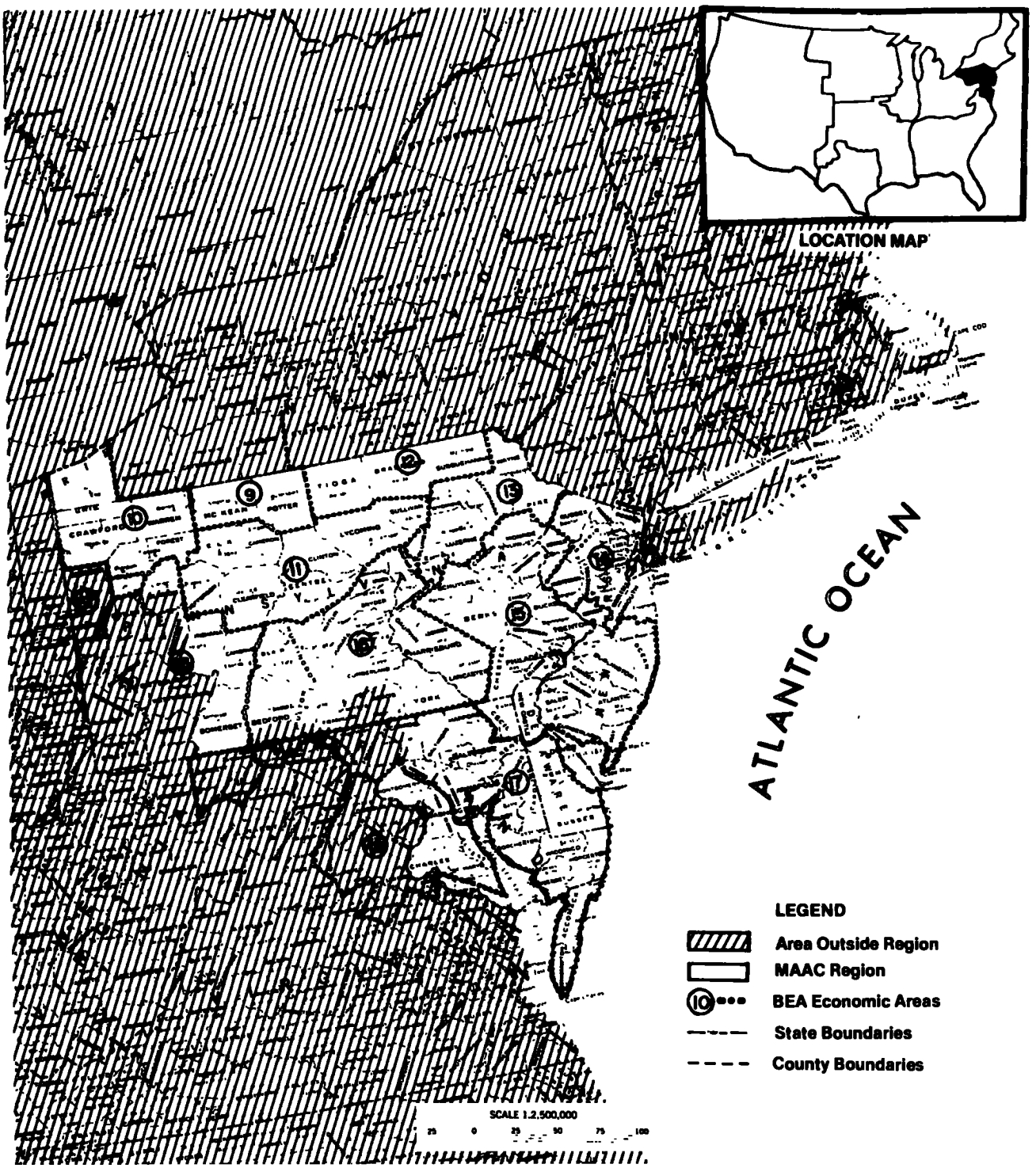


Figure 2-4
MID-ATLANTIC AREA RELIABILITY COUNCIL REGION–SUB AREA BOUNDARIES

economic and educational opportunities and ease of transportation.

The population of the MAAC Region was about 19,700,000 in 1970. While the region constitutes only about 1.6 percent of the total area of the (contiguous) continental United States, about 9.7 percent of the Nation's population resides within its boundary. Historically, the population in the region has grown slightly slower than that in the Nation. During the period 1960-70, population in the region had been increasing at an average rate of 1.2 percent. The average population density of 1,014 per square mile was slightly more than the national average; it varied considerably within the region. The largest population concentrations are the metropolitan areas in conjunction with the major cities in the region. The rural areas of the region contain many small towns and cities, and many counties have less population than usually found within a square mile of inner-city neighborhoods in large metropolitan areas. Table 2-1 lists the Standard Metropolitan Statistical Areas (SMSA's) encompassing the MAAC Region. It generally shows population and percent change for the region during the period 1960-70.

Table 2-1

STANDARD METROPOLITAN STATISTICAL AREAS MAAC REGION-1970

SMSA	Area Sq Miles	Population	Density Pop/ Sq Mile	Changes 1960-1970 Percent
Philadelphia, PA--NJ	3,553	4,822,245	1,357	11.0
Baltimore, MD	2,259	2,071,016	917	24.0
Newark, NJ	701	1,859,096	2,652	10.0
Washington DC--MD--VA 1/	546	1,417,592	13,585	26.4
Paterson--Clifton--Passaic, NJ	427	1,357,930	3,180	14.4
Jersey City, NJ	47	607,839	12,933	- 0.5
New Brunswick--Perth Amboy--Sayreville, NJ	312	583,813	1,871	
Allentown--Bethlehem--Easton, PA--NJ	1,086	543,803	501	10.5
Wilmington, DEL--NJ--MD	1,165	499,493	429	20.5
Long Branch--Asbury Park, NJ	476	461.849	970	
Harrisburg	1,624	410,505	253	10.5
Wilkes Barre--Hazleton, PA	888	342,329	386	- 1.3
York, PA	1,435	329,540	230	13.5
Lancaster, PA	946	320,079	338	15.0
Trenton, NJ	228	304,116	1,334	14.2
Reading, PA	862	296,382	344	35.4
Erie, PA	813	263,654	324	5.2
Johnstown, PA	1,780	262,822	148	- 6.4
Scranton, PA	454	234,107	516	- 0.2
Atlantic City, NJ	569	175.043	308	8.8
Altoona, PA	530	135,356	255	- 1.4
Vineland--Millville--Bridgeton, NJ	500	121,374	243	13.6
Williamsport, PA	1,216	113,296	93	
Binghamton, NY--PA 2/	833	34,344	41	6.7
TOTAL	23,250	23,567.623		

1/ Reflects statistics data for only the District of Columbia and Prince George County, Maryland. Small portion of Montgomery within MAAC Service area not included.

2/ Within the State of Pennsylvania (Susquehanna County).

These areas also represent the most significant power load centers or groups of communities and heavy power consuming industrial complexes. The region contains a well-diversified industrial and commercial development structure all of which can serve as a foundation for future economic development. It overlaps and or is near several large national markets, has a good transportation network and has created a good supply of highly skilled technical and professional workers.

The present economic activities in the region range from manufacturing and trade to agriculture and mining. In 1970, manufacturing and trade, two of the major activities accounted for about 31 and 16 percent of the total earnings in the region, respectively. Activities related to government and service industries also accounted for a significant portion of the region's earnings. Table 2-2 lists significant demographic and economic data including earnings for the region for 1978. These data are for economic areas corresponding reasonably closely but not identically with the boundaries of MAAC as discussed in Volume III of the National Hydroelectric Power Resources Study Report. Total earnings originating in the region grew at about 3.6 percent annually, although the region's share of national earnings decreased from 11.6 percent in 1950 to 10.6 percent in 1970.

Table 2-2

INDUSTRIAL SECTOR EARNINGS, POPULATION AND PER CAPITA INCOME-1970 1/

Industrial Sector	Earnings (million $) 2/
Agriculture	699
Mining	161
Construction	3,555
Manufacturing	18,235
Transportation Utilities	4,523
Trade	9,838
Finance	3,668
Services	9,702
Government	9,276
Total Earnings (million $) 2/	59,657
Total Population (thousands)	19,737
Per Capita Income ($)	3,850
Per Capita Income Relative to U.S.	1.107

Source: U.S. Water Resources Council, "1972 OBERS Projections, "Vols. 1 and2 (April 1974).

Due to rounding, the sum of parts may not equal totals.

1/ MAAC Region is approximated by BEA Areas 10, 11, 13, a portion of 14, 15, 16 and 17. Portions of BEA Area 18 encompassing parts of MAAC Region in the District of Columbia and southern counties of Maryland are not reflected in above statistics.

2/ Constant 1967 dollars.

As a measure of the economic output of the region, the total earnings for MAAC was over 59 billion dollars in 1970 or about 10.6 percent of the national total. Manufacturing and construction contributed 11.6 to 10.3 percent to total earnings of the respective national markets in 1970.

2.4 MAJOR ENERGY USERS

Energy consumption in the region varies according to the population, array of load centers, geographical area and types of users. Important among these are the growth of population and number of households, expansion of industrial production and of activities associated with service, trade and professional establishments. Table 2-3 lists electric energy delivered and number of customers for 1979, as reported by representative utility systems in the MAAC Region. As shown in the table, total electric energy usage was approximately 157.4 billion kilowatt-hours for about 7.5 million ultimate customers during the twelve month period ending December 1979. This represented about 8.3 percent of the national usage of 1,899 billion kilowatt-hours.

Table 2-3
ENERGY DELIVERED AND ULTIMATE CUSTOMERS SERVICED BY REPRESENTATIVE UTILITIES, MAAC-1979

Representative Utilities	Kilowatt-Hours (Thousands)	Electric Customers
Atlantic City Electric Company	5,308,219	352,214
Baltimore Gas and Electric Company	16,823,240	817,436
Delmarva Power & Light Company	7,491,800	269,689
General Public Utilities Corporation	31,995,000 1/	1,548,834
Jersey Central Power & Light Company	(12,770,989)	687,998
Metropolitan Edison Company	(8,084,032)	354,857
Pennsylvania Electric Company	(11,140,457)	505,979
Pennsylvania Power & Light Company	22,281,317	972,369
Philadelphia Electric Company	27,559,655	1,266,084
Potomac Electric Power Company	15,676,939	484,872
Public Service Electric and Gas Company	29,587,310	1,868,483
UGI Corporation	632,782	54,061
Total	157,356,739	7,452,042

Source: 1979 annual reports of above listed utilities (FPC Form No. 1)

1/ Represents total for Jersey Central, Metropolitan Edison and Pennsylvania, subsidaries of GPU.

The distribution of energy consumption in 1979 by class of service for utility systems in the region is shown in Table 2-4. Residential, commercial and industrial are the three major categories of use in the region. Table 2-5 shows the total annual growth rates of consumption for these three

Table 2-4
ENERGY CONSUMPTION BY CONSUMER CATEGORIES
(PERCENT OF TOTAL SALES FOR 1979)

UTILITIES	CONSUMER CATEGORIES Residential	Commercial	Industrial	Resale	Others	Total 1/
Atlantic City Electric Company	45.43	29.8	23.6	-	1.2	100.0
Baltimore Gas and Electric Company	32.7	17.4	47.8	-	2.1	100.0
Delmarva Power & Light Company	26.3	21.3	35.0	16.6	0.8	100.0
General Public Utilities Corp.						
Jersey Central Power&Light Co. 1/	40.2	27.3	29.5	2.3	0.7	100.0
Metropolitan Edison Company 1/	30.8	19.0	41.3	6.0	2.9	100.0
Pennsylvania Electric Company 1/	28.1	21.00	43.7	6.8	2.9	100.0
Pennsylvania Power & Light Company	36.0	24.4	36.0	2.6	1.0	100.0
Philadelphia Electric Company	28.1	10.3	55.3	2.0	4.2	100.0
Potomac Electric Power Company	23.5	41.7	25.8	6.5	2.5	100.0
Public Service Electric & Gas Company	26.3	34.1	37.4	0.4	1.0	100.0
UGI Corporation	58.9	28.2	12.1	-	0.8	100.0

Source: 1979 Annual reports of above listed utilities.

1/ Subsidaries of General Public Utilities Corporation (GPU).

categories by representative utilities for period 1971 to 1977. Annual growth rates for each of the major categories are shown in Table 2-6 for the same period.

Table 2-5
ANNUAL GROWTH RATES OF TOTAL ENERGY CONSUMPTION, 1971-1977
(PERCENTAGE)

Representative Utilities	1971	1972	1973	1974	1975	1976	1977
Atlantic City Electric Company	6.4	8.5	9.6	1.2	0.1	6.6	6.8
Baltimore Gas & Electric Company	-	-	-	(2.4)	(0.9)	6.5	4.8
Delmarva Power & Light Company	3.9	7.8	7.8	(2.6)	(3.5)	5.5	4.3
General Public Utilities Corp.	-	-	-	(1.6)	(1.5)	6.2	3.9
Pennsylvania Power & Light Company	-	-	-	2.7	2.6	6.6	4.2
Philadelphia Electric Company	-	-	7.4	(3.1)	(0.9)	3.7	3.4
Potomac Electric Power Company	-	-	-	(8.3)	4.3	2.9	4.3
Public Service Electric & Gas Company	-	-	6.1	(4.4)	(2.6)	3.6	1.6

Source: The 1977 annual reports for each respective utility.

Residential energy consumption constitutes the second largest category of use. This class of service includes by far the largest number of customers. Approximately 31 percent of the total 1979 electric usage or about 48 billion kilowatt-hours was consumed by about 6,625,000 ultimate customers who represented about 89 percent of the customers for the region. Residential consumption is largely concentrated in the urban centers of the region. It is a function of population, the amount of disposable income, and use per customer; this determines to a large degree the saturation of high energy use appliances, such as refrigerators, water heaters, ranges. air conditioners and electric heaters.

Commercial energy consumption is the third largest category of use in the region. It accounted for approximately 25 percent or about 39 billion kilowatt-hours of the 157 billion kilowatt-hours total energy consumption in the region for 1979. This use generally encompasses about 766,000 utility customers serving directly the functional and recreational needs of people in their day-to-day lives. It provides for the demands of widely differing types of use including wholesale and retail trade, communications. utilities, except electric finance, real estate, insurance, professional and personal services and construction. Generally, commercial consumers utilize electric energy for lighting, air conditioning and the operation of a great variety of appliances and equipment. Commercial energy consumption generally varies throughout the region with high concentration being dominant in highly populated areas. As reflected in Table 2-4, commercial use as a percent of the total electric use for the major utilities in the MAAC System in 1979 ranged from a high of approximately 42 percent in the area serviced by the Potomac Electric Power Company to a low of approximately 10 percent in area serviced by the Philadelphia Electric Company.

Industrial consumption, is the largest category in the region. It

Table 2-6
ANNUAL GROWTH RATES OF ENERGY CONSUMPTION BY CONSUMER CATEGORIES

REPRESENTATIVE UTILITIES	CATEGORIES																				
	RESIDENTIAL							COMMERCIAL							INDUSTRIAL						
	1971	1972	1973	1974	1975	1976	1977	1971	1972	1973	1974	1975	1976	1977	1971	1972	1973	1974	1975	1976	1977
Atlantic City Electric Company	6.8	7.2	9.0	(0.9)	3.0	6.8	7.3	8.4	11.7	14.2	(3.9)	3.6	3.4	6.2	3.8	7.2	5.4	1.6	(8.8)	10.3	6.7
Baltimore Gas and Electric Company	-	-	-	(3.2)	4.4	4.8	7.0	-	-	-	(2.9)	4.2	3.3	3.7	-	-	-	(1.8)	(6.3)	9.1	3.6
Delmarva Power & Light Company	7.8	6.0	11.3	(2.0)	4.6	6.9	7.7	9.0	11.6	10.8	(4.2)	4.3	3.9	5.9	(0.5)	7.1	4.2	(2.1)	(13.0)	5.5	0.8
General Public Utilities Corporation	-	-	-	0.5	3.2	5.5	3.3	-	-	-	(1.2)	6.6	6.9	5.4	-	-	-	(3.4)	(9.7)	6.4	3.6
Pennsylvania Power & Light Company	-	-	-	2.7	5.0	6.6	3.7	-	-	-	0.3	7.0	6.5	6.9	-	-	-	4.2	(2.1)	6.6	2.9
Philadelphia Electric Company	-	-	9.3	(4.5)	3.7	2.2	6.9	-	-	6.4	(3.9)	2.6	5.0	2.5	-	-	6.7	(2.2)	(3.8)	4.3	1.7
Potomac Electric Power Company	-	-	-	(6.4)	2.9	2.5	3.8	-	-	-	(7.3)	5.9	3.5	(7.2)	-	-	-	(12.5)	2.6	2.2	31.8
Public Service Electric and Gas Company	-	-	8.2	(6.2)	1.2	1.4	0.8	-	-	7.6	(2.5)	3.5	5.8	2.5	-	-	4.0	(5.0)	(9.8)	3.3	1.5

Source: The 1977 annual reports for each respective utility.

accounted for about 39 percent or about 61.8 billion kilowatt-hours of the total energy consumption for about 33,361 customers in 1979. It generally refers to the large bulk power consumers. Concentrated by geographical area and industrial sectors, it covers a wide range of industry types such as primary metals processing, chemical production, manufacturing and mining. Industrial consumption is largely concentrated throughout the region. Several SMSA's: Philadelphia, Pennsylvania-New Jersey; Newark, New Jersey; Allentown-Bethlehem-Easton, Pennsylvania-New Jersey; Baltimore, Maryland; New Brunswick-Perth Amboy-Sayerville, New Jersey; Wilmington, Delaware-New-Jersey-Maryland; and York and Erie, Pennsylvania are large established industrial centers. A summary of electric energy use for selected industrial sectors (SIC) and selected States in the region is given in Table 2-7.

Table 2-7

MAJOR ELECTRIC ENERGY USE BY SIC GROUP AND SELECTED STATES IN THE MAAC REGION, 1977

SIC	Industry	Distribution of Total Energy Purchased 1/ (Percent)	
		Pennsylvania	New Jersey
33	Primary metals, Blast Furnances, Basic Steel	38	7
28	Industrial Inorganic Chemicals	8	25
32	Stone, Glass and Clay	8	9
26	Paper Mills & Allied Products	6	7
20	Food and Kindred Products	6	8
State Total 2/		71	63
Percent of Total US Industrial Consumption		5.5	2.5

Source: Annual survey of manufacture 1976.

1/Figures are the percentage of the state's total purchased electrical energy consumed by each SIC industry group.

2/Electrical energy purchased, excludes self generated which represented approximately 8.5 percent of total U.S. industrial electrical energy consumed in 1977.

Primary metals and chemical users primarily concentrated in the States of Pennsylvania and New Jersey are the two largest industrial users. They consumed 38 and 25 percent of the total electric energy purchased by respective States in 1976. Other users and percent of States' totals purchased are stone, glass and clay, 9 and 8 percent; paper mills and allied products, 7 and 6 percent and food and household products, 8 and 6 percent for New Jersey and Pennsylvania, respectively. Industrial consumption represented about 71 and 63 percent of the total consumption for the States of Pennsylvania and New Jersey, respectively in 1977.

All other users consisting of about 13,500 ultimate customers consumed about 7.9 billion kilowatt-hours in 1979. This represented less than two percent of the total electric usage in the region. The users in this category includes sales to governmental entities, public schools, hospitals, libraries, municipal water supply stystems, street and highway lighting, railways and railroads and various miscellaneous customers not included in other classification. This group constitutes the smallest category of users in the region.

2.5 FUTURE DEVELOPMENT

The MAAC Region represents a substantial portion of the country's total utility load and has shared, and is continuing to share in the growth of this vital and dynamic industry. The five States of the multistate region as a whole are expected to continue to grow at a constant rate comparable to that of accompanying population concentrations, retail and wholesale market centers. Table 2-8 shows a summary of projected demographic and economic data for the region for 1980 through 2000 based on 1972 OBERS projections. Energy requirements are expected to grow at a similar rate. The 1978 energy requirement of 169,800 GWH is expected to increase to about 342,700 GWH in 2000. This projection is explained in more detail in Chapter 4.

Table 2-8
PROJECTED POPULATION, INCOME AND MAJOR SECTOR EARNINGS

Section Earnings ($ Million)	1980	1985	1990	2000
Agriculture	714	738	764	852
Mining	166	173	179	203
Construction	5,286	6,146	7,147	9,702
Manufacturing	24,270	27,463	31,084	40,502
Transportation Utilities	6,417	7,451	8,651	11,836
Trade	13,870	15,867	18,153	24,324
Finance	5,870	7,031	8,423	12,140
Services	16,962	21,066	26,163	39,820
Government	13,845	16,739	20,238	29,322
Total Earnings (Million $)	87,402	102,754	120,806	168,713
Total Personnel Income (Million $)	112,330	132,431	156,137	218,745
Total Population (Thousands)	21,419	22,336	23,294	24,865
Per Capita Income ($)	5,245	5,929	6,702	8,797
Per Capita Income Relative to U.S.	1.10	1.09	1.09	1.09

The service area is approximated by BEA Areas 10, 11, 13, 15, 16, 17 and a portion of BEA Area 14. Sum of sector earnings may not equal the total because of discrepancies in OBERS data.

2.5.1. Population

Population, which was approximately 19.7 million people in 1970, is expected to reach about 23.3 million by 1990 and 24.9 million in 2000 as shown in Table 2-8. This represents an annual growth rate of about 0.8 percent. As in the past, population in the MAAC Region is expected to represent less than 10 percent of the total U.S. population.

2.5.2 Commercial and Industrial

Total earnings for the MAAC Region are expected to grow at an average annual growth rate of 3.3 percent between 1980 and 2000, slightly lower than the national average. Agriculture and mining which are relatively small components of the economic activity in the region are likely to grow by only moderate amounts. Manufacturing, which produced about 31 percent of the total earnings in 1970 is expected to remain the largest earning component. However, its proportion is expected to decline as business, services and trade for an urban population become more dominant. As shown in Table 2-8, service earnings are expected to be almost as large as those in the manufacturing sector by the year 2000.

Manufacturing is varied, including food, textiles, lumber, chemicals, petroleum, metals, machinery, and other products; it places a large demand on water and impacts on its quantity and quality. Non-manufacturing activities include contract construction, finance, insurance, real estate, transportation, communication, utilities, wholesale and retail trade, and government. In this group, electrical power generation places major demands on water; its consumptive uses will increase as recycling of cooling water is employed to reduce heat pollution of water bodies.

Although per capita income in the MAAC Region has historically been above the national average and is expected to remain so, the disparity is decreasing. From 15 percent above the national average in 1950, per capita income in the region is expected to be about 10 percent above the national average in 1980, and 8 percent in 2000. Per capita income for the region is projected to increase to $5,200 in 1980 and $8,800 in 2000.

2.6 OPERATING PROCEDURES

The principal companies composing the Mid-Atlantic Area Council are coordinated in the Pennsylvania-New Jersey-Maryland Interconnection (PJM). The capacity of PJM, installed in approximately 114 generating stations is operated under the one-system concept to load these generators most economically to meet the total power requirements. Operation of the MAAC System is coordinated from the PJM Control Center located in Valley Forge, Pennsylvania.

The major responsibility of the center is to conduct the operation of the PJM to achieve maximum reliability of systems at the least possible costs. As a result of the economic dispatch of generation, energy is not scheduled in predetermined amounts or origins, but essentially flows freely over all PJM transmission facilities.

In order to insure the overall system reliability, an operating reserve is maintained. The reserve objectives, including a Primary Reserve Objective and a Spinning Reserve Objective, have been established by the PJM operating committee and are in effect at all times. Reserve margin as projected by the utilities in the future expansion plans developed in 1979 is decreasing rapidly from the high 1978 level of 45 percent to about 30 percent in 1985, and 25 percent in 1995. Operating reserve is generating capability and equivalent generation in excess of the forecast system peak load to provide for adequate tie-line regulation in the event of load variation or equipment failure.

The PJM transmission facilities include approximately 4,400 circuit miles of 230 KV transmission lines, approximately 160 miles of 345 KV lines and more than 1,250 miles of 500 KV lines. A total of 55 intercompany ties and 27 interpool ties form the interconnection within PJM and between PJM and its neighboring systems. PJM is interconnected with the New York Power Pool (NYPP), the Cleveland Electric Illuminating Company, Alleghany Power System, and Virginia Electric and Power Company.

The MAAC Region has strongly supported the principles of pooling, shared ownership and coordination and region operation in order to achieve the objectives of maximum bulk power reliability, adequacy and operating economy. Regional coordination in planning and operating is essential in achieving these objectives which result in optimal use of natural resources. PJM (MAAC Region) participates with VACAR (a subregion of SERC) and ECAR, and also ECAR and NPCC in conducting interregional operation and reliability studies.

Chapter 3
EXISTING ENERGY SYSTEMS

3.1 EXISTING ENERGY SYSTEM

The existing energy system in the MAAC Region is a composite network of approximately 93 individual utilities varying in size, type of ownership and range of functions. These utilities are engaged in one or more of the three distinct functions of generation, transmission and distribution, as required in the production and delivery of electricity to about 7,500,000 ultimate customers. This group of utilities is composed of three types of ownership; investor-owned, public non-Federal and cooperatives. The number of systems in each ownership classification at the end of 1979 is summarized by State in Table 3-1. The composition of the energy system by State and ownership including installed capacity, peak demand and customers served is listed in Exhibit A-1 of Appendix A.

Table 3-1
OWNERSHIP OF UTILITY SYSTEMS IN THE MAAC REGION-1979

State	Investor-owned	Public Non-Federal	Cooperatives	Total
Delaware	1	9	1	11
District of Columbia	1	0	0	1
Maryland	3	4	2	9
New Jersey	4	9	1	14
Pennsylvania	15	26	14	55
Virginia	1	0	1	2
Total	25	48	19	92

Source: Compiled from Electrical World Directory of Electric Utilities, 88th Edition, McGraw-Hill Publications Company. 1979-1980.

The investor-owned utilities are the principal suppliers of energy in the region. They generally operate integrated generation, transmission and distribution systems, and some (so-called "combination companies") are also engaged in the distribution of gas within their service areas. The majority are independently owned and operated, although three are subsidiaries of companies registered as holding companies under the Public Utility Holding Company Act of 1935, and an additional 9 are subsidiaries of companies which for various reasons are exempt from provisions of that Act. This group comprised of eleven prinicpal or operating companies operates as an intergral part of the Pennsylvania-New Jersey-Maryland Interconnection (PJM), the formal power pool which coordinates the bulk power supply of the companies in the pool.

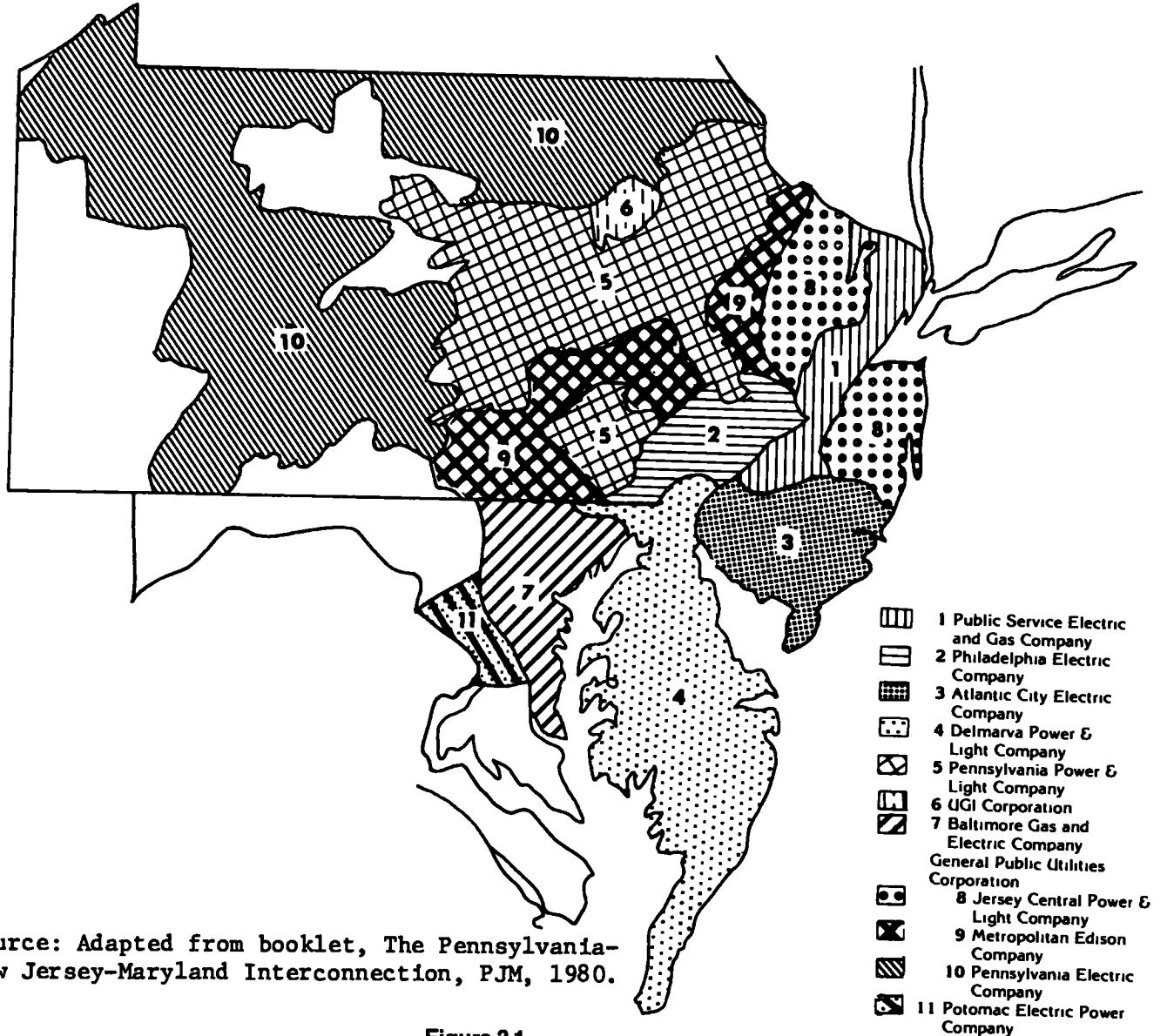
The eleven member systems are signatories to a service-reliability compact with the National Electric Reliability Council (NERC) entered into in 1967 which formed the Mid-Atlantic Area Council (MAAC). The municipals, electric cooperatives and small investor-owned electric systems in the region participate in activities of MAAC through associates. There are currently five associates in MAAC; each is a representative for the interests of groups of those systems in their respective States. The principal companies and associates comprising MAAC are listed in Table 3-2. Although the principal companies, along with associates constitute only about 16 percent of the total number of utilities, they generally account for the total generating capability in the region. The prescribed service areas of principal companies within the Mid-Atlantic Area Council are generally as shown in Figure 3-1.

Table 3-2
UTILITY SYSTEMS COMPRISING MAAC

Members of MAAC (PJM):	Atlantic City Electric Company
	Baltimore Gas & Electric Company
	Delmarva Power & Light Company
	Jersey Central Power & Light Company 1/
	Metropolitan Edison Company 1/
	Pennsylvania Electric Company 1/
	Pennsylvania Power & Light Company
	Philadelphia Electric Company
	Potomac Electric Power Company
	Public Service Electric and Gas Company
	UGI Corporation
Associate Members:	Allegheny Electric Cooperative (representing the the Pennsylvania and New Jersey Cooperatives)
	The Easton Utilities Commission (representing the Maryland Municipals)
	The City of Vineland Electric Utility (representing the New Jersey Municipals)
	The City of Dover (representing the Delaware Municipals)
	Southern Maryland Electric Cooperative Inc. (representing the Maryland Cooperatives)

Source: "MAAC system plans report" MAAC response to FERC (FPC) order 382-4, Docket R-362, April 1, 1980.
1/ Subsidiaries of the General Public Utilities Corporation.

The public non-Federal ownership segments of the system, comprising 48 individual utilities mostly are relatively smaller systems. This group consists largely of municipal systems, and a small number of county and special utility districts. It is generally engaged in the distribution and resale of electricity purchased from the investor-owned companies or bulk suppliers in the PJM power network. Presently, Dover, Delaware; Vineland, New Jersey; and Easton, Maryland, associates of MAAC, are the only three



Source: Adapted from booklet, The Pennsylvania-New Jersey-Maryland Interconnection, PJM, 1980.

Figure 3-1
SERVICE AREAS OF MEMBER UTILITY SYSTEMS IN MAAC REGION
(PENNSYLVANIA-NEW JERSEY-MARYLAND INTERCONNECTION)

municipals generating any of their requirements. They generate most of their energy needs, which constituted less than 0.5 percent of the total load in the region in 1979. The remainder of the municipal load is met with purchases from private utilities in the PJM power network. Although the municipals serve substantially fewer customers, their combined load nearly equals that of the cooperatives due to the much higher commercial and industrial load carried by the municipals.

There are 19 cooperatives in the MAAC Area. They comprise about 20 percent of the number of utilities in MAAC consisting of relatively small systems that supply power to many of the rural areas of the multi-state region. All the cooperatives except those in the State of Maryland, are members of the Allegheny Electric Cooperative, an associate member of MAAC. Allegheny, headquartered in Harrisburg, Pennsylvania, is responsible for the bulk power requirements of its member distribution cooperative systems in the Commonwealth of Pennsylvania and the State of New Jersey. Southern Maryland Electric Cooperative, which became a new associate member of MAAC in 1979, represents the interests of the cooperative systems in the State of Maryland. The geographical location of public-owned and cooperative systems are listed and shown in Exhibit A-2 and on Figure A-1 of Appendix A, respectively.

3.1.1 Generating Capability

The member utilities of MAAC have a total installed capability of about 45,000 megawatts (MW) in more than 540 generating units at approximately 114 generating stations in the region. This capability which represented about eight percent of the national total, serves a population of about twenty-one million. Table 3-3 shows the installed capability of MAAC by type of plants and percent of total capability.

Table 3-3
GENERATING CAPABILITY BY TYPE OF PLANTS, PENNSYLVANIA-NEW JERSEY-MARYLAND INTERCONNECTION DECEMBER 1979

Type of Plant	Summer Capability (Megawatts)	Percent
Steam, coal	13,724	30.5
Steam, oil	12,122	26.9
Steam, coal/oil	1,753	3.9
Steam, nuclear	7,076	15.7
Combustion turbines and diesels	7,496	16.7
Combined Cycle	452	1.0
Conventional hydroelectric	956	2.1
Pumped storage	1,280	2.8
Transfers	180	0.4
Total	45,039	100.0

Source: 1979 Annual Report, National Electric Reliability Council (NERC) April 1980.

The MAAC Region relies heavily upon coal, oil and nuclear power as primary sources of fuel for the generation of electric energy. The region is dependent on coal and oil to drive steam turbines for more than half of its generation. Its current generating mix is comprised of about 48 percent coal, 20 percent oil and about 18 percent nuclear. Gas and hydropower comprise the remaining portion of the mix. In 1979, more than 163 billion kilowatt-hours of net energy was generated by an aggregation of 175 fossil fuel steam generating units, 8 nuclear, 224 combustion turbines, 65 diesel and 69 hydroelectric units; owned by the eleven signatory members of MAAC. Purchases from utilities outside of the MAAC Region provided an additional 11.1 billion kilowatt-hours.

The mix of coal, oil, and nuclear in the PJM Network has been beneficial during operation in periods of oil shortages or coal shortages. Table 3-4 shows a summary of net energy generated by fuel type in 1979. Twenty-two additional generating units, with a total capacity of about 13,800 megawatts are scheduled to be installed in the 1980's. Table 3-5 lists additional nuclear and fossil fuel units scheduled for the MAAC Region by membered utilities of the Pennsylvania-New Jersey-Maryland Interconnection Network. Principal generating and transmission facilities in the MAAC Region are shown on Figure 3-2.

Table 3-4
GENERATION OF ELECTRIC ENERGY BY FUEL TYPE
PENNSYLVANIA-NEW JERSEY-MARYLAND INTERCONNECTION
DECEMBER 1979

Fuel Type	Generation (million megawatt-hours)	Percent of Total
Steam, coal	83.0	47.6
Steam, oil	34.7	19.9
Steam, nuclear	31.8	18.2
Combustion turbines & diesels	7.5	4.3
Conventional hydroelectric	4.3	2.5
Pumped storage hydroelectric	1.9 1/	1.1
Subtotal	163.2	93.6
Net purchases from others	11.1	6.4
Total	174.3	100.0

1/ 2.8 million megawatt-hours was required for pumping.

Nuclear

There are eight existing nuclear generating units at five nuclear power plants in the region at this time, with a total capability of 7,076 megawatts, which is about 16 percent of MAAC's generating capability. These units are operated as base load units for continuous operation and generate about 18 percent of the total energy output for the region. As shown in Table 3-4, nearly 32.0 billion kilowatt-hours of net energy or about 18 percent of the total for the region were generated by nuclear power in 1979.

Table 3-5
CAPABILITY OF ADDITIONAL NUCLEAR AND FOSSIL FUEL GENERATING UNITS SCHEDULED FOR COMPLETION BY UTILITY SYSTEMS IN MAAC, AS OF DECEMBER 1979

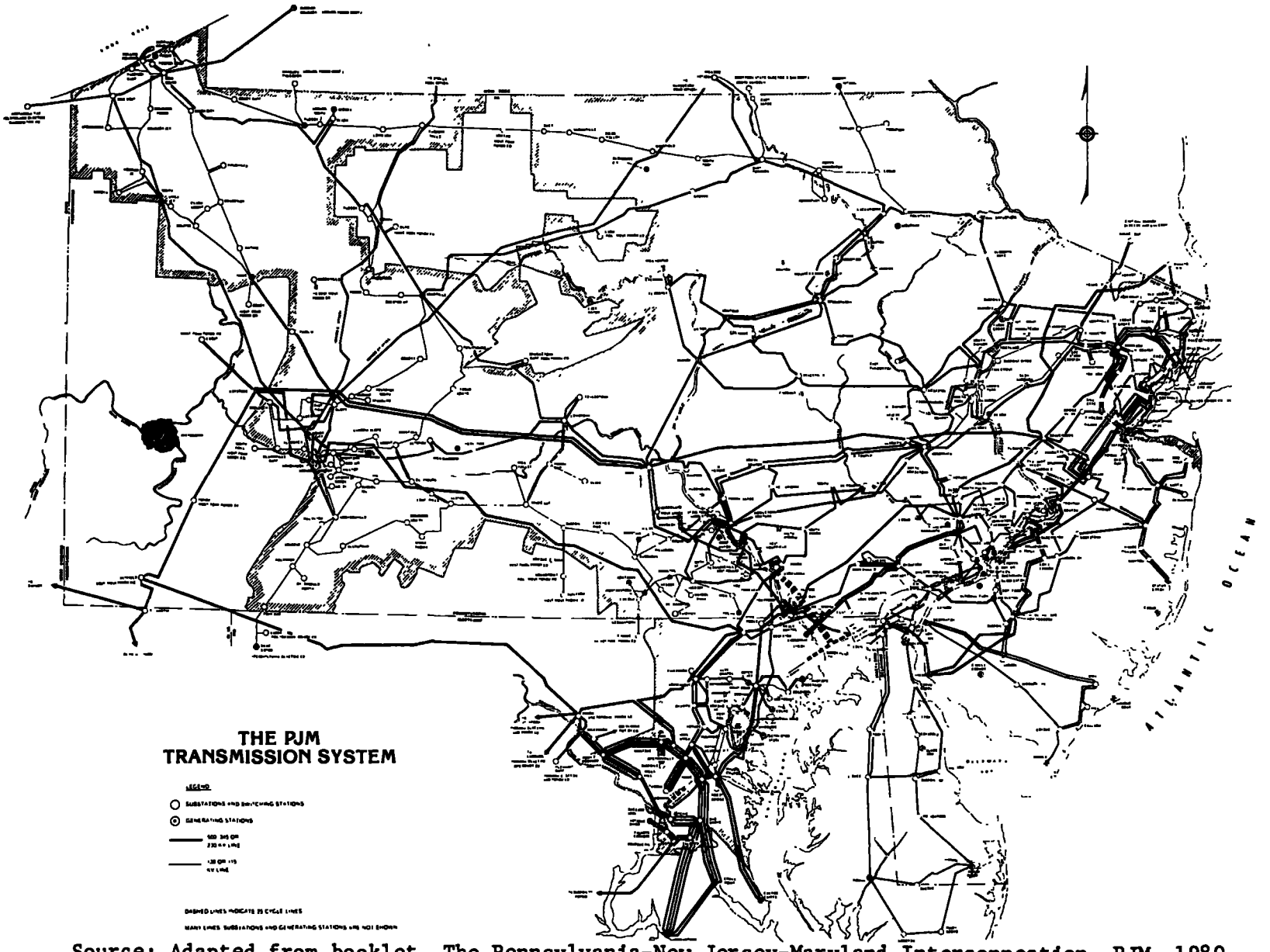
State	Units	Ownerships	Summer Capability, MW: Steam Generation: Nuclear	Steam Generation: Coal	Steam Generation: Oil	Internal Combustion & Gas Turbine: Gas	Internal Combustion & Gas Turbine: Oil	Scheduled Service Date
					1980 - 1985			
Delaware	Indian River #4	Delmarva Power & Light Co.		400				9/80
Maryland	Brandon Shores #1	Baltimore Gas & Electric Co.		620				5/84
	Chalk Point	Potomac Electric Power Co.			600			
New Jersey	Hope Creek #1	Public Service Electric & Gas Co.[1]	1,066					5/85
	Salem #2	Public Service Electric & Gas Co.[2]	1,115					10/85
Pennsylvania	Susquehanna #1	Pennsylvania Power & Light Co.[3]	1,050					1/82
	Susquehanna #2	Pennsylvania Power & Light Co.	1,050					1/83
	Limerick #1	Philadelphia Electric Co.	1,055					5/85
Subtotal, 1980-1985			5,336	1,020	600			
					1986 - 1989			
Maryland	Brandon Shores #2	Baltimore Gas & Electric Co.		620				1/88
	Unsited	Delmarva Power & Light Co.		400				5/89
	Vienna #9	Delmarva Power & Light Co.		500				5/87
	Easton #23-24	Delmarva Power & Light Co.					12.5	5/86
	Dickerson #4	Potomac Power Co.		400				5/87
New Jersey	Unsited	Atlantic City Electric Co.		250				5/88
	Forked River #1	Jersey City Power & Light Co.	1,120					5/86
	Hope Creek #2	Public Service Electric and Gas Co.[1]	1,066					5/87
Pennsylvania	Coho #1	Pennsylvania Electric Co.		625				5/89
	Seward #7	Pennsylvania Electric Co.		625				5/87
	Limerick #2	Philadelphia Electric Co.	1,055					5/87
Subtotal, 1986-1989			3,241	3,420	0		12.5	
Total			8,577	4,440	600		12.5	

Source: MAAC Regional Reliability Council Coordinated Bulk Power Supply Program, as submitted to the Department of Energy, April 1, 1980.

[1] Hope Creek is jointly owned by Public Service Electric and Gas Company and Atlantic City Electric Company.

[2] Salem is jointly owned by Public Service Electric and Gas Company, Philadelphia Electric Company, Atlantic City Electric Company and Delmarva Power and Light Company

[3] Susquehanna Units are jointly owned by Pennsylvania Power and Light Company and Allegheny Electric Cooperative, Inc.



Source: Adapted from booklet, The Pennsylvania-New Jersey-Maryland Interconnection, PJM, 1980.

Figure 3-2
PRINCIPAL GENERATING AND TRANSMISSION FACILITIES

Nuclear power plants in the region are owned and operated by eight of the eleven signatory members of MAAC; Peach Bottom, Pennsylvania, the largest in the system, and Salem, New Jersey are jointly owned by Public Service Electric and Gas Company, Philadelphia Electric Company, Atlantic City Electric Company and Delmarva Power and Light Company; Oyster Creek, New Jersey, the smallest and oldest plant in the system, and Three Mile Island, Pennsylvania, the most publicized plants are owned by the GPU group comprising Jersey Central Power and Light Company, Metropolitan Edison Company and Pennsylvania Electric Company. Calvert Cliffs, Maryland is solely owned by Baltimore Gas and Electric Company. Nuclear plant's generating units are generally very large, ranging from 650 megawatts at Oyster Creek to sizes of about 1,100 megawatts at Peach Bottom and Salem.

The use of nuclear power for the generation of electric energy has become practical, in recent years, as a viable alternative to fossil fuel plants for supplying base loads in the region. It is relatively cheap base load power, even though capital and operating costs have been rising. However, there are environmental impacts both positive and negative associated with nuclear power plants. Nuclear generation neither rely on the depletion of natural resources such as deposits of fossil fuels, nor do they release sulfur compounds and carbon dioxides into the atmosphere. They do however, release more waste heat per kilowatt produced than plants using fossil fuels. Also, technical problems on the safe disposal of nuclear waste and decommissioning of plants, which have not been satisfacorily solved, pose additional environmental concerns. Public concern and citizen opposition have been stimulated by short and long-term radiation hazards as well as the threat of a catastrophe. This has been most recently highlighted in the region by the accident at the Three Mile Island Nuclear Power Plant, located just below Harrisburg, Pennsylvania.

Nuclear generation of energy is expected to provide for an increasingly larger share of the region's future electric power supply. Eight generating units as shown in Table 3-5 with a total generating capability of about 8,600 megawatts are currently in various stages of construction by investor-owned utilities at four power plants in the State of New Jersey and the Commonwealth of Pennsylvania. As projected, these units will generate approximately 95 billion kilowatt-hours of energy or about 40 percent of the net energy requirement for the region through 1989. As planned by the utilities, nuclear generation is expected to increase rapidly. However, it is likely that nuclear additions will continue, but at a slower rate as plants under construction are completed and continued caution relating to planning and construction of new nuclear plants is exercised. The recent accident at Three Mile Island will no doubt have a significant impact on the future of nuclear energy in the MAAC Region. In addition, the initial investment costs are high.

Coal

Coal is used as a primary source of fuel to fire generating units for about 33 percent of the region's total generating capability. Generating units, primarily steam turbines are installed at a large number of coal-fired

power plants in the region to supply either base or intermediate loads, although some intermediate cycling plants are capable of operation near the top of the load curve. These units with a total capability of about 16,000 megawatts burned approximately 34.3 million tons of coal to generate a little over 83 billion kilowatt-hours of energy, or about 48 percent of the net energy requirement for the region in 1979.

Coal-fired power plants in the region are primarily owned by utility systems in the PJM Network. The sizes of generating units vary widely, ranging from several units rated under 100 megawatts to several units of 840 megawatts or more. Five units comprising almost 34 percent of the total generating capability of coal-fired units are installed in three power plants near Johnstown, Pennsylvania: Homer City, Conemaugh and Keystone. Homer City is the largest plant in the region, with a total installed capability of 1,850 megawatts. It is jointly owned by Pennsylvania Electric Company, a subsidiary of GPU and New York State Electric and Gas Company, a member of the neighboring Northeast Power Coordinating Council. However, the largest generating units of 850 megawatts each are installed at Conemaugh and Keystone in western Pennsylvania. Conemaugh is jointly owned by all of the member utilities in the PJM network except Jersey Central Power and Light and the Pennsylvania Electric Company, both subsidiaries of GPU. Ownership of keystone is shared by all of the utility network except Potomac Electric Power Company of UGI and two subsidiaries of GPU: Metropolitan Edison and Pennsylvania Electric Company.

Coal is the region's most abundant energy resource and it is relatively inexpensive. However, there are significant concerns and obstacles that must be overcome in making coal more compatible as a source of fuel for the generation of electric energy. The extraction, transportation, and use of coal, along with wastes generated all highly impact on the environment. Mining or the extraction of coal presents challenges in areas of land disturbance and surface water contamination.

Recent concern regarding "acid rain" and visibility protection in mandatory Federal Class I Areas indicates a growing recognition of the environmental cost of energy. The additional cost of meeting current air quality standards is quite high. Expensive flue gas desulfurization systems are required at each plant to reduce air pollution.

Changes in the growth of electric demand, regulations associated with the Power Plant and Industrial Fuel Use Act, implementation of the Revised New Source Performance Standards, and installations of new nuclear generating capacity all affect the coal consumption of the utility systems. Whereas environmental standards may affect the mix of coals consumed, other uncertainties will result in either increases or decreases in the use of coal as a fuel; the ability of utilities to generate sufficient capital to build additional coal-fired equipment depends on the responsiveness of utility commissions and governmental agencies and their willingness to permit the building of new coal-fired generating capacity to replace expensive, existing oil and natural gas-fired steam equipment.

As shown in Table 3-5, coal-fired units comprising nine generating units are scheduled to provide an additional capability of about 4,400 megawatts at

eight power plants by 1990. The addition of the new units to the existing coal generation units would provide for a net generation of about 103 billion kilowatt-hours or about 44 percent of the net energy requirement projected for 1989 for the MAAC Region.

Coal is a vital source of fuel for energy generation in the MAAC Region and is relatively inexpensive compared to oil. The considerable coal resources of the Appalachian Region are directly accessible to the region. There are large deposits of bitiminous coal in the western part of Pennsylvania, where an estimated reserve of more than 20 billion tons of identified resources occur at depths of 1,000 feet or less. In the eastern part of Pennsylvania, there are deposits of anthracite. The large coal supplies in Pennsylvania and other Appalachian States have made large coal-fired plants very feasible and economical, especially in the central and western parts of Pennsylvania. Coupled with sulfur removal techniques, future development in coal gasification technologies should allow the MAAC Region to continue to rely primarily on coal for electric generation. By the turn of the century, the region could produce more than half of its electric energy needs from coal or its derivatives.

Oil

Electric generating units using oil as a primary source of fuel provide for about 45 percent of the total generating capability in the region. Oil-fired generation is generally provided by three types of plants: steam turbines, combustion turbines and combined cycle plants. They are used to supply base, intermediate and peaking power to meet varying electric loads. In 1979, Oil-fired units with an installed generating capability of about 20,400 megawatts burned over 69 million barrels of oil to generate aproximately 42 billion kilowatt-hours of electric energy, or about 24 percent of the net electric energy load for the region; steam turbines contributed about 20 percent, the remaining portion was contributed by combustion turbines and combine cycle units with combustion turbines comprising less than two percent of the load.

Oil-fired plants are widely owned and operated by most utility systems in the region. Environmental and economic factors have contributed to the installation of a large number of oil-fired units in the eastern portion of the MAAC Region. Units developed along the coastal areas because fuel could be supplied economically by sea-going tankers. A number of older coal-burning plants were converted to heavy oil-burning units some years ago to comply with clean air laws. The size of the units vary widely and they generally have a low initial investment cost. Martins Creek in Northampton County, Pennsylvania is the largest oil-fired steam plant in the region. It is comprised of two oil-fired units with an installed capability of 850 megawatts each; it also has two coal-fired units.

The availability of oil, environmental consideration and the increased need for quickstart peaking units have been instrumental in the considerable increase in the use of oil for the generation of energy during the past decade. However, the recent increases in oil prices, along with its

availability has resulted in a decreased emphasis on oil-fired generation. Oil fuel for the MAAC Region is primarily imported from the Mid-East and is subject to periodic disruptions such as the 1973 Arab oil embargo and the most recent Iranian revolution. Increased oil conservation efforts and slow growth in peak demands in the region have increased the demand for base load coal-fired generation and decreased the demand for oil. Although oil is cleaner than coal, it still pollutes the air and discharges heated water into streams, thereby affecting fish and wildlife.

By the year 1990, one unit with a total capability of 600 megawatts is scheduled to be installed at Chalk Point in Prince Georges County, Maryland. The outlook for residual oil use for electric generation has been somewhat dimmed by recent developments: the emergence of environmental quality as a major public concern and resulting emphasis on low-sulfur fuel; nuclear power with its economic incentive, notwithstanding, certain urban siting problems still to be resolved; and the pressure to reduce foreign oil consumption. Also, associated with foreign oil supply, increasing prices, DOE action including restrictions on new oil-fired capacity, and other factors, the role of oil-fired units is expected to decrease sharply in the future.

Other Types of Generation

Gas is the only other type of fossil fuel used for the generation of electric energy in the MAAC Region. It is used as a source of fuel for some combustion turbines and internal combustion units. The sizes of units in the MAAC area vary widely ranging from two units of 206 megawatts to many rated between 10 and 20 megawatts. Available capacity and energy production are often included as part of the combustion turbine capability. Gas-fired units are generally used only as standby power sources. Combustion turbines play a vital role in the reliability of the utility systems. The cost of operating these units is very high, but they are relatively inexpensive to install. They are used to provide independent start-up power and allow for safe shutdown of major equipment at the larger plants. Also, such plants have the advantage of fast start-up times, so they can be used to provide quick assistance in an emergency. Internal and combustion turbines generating capacity in the past was most commonly associated with the power supply of small utilities generally municipally owned. Such units were of relative minor significance in large systems and their use was somewhat limited until fairly recently. With development in the application of gas turbines to electric power generation, particularly the adoption of aircraft jet engines, unit sizes have been extended. Gas-turbine units because of low investment cost and flexibility in location are adoptable to a variety of peaking uses. This includes capacity in extended areas of a system when also needed for protection and to assure satisfactory voltage at times of maximum peak demand. However, due to high cost of operation they are limited in use.

A realistic assessment of solar and other non-conventional energy sources (biomass, wind, thermal energy storage, etc.) indicates that they will play a minor role in the electric energy future in MAAC during this century. Only an additional 3 percent of capacity is anticipated from these new energy sources.

3.2 THE ROLE OF HYDROPOWER WITHIN EXISTING SYSTEM

There are 71 utility hydropower generating units with a total installed capability of 2,236 megawatts in the existing system. In 1979, hydropower comprised only about 5.0 percent of the total generating capability in the MAAC System.

The major hydropower facilities in the system consist of both conventional and pumped storage, which comprises about 57 percent of the total hydropower capability. These facilities produce an average annual generation of about 6.2 billion kilowatt-hours at an average annual plant factor of 32 percent. The role of hydropower had been expected to decline in the MAAC Region due to the lack of available sites and the expansion of other types of energy generation. However, due to the recent problems in the energy situation, such as the oil embargo, the Three Mile Island nuclear accident and the rapidly increasing cost of fossil fuels, interest in all alternative sources including hydropower has been renewed. Three additional generating units with a total installed capability of 219 MW are scheduled to be installed by utilities in the region by 1990. However, there is a potential that this capacity could be increased as a result of recent interest in the development of smaller hydropower sites by individual owners and entrepreneurs. Table 3-6 lists additional capacity currently scheduled for the region by privately owned utilities. The names, size and owners of existing hydroelectric power facilities are listed by State and type in Table 3-7.

Table 3-6

CAPABILITY OF ADDITIONAL HYDROELECTRIC POWER GENERATION SCHEDULED FOR COMPLETION BY UTILITY SYSTEMS IN MAAC, AS OF DECEMBER 1979

System	Ownership	Total Capability (MW)	Sched. Service Date
Raystown	Allegheny Electric Cooporative and Pennsylvania Electric Co. 1/	30	5/83
Warrior Ridge	Pennsylvania Electric Co. 1/	1	5/81
Safe Harbor	Safe Harbor Water Power Corp. 2/	188	9/85
Total		219	

Source: MAAC Regional Reliability Council Coordinated Bulk Power Supply Program as submitted to the Department of Energy, April 1, 1980.

1/ Pennsylvania Electric Company is a subsidiary of the General Public Utilities Corporation.

2/ Safe Harbor is jointly owned by Pennsylvania Power and Light Company, the parent company of the Safe Harbor Water Power Corporation, and Baltimore Gas and Electric Company which owns 66 2/3 percent of the facility.

Table 3-7
EXISTING HYDROELECTRIC POWER FACILITIES AND CAPABILITY
(UTILITY SYSTEMS IN MAAC. 1979)

State and Plant	Ownership	Stream	Number of Units	Total Capability, MW (Summer) Conventional	Pumped Storage
MARYLAND					
Conowingo	Susquehanna Power Company 1/	Susquehanna River	11	512	
Deep Creek	Pennsylvania Electric Company 2/	Youghiogheny	2	18	
NEW JERSEY					
Yards Creek	Jersey Central Power & Light Co. 3/	Yards Creek	3		330
PENNSYLVANIA					
Yorkhaven	York Haven Power Company 4/	Susquehanna River	20	19	
Piney	Pennsylvania Electric Company	Clarion River	3	27	
Seneca	Pennsylvania Electric Company 5/	Allegheney River	3	6	70
Holtwood	Pennsylvania Power and Light Co.	Susquehanna River	10	102	
Wallenpaupack	Pennsylvania Power and Light Co.	Wallenpaupack Creek	2	44	
Muddy Run	Philadelphia Electric Company	Susquehanna River	8		880
Safe Harbor	Safe Harbor Water Power Corp. 6/	Susquehanna River	9	228	
TOTAL			71	956	1280

SOURCE: MAAC Regional Reliability Council Coordinated Bulk Power Supply Program, as submitted to the Department of Energy, April 1, 1980.

1/Subsidiary of Philadelphia Electric Company

2/Subsidiary of the General Public Utilities Corporation. Although Deep Creek is owned by Utility in MAAC System, it is located in the geographical area of the ECAR Region.

3/Yards Creek is jointly owned by Jersey Central Power and Light Company, a subsidiary of the General Public Utilities Corporation (GPU) and Public Service Electric and Gas Company.

4/York Haven Power Company is a subsidiary of Metropolitan Edison Company, which is a subsidiary of GPU.

5/Seneca is primarily owned by Cleveland Electric Illuminating Company, a member of ECAR. Pennsylvania Electric Company only has a 20 percent interest in the plant. Total capability is 308 MW.

6/Safe Harbor is jointly owned by Pennsylvania Power and Light Company, the parent company of the Safe Harbor Water Power Corporation, and Baltimore Gas and Electric Company.

3.2.1 Conventional Hydropower

As of December 1979, there was an installed generating capability of about 950 MW of conventional hydropower, representing just over 2 percent of the total generating capability in MAAC. The total electric energy generated by conventional hydropower was about 4.3 billion kilowatt-hours in 1979, representing about 2.5 percent of the total generation in the system. Most conventional hydropower may be used either for peaking or base load operation depending on plant design, system requirements, and prevailing conditions of water and economy. The advantage of hydroelectric power for power system operations are well known: high availability, quick starting and flexible operation, absence of pollution and low costs for operation and maintenance.

The major conventional hydroelectric power plants in MAAC predominately operate as run-of-river projects utilizing the limited pondage in their reservoirs to regulate the natural runoff. The three major plants are associated with three reservoirs located in close succession on the main stem of the Susquehanna River below Harrisburg. They are Safe Harbor, Holtwood and Conowingo. Conowingo, unlike Safe Harbor and Holtwood, is divided into two plants, each with distinct performance characteristics. Flow on the Susquehanna River is quite variable. generally ranging from 5,000 to 85,000 cfs. These run-of-river plants, operate as peaking equipment on a weekly drawdown and refill cycle, utilizing the riverflow and the storage capability of the associated reservoirs. Sufficient storage is not available in these reservoirs for long term flow augmentation.

The characteristics of these reservoirs are quite different. Safe Harbor, the uppermost reservoir, serves as the primary regulating reservoir for the Susquehanna River flow received by the three projects. It contains seven main generating units and two station service units with a total capacity of 230,000 KW and can discharge a maximum flow of 67,000 cfs through its power house. The normal maximum elevation of the pond at the dam is 227.2 feet above sea level. The pond, known as Lake Clarke formed by the dam extends about 10 miles upstream and has a surface area of about 7,360 acres.

Holtwood, the middle reservoir is the oldest of the three and contains ten main generating units with a total capacity of 102,000 KW. It can discharge a maximum of 32,000 cfs through its power house. The dam with a crest elevation of 165.0 feet forms a pond, known as Lake Aldred. The pond extends upstream about eight miles and has a surface area of about 2,400 acres. The channel leading from the Holtwood to the Conowingo Reservoir is restricted by natural rock formations such that the tailwater rise on the Holtwood Power Plant is significant at high rates of discharge. This characteristic is strongly influenced by the level of the forebay in the Conowingo Reservoir.

The Conowingo Reservoir serves two power plants. an older plant and a newer plant of differing characteristics. The operating requirements on the newer plant are such that operation is not permitted unless the composite flow from both plants exceed a certain minimum flow. This flow assures a

given tailwater elevation at the second power house. The dam and power house are located in the State of Maryland and most of the reservoir is in the Commonwealth of Pennsylvania. The plant is comprised of eleven generating units with a total installed capacity of 512 megawatts. It can discharge a maximum flow of 86,000 cfs through its power house. The reservoir above the dam stretches upstream approximately 15 miles to the lower end of pool level at the Holtwood Hydroelectric Project, and has an area of 13.5 square miles or about 8,500 acres. At the normal forebay elevation of 108.5 ft. approximately 13.5 billion cubic ft. of water is impounded.

The other existing conventional hydroelectric power sites are smaller and do not have as much regional significance. Wallenpaupack, Deep Creek, and Piney Creek are high dams with small dependable flows but with power storage available to augment the flows. York Haven is a small run-of-river plant located on the Susquehanna River and is associated with the Brunner Island coal fired steam plant. These sites do contribute to the overall PJM power grid. The other small industrial and publicly owned hydropower facilities supply power in the local areas only.

The utilities have reported that there are three conventional plants under planning and FERC licensing procedure, Safe Harbor Expansion (188 MW), Holtwood Expansion (188 MW), and Raystown (30 MW). However, conventional hydropower is expected to account for decreasing portions of the total system capability. Previous projections have reported that in 1988, hydropower energy is expected to account for only 1.5 percent of the "median" demand.

3.2.2 Pumped Storage

As of December 1979, there were three pumped storage plants (Yards Creek, Muddy Run, and Seneca) with a capacity of 1,280 (MW), producing about one percent of the energy demand, based on gross generation. Pumped storage, which may be one of the best and most economical alternative ways of providing necessary peaking power, generates power in the same way as a conventional hydroelectric power plant. It differs from a conventional plant in that it utilizes water previously pumped from a lower reservoir back through penstocks to an upper reservoir, and is dependent on other electrical power sources for the energy required for pumping. Normally, the pumping is done at night and on weekends when there is an excess of thermal-electric capacity in the utility system. Power is generated during weekday peak-load hours when it is most needed and, therefore, has greater value.

Although pumped storage plants consume more electricity than they provide, there may be little, if any, increase in fuel use for energy systems as a result of pumped storage installations; pumping energy is usually generated by the more efficient thermal units in the system and pumped storage generation replaces energy that would otherwise be generated by the least efficient thermal units. Pumping energy can be provided by coal-fired or nuclear-fueled plants, while the pumped storage generation would replace the peak-load output of combustion turbine plants using costly distillate oil.

Pumped storage hydroelectric power projects offer many of the same advantages as conventional hydroelectric power projects: rapid start-up and loading, long life, low operation and maintenance, and low outage rates. They are comparable to storage batteries in that low cost non-peak energy is used to pump water into the upper reservoir and saved to release through the generating cycle to the afterbay supplying power during times of peak load.

The three pumped storage projects in the MAAC Region, Muddy Run, Yards Creek, and Seneca are listed in Table 3-7. Muddy Run is located adjacent to the Susquehanna River and is hydraulically coupled with the previously described run-of-river complex on the lower Susquehanna River. The upper reservoir is located on a hilltop overlooking the Susquehanna River and utilizes the Conowingo Pond during its daily pumping and generating schedule. Yards Creek is located in New Jersey near the Delaware River. The system is basically a hydraulically closed system. The upper reservoir is located on top of Kittatinny Mountain. The lower reservoir and powerhouse is situated a mile east on Yards Creek. The Seneca Pumped Storage Plant is located physically within the MAAC Region, but is primarily owned by the Cleveland Electric Illuminating Company (80%) which is not part of the PJM Interconnection. Only 76 MW are allocated to MAAC and 365 MW are allocated to ECAR. Seneca is comprised of an adjacent pumped storage plant with the forebay located on a hill adjacent to the reservoir. It is somewhat unique in that the re-cycled water from the forebay may be discharged into the reservoir or downstream of the dam depending upon the flow condition in the river.

Although, at this time, there are no pumped storage units under construction, the regional geology and topography provides potential for conventional or underground pumped storage facilities. The market potential for pumped storage peaking plants could be as much as 3 percent of system capacity by the year 2000. This projection assumes that the MAAC generation mix will be largely nuclear and coal-fired steam for base loads.

3.2.3 Ownership of Existing Hydroelectric Facilities

Existing hydropower facilities in the MAAC Region are primarily owned by investor or privately owned companies. As shown in Table 3-7, ownership of the ten hydropower plants in the region is individual or jointly distributed through subsidiaries of six of the eleven members of the Pennsylvania-New Jersey-Maryland Interconnection and a member of the Central Area Power Coordination Group of the adjacent reliability council; ECAR. Conowingo, the largest conventional plant in the system is owned by the Susquehanna Power Company a subsidiary of Philadelphia Electric Company. Three plants: Deep Creek, Piney and Seneca are owned solely by Pennsylvania Electric Company, a subsidiary of General Public Utilities Corporation (GPU). Yards Creek is jointly owned by Public Service Electric and Gas Company, and Jersey Central Power and Light Company, a subsidiary of GPU. The remaining four plants, Holtwood and Wallenpaupack are owned by Pennsylvania Power and Light Company; Muddy Run is owned by Philadelphia Electric Company and Safe Harbor is owned by the Safe Harbor Water Power Corporation which is jointly owned by Pennsylvania Power and Light Company and Baltimore Gas and Electric Company.

There are no Federally-owned hydropower projects in the MAAC Region at this time. However, there is a potential for such development at a number of multiple purpose projects that have been constructed by the Corps of Engineers for other purposes such as flood control, recreation, etc. Although the Seneca Pumped Storage Plant is owned by an investor-owned utility, it is located at a Corps of Engineers' project known as Kinzua Dam in northwestern Pennsylvania. Federal development of hydropower in the region has only been addressed as an indirect result of achieving other goals or objectives. In many cases hydropower has been considered as a secondary benefit or purpose.

3.2.4 Marketing Federal Hydropower

Currently, no formal mechanism exists within the MAAC Region to provide for the sale of electric power produced by Federally- owned hydroelectric plants. The Federal Department of Energy is responsible for marketing Federally produced power through its marketing administrations such as SEPA (the Southeast Power Administration) and BPA (the Bonneville Power Administration). Studies are currently underway to determine the need for such a regional marketing administration for the northeastern United States including MAAC as a result of the likelihood of Federal development of hydropower in the region.

3.2.5 Parameters Governing Use of Existing Hydropower

There are several parameters which affect the use and operation of existing hydroelectric facilities. These are broadly categorized as institutional, social, economic and physical. To a large extent, these parameters depend on ownership and location of facilities.

Institutional

The institutional parameters associated with hydropower are reflected in the process by which private and public hydropower projects are initiated and implemented. In the MAAC Region, all existing hydropower projects are developed and operated under regulations of the Federal Energy Regulatory Commission (FERC). The Commission through the Federal Power Act of 1920, as amended, is vested with the authority to license all non-Federal hydropower projects constructed on navigable waters, public lands of the United States, or on any streams which use water or water power at Federal dams or affect interstate commerce.

The Federal Power Act and the requirements of other statutes have generated a highly complex decision-making process with a large number of participants, in certain circumstances involving overlapping and conflicting authorities. Many laws have been enacted to assure that hydropower projects are evaluated from a multiple purpose standpoint such as flood control, recreation, water quality, fish and wildlife enhancement and overall environmental effect. Table 3-8 lists major laws involved in FERC licensing procedures and Federal water resource programs.

Table 3-8
MAJOR LAWS AFFECTING HYDROPOWER DEVELOPMENT AND FEDERAL WATER RESOURCE PROGRAMS

Federal Legislation	Agency Contacts Required
Public Law 85-624, Fish and Wildlife Coordination Act (72 Stat. 563)	U. S. Fish and Wildlife Service, State Fish and Game Commissions
Public Law 88-29, Outdoor Recreation-Federal-State Programs Act of 28 May 1973 (78 Stat. 49)	National Heritage Conservation and Recreation Service
Public Law 88-577, Wilderness Act (78 Stat. 890)	Federal Land Holder (Department of the Interior, Department of Agriculture) State Land Management Organizations
Public Law 89-665, Historic Properties - Preservation (80 Stat. 915)	Advisory Counsel for Historic Preservation, Department of the Interior, State Historical Preservation Office
Public Law 90-542, Wild and Scenic Rivers Act (82 Stat. 906)	Department of the Interior and Agriculture
Public Law 90-543, National Trails System Act (82 Stat. 919)	Department of the Interior, National Heritage Act Conservation and Recreation Service, Department of Agriculture, U.S. Forest Service
Public Law 91-190, National Environmental Policy Act of 1969 (83 Stat. 852)	U.S. Environmental Protection Agency, Federal Land Holder (U.S. Forest Service, Department of the Interior), U.S. Fish and Wildlife Service or other agencies designated as the lead agency
Public Law 92-500, Federal Water Pollution Control Act Amendments of 1972 (86 Stat. 816)	Corps of Engineers, Environmental Protection Agency, Various State EPAs
Public Law 92-583, Coastal Zone Management Act of 1972 (86 Stat. 1280)	Federal Land Holder, U.S. Forest Service, Department of the Interior, State of Alaska
Public Law 93-205, Endangered Species Act of 1973 (87 Stat. 884)	U.S. Fish and Wildlife Service, State Fish and Game Commissions, et al.
Public Law 93-291, Historical and Archeological Data - Preservation (88 Stat. 174)	Advisory Counsel for Historic Preservation, Department of the Interior, State Historical Preservation Office
Public Law 94-579, Federal Land Policy and Management Act of 1976 (90 Stat. 2743)	Bureau of Land Management, U.S. Forest Service, or other Federal land holders, such as the Corps of Engineers
Public Law 95-217, Clean Water Act of 1977 (91 Stat. 1566)	Environmental Protection Agency

FERC through its licensing process, insures that hydropower projects comply with State and Federal laws. Under existing laws, it is required to obtain and consider the views of Federal, State and local agencies having jurisdiction over water resources development, or expertise in a subject area affected by a proposed project, in the processing of applications for licensing hydropower projects.

A Federal Energy Regulatory Commission's hydroelectric license is issued for periods up to 50 years, after which the holder can file for another 50 year license renewal. Under the "preference clause" of the Federal Water Power Act, public agencies can challenge a private agency's right to renew its license. The Act gives preference to public agencies over private ownership, where competing applications are equal for the same site.

There are two procedural options available to a developer for obtaining a license for a hydropower development:

- File an application directly, or
- Initially file an application for a preliminary permit with a subsequent application for license.

A license provides the authorization to construct, operate and maintain a hydropower facility. With a preliminary permit which is generally good for up to three years, a prospective developer is allowed to study a potential site while at the same time, maintain priority to file an application for license. This priority protection provided by a permit is important if a developer believes that someone else may compete for development of the same site.

Power companies are free to operate hydropower facilities in the region as necessary to meet power demands within the procedures set forth in their licenses. Once the operating procedures are established through the licensing process, they may only be changed through petition to the Federal Energy Regulatory Commission.

In addition to the factors noted above, the State in which a project is located may require that the project be modified in order to meet State standards for downstream water needs. Many projects have operating procedures that reflect State standards or restrictions, particularly in the area of environmental and social impacts.

Social

The social parameters that affect the operation of hydropower facilities are often reflected in the institutional arrangements noted above for the operating procedures. Occasionally, power production at a hydropower facility is curtailed due to impacts on reservoir users or downstream water users. Recreational use of existing reservoirs is extremely heavy in the MAAC Region resulting in a public demand for a fairly constant pool level with minimal fluctuation or drawdown. Therefore, even though the original

project planning may have adjusted the operating procedures to enhance recreational use, additional temporary adjustments may be required at times due to limited water and heavy recreational use.

Social consideration may also tend to increase power generation over short periods at hydroelectric projects. During periods of unusually high electricity demand, such as periods of very hot weather, hydropower facilities may be operated at a higher plant factor then normal to help meet the demand. This reduces the possibility of power service curtailment or outages.

Other social impacts relate to downstream water use. Additional releases may be desired during the normal non-generating times in order to meet certain downstream needs, such as water quality or water supply. Temporary needs can often be handled under normal project operation even though it may have negative impacts on power generation by changing peak releases to off-peak releases. Long term needs have occasionally resulted in permanent modifications to existing project operation procedures.

Economic

Economic parameters governing the use of hydropower are generally related to the higher value placed on peak power than off-peak power. As such, hydropower plants are generally designed as peaking units where possible, with primary emphasis placed on the installed capacity. Operation procedures are then based on a low (less than 20%) plant factor in order to operate at full capacity. This provides the maximum energy during periods of peak demand.

Another major economic factor that governs the use of existing hydropower plants, particularly Federal plants, is the pricing policies established for hydropower. Power produced and marketed by the Federal government is sold only to repay construction costs allocated to the hydro facilities with interest and operation and maintenance costs. As such, this power is usually considerably less expensive than alternative power. Therefore, the demand for this power is high. Considering the preference given to publicly-owned utilities and the recent increase in the requests for Federal power, the power produced at new Federal hydroelectric power plants could be divided up and wheeled to public utilities.

Physical

The most significant physical parameter affecting the use of existing facilities is generally the availability of water for generation. During periods of excess water, the hydroplant must often generate during off-peak periods just to pass excess water. Then, during dry periods, peak power production may have to be curtailed because of a lack of water. Downstream needs may also impact plant operation by requiring water releases when not desired for power production. These needs may be accented by varying hydrologic conditions such as either water shortage or flooding. The severity of these impacts due to water availability depends on the original planning and design

of the project. Power production at storage projects is generally impacted less by short-term water shortage or excess than run-of-river projects.

The impact of the terrain and physical setting around the existing hydroelectric power plants on power production is usually taken into account in the original design. Projects located in steep or mountainous terrain usually have higher energy heads for power production, but less storage. Therefore, while the high heads favor high capacity, the lower storage requires dependence on the hydrologic cycle. Older hydroelectric plants in this region were usually designed for higher plant factors which tended to reduce the installed capacity. However, more recently constructed plants maximize capacity for peaking purposes. This is evident by the construction of the high capacity pumped storage plants in steep terrain areas.

3.3 OTHER WATER RESOURCE USES

The competing demands for water also impact the operation of existing hydroplants. The increasing requirement for water supply in the growing MAAC Region has been focusing on existing reservoir projects as readily available resources. New requirements for water supply from a power reservoir will usually have a direct adverse impact on power production by removing water otherwise used for power generation. As noted earlier, increased recreational use of power related reservoirs has created social demands for decreased pool fluctuations and drawdowns. This loss in operational flexibility, whether as originally designed or considered as a result of increased use, could adversely impact power production. Downstream requirements for water supply, water quality, or navigation also tends to adversely affect power production by requiring water release during normal minimal discharge periods. While some of these requirements were included in the original project planning, changing emphasis on items like environmental quality have placed additional restraints on hydroelectric power plant operations. Many of these impacts are reflected in the institutional parameters governing hydroelectric power production.

Chapter 4
DEMAND SUMMARY

The MAAC Region which includes very heavily developed residential, commercial and industrial centers represents a substantial portion of the country's total utility load. It is expected to continue as one of the most concentrated load areas in the country, accompanying the constant rate of growth expected for the multi-state region. Three projections of electric power demands; Projections I, II and III were developed from published and readily available information and data on electricity demand forecasts. All three are based on population and economic trends and incorporate the impact of various demand reducing methods such as conservation and load management.

Projection I is derived from forecasts made by member utilities of MAAC as filed with the Department of Energy. It reflects the plans of the electric industry. Based on utility projections, each NERC Region is required to forecast annually, electric demand for the next ten years and provide "conceptual planning" projections for the subsequent eleven to twenty years. The reports filed by the utilities through the Regional Electric Reliability Councils to the Department of Energy in April 1979, were the latest available for this study. In these reports the utilities forecast energy demand and peak demand for the 1979-1988 period. The "conceptual planning" projections for the 1989-1998 period include peak load but not energy. From Projection I, the average annual growth rate for demand in the MAAC Region is projected to be 2.9 percent for the period 1978-2000.

Projection II is derived from the forecasts made by the Institute for Energy Analysis (IEA) at the Oak Ridge Associated Universities in September 1976. The IEA study is a well recognized independent study of the Nation's future energy demand. As reflected in the IEA study, both the Gross National Product (GNP) and energy demand are likely to grow significantly more slowly than has been assumed in most analysis of energy policy. A large, nationwide move to energy conservation is assumed in the forecasts. Based on Projection II, total electric demand in the MAAC Region is projected to grow at a rate of 3.2 percent for the period 1978-2000. However, this is a reduction from the high rate of 3.4 projected for the periods between 1990 and 2000.

Projection III is based on the "Consensus Forecast of U.S. Electricity Demand to the year 2000." The electricity demand was derived from the energy demand which represents an average of 15 forecasts made by Federal and private economists in the post-embargo period. The forecasts are conservation oriented, and do not reflect historical growth trends of the pre-embargo period. The "Concensus Forecast" reflects an average forecast of electric energy demand. An annual growth rate of 4.5 percent for energy demand is projected for the period 1978 to 2000 in the MAAC Region by Projection III, although projected rates decrease from 4.9 between 1978 and 1985 to 3.9 between 1995 and 2000.

The three projections developed for the MAAC Region are summarized in Table 4-1. From these projections, a "median" electricity projection was selected and is considered to be representative of future power and energy demand for the region. A more detailed discussion of the assumptions and methodology used in the development of the projections are presented in Volume IV of the National Hydroelectric Power Study, "Projected Regional Demands for Hydroelectric Power." Historical and projected energy and peak demand growth for the period 1950-2000 are shown in Table 4-2 and Figure 4-1.

Table 4-1
ELECTRIC POWER DEMAND
MID-ATLANTIC AREA COUNCIL REGION

		Projected, 1978-2000				Annual Growth
	1978	1985	1990	1995	2000	Rate 1/
PROJECTION I						
PER CAPITA CONSUMPTION (MWH)	8.5	10.6	11.7	12.7	13.8	2.2
TOTAL DEMAND(THOUSAND GWH)	169.8	217.8	251.1	282.0	317.2	2.9
PEAK DEMAND(GW)	31.8	40.4	48.3	52.0	58.5	2.8
PROJECTION II						
PER CAPITA CONSUMPTION (MWH)	8.5	10.2	11.5	13.1	14.9	2.6
TOTAL DEMAND(THOUSAND GWH)	169.8	209.0	247.3	291.1	342.7	3.2
PEAK DEMAND(GW)	31.8	38.5	45.6	53.7	63.2	3.2
PROJECTION III						
PER CAPITA CONSUMPTION (MWH)	8.5	11.5	14.1	16.5	19.3	3.8
TOTAL DEMAND(THOUSAND GWH)	169.8	237.6	300.9	366.4	444.2	4.5
PEAK DEMAND(GW)	31.8	44.1	55.5	67.6	81.9	4.4
MEDIAN PROJECTION						
PER CAPITA CONSUMPTION (MWH)	8.5	10.6	11.7	13.1	14.9	2.6
TOTAL DEMAND(THOUSAND GWH)	169.8	217.8	251.1	291.1	342.7	3.2
PEAK DEMAND(GW)	31.8	40.4	46.3	53.7	63.2	3.2
MARGIN(PERCENT)		25.0	25.0	25.0	25.0	
RESOURCES TO SERVE DEMAND(GW)		50.5	67.9	67.1	73.0	
LOAD FACTOR(PERCENT)		61.0	61.5	61.9	61.9	

1/ The growth rates are average annual compounded rates over the period.

4.1 CAPACITY

MAAC is a summer peaking region, although some individual power systems have a winter peak. The winter peak varies between 7.5 and 13 percent below that of the summer peak demand. A summer generating capability of 44,755

Table 4-2
PAST AND FUTURE ENERGY REQUIREMENTS FOR MAAC REGION

Year		Annual Energy			Peak Demand			Annual Load
Past	Estimated	Thousands of GWH	Average Annual Growth Rate % 1 yr	5 yr	Peak MW	Average Annual Growth Rate % 1 yr	5 yr	Factor %
1950		34.1			6.6			58.6
1955		47.5		5.8	9.3			58.1
1960		63.0		5.8	12.0			59.8
1965		89.0		7.2	16.5			61.6
1970		129.4		7.8	24.1			61.2
1973		154.1			30.7			57.4
1974		152.1	0.9		28.2	7.8		61.7
1975		153.3	0.4	3.4	28.9	2.3	3.7	60.6
1976		158.3	3.4		29.4	1.8		61.3 1/
1977		164.1	3.5		32.3	9.7		58.0
1978		169.8			31.8			61.0
1979		172.5			31.8			62.2
	1985	217.8			40.4			61.5
	1990	251.1		2.9	46.3		2.8	61.9
	1995	291.1		3.0	53.7		3.0	61.9
	2000	342.7		3.3	63.2		3.3	61.9

Source: Federal Power Commission, "The 1970 National Power Survey", Part II, Washington, D.C., 1970; Department of Energy, "Energy Information Report on annual report of monthly comparisons of peak demands and energy for loads---1973 to 1977, "Washington, D.C., May 1978; and "MAAC System Plans Report" FERC (FPC) Order 382-4, Docket R-362, April 1, 1978.

1/ Load Factor was computed using 8784 hours to reflect leap year.

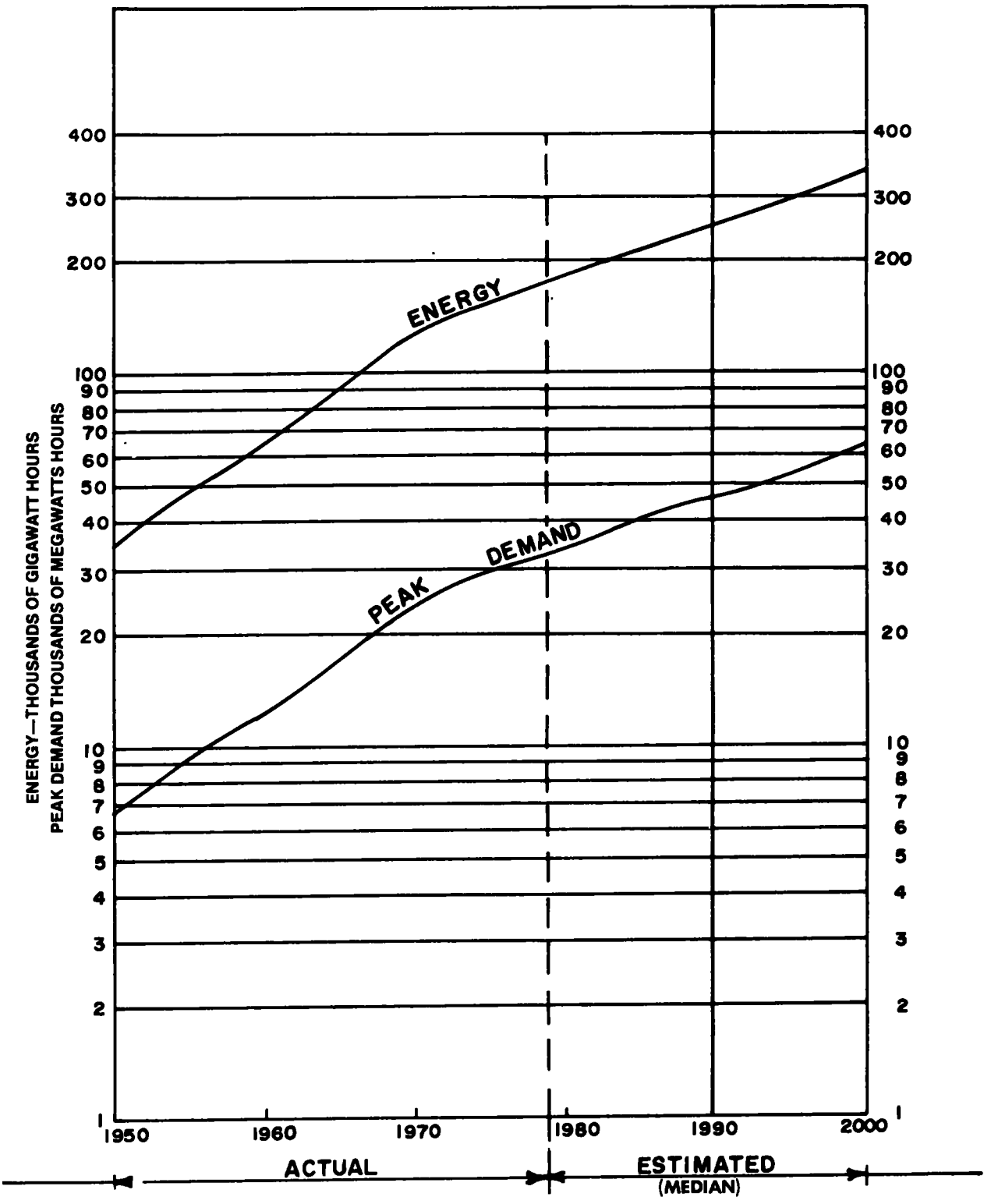


Figure 4-1
ELECTRICAL POWER REQUIREMENTS
MAAC REGION

megawatts and summer non-coincident peak demand of 33,550 megawatts were planned by the utility system for 1980. This capacity exceeded peak demand requirements by 10,034 megawatts, which represents a 29.8 percent adjusted reserve margin. The current peak represents an increase of 5.6 percent over that of the previous summer and is a reversal of the decreasing trend that the area has been experiencing for the past two years, and only 4.3 percent above the previous highest peak of 32,180 megawatts in 1977. The loads, resources and reserves for the 1980 summer and winter peaks are shown in Table 4-3.

Table 4-3
RESOURCES, DEMAND AND MARGIN
FOR MAAC, DECEMBER 1979

	Summer MW	Winter MW
RESOURCES		
Net Dependable Capability	44,755	48,809
All Scheduled Imports	157	157
All Scheduled Exports	0	0
Total Resources	44,912	48,966
Inoperable Capability	281	281
Operable Resources	44,884	48,685
DEMAND		
Peak Hour Demand	33,550	29,850
Interruptible Demand	0	0
Demand Requirements	33,550	27,850
MARGIN		
Margin	11,332	18,835
Scheduled Outage	1,300	4,550
Adjusted Margin	10,034	14,285
Percentage of Demand Requirements	29.9	47.9
Percentage of Operable Resources	22.4	29.3

Source: MAAC Regional Reliability Council Coordinated Supply Program, April 1, 1980.

As indicated in Table 4-3 for the year 1980, the region will have adequate reserves well above the PJM Agreement criterion of 22 percent. The reserve or margin capacity in the MAAC Region averaged about 39 percent above demand in 1980. This high reserve margin was due to a recent decrease in load growth as compared to earlier projections. The margin is expected to be reduced in subsequent years. It is decreasing rapidly from the high level of 45 to about 32 percent in 1985, and 25 percent in 1995. However, a maximum of 25 percent is applied to compute future generating capacities to provide an adequate and reasonable supply of energy to meet the "median" peak demand as previously described.

MAAC was projected to have a net import of 157 megawatts in 1980. In addition, it has interchange of emergency, short term, diversity and economy

power and energy with adjoining systems. During 1979, MAAC participated in 14,450 MW of interchange with adjoining systems. Table 4-4 lists current emergency transfer capabilies between MAAC and surrounding Reliability Councils.

Table 4-4
TRANSFER CAPABILITIES (MW)
BETWEEN RELIABILITY COUNCILS, 1979

From		To
MAAC	2,400	NPCC
NPCC	3,300	MAAC
MAAC	3,050	ECAR
ECAR	3,150	MAAC
MAAC	1,800	VACAR
VACAR	3,000	MAAC

Source: 10th Annual Review of Overall Reliability and Adequacy of the North American Power Systems, National Electric Reliability Council, August 1980.

Total capability needs are expected to increase from about 44,500 megawatts in 1978 to about 79,000 megawatts in 2000. Over this 22 year period, an additional capability of 34,600 megawatts will be required for the MAAC Region. The probable percentage generation mix by fuel type to meet the projected peak demand is shown in Table 4-5.

Table 4-5
PROJECTED GENERATION MIX FOR MAAC REGION
(PERCENT OF TOTAL CAPABILITY)

Generation Type	1985	1990	1995	2000
Base				
Nuclear	25-26	23-25	20-25	20-25
Coal	26-28	30-32	35-38	38-40
Oil	10-12	8-10	5-8	2-5
Intermediate				
Coal	4-6	6-8	8-10	10-15
Oil	12-14	10-12	10-12	8-10
Conv. Hydro	1-2	1-2	0-1	0-1
Other	0	0-1	0-1	1-2
Peaking				
Coal	-	-	-	-
Oil	13-15	13-15	10-13	8-10
Conv. Hydro	1-2	1-2	1-2	1-2
Pumped Storage	2	2	2-3	1-3
Other	0	0-1	0-1	1-2
Total Capability (GW)	50.5	57.9	67.1	79.0

Coal is expected to increase its proportional share of the total electric generation with a corresponding reduction in oil to meet the projected peak demands for the 1978-2000 period. Conventional hydropower is projected to account for from two to four percent of the total generating capability in 1985 and 1990, and from one to three percent of the generating capability for the remaining period 1995 through 2000. Additional hydroelectric capability could contribute to meeting the future power requirements for the region.

4.2 ENERGY

The total net energy of about 172.5 billion kilowatt-hours for 1979 represents an increase of about 1.6 percent over the nearly 170 billion kilowatt-hours generated in 1978. As shown in Table 4-2, total energy demand is expected to increase to just over 251 billion kilowatt-hours by 1990, and to nearly 343 billion-kilowatt-hours by 2000 or at an average growth rate of 3.0 and 3.2 percent, respectively. Over the 22 year period, an additional energy load of about 173 billion kilowatt-hours will be required to meet the electric demand in the region. The net energy projected for 2000 is more than double that of the actual requirements for 1978. Although an increase in growth is projected for the overall period, the regional energy rate is projected to decrease from an average annual growth rate of 3.6 percent between 1977 and 1985 to about 3.3 percent between 1990 and 2000.

Net annual energy peak demand and load factors for the 12 months of 1979 are listed in Table 4-6.

Table 4-6
ANNUAL ENERGY, PEAK DEMAND AND LOAD FACTOR
(MAAC REGION-1979)

Month	Peak Hour Demand MW	Net Energy GWH	Load Factor %
Jan	28,297	16,186	77
Feb	28,655	15,117	78
Mar	26,009	14,367	74
Apr	24,760	13,089	73
May	26,081	13,381	69
Jun	26,856	13,628	70
Jul	30,497	15,296	70
Aug	31,780	15,922	67
Sep	30,083	13,668	63
Oct	24,096	13,772	77
Nov	25,511	13,388	73
Dec	27,585	14,717	71

Total Year Peak

Summer	31,780
Winter	27,858

Net Energy 172,540

The energy demand for the region does not occur constantly; demand generally varies on a fairly predictable basis, with periods of high demand or peaks preceded and followed by valley or periods of lower demand. Annual peaks are caused by winter heating and summer air conditioning demands. Normally, the highest demand month in the region alternates between July/August/September or December/January, depending on weather conditions. The lowest demand for the MAAC Region generally alternates between April and October due to moderate weather conditions. As shown in Table 4-6, the highest peak demand for the MAAC Region occurred in August, followed by July, September and February. The lowest peak demand occurred in October, followed by April and November.

Seasonal variations in the region are reflected on weekly load curves for the first week of April, August and December 1977 shown on Figure 4-2. The weekly load factors during this period are shown in Table 4-7.

Table 4-7
SYSTEM LOAD VARIATIONS FOR MAAC 1/ 2/

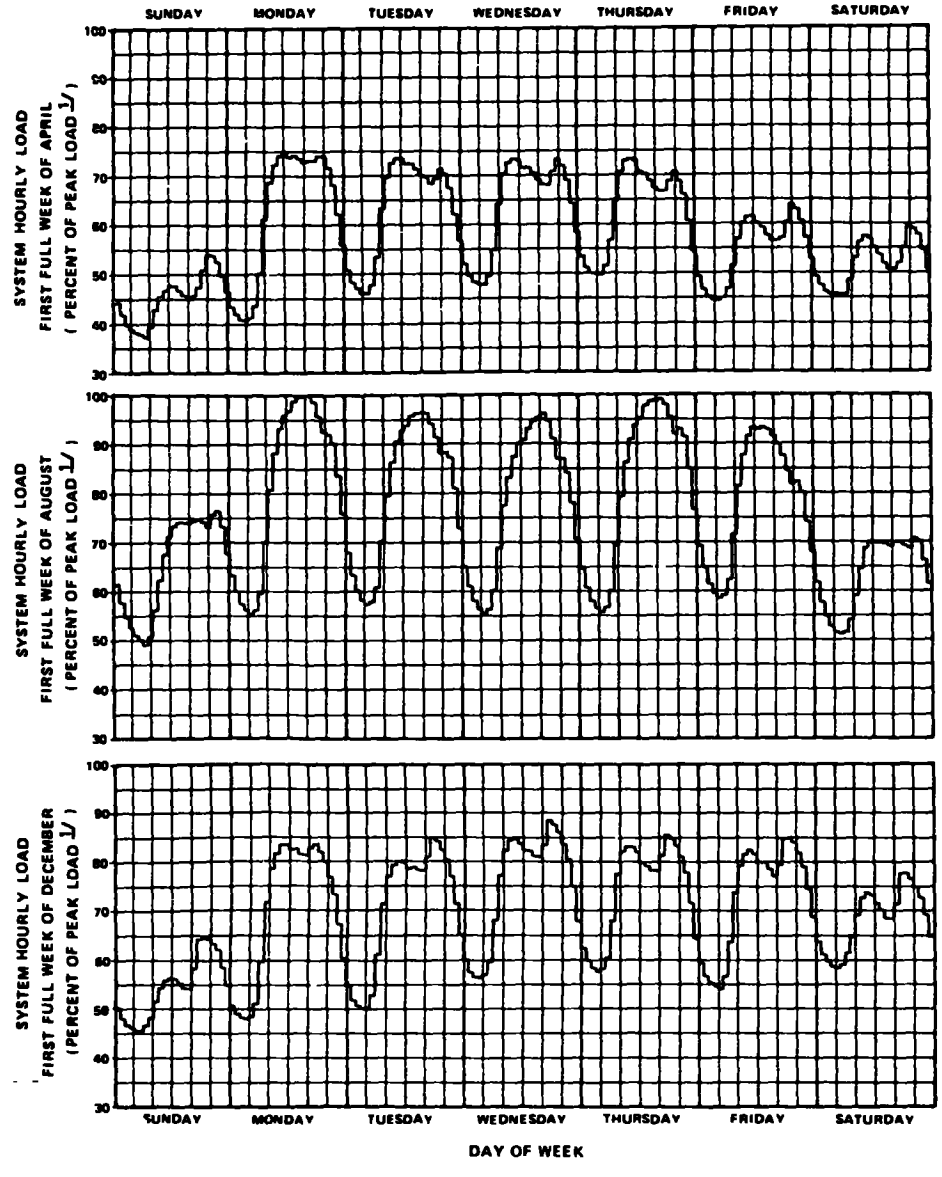
First Week of April		First of Week of August		First Week of December	
Peak Demand Annual	Weekly Load Factor	Peak Demand Annual	Weekly Load Factor	Peak Demand Annual	Weekly Load Factor
%	%	%	%	%	%
68.7	77.6	92.5	75.5	81.8	78.8

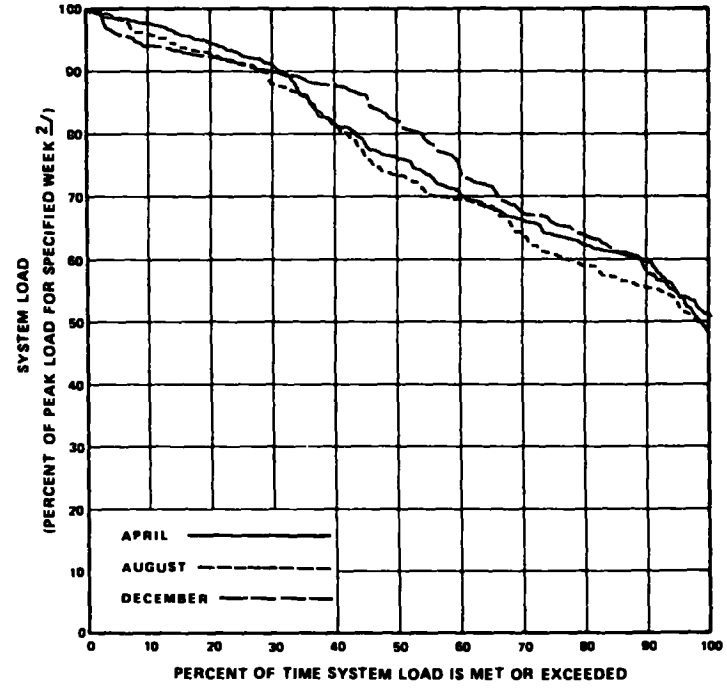
1/ Computations based on information provided in schedules 14 and 15 of the 1977 FERC Form 12.
2/ Since PJMI submits a Form 12 to FERC as a system as well as on an individual utility basis, the system information is recorded for simplicity.

During each season, the load may vary by several percent. A breakdown of utility system loads (base, intermediate and peak is presented in Table 4-8.

Table 4-8
LOAD DISTRIBUTION IN MAAC REGION
(PERCENT OF ANNUAL PEAK LOAD)

	Base	Intermediate	Peak
	%	%	%
Pennsylvania-New Jersey-Maryland Interconnection			
Off Season	49	16	5
Summer	63	21	16
Winter	62	14	5
Annual	63	21	16





NOTES

1 PEAK LOAD IS EQUAL TO THE LARGEST SYSTEM LOAD IN THE FIRST FULL WEEK OF APRIL AUGUST AND DECEMBER

2 PEAK LOAD IS THE PEAK SYSTEM LOAD FOR THE CORRESPONDING WEEK FOR THE APRIL AUGUST OR DECEMBER CURVES

SOURCE

DATA OBTAINED FROM FERC FORM NO 12 (SCHEDULES 14 AND 15) FOR 1977

FIGURE 4-2
WEEKLY LOAD CURVES, FIRST WEEK OF INDIVIDUAL SEASONS

Base load as defined for this study is the mean of the Monday-Friday minimum loads plus 10 percent of the computed mean minimum load. Peak load is defined as the greatest difference between the Monday-Friday daily peak and the daily load equaled or exceeded 12 hours a day. The intermediate load is that portion between base load and peak load. It usually lasts from 12 to 14 hours, beginning in the early morning and lasting until late afternoon.

On a weekly basis, the day of peak demand varies from Monday through Friday, but for a given day, the peak demand generally falls during the hours from 8:00 a.m. to 8: p.m. These peaks are the results of residential and work place demands for electric power.

4.3 SENSITIVITY ANALYSIS

The projections of future electric demand and supply presented in this chapter are based on numerous factors, each of which is sensitive to public opinion, economics of energy use, and changes in domestic or international policies. The number of variations that could be analyzed is nearly infinite. However, regardless of variations in items, population reflects the ultimate energy use. Of particular importance are variations in projected population growth rates. Such variations will directly affect projections II and III, since they are based upon per capita energy consumption. Projection I would be indirectly affected as it is based on an aggregation of utility forecasts, each of which may have a different underlying forecast methodology. Changes in projected economic growth, rate of implementation of conservation measures, federal and state regulations, and other regional factors are difficult to gauge but will no doubt affect all of the projections.

Changes in the regional population growth rates would definitely affect Projections II and III, and, most likely, the "Median" Projection. Table 4-9 indicates what effects, if any, selected changes in population growth rates would have on the median projection of electric energy comsumption in MAAC.

Table 4-9

EFFECTS OF POPULATION GROWTH RATES CHANGES ON PROJECTED ENERGY CONSUMPTION

Percent Change in Population Growth Rates	Percent Change in Energy Demand of Projections II & III in the Year 2000	"New" Median Energy Demand (GWH)
-50	-6.6	320.0
-15	-2.0	335.7
-0	0	342.7
+15	+2.1	349.8
+50	+7.1	367.0

Median energy demand is computed as the median of Projection I (unchanged) and Projections II and III (adjusted as indicated).

In MAAC as well as through the country, electric energy conservation measures and load-management measures will most likely be employed in an attempt to offset rising energy prices regardless of other economic activity. Large scale adoption of conservation will have an effect on electric generation requirements similar to that of depressed economic conditions in that projected demand for both electric power and energy would be reduced. However, conservation will not impede hydroelectric generation, but rather will point to its value and its contribution to conservation. More likely than not, planned thermal-electric generation will be curtailed.

Conversely, if economic activity were to exceed expectations, future demand for energy might exceed the median projection. However, conservation and load-control measures could relieve the capacity situation somewhat, so that electric energy use would increase to a larger degree than would capacity requirement. Under such circumstance, hydroelectric power and energy would provide operating economy and there would be demand for all that could be economically installed.

To summarize, electric capacity and energy demand could vary widely from the projections, but the overall need for national energy conservation will continue to justify the production of hydroelectric energy.

Chapter 5
METHODOLOGY

5.1 REGIONAL PROCEDURES AND CRITERIA

A four stage process was used in the assessment and evaluation of hydroelectric potential in the MAAC Region. It consisted primarily of a series of computational and screening stages pursued within the framework of objectives established for the National Hydroelectric Power Resources Study.

- Stage 1 - Inventory total physical hydropower potential.
- Stage 2 - Identification of physical potential which shows possible economic feasibility.
- Stage 3 - Identification of potential sites or projects that are economically feasible and acceptable.
- Stage 4 - Formulation of regional system plans.

Each of the four stages was designed to improve and increase the level of detail and reliability of data and analyses for a successively smaller number of potential hydroelectric power sites as the study proceeded through various iterations. The first three stages progressively narrowed the number of potential hydroelectric power sites that remained active from preceding analyses. Different levels of screening were used to successively delete sites in the active inventory, which did not meet established evaluation criteria. The fourth stage consisted of the formulation of a regional plan; sites identified from preceding analyses were assimilated to form a plan for the utilization of hydroelectric power resources in the MAAC Region. A comprehensive computerized data base was compiled and used to facilitate a systematic evaluation and screening of sites that were identified from preceding iterations. Specific screening criteria and data and collection procedures used to screen and evaluate potential hydroelectric sites in the inventory data base during successive stages are described in the following paragraphs.

5.1.1 Screening Criteria

Potential hydroelectric power sites in the inventory data base were screened primarily on the basis of physical, economic, environmental, social and institutional criteria developed or established for successive stages of the study.

Stage 1

The physical potential of sites to generate hydroelectric power was the primary criteria used for screening during the initial stage of the study.

Sites with a potential capacity less than 1,000 kilowatts (KW) were deleted from the initial inventory. This criteria was based upon hydraulic height of the dam and total storage:

$$\text{Hydraulic Height(ft)X Storage Capacity(Acft)X0.036} \geq 1{,}000$$

However, to screen known undeveloped and extremely low head sites which appeared to have some potential, an additional criteria based on a drainage area of 10 square miles or more was used to retain these sites in the inventory. Those sites which did not possess either sufficient storage, head or flow to generate a significant amount of hydroelectric power were deleted from the inventory.

Stage 2

Potential hydroelectric power sites retained for evaluation were screened in Stage 2 on the basis of both capacity and economic standards established to identify sites for more detailed study during Stage 3. Each site had to surpass an installable capacity standard established to maintain an active status in the inventory. The capacity of 1,000 kilowatts used during the initial screening was retained as a minimum standard during Stage 2 screening for the MAAC Region. Those sites that did not meet this standard were retained in the inventory, only if there was substantial non-Federal interest in the sites or an identifiable local user for the power. A benefit-to-cost ratio of 1.0 was used to screen those sites which satisfied the minimum standard for power potential. This ratio of power benefits measured by FERC's generalized power values and the costs of only the powerhouse facilities should not be interpreted as a conventional B/C ratio; it was simply a device for eliminating clearly uneconomic sites from active consideration under the National Hydroelectric Power Resources Study. Results of this screening were published in a report titled "National Hydroelectric Power Resources Study - Preliminary Inventory of Hydroelectric Power Resources" in July 1979.

Stage 3

Two iterations were used for screening potential hydroelectric power sites during Stage 3. Initially sites in the active inventory were screened on the basis of more detailed and refined economic information. The results were an evaluation of sites based only on the economics of hydroelectric power development. Based on the estimates of benefits and costs generated by the computer, existing and undeveloped sites were deleted from the active inventory if they did not satisfy the following criteria:

- Existing Sites-Benefit-Cost Ratio (B/C) $\geq$ 1.0.
- Undeveloped Sites-B/C $\geq$ 0.7.

The criteria for existing sites was generally used except for those sites which showed some marginal power potential and had definite non-Federal interests or local conditions which warranted further consideration. The

economic data for the undeveloped sites were based on a single purpose power project and did not consider the other multi-purpose benefits. This criteria was not definite because the additional benefits from other purposes could vary greatly.

Additional data on environmental, social and institutional impacts of sites which evolved from the preceding iteration provided the basis for the second screening of Stage 3. The evaluation of sites based on the above criteria was very difficult. In some cases, it was based on an either/or decision. For example, if a site was located in a designated wild or scenic river, it was considered to have an overriding environmental impact and did not pass the screening.

Stage 4

During Stage 4, the sites retained in the active inventory were generally screened on the basis of site specific information and other significant environmental, social and institutional problems which were not expected to be resolved in the near future. Based upon a reevaluation of sites passing preceding stages, a group of potential hydroelectric power sites were identified for inclusion in the regional plan for the MAAC Region. Screened on the basis of the cost of energy production, these sites were placed into two categories:

- Near term, sites with a definite hydropower potential that could be reasonably put on line by 1990.

- Long term, sites with reasonable hydropower potential which are expected to become more feasible in the future and could be put on line after 1990.

The cost of energy production (Mills/KWH) was used to select the most appropriate size project at existing non-hydropower or undeveloped sites, unless the site had peaking capabilities. For those sites with peaking capabilities, both energy and capacity benefits were used to select the optimal project. The sites included in the regional plan were screened on the basis of an energy production cost of 40 Mills/KWH for sites in the near term category and 60 Mills/KWH for the long term category.

5.1.2 Data Collection Procedures

Data collection procedures along with the screening process were developed and used to assemble a comprehensive nationwide data base and inventory of hydroelectric power resources. The format and existing inventory for the Corps of Engineers' National Program of Inspection of Non-Federal Dams were used to the maximum extent possible. Through a series of successive iterations, additional data elements for developed and undeveloped hydroelectric power sites were obtained from Corps' studies, the Federal Energy Regulatory Commission; other Federal, State and local agencies; and private interests. The data base was updated and refined as the study proceeded through the four stages.

Stage 1

Data on about 50,000 existing dams were transferred directly by machine from the exising Corps' National Dam Inspection inventory to the National Hydroelectric Power data base. This data was supplemented by existing information on previously determined potential for power developed at the sites. This data base which provided name, location, ownership, maximum storage capacity streamflow and maximum hydraulic height of dams were supplemented by similar information on undeveloped sites compiled by field offices within the region. Data on other undeveloped and developed sites were obtained from FERC's data base of existing and potential projects; other agencies, both Federal and local; and private interests. The usable data elements from the existing inventory and additional data elements obtained during the early assessment of power potential were incorporated and organized to form the preliminary inventory for the study.

Stage 2

The data base developed in the initial stage of the study was supplemented by additional physical data during Stage 2. The additional data consisting of the designation of a U.S. Geological Survey reference gaging station, a refined estimate of the available net power head and an estimate of the drainage area was compiled for each of the sites that was retained in the inventory data base after Stage 1. Three options were used in the compilation of additional data in the data base during the second stage of the study:

- Information from previous studies or other available sources was entered directly into the active data base.
- Field estimates performed specifically for the study were entered into the active data base.
- Generation of required data by machine based on input previously entered in the active data base.

Stage 3

Additional data was collected and compiled during two phases of Stage 3. In the initial phase, the data base was extended to include the following major refinements.

- Identification of the amount of storage allocated for multi-purpose sites.
- Estimation of the power head by setting top of power pool equal to top of conservation storage and estimating a tailwater rating curve.
- Deletion of flow diverted for other purposes (municipal water supply) for flow generating capability.

- Incorporation of evaporation losses.

- Incorporation of additional data to estimate all costs for the addition of hydropower to existing reservoir sites, such as powerhouse, intake, outlet, and other associated power costs.

- Incorporation of physical data for undeveloped sites to estimate the cost for embankment, spillway, reservoir, and other power associated costs.

During the second phase of Stage 3, additional data was collected on the environmental, social, and institutional aspects of adding hydropower. Where available, specific data concerning environmental, social, and project acceptability was included in the active data base for those sites passing the economic screening criteria in the preceding phase. Examples of quantative data that were cited during this iteration are as follows:

- Environmental

  Miles of Wild and Scenic River Impacted

  Area of Park Land Affected

  Recreation Areas Impacted

  Number of Cultural Resources Sites Affected

  Area of Wildlife or Fishery Habitat Impacted

- Social

  Communities Relocated

  Business Relocated

  Transportation Routes Relocated

  Area of Inundation

- Project Acceptability

  Known Proponents of Hydropower Development at the Site

  Known Opposition of Hydropower Development at the Site

The data compiled was limited to that which was readily available from existing reports or could be easily obtained from general topographic mapping such as USGS quad sheets. In most cases, very little quantitative data was available. For most of the existing sites, where there was minimal disruption to the environment, local community or existing project purposes, there were very few site specific impacts which could be identified. The overall general impacts that would be common to any hydropower development are

covered in more detail in Volumes V-XI of the National Hydroelectric Power Resources Study Report.

Stage 4

The active inventory data base was updated to reflect the incorporation of site specific power values of more refined analysis for the 47 sites that were retained in the active data base after the completion of Stage 3. Sites identified for the regional plan were categorized as near-term and long-term.

5.1.3 Screening Procedures and Evaluation

An iterative process utilizing criteria and data as described in preceding paragraphs were used in the evaluation of potential sites during the successive stages of the study.

Stage I

Existing computerized data bases and automated data processing techniques were used in the identification of potential hydroelectric power sites during the first stage of the study. Initially special studies were conducted to support the screening and specific plan identification activities required for the study. These included development of the following:

- Data collection procedures and formats to assure that raw data essential to screening and site identification were uniformly collected for all identified sites.

- Generalized and site specific power values used in the evaluation of sites during States 2 and 3. These power values as developed by FERC (Vol. XIII) were used when possible during the development of regional plans (final stage of plan identification) to more accurately evaluate the relative potential benefits of each project contained in the final regional plans(s).

- Generalized cost estimating procedures to facilitate the estimate of needed reconnaissance level project costs at sites where more accurate cost data was unavailable. These procedures were developed in two phases; first, cost estimating curves which include powerhouse and switchyard costs were developed. These curves were used as the basis for estimating the project costs during Stage 2. During the second phase, the powerhouse and switchyard costs were refined and a cost estimating procedure for use during Stage 3 was developed for estimating the nonpowerhouse/switchyard project costs. The results of this special study were presented in the form of generalized cost curves for use in making computer analyses, and in the form of a manual which can be used by field offices. The total project cost estimating procedures and curves were used as the basis for computing project costs during the first screening of Stage 3. The cost estimating manual is included in Volume XIII of the NHS reports.

- Computer routines to evaluate site hydrology and costs and benefits for the large number of the sites that were identified during this study. These routines analyzed stream flow data using flow-duration and/or sequential flow techniques to develop a range of capacity and energy potentials; computed project benefits using FERC power values; computed project costs from generalized cost curves; and identified the scope of project which maximized net benefits.

Drainage area and flow data were not included for the potential sites compiled in the preliminary inventory and assumptions based on the rationale that height of dam and storage capacity provided by the construction of a dam would give some indication of the flow at the dam was used in an initial analysis. The assumptions used were: that continuous flow would be available sufficient to refill the maximum storage capacity of the reservoir in each 24-hour period; that this flow could be converted to power with a net head equal to the maximum hydraulic height of the dam; and that the combined efficiency of this conversion would be 85%.

$$KW = \frac{QHE}{11.8} = 0.072\ QH$$

where KW = power in kilowatts

Q = flow in cubic feet per second

H = net power head in feet

E = efficiency

Since one acre-foot yields approximately 0.5 cubic feet per second for a 24-hour period,

$$KW = 0.072 \times 0.5\ SH = 0.036\ SH$$

where S = storage in acre-feet.

This computation, with its associated assumptions, gave an extremely optimistic estimate on power potential for most dams. Therefore, the screening level based on these results was 1,000 KW. This criteria did not provide for the retention of small head hydropower sites which were found to have some potential due to a large drainage area. A subsequent evaluation was made utilizing the drainage area added to the inventory data base. On the basis of this evaluation, sites with a drainage area less than 10 square miles were deleted from the inventory.

Stage 2

Optimistic estimates of capacity and energy were computed from data collection and compiled in the inventory data base. This provided the basis for the determination of the physical potential of the approximately 17,000

sites which passed the Stage 1 screening. For those sites on which capacity and energy had been initially computed without flow, a refined estimate of capacity and energy was made using a hydrologic model developed by the Corps' Hydrologic Engineering Center (HEC). Due to the limited amount of available data at this stage and the desire not to eliminate potential sites unless it was apparent that they were definitely unsuitable, the following assumptions were made:

- All sites are considered as single purpose hydropower projects. (Disregard other purposes).
- Power head equals 75 percent of the total hydraulic head.
- No tailwater adjustment to the powerhead.
- Overall plant efficiency was assumed at 86 percent.

The physical data along with flow duration data computed for the site from the nearest representative gage were used to estimate the sites capacity and energy potential. For the different levels of exceedance on the flow duration curve, alternative plant sizes were formulated. Regional energy and capacity values, obtained from FERC, were used to estimate benefits for each of the alternatives, and generalized cost curves were utilized to estimate costs for the power facilities. Optimum plant sizes were selected by optimizing the net benefits. During this stage only powerhouse and switchyard costs were included in the estimates due to the lack of data. Other cost, which could include intake and outlet cost and other power associated costs, biased the economic evaluation of each of the sites very optimistically. Costs for reservoir and embankment costs for the undeveloped sites were not idendified during this stage.

The screening during this stage was accomplished using both capacity and economic estimates compiled during the initial stage of the study. Each site had to surpass an installable capacity standard established to maintain active status in the inventory. As previously indicated, for those sites a capacity of 1,000 kilowatts or 1 MW was determined to be the minimum standard for the MAAC Region due to the optimistic assumption utilized in the estimating procedure. Other sites not meeting this standard were retained in the inventory, only if there was substantial non-Federal interest in the site or an identifiable local user of the power. Those sites which were retained, were then screened according to a ratio of power benefits to costs of the powerhouse facilities.

The results of screening and evaluation of potential sites in Stage 2 were published in a report titled, "Preliminary Inventory of Hydroelectric Power Resources" in July 1979. The number of active sites nationwide were screened down to approximately 11,000 sites, including the 254 sites in the MAAC Region.

Stage 3

The iterative process used in evaluating the economic, environmental, social and institutional viability of sites was generally accomplished by computer using the cost program developed by HEC.

In the first iteration, additional site specific data were used to refine the power estimates and estimate all project costs and benefits. The refined costs were compared with a refined estimate of benefits to determine which sites show sufficient promise of economic feasibility to warrant their retention for evaluation during the succeeding iterations. Successive iterations constituting the second screening were made to compare projects with environmental, social and institutional criteria. Sites without overriding adverse impacts in these areas were retained for evaluation during the identification of regional plans.

Subsequent to the completion of data collection for the first iteration of Stage 3, a computer program designed to estimate the overall power capability and associated costs and benefits, was run. Sites were analyzed as a strictly run-of-river hydropower project using a flow duration analysis technique, or as a storage hydropower project if the site had sufficient conservation storage to augment firm generating flow capability, by using a sequential routing analysis technique. The program formulates alternative installed capacity sizes for the power project related to amount of generating flow and a plant factor, and selects the project with the optimum net benefits. The benefits were estimated similarly to Stage 2 by applying regional power values from FERC to the capacity and energy values for each alternative.

The initial screening and evaluation of Stage 3 was based on more detailed and refined site evaluation previously compiled in the active inventory data base. The results of this screening was an evaluation of projects based only on the economics of power development. The economic data generated was used to delete from the active inventory less desirable projects based solely on an estimate of hydropower benefits and costs.

For the existing sites the $B/C \geq 1.0$ criteria was generally used except for those sites which showed some marginal power potential and had definite non-Federal interests or other local conditions which warranted further consideration. The undeveloped sites were screened on a $B/C \geq 0.7$ criteria. since the economic data was based on a single purpose power project and did not consider the other multi-purpose benefits. This criteria was not definite because the additional benefits from other purposes could vary greatly for the undeveloped sites. Each of the undeveloped sites were reviewed on a case by case basis to determine if they warranted further consideration.

The screening and evaluation of potential sites on the basis of environmental, social and institutional factors were very difficult. In some cases, the criteria set was based on an either-or decision. For example, if a site was located in a designated wild or scenic river, it was considered to have an overriding environmental impact and did not pass the screening.

However, except for such obvious cases, individual judgment was exercized in the assessment of the environmental, social and/or institutional feasibility of a site.

In the evaluation of the environmental, social, and project acceptability of the sites in the active file, all but one of the undeveloped sites were eliminated due to overriding adverse impacts, however, consideration was given to impacts on the existing projects in selecting the most appropriate power project for each site.

Stage 4

Stage 4 involves the formulation of hydropower plans to meet the demands of the electric reliability area. In formulating the regional plans, additional site specific analysis for sites passing Stage 3 was accomplished to identify those sites which appear to be suitable for inclusion in the regional plans. Formulation of alternative plans generally proceeded as follows:

- Reevaluation of those sites which passed the Stage 3 screening to select the most reasonable size and type of project.
- Reevaluation of the Stage 3 screening to add or delete sites based on new criteria.
- An analysis of potential sites according to economic and environmental/social/institutional criteria.
- Development of systems for hydropower development to meet near and long term projections of regional demands for electric power.
- Evaluation of impacts and accomplishments of the identified plans.

Initially the results from Stage 3 were reevaluated and refined. As previously described, the Stage 3 screening was primarily based upon an economic benefit and cost analysis. However, during Stage 4, it was determined that the benefit analysis was not the most applicable screening criteria for all the sites being evaluated. For the smaller scale potential hydropower sites (0.5 to 5.0 MW), the benefit analysis could be misleading. For these sites, the cost of energy production was determined to be more applicable since the major need for these type projects would be energy (fuel) savings. It was also determined that some of the sites previously screened out in Stage 3 may have some local potential or long term potential. For the small scale sites which are included in these categories, new screening criteria were developed for near term and long term development. Subsequent to coordination with utilities within the reliability council, it was found that the cost at which energy may be sold varies considerably. Therefore, a generalized approach utilizing a possible sale value of energy was used for Stage 4 screening. This approach used 40 Mills/KWH and 60 Mills/KWH as the screening criteria for near and long term sites respectively. These values were derived on the basis of discussions with

member utilities of the Pennsylvania-New Jersey-Maryland Interconnection (PJM), which generally comprises MAAC; and coordination with Regional Office of the U.S. Department of Energy (DOE), Region III.

Billing rates in PJM currently range from 15 Mills/KWH, during baseload periods, to approximately 80 Mills/KWH, during peak demand periods with an average rate of 27 to 30 Mills/KWH based on discussions with member utilities of the system. The Water Resources Council's Principles, Standards, and Procedures for Water Resources Planning allow the energy value to increase to take into account real fuel price escalation over the project life. Real fuel price escalation could potentially increase benefits by 40 or 50 percent in present worth terms based on data published by the Department of Energy in the Federal Register, 23 January 1980.

Coordination with the Region III Office of the U.S. Department of Energy, (DOE) indicated that the Commonwealth of Pennsylvania is currently considering what value to set for the purchase of energy from qualifying small hydroelectric generating plants under the Public Utilities Regulatory Policies Act of 1978 (PURPA). This Act requires utilities to purchase energy produced by qualifying facilities. Rates currently under consideration are 43 Mills/KWH for plants with no dependable capacity and 48 Mills/KWH for plants with dependable capacity. This is further evidence of the reasonableness of the 40 Mills/KWH figure used. DOE also indicated that it is possible that the final rates set by Pennsylvania will be in the 55 Mills/KWH to 60 Mills/KWH range.

In subsequent iterations the size and type of project selected for each site was evaluated to determine if the plans optimized in Stage 3 were the best and most realistic for development. No strict rule was developed for this optimization of project size and type; however, judgment was generally based on the following guidelines. For the existing hydropower projects within MAAC, additional hydropower potential was selected by analyzing a combination of the incremental economic factors (benefits, costs for additional capacity, and costs for additional energy production) and reasonable operating characteristics. The alternatives were then coordinated with the owners and other power interests to determine if they were appropriately sized. If the power interest were actively studying additions to their plant or had other suggestions in sizing the projects, the project in the inventory was sized accordingly. For the potential project at existing non-hydroelectric power sites or undeveloped sites, the cost of energy production (Mills/KWH) was used to select the most appropriately sized project, unless the site had peaking capabilities. For those sites with peaking capabilities both the energy and capacity benefits were used to select the optimal project.

The final iterations of Stage 4 were used to develop a plan for hydropower development and to evaluate the accomplishments and impacts of the plan. A plan of development was formulated for near and long term projections of the regional demands. The near term plan has been defined as projects with definite hydropower potential, which could be reasonably put on line by 1990 and the long term plan is defined as those projects with reasonable

hydropower potential which could be expected to become more feasible in the future and could be put on line following 1990. The near term plan included all existing sites which have been identified by the utilities for development, all existing sites which have peaking capability and were found to be economical by considering both capacity and energy benefits and all existing sites which could produce energy for 40 Mills/KWH or less. The long term plan included all active undeveloped sites which have hydropower potential and all other existing sites which could produce energy for a cost of less than 60 Mills/KWH.

5.2 REGIONAL DEMAND ASSESSMENT

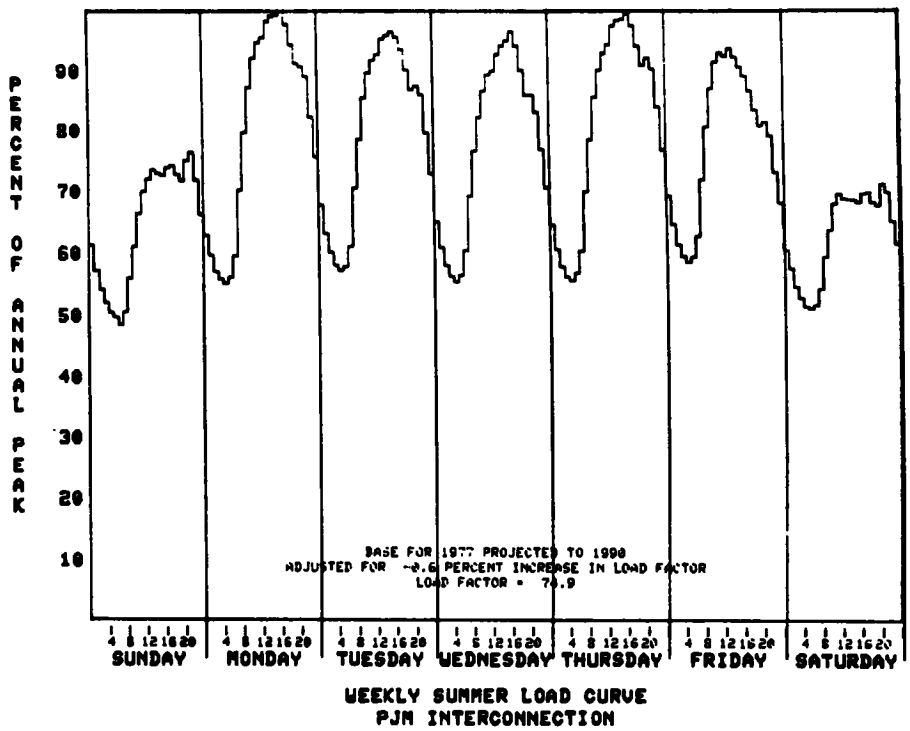
The primary objectives for assessment of the current and projected demands for power and energy within the Mid-Atlantic Area Electric Reliability Council Region were to show that the production from potential hydropower development could be used to meet specific segments of the projected need; and to indicate the amount and type of alternative fuel consumption which might be foregone.

Presentation of needs is based on the information developed for this report under one of the Policy and Technical Overview studies contracts for the National Hydropower Study. Complete documentation of this contract effort is included in Volumes III and IV of the NHS Report.

Specific contract products include: hourly loads for representative weeks (weekly load shapes) for representative utilities within each ERC; cumulative ERC projections of annual peak loads and annual load factors; suggested techniques for adjusting current load shapes to represent future load shapes (primarily an adjustment of annual load factor); and suggested techniques for "placing" potential hydropower potential within the future load shape.

The first three products have been utilized in our assessment of the MAAC demands. However, the technique suggested for placing potential hydropower on the future load shape, as suggested by the contractor, depends too heavily on availability of data on the seasonal characteristics of the available power production.

The flow-duration technique developed for analysis for power potential for the NHS provides average annual characteristics. Consequently, a method for indicating annual demand characteristics has been developed which utilizes the basic load shape data furnished by the contractor. For the MAAC Region, hourly loads presented for the representative utilities have been added to produce composite load shapes for three representative weeks of the year. These hourly load shapes were then converted to weekly load-duration curves. Figures 5-1 through 5-3 show hourly load shapes and weekly load-duration curves for representative summer, winter, and off-season weeks, respectively. The weekly load-duration curves were then combined to represent an annual load-duration curve by weighting each weekly curve by the duration of the season for which that week represents (i.e., x-weeks of summer, y-weeks of winter, and z-weeks off-season).



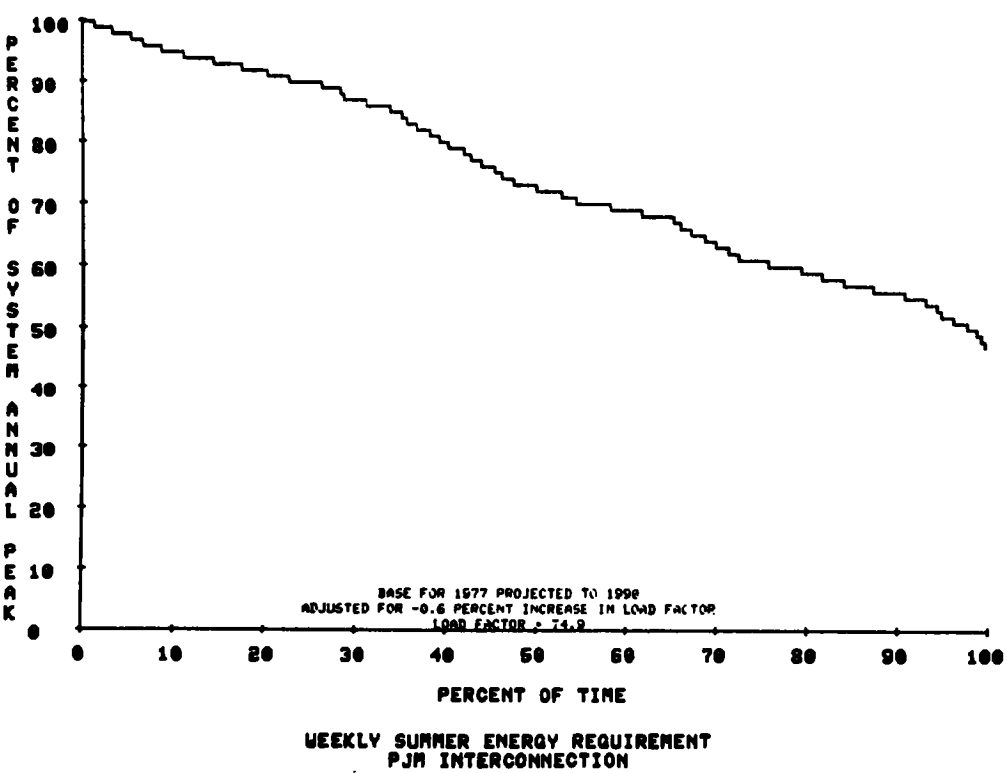
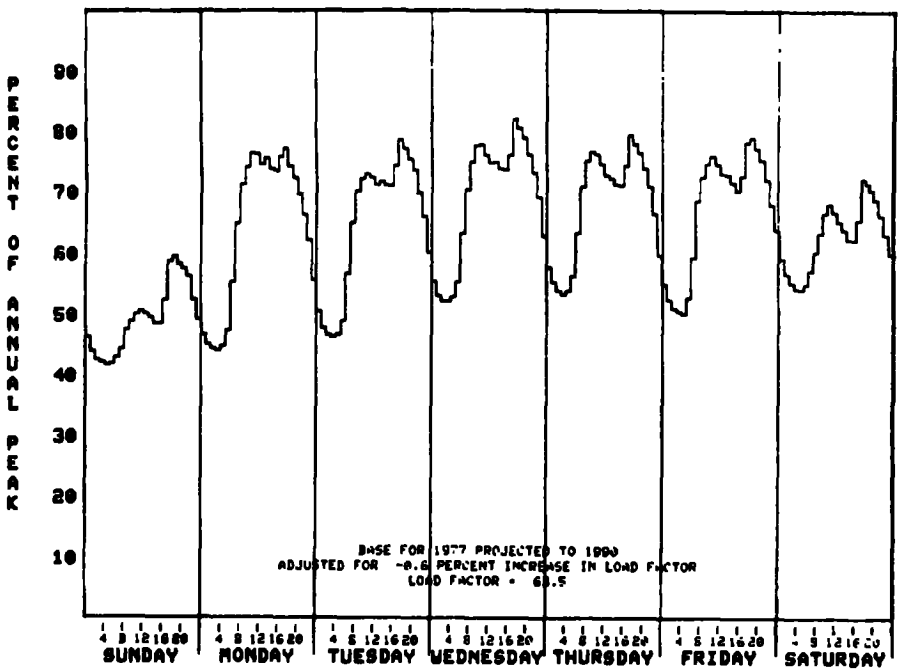
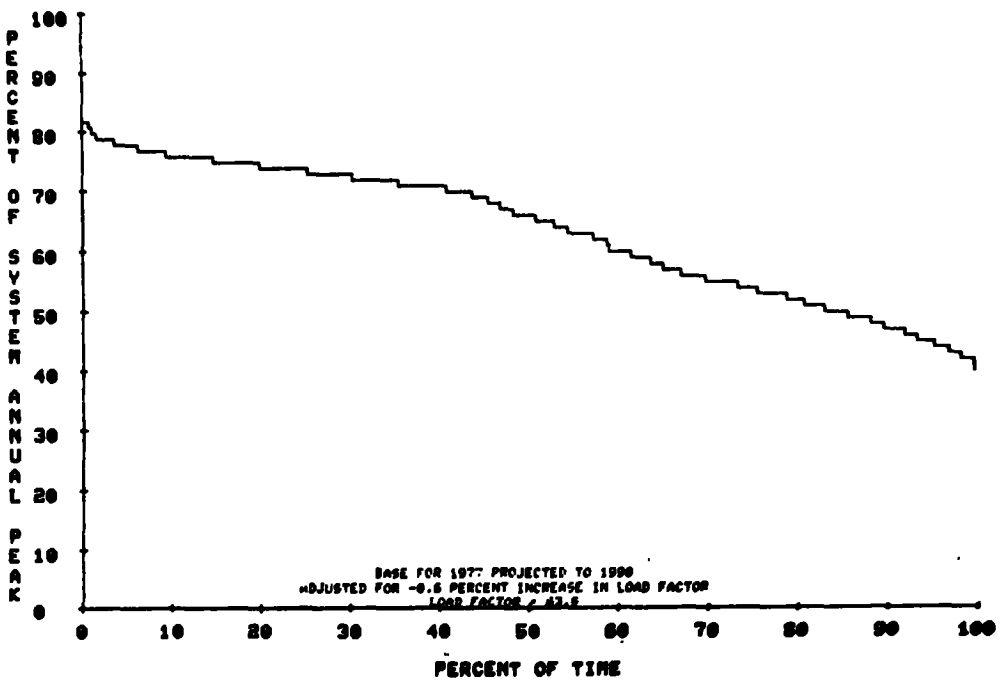


Figure 5-1
WEEKLY SUMMER LOAD CURVE AND ENERGY REQUIREMENTS

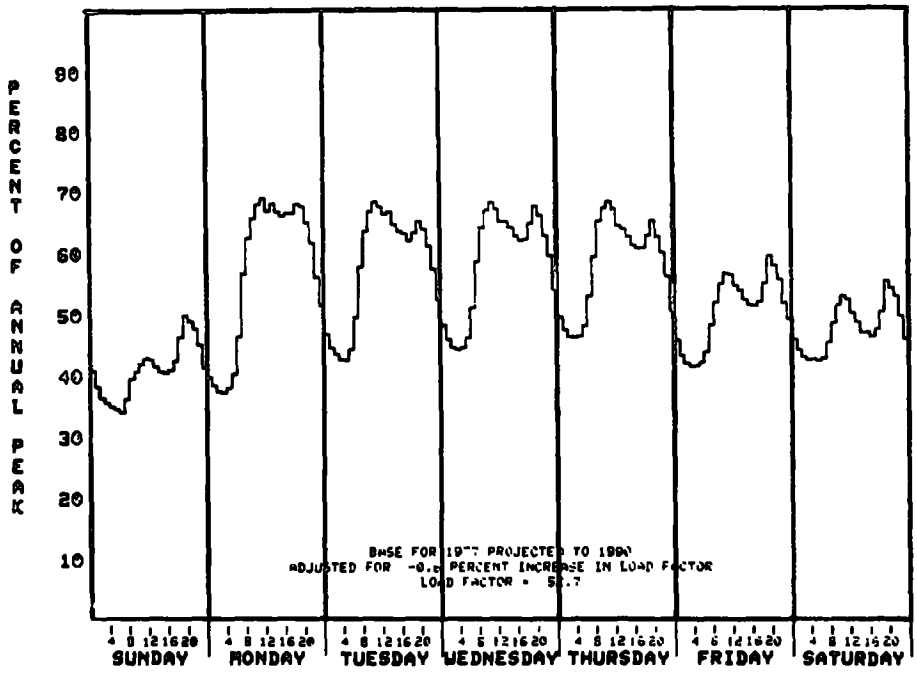


WEEKLY WINTER LOAD CURVE
PJM INTERCONNECTION

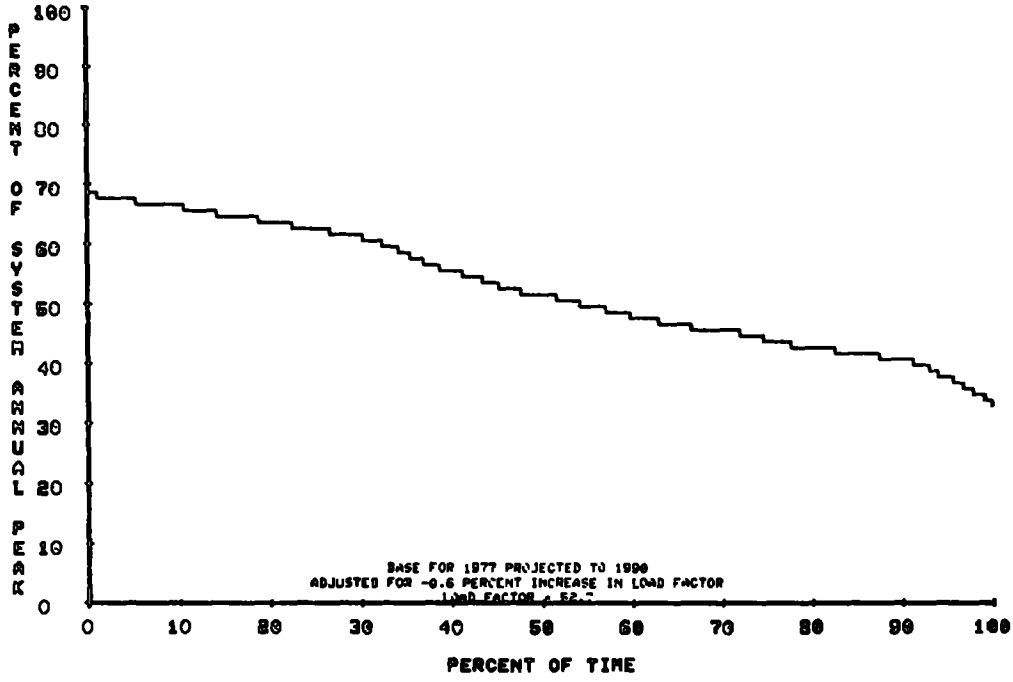


WEEKLY WINTER ENERGY REQUIREMENT
PJM INTERCONNECTION

Figure 5-2
WEEKLY WINTER LOAD CURVE AND ENERGY REQUIREMENT



WEEKLY OFF-SEASON LOAD CURVE
PJM INTERCONNECTION



WEEKLY OFF-SEASON ENERGY REQUIREMENT
PJM INTERCONNECTION

Figure 5-3
WEEKLY OFF-SEASON LOAD CURVE AND ENERGY REQUIREMENT

The resulting annual load-duration curve was then adjusted to match the projected regional peak and annual load factor for 1990 and 2000. In this form, the annual characteristics of existing, near term, and long term potential power developments can be indicated in relation to their placement on the future load shapes. Figure 5-4 shows the 1990 load shape with existing projects and near term potential projects occupying the upper peaking and intermediate portions of the load shape. Figure 5-5 shows the projected load shape for 2000 with existing plus near term and long term potential occupying the upper portion of the load.

This presentation should only be considered as a rough indication of the placement of potential hydropower on the projected future load shape since the actual placement can only be determined by detailed operational studies which are clearly beyond the scope of detail utilized in the National Hydropower Study.

5.3 IDENTIFYING SYSTEMS OF PROJECTS

The successive stages of the study culminated in the identification of 47 potential hydroelectric power sites including one which has been identified for both near and long term development in the MAAC Region. These sites which evolved through the several iterations previously described were assimilated into a group generally based upon their relative probability of development within two time frames, categorized as near term and long term. This group essentially comprises the regional plan for the MAAC Region. The composition of the plan is described in detail in Chapter 7 of this report.

The near term time frame is based on the assumptions that only retrofit of existing dams or additional facilities at dams currently under construction could be achieved within the next 10 years and that potential developers would be interested in developing hydroelectric power at sites where the unit cost of energy is shown to be 40 Mills/KWH or less. As shown in Table 7-5 of Chapter 7, there are 26 sites with a total potential of almost 440 megawatts which have been identified for near term development. The long term category comprised of 22 sites with a total potential of about 465 megawatts was generally designated for undeveloped sites and existing projects where the cost of retrofit would be 60 Mills/KWH or less.

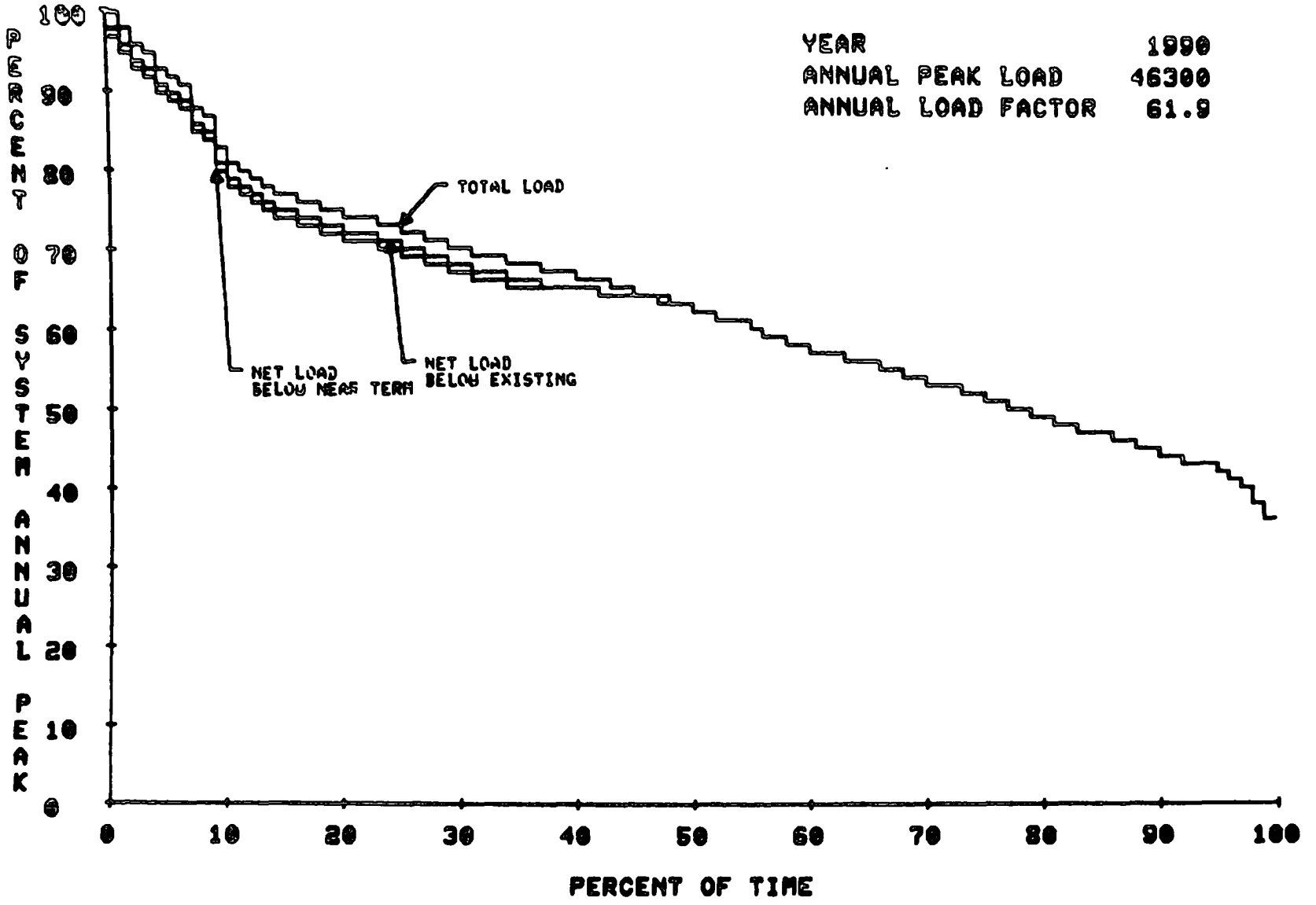


Figure 5-4
YEARLY ENERGY REQUIREMENT (LOAD SHAPE)—1980
COMPOSITE FOR SELECTED UTILITIES IN MAAC

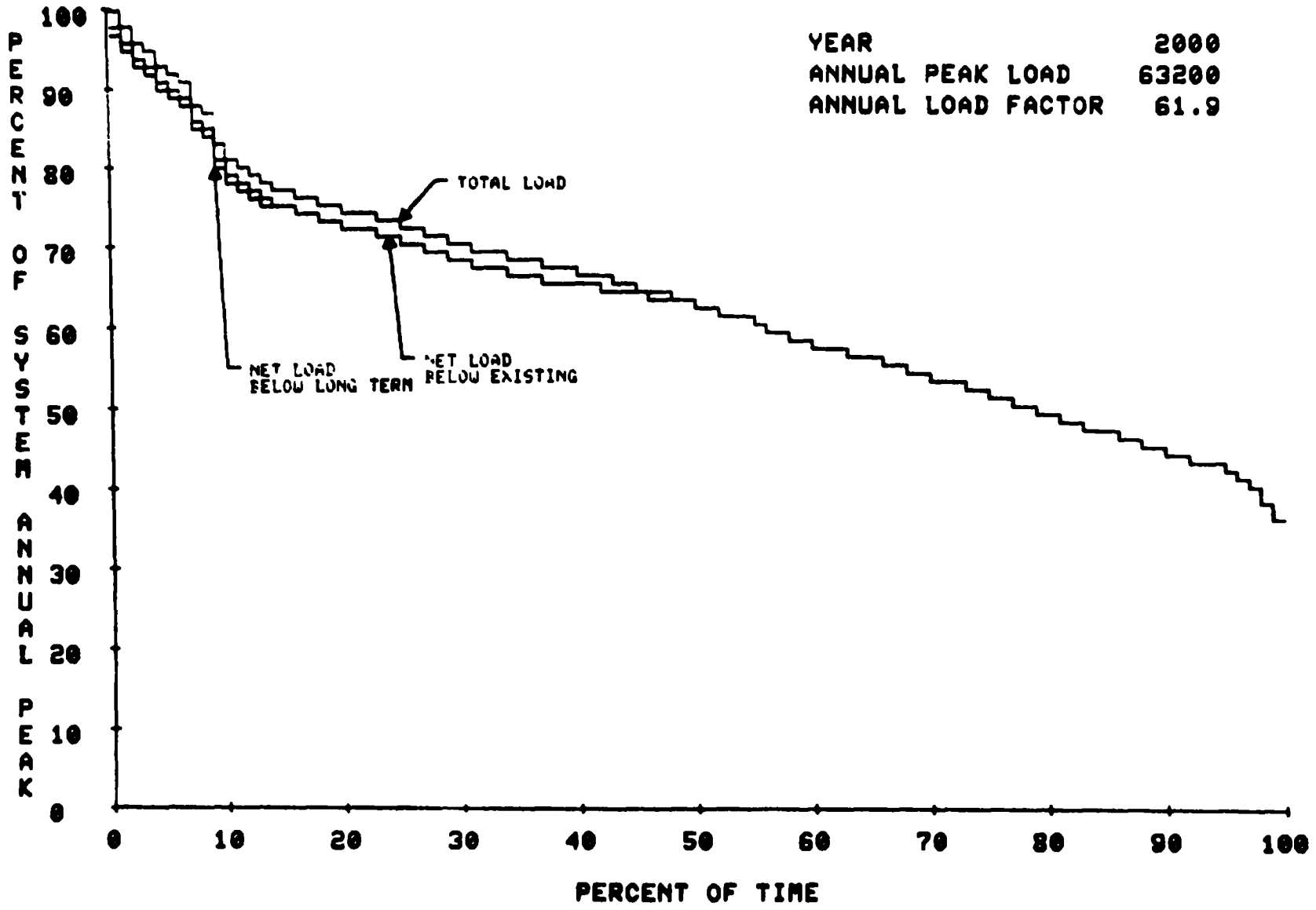


Figure 5-5
YEARLY ENERGY REQUIREMENT (LOAD SHARE)—2000

Chapter 6
PUBLIC INVOLVEMENT

6.1 ROLE OF PUBLIC INVOLVEMENT

Public involvement has been a valuable and an integral component of the study effort for the geographical region within the Mid-Atlantic Area Electric Reliability Council (MAAC). This component has been primarily directed to generating public awareness of and involvement in the study; soliciting information and providing a forum for review and coordination of the study output.

During the early stages of the study, public involvement mainly consisted of formal and informal coordination and contact with other Federal, state and local agencies, utilities, organizations and interested individuals. Although the generation of a public response was a continuous effort throughout the study, more emphasis was placed on involving the general public during the evaluation and identification of potential hydropower sites for the regional plan. The culmination of these efforts was the public meetings held during the latter stages of the study.

6.2 PUBLIC MEETINGS

Two public meetings were held on the regional study for the MAAC Region. Before each meeting, over 1,200 announcements, along with a listing of potential hydropower sites, were mailed to interested parties throughout the multi-state region. The mailing list developed for the region was derived from several sources and was representative of all public and private interests including governmental officials, utilities, and individuals with a known interest in hydroelectric power development. All interested parties were notified of the availability of a written transcript of meetings by notices subsequent to each meeting.

6.2.1 Location and Participation

The regional public meetings for the MAAC Region were held in Philadelphia, Pennsylvania on 7 May 1980 and 10 September 1980. Each of the meetings was attended by about 50 persons generally representing regional and local interests including Federal, state and regional agencies, utilities, professional organizations, educational and private interests.

The first public meeting was conducted after the initial screening of Stage 3. It was designed not only to provide a forum for the dissemination of background information, but also discussion of regional issues and the results of regional screening for the MAAC Region. Comments were received, either lending support to the analyses or providing additional information which led to a reassessment of individual sites and subsequent modifications to the screening results.

The second public meeting held on 10 September 1980 was designed to

inform the public and solicit public reaction or input on the reevaluation of sites in the active inventory which emerged from Stage 4 iterations. A preliminary plan was presented for the short and long term development of hydroelectric resources in the MAAC Region. Tabulated results of the reevaluation identified 47 sites which were proposed for inclusions in the regional plan.

6.2.2 Input

Public comments and concerns generated from the initial public meeting either lent support to study analysis or provided additional information on the validity of the physical data and operational assumptions used in the computation of hydropower potential and on the environmental, social and institutional aspects of developing identified sites for hydropower. This input set the stage for additional study effort and was incorporated in the formulation of the regional plan presented at the second public meeting.

6.2.3 Results

Public input generated from public meetings and associated activities resulted in refining the analyses of the physical and economic potential of hydropower in the MAAC Region. Potential hydropower sites with overriding impacts or problems were deleted from the active inventory. Other sites exhibiting problems or issues which would require considerable time to resolve were placed in the long range component of the regional plan. The foregoing analyses were described in the draft regional report which was coordinated with state agencies and utility interests prior to the second public meeting. Comments received through this activity have been carefully considered, and where appropriate, incorporated into the final decision process as reflected in the regional report.

Chapter 7
INVENTORY

7.1 STAGE 1, 2, AND 3 RESULTS

A comprehensive nationwide inventory of over 65,000 existing dams and undeveloped damsites was compiled during the initial phase of the National Hydroelectric Power Resources Study. The extensive computerized data base developed for the Corps' National Dam Safety Inventory Program was used as the foundation for the preliminary inventory; the format and data of the existing inspection inventory were utilized to the maximum extent possible. Data elements were transferred directly from the existing dam safety inventory to the preliminary inventory data base. This was supplemented by additional data on developed and undeveloped sites obtained from other available sources. The initial inventory for the MAAC Region as explained below was reduced to 47 sites during the first three stages of the study.

7.1.1 Size of Inventory

During the first stage of the study, all sites in the initial inventory were screened to delete those which did not possess sufficient storage, head, or flow to generate a significant amount of hydroelectric power. Those sites failing to meet the screening criteria were placed in an inactive category within the inventory. The criteria and standards used in the screening process are discussed in Chapter 5 of this report. Approximately 17,000 of the initial 65,000 sites were retained for evaluation in Stage 2.

The national inventory was further reduced to approximately 11,000 active sites as a result of a second screening during Stage 2 of the study. Screened on the basis of more refined or detailed data, these sites were retained in the active data base for analysis in the next stage of the study. The sites passing the study's second stage screening were summarized regionally and listed in a six volume report: "Preliminary Inventory of Hydropower Resources," dated July 1979 (NTIS # ADA-075962 thru 67).

From the active inventory of the approximately 11,000 sites identified during Stage 2, 254 sites were identified as being in the MAAC Region. These sites listed by States and FERC Power Supply Areas 5 and 6, which generally coincides with the boundary of MAAC are included in Volume 6 (Northeast Region) of the inventory referenced in preceding paragraph. The total potential capacity and energy for these sites are summarized by State and size in Table 7-1.

The iterative screening process of Stage 3 as described in Chapter 5 resulted in the deletion of over 200 of the 254 sites identified in Stage 2. Only about 50 percent of the existing sites were retained in the active inventory; most of the undeveloped reservoir sites were deleted. Based upon an evaluation of the screening, additional sites were added or deleted from

Table 7-1
PRELIMINARY INVENTORY OF HYDROELECTRIC POWER RESOURCES
(MAAC REGION')

STATE	EXISTING,[1] POTENTIAL INCREMENTAL[2] AND UNDEVELOPED[3] CAPACITY RANGES												TOTAL			
	Small-Scale (.05-15 MW)				Intermediate (15-25 MW)				Large-Scale (Greater Than 25 MW)				(All Sizes)			
	Exist	Incre	Undev	Total	Exist	Incre	Undev	Total	Exist	Incre	Undev	Total	Exist	Incre	Undev	Total
Delaware																
No. of Sites	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	2
Cap. (MW)	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	2
Ener (GWH)	0	0	6	6	0	0	0	0	0	0	0	0	0	0	6	6
Maryland																
No. of Sites	2	10	1	13	0	0	0	0	1	2	1	4	3	12	2	17
Cap. (MW)	2	13	4	19	0	0	0	0	474	437	191	1,102	476	450	195	1,121
Ener (GWH)	14	39	13	66	0	0	0	0	1,719	528	464	2,711	1,733	567	477	2,777
New Jersey																
No. of Sites	2	36	0	38	0	1	0	1	0	0	5	5	2	37	5	44
Cap. (MW)	6	21	0	27	0	23	0	23	0	0	647	647	6	44	647	697
Ener (GWH)	18	58	0	76	0	56	0	56	0	0	1,821	1,821	18	114	1,821	1,953
Pennsylvania																
No. of Sites	0	102	55	157	0	3	4	7	3	4	20	27	3	109	79	191
Cap. (MW)	0	118	176	294	0	51	79	130	374	436	2,420	3,230	374	605	2,675	3,654
Ener (GWH)	0	360	519	879	0	113	170	283	1,586	890	6,701	9,177	1,586	1,363	7,390	10,339
Region Total																
No. of Sites	4	148	58	210	0	4	4	8	4	6	26	36	8	158	88	254
Cap. (MW)	8	152	182	342	0	74	79	153	848	873	3,258	4,979	856	1,099	3,519	5,474
Ener (GWH)	32	457	538	1,027	0	169	170	339	3,305	1,418	8,986	13,709	3.337	2,044	9,694	15,075

[1] Existing hydroelectric power facilities currently generating power.

[2] Existing dams and/or other water resource projects with the potential for new and/or additional hydroelectric capacity.

[3] Undeveloped sites where no dam or other engineering structure presently exists.

the active inventory if there was definite non-Federal interest or local conditions warranted further study. The number of sites, along with capacity and energy, retained in the active file at the end of Stage 3 are summarized by state and listed in Table 7-2 and Table 7-3 respectively. Additional information on all sites that passed the Stage 3 screenings are listed in Exhibit B-1 of Appendix B.

Table 7-2
TOTAL HYDROELECTRIC POWER POTENTIAL IDENTIFIED DURING STAGE 3
(STAGE 3 RESULTS)

STATE	Capacity			
	Existing 1/	Incremental 2/	Undeveloped 3/	Total
Delaware				
No. Sites	0	0	0	0
Capacity (MW)	0	0	0	0
Energy (GWH)	0	0	0	0
District of Columbia				
No. Sites	0	0	0	0
Capacity (MW)	0	0	0	0
Energy (GWH)	0	0	0	0
Maryland				
No. Sites	0	2	0	2
Capacity (MW)	0	2.2	0	2.2
Energy (GWH)	0	9.6	0	9.6
New Jersey				
No. Sites	1	3	0	4
Capacity (MW)	7.6	20.1	0	27.7
Energy (GWH)	14.3	60.7	0	75.0
Pennsylvania				
No. Sites	3	37	1	41
Capacity (MW)	328.9	119.3	423.5	871.7
Energy (GWH)	656.8	466.9	520.7	1,644.4
Region Total				
No. Sites	4	42	1	47
Capacity (MW)	336.5	141.6	423.5	901.6
Energy (GWH)	671.1	537.2	520.7	1,729.0

1/ Existing hydroelectric power facilities currently generating power.
2/ Existing dams and/or other water resources projects with the potential for new and/or additional hydroelectric capacity.
3/ Undeveloped sites where no dam or other engineering structure presently exists.

Table 7-3
SITES RETAINED IN ACTIVE INVENTORY, STAGE 3

NAME	STATE	STREAM	CAPACITY (MW)	ENERGY (MWH)	B/C	MILLS/KWH
ALLENTOWN	PA	LEHIGH RIVER	1.757	8,940	0.62	44.391
ALVIN R. BUSH	PA	KETTLE CREEK	1.323	5,160	0.88	38.209
BELTZVILLE	PA	POHOPOCO CREEK	2.291	10,915	1.17	24.115
BLACK ROCK DAM	PA	SCHUYLKILL	1.383	8,140	0.61	42.785
BLUE MARSH	PA	TULPEHOCKEN	1.098	6,338	1.15	23.162
BRIGHTON DAM	MD	PATUXENT	0.379	1,771	0.75	53.381
CHAIN DAM	PA	LEHIGH RIVER	1.625	10,292	0.71	36.296
CONEMAUGH	PA	CONEMAUGH RIVER	8.000	33,100	1.57	25.774
COWANESQUE	PA	COWANESQUE RIVER	2.394	6,363	1.14	37.150
CURWENSVILLE	PA	WEST BRANCH	1.375	6,539	0.81	33,841
EASTON DAM	PA	LEHIGH RIVER	1.835	11,621	0.78	33,237
FAIRMOUNT DAM	PA	SCHUYLKILL	2.850	14,834	0.96	28.332
FELIX DAM	PA	SCHUYLKILL	1.576	9,588	0.90	28.723
FLAT ROCK DAM	PA	SCHUYLKILL	3.716	18,397	1. 3	26.440
F. E. WALTER 1/	PA	LEHIGH RIVER	24.678	64,287	2.99	18.187
GREEN LANE	PA	PERKIOMEN	0.828	2,697	0.85	56.999
HAMMOND DAM	PA	CROOKED CREEK	1.155	3,368	0.75	54.330
HEPBURN ST. DAM	PA	WEST BRANCH	6.357	36,235	1. 7	23. 68
HOLTWOOD	PA	SUSQUEHANNA	121.767	385,185	2.56	13.665
KEATING 2/	PA	W. BR. SUSQUEHANNA	423.580	520,713	1. 2	54.917
LAKE ONTELAUNFE	PA	MAIDEN CREEK	1.608	4,544	0.96	43.402
LITTLE FALLS	NJ	PASSAIC	7.585	14,337	1.73	29.523
LITTLE PINE CK. DAM	PA	LITTLE PINE CREEK	0.812	3,262	0.64	50.218
MUSSERS DAM	PA	MIDDLE CREEK	0.654	3,595	0.62	43.585
NEW KERNSVILLE	PA	SCHUYLKILL	0.639	3,780	0.49	52.880
NOCKAMIXON	PA	TOHICKON CREEK	0.959	3,068	1. 5	46.619
NORRISTOWN DAM	PA	SCHUYLKILL	1.404	7,165	0.55	49. 47
OAKLAND	PA	SUSQUEHANNA	3.000	12,200	0.72	45.190
OAK RIDGE	NJ	PEQUANNOCK	4.255	10,398	1.47	29.464
OCTORARO	PA	OCTORARO CREEK	0.301	2,623	0.70	43. 80
PENN FOREST DAM	PA	WILD CREEK	0.495	2,487	0.71	38.420
POCONO DAM	PA	TOBYHANNA	1.123	3,742	0.87	44.746
PRETTY BOY	MD	GUNPOWDER	1.790	7,875	1. 6	28.542
PROMPTON DAM	PA	LACKAWAXEN	1.238	4,793	1.27	35.601
RAYSTOWN	PA	RAYSTOWN BRANCH	21.257	84,740	2.53	13.146
SAFE HARBOR	PA	SUSQUEHANNA	175.141	131,599	2.34	49.176
SUM HYDRO	NJ	PASSAIC	14.942	45,314	1.29	31.223
TIOGA DAM	PA	TIOGA RIVER	3,393	8,477	1.36	31.604
TREICHLERS	PA	LEHIGH RIVER	1.428	8,279	0.61	42.829
UNION LAKE DAM	NJ	MAURICE RIVER	0.888	5,017	0.76	35.891
VINCENT DAM	PA	SCHUYLKILL	.942	5,587	0.51	51.664
WARRIOR RIDGE	PA	JUNIATA RIVER	4.468	17,798	1.79	18.609
YORK HAVEN	PA	SUSQUEHANNA	32.000	140.000	1.62	28.900
PYMATUNING	PA	SHENANGO RIVER	1.314	4,160	0.89	44.202
QUEMAHONIN	PA	QUEMAHONING CREEK	1.504	5,192	0.97	39.108
TIONESTA DAM	PA	TIONESTA CREEK	7.229	20,198	1.73	24.009
TWO LICK CREEK	PA	TWO LICK CREEK	1.219	4,343	0.89	41.488
TOTAL			901.555	1,729,056		

1/ Includes 8.3 Megawatts (MW) of the total 24.7 MW for the existing project which can possibly be developed before 1990 prior to the construction of authorized plan of improvement for water supply development. This is reflected under the near term category in the regional plan.

2/ Undeveloped site.

As shown in the preceding tables, almost 90 percent of all the sites which passed Stage 3 evaluations, including the four largest, are in the Commonwealth of Pennsylvania. The four largest sites: Holtwood, Keating, Safe Harbor and York Haven are located in the Susquehanna River Basin in the south central portion of the MAAC Region.

Thirteen of the sites that survived the initial screening in Stage 3 were subsequently deleted from the active inventory on the basis of environmental, social and institutional factors. These sites, along with the major reasons for their deletion are listed in Table 7-4.

7.1.2 Potential Development

Of the 47 sites surviving the first three stages of the study, four are existing sites currently generating power, 42 are existing sites with a potential for new hydroelectric capacity, and one is an undeveloped site. These projects are listed in Table 7-2. Three of the four existing sites: Holtwood, Safe Harbor and York Haven are the only existing sites that can be categorized as large scale sites. Except for Francis E. Walters, which shows a capacity of 24.6 MW, the other existing sites are all small scale sites. Keating, the only undeveloped or new site identified in the active inventory has a potential capacity of about 425 megawatts. It shows a potential for large scale development. A listing of these sites by size is in Exhibit B-2 of Appendix B.

7.2 STAGE 4 INVENTORY

The sites which emerged from Stage 3 were used to assimilate a regional plan as described in Chapter 5. Sites retained in the active file were grouped into two categories: near term and long term for evaluating the relative importance of the regional hydroelectric power potential. The sites within the two categories comprise the regional plan for the MAAC Region. One site, the Francis E. Walters, an existing Corps of Engineers' project has been identified for both near and long term development. Table 7-5 shows the composition of the plan for the region. The locations of the sites are shown in Figure 7-1 and in the MAAC regional map in the pocket insert (back cover).

The sites included in the near term component of the plan, can be separated into three groups. First, there are the existing hydroelectric power projects located on the main stem of the Susquehanna River which show good potential for increasing their capacity. These sites, Safe Harbor, Holtwood and York Haven. are currently being actively pursued by the power companies. They have the potential for adding significant energy and capacity to the existing power grid. Secondly, there are existing reservoir sites which have exhibited potential for adding 5-20 MW of hydropower to the existing project purposes. These sites have primary energy producing potential but also have some dependable capacity. The third group is comprised of reservoirs which have energy producing potential, but little or no dependable capacity.

The long term component includes the undeveloped site; the proposed

Table 7-4
POTENTIAL HYDROELECTRIC POWER SITES DELETED, SECOND SCREENING, STAGE 3

Location and Name of Site	River	SIZE OF SITE, CAPACITY Intermediate Scale (15-25 MW)	Large Scale (Greater than 25 MW)	Energy GWH	Major Reason for Deletion
Maryland					
New Jersey					
Chestnut Hill	Delaware	23.20		167.1	Floods Pennsylvania Power & Light Company's Martins Creek Power Plant
Tocks Island	Delaware		46.00	281.5	Within Delaware Water Gap National Recreation Area
Pennsylvania					
Barryville	Delaware		52.61	163.9	Within Delaware River Scenic Limits and extensive relocations.
Bloomsburg	Susquehanna		73.66	276.0	Inundate part of Berwick plus extensive relocations required.
Farrandsville	W. Branch Susquehanna		95.13	261.9	Inundate part of Renovo
Half Falls	Susquehanna		275.03	642.8	Parts of 3 small communities would be inundated and major road and railroad relocations.
Keelersburg	Susquehanna		323.92	737.7	Many communities inundated, major relocations.
Lackawaxen	Lackawaxen		64.04	124.7	Major disruption of local economy, social impacts and extensive relocations.
Marysville	Susquehanna		264.69	595.2	Part of Dauphin Borough would be inundated and major relocations required.
Newport	Juniata	24.65		77.5	Backwater flooding problem and railroad relocation.
Paxton	Susquehanna		274.44	788.3	Inundate part of Selingrove and major road and railroad relocation would be required.
Yardley	Delaware	21.93		137.2	Inundates portions of Washington's Crossing State Park and inundate major highway interchange.
TOTALS		69.78	1,469.52	4,253.8	

Table 7-5
COMPOSITION OF REGIONAL PLAN FOR MAAC REGION

IDENTIFICATION	NAME	CAPACITY (MW)	ENERGY (GWH)	MILLS/KWH
NEAR TERM				
PAINAB0082	SAFE HARBOR	175.1	131.6	49.0 1/
PAINAB0081	HOLTWOOD	121.8	385.2	22.1 1/
PAINAB9989	YORK HAVEN	32.0	140.0	28.9 1/
PACNAB0072	RAYSTOWN	21.3	84.7	13.1
NJMNAN0029	SUM HYDRO	14.9	45.3	31.0
PACNAP0058	F.E. WALTER 2/	8.3	21.8	22.5
PACORP0098	CONEMAUGH	8.0	33.1	24.0
NJBNAN0028	LITTLE FALLS	5.2	9.8	41.6
PACORP0094	TIONESTA	7.2	20.2	25.0
PAANAB9991	HEPBURN ST.	6.4	36.0	23.7
PAMNAB0073	WARRIOR RIDGE	4.5	18.0	18.6
NJCNAN0009	OAK RIDGE	4.3	10.4	29.0
PAANAP8025	FLAT ROCK	3.7	18.4	26.4
PACNAB0143	TIOGA	3.4	8.5	31.6
PAANAP0063	FAIRMOUNT	2.8	14.8	28.3
PAANAB0142	COWANESQUE	2.4	6.4	37.1
PACNAP0047	BELTSVILLE	2.3	10.9	24.1
PAANAP8022	EASTON	1.8	11.6	33.2
MDCNAB0003	PRETTY BOY	1.8	7.8	28.5
PAANAP8023	CHAIN DAM	1.6	10.3	36.3
PAANAP8030	FELIX	1.6	9.6	28.7
PACNAB0056	CURWENSVILLE	1.4	6.5	33.2
PACNAB0061	ALVIN R. BUSH	1.3	5.1	38.2
PACNAP0038	BLUE MARSH	1.1	6.3	23.2
NJCNAP8032	UNION LAKE	0.9	5.0	35.9
PACNAP0049	PENN FOREST	0.5	1.5	38.4
SUBTOTAL		435.6	1059.1	
LONG TERM				
PAGNAB0059	KEATING	423.6	520.7	50.0
PACNAB8021	F.E. WALTER 2/	16.4	42.5	18.2
PAMNAA9980	OAKLAND	3.0	12.2	45.2
PAANAP9001	ALLENTOWN	1.8	8.9	46.5
PACNAP0037	LAKE ONTELANEE	1.6	4.5	43.4
PAAORP0127	QUEMAHONING	1.5	5.7	40.0
PAANAP8027	NORRISTOWN	1.4	7.2	49.5
PAANAP8028	BLACK ROCK	1.4	8.2	42.8
PAANAP8024	TREICHLER	1.4	8.2	42.8
PAORP0079	PYMATUNING	1.3	4.2	44.2
PACNJAB0144	HAMMOND	1.2	3.4	54.0
PACORP0100	TWO LICK	1.2	4.3	42.0
PACNAP8039	PROMPTON	1.2	4.8	35.0
PACNAP0059	POCONO	1.1	3.7	44.7
PACNAP0041	NOCKAMIXON	1.0	3.1	46.6
PAANAP8029	VINCENT	0.9	5.6	51.7
PACNAP0062	GREEN LANE	0.8	2.7	57.0
PACNAB0071	LITTLE PINE CREEK	0.8	3.3	50.2
PAANAP8031	NEWKERNSVILLE	0.6	3.8	52.9
PACNAB0052	OCTORARO	0.5	2.8	45.0
PAANAB9992	MUSSERS	0.7	3.1	42.5
MDCNAB0016	BRIGHTON	0.4	1.7	52.3
SUBTOTAL		463.8	664.6	
TOTAL FOR REGIONAL PLAN		899.4	1723.7	

1/ Benefits primarily from capacity benefits, sizing based on owners projected power additions.

2/ Total capacity of 24.7 MW at the existing project adjusted to reflect 8.3 MW that can possibly be developed before 1990 prior to the construction of authorized plan of improvement for water supply development. This is reflected under the near term category.

modifications to existing sites; and those existing sites with marginal economic feasibility based on the current costs of energy. These sites are expected to become more feasible in the future as a result of projected costs of energy. All but three of the 22 long term sites, including Francis E. Walter are existing reservoirs with some energy producing potential, but little or no dependable capacity. Two sites included in the plan: Francis E. Walter and Prompton, which exhibit good hydropower potential are existing reservoir projects that have been authorized for modifications by the Corps of Engineers, Although these sites are considered to meet the criteria for the near term component of the plan, it is not anticipated that modifications to the project would be completed in time to put the power on line before 1990.

The only undeveloped site to pass the economic and environmental screening was the Keating site. The Keating site, located in an essentially undeveloped region of central Pennsylvania has the potential for a large scale multi-purpose project. This site has been studied several times in the past and has shown significant potential for hydropower, flood control, and water supply; however, the expensive embankment construction and extensive railroad relocations have made it uneconomical. However, the information generated by the Stage 3 analysis showed the site to be economically feasible.

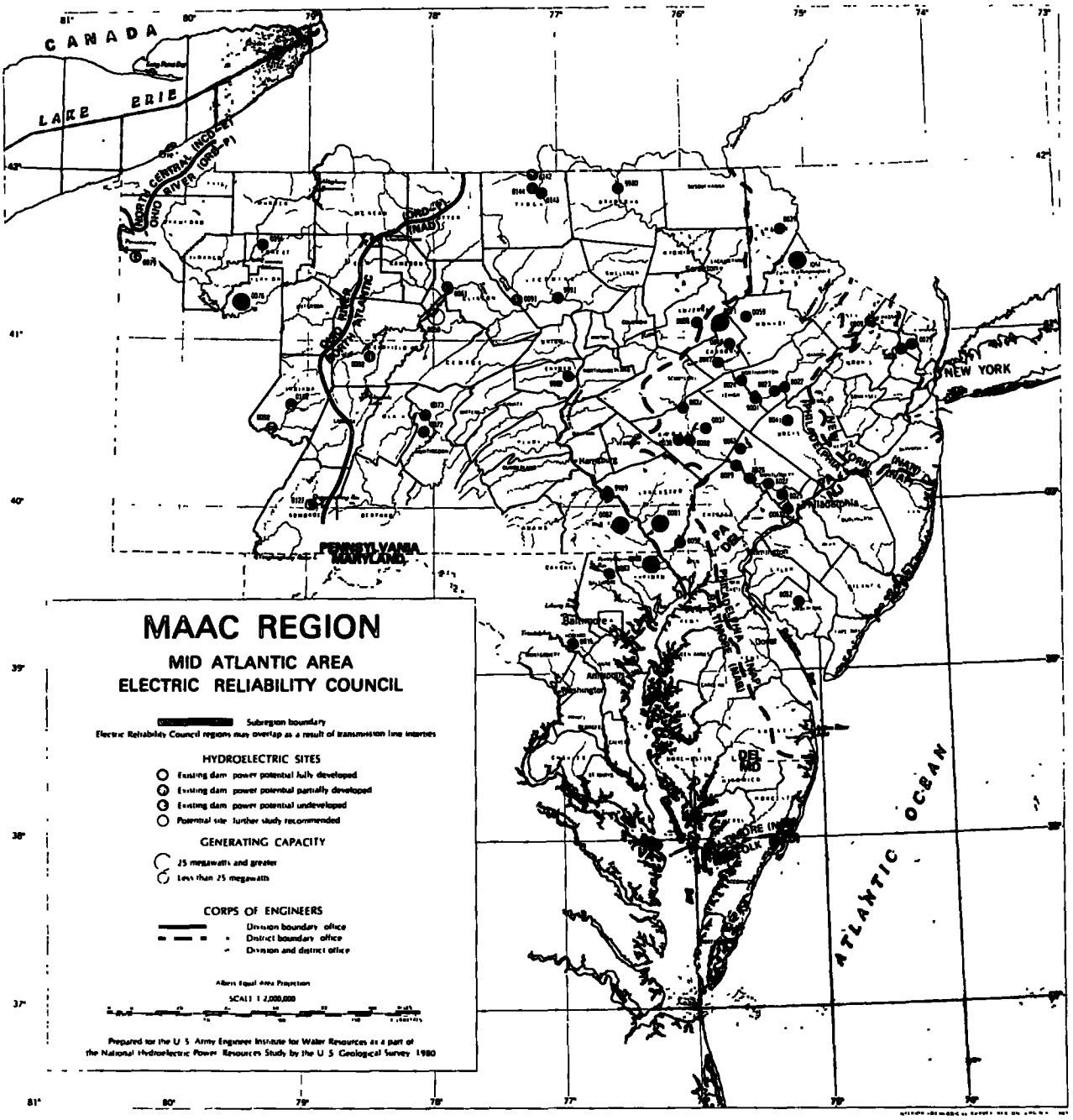


Figure 7-1
LOCATION OF SITES COMPRISING REGIONAL PLAN

Chapter 8
EVALUATION

8.1 REGIONAL PLAN DEVELOPMENT

The evaluation of hydroelectric power resources in the MAAC Region resulted in the identification of 46 existing dams and one undeveloped site, with a total potential of about 900 megawatts and a combined annual generation of about 1.7 billion kilowatt-hours of energy. As previously listed and shown in the preceding chapter, Table 7-5 and Figure 7-1 respectively, these 47 sites were grouped to comprise the regional plan. They were categorized as having either near or long term potential for development. The time frame for development of these sites was based on the economic feasibility under current and anticipated future conditions or by a realistic estimate of an implementation schedule.

Twenty-six of the 47 sites comprising the regional plan were identified for near term development. These consist of three existing dam sites which could be modified to increase their current hydroelectric power capacities and 22 existing dam sites where a potential exist for adding hydroelectric power facilities as a new project feature. A total potential of about 436 megawatts or 48.4 percent of the total identified for the regional plan could be achieved for the MAAC Region by developing the 26 sites. The total annual generation of these sites would amount to nearly 1.1 billion kilowatt-hours of energy. Of the increased capacity, about 350 megawatts would have some load following capability primarily from four existing sites: Safe Harbor, Holtwood, York Haven and Raystown; only the first three are currently generating power. The implementation of the other sites would be justified primarily because of their energy producing capability. Most of the energy would be secondary energy without much dependable capacity.

The 22 sites identified for long term development consist of 21 existing dam sites, including one also identified for near term development, the Francis E. Walter site; and one undeveloped site which could be modified to add hydroelectric power facilities. Francis E. Walter site is also identified for near term development due to its good potential for hydroelectric power. The total capacity and energy which could be provided by the long term sites are nearly 464 megawatts and about 0.7 billion kilowatt-hours respectively. All of the dependable capacity and load following potential is contained at two sites: Francis E. Walter and Keating; these two sites provide nearly 95 percent of the total potential identified for long term development. Francis E. Walter, an existing Corps of Engineers project is currently being evaluated for water supply. In addition to the near term potential identified for Francis E. Walters, an increase in hydroelectric power potential would be realized from the modification of the site.

By far, the largest site, Keating has a capacity of about 424 megawatts. It could provide large amounts of dependable capacity and energy along with

significant flood control and water supply benefits. Although past studies have shown significant potential for providing hydroelectric power, flood control, and water supply at Keating, it was found to be uneconomical due to expensive embankment construction and extensive railroad relocations. Due to the increased costs of other forms of power generation, the benefits for hydropower have been increasing rapidly and may make development of this site economical. The site has definite peaking capabilities and sufficient storage for a significant dependable capacity. Significant cost and benefits are not reflected in the evaluation for Keating. No railroad relocation costs or costs for a re-regulating dam or significant benefits for flood control and water supply were included in the analysis. True, economic feasibility is difficult to determine without further study on the multi-purposes; however, with power costs increasing, the potential for economically justifying a project like Keating can only be improving. Substantial environmental opposition has been voiced in the past on Keating, which is not unlike any reservoir project of this size and nature. The environmental implementation constraints may be significant due to the undeveloped nature of the project, but due to the large contribution to the power grid and the lack of detailed analysis of the adverse impacts of the project, it has been identified in the regional plan for long term development.

Although there are apparent definite impacts of the implementation of a project, the scale of Keating, the limited investigation done under this study did not identify any overriding impacts. The 19 remaining sites identified for the long term development are primarily energy producing sites with no dependable capacity.

The total capacity of about 900 megawatts for the regional plan for the MAAC Region is only about 1.4 percent of the total demand of 63,200 megawatts projected for 2000. As described in Chapter 5 and shown on Figures 5-4 and 5-5 respectively, near term sites along with existing projects will occupy the upper peaking and intermediate portion of the load curve, and the long term sites with existing and long term potential would occupy the upper portion of the load curve. The contribution which hydroelectric power can make to the region is not large when compared to MAAC's total generating capability. However, it should not be overlooked because it is an economically stable, environmentally sound and renewable source of energy. Figures 5-4 and 5-5, the loads for 1990 along with existing projects will occupy the upper peaking and intermediate portion of the load curve.

The environmental and social impacts of the near term and long term potential sites should be minimal with the exception of the identified site, Keating. Except for Keating, the other sites are existing dams and except for a minimal amount of pondage no storage has been allocated for the purpose of hydropower at any of the sites. Only minimal impact to the existing project purposes of these sites is anticipated due to the addition of hydropower. Only obvious adverse impacts were identified during this study, but, during more detailed feasibility studies, extensive studies would be required to determine the impacts of adding hydroelectric power such as

downstream releases, water quality, dam safety and effect on other project purposes

8.2 SCHEDULE FOR DEVELOPMENT

The two time frames established for the development of hydroelectric power potential identified in this report are based on the economic feasibility of sites under current and anticipated future conditions or by a realistic estimate of schedule for implementation.

Near Term

It is anticipated that the 26 sites identified for near term development could have power on line by 1990. The total potential of 435.6 megawatts, along with an average annual generation of about 1.1 billion kilowatt-hours, is only about one percent of the total demand of 46,000 megawatts projected to 1990 for the MAAC Region.

Long Term

The 21 sites identified for long term development are anticipated to be able to have power on line between 1990 and 2000. The total potential of about 464 megawatts with existing and near term potential would account for a little over 1.4 percent of the total demand of 63,200 megawatts projected to year 2000. It would provide for an average annual generation of about 0.7 billion kilowatt-hours of energy. Although Francis E. Walter and Prompton, the two existing Corps of Engineers' sites satisfied the criteria for near term development, they are designated for long term development since it is unlikely that authorized modifications would be completed in time for power to be put on line before 1990.

8.3. FEASIBILITY OF REGIONAL PLAN

The results of this study indicate that hydroelectric power generation has some limited but significant potential within the MAAC Region. The primary sources of hydroelectric power in the region are from optimizing the size and operation of the few existing hydroelectric power installations and from incorporating small hydroelectric power projects at other existing dams where there is a potential to produce energy at an economical cost. Very little new dependable capacity could be obtained from hydroelectric power in this region because most of the water resource projects are small and are now operated for conflicting purposes. All but one undeveloped site has been eliminated as potential hydroelectric power projects because of overriding economic and environmnental impacts.

The very heavily developed nature of the river basins in the MAAC Region make development of any new large multi-purpose reservoir very difficult. The undeveloped Keating site has been retained in the long term plan due to its very good hydroelectric power potential combined with additional water supply and flood control benefits. More detailed studies of all sites will be required to definitely determine their feasibility for hydroelectric power development.

GLOSSARY

Abbreviations

British thermal units	Btu	kilowatt	kW
doliars	$	kilowatt-hours	kWhr
gigawatt	GW	megawatt	MW
gigawatt-hours	GWhr	megawatt-hours	MWhr

AVERAGE LOAD-the hypothetical constant load over a specified time period that would produce the same energy as the actual load would produce for the same period.

BENEFIT-COST RATIO (B/C)-the ratio of the present value of the benefit stream to the present value of the project cost stream computed for comparable price level assumptions.

BENEFITS (ECONOMIC)-the increase in economic value produced by a project, typically represented as a time stream of value produced by the generation of hydroelectric power.

BRITISH THERMAL UNIT (Btu)-the quantity of heat energy required to raise the temperature of 1 pound of water degree Fahrenheit, at sea level.

BUS-an electrical conductor which serves as a common connection for two or more electrical circuits. A bus may be in the form of rigid bars, either circular or rectangular in cross sections, or in form of stranded-conductor overhead cables held under tension.

BUSBAR-an electrical conductor in the form of rigid bars, located in switchyard or powerplants, serving as a common connection for two or more electrical circuits.

CAPACITY-the maximum power output or load for which a turbine-generator, station, or system is rated.

CAPACITY VALUE-that part of the market value of electric power which is assigned to dependable capacity.

COSTS (ECONOMIC)-the stream of value required to produce the project output. In hydro projects this is often limited to the management and construction cost required to develop the powerplant, and the administration, operations, maintenance and replacement costs required to continue the powerplant in service.

CRITICAL STREAMFLOW-the amount of streamflow available for hydroelectric power generation during the most adverse streamflow period.

DEMAND-see LOAD.

DEPENDABLE CAPACITY-the load carrying ability of a hydropower plant under adverse hydrologic conditions for the time interval and period specified of a particular system load.

DIVERSION-the removal of streamflow from its normal water source such as diverting flow from a river for purposes such as power generation or irrigation.

DRAFT TUBE-that section of the turbine water passage which extends from the discharge side of the turbine runner to the downstream extremity of the powerhouse structure.

ENERGY-the capacity for performing work. The electrical energy term generally used is kilowatt-hours and represents power (kilowatts) operating for some time period (hours).

ENERGY VALUE-that part of the market value of electric power which is assigned to energy generated.

FEASIBILITY STUDY-an investigation performed to formulate a hydropower project and definitively assess its desirability for implementation.

FEDERAL ENERGY REGULATORY COMMISSION (FERC)-an agency in the Department of Energy which licenses non-Federal hydropower projects and regulates interstate transfer of electric energy. Formerly the Federal Power Commission (FPC).

FIRM ENERGY-the energy generation ability of a hydropower plant under adverse hydrologic conditions for the time interval and period specified of a particular system load.

FORCED OUTAGE-the shutting down of a generating unit for emergency reasons.

FORCED OUTAGE RATE-the percent of scheduled generating time a unit is unable to generate because of forced outages due to mechanical, electrical or another failure.

FOREBAY-this generally refers to the reservoir area located immediately upstream of a dam or powerhouse.

FOSSIL FUELS-refers to coal, oil, and natural gas.

GENERATOR-a machine which converts mechanical energy into electric energy.

GIGAWATT (GW)-one million kilowatts.

HEAD, GROSS (H)-the difference in elevation between the headwater surface above and the tailwater surface below a hydroelectric powerplant, under specified conditions.

HORSEPOWER-mechanical energy equivalent to 550 ft. lbs. per second of work.

HYDROELECTRIC PLANT OR HYDROPOWER PLANT-an electric power plant in which the turbine-generators are driven by falling water.

IMPOUNDMENTS-bodies of water created by erecting a barrier to flow such as dams and diversion structures.

INSTALLED CAPACITY-the total of the capacities shown on the nameplates of the generating units in a hydropower plant.

INTAKE STRUCTURE-a concrete structure arranged to control the flow of water from a reservoir to the ultimate point of use. This structure usually contains either intake gates, or large valves, for regulating the rate of flow and for shutoff purposes.

KILOWATT (kW)-one thousand watts.

KILOWATT-HOUR (kWh)-the amount of electrical energy involved with a one kilowatt demand over a period of one hour. It is equivalent to 3,413 Btu of heat energy.

LOAD-the amount of power needed to be delivered at a given point on an electric system.

LOAD CURVE-a curve showing power (kilowatts) supplied, plotted against time of occurrence, and illustrating the varying magnitude of the load during the period covered.

LOAD FACTOR-the ratio of the average load during a designated period to the peak or maximum load occurring in that period.

LOW HEAD HYDROPOWER-hydropower that operates with a head of 20 meters (66 feet) or less.

MEGAWATT (MW)-one thousand kilowatts.

MEGAWATT-HOURS (MWh)-one thousand kilowatt-hours.

MULTIPURPOSE RIVER BASIN PROGRAM-programs for the development of rivers with dams and related structures which serve more than one purpose, such as - hydroelectric power, irrigation, water supply, water quality control, and fish and wildlife enhancement.

NUCLEAR POWER-power released from the heat of nuclear reactions, which is converted to electric power by a turbine-generator unit.

OPERATING POLICY (Operating Rule Curves)-the technical operating guide adopted for water resources projects to assure that authorized output of the project is achieved. Usually in the form of charts and graphs of reservoir release rates for various operational situations.

OUTAGE-the period in which a generating unit, transmission line, or other facility, is out of service.

PEAK LOAD-the maximum load in a stated period of time.

PEAKING CAPACITY-the part of a system's capacity which is operated during the hours of highest power demand.

PENSTOCK-a large water conduit which is subjected to high internal pressure and is fully self-supporting.

PLANT FACTOR-ratio of the average load to the installed capacity of the plant, expressed as an annual percentage.

PONDAGE-the amount of water stored behind a hydroelectric dam of relatively small storage capacity used for daily or weekly regulation of the flow of a river.

POWER (ELECTRIC)-the rate of generation or use of electric energy, usually measured in kilowatts.

POWER POOL-two or more electric systems which are interconnected and coordinated to a greater or lesser degree to supply, in the most economical manner, electric power for their combined loads.

PUMPED STORAGE-an arrangement whereby electric power is generated during peak load periods by using water previously pumped into a storage reservoir during off-peak periods.

REALLOCATION-the concept of changing the existing distribution in use of reservoir storage space to a new distribution. Reallocation of flood control storage to power storage would reduce reservoir storage space reserved for temporary storage of flood water and increase the conservation storage available for power operation.

RECONNAISSANCE STUDY-a preliminary feasibility study designed to ascertain whether a feasibility study is warranted.

REVERSIBLE PUMP TURBINE-a Francis type hydraulic turbine which is designed to operate a pump in one direction of rotation, and as a turbine in the opposite direction of rotation. Good efficiencies can be achieved with both modes of operation.

RUNNER BLADES-the propeller like vanes of a hydraulic turbine which convert the kinetic energy of the water into mechanical power.

SECONDARY ENERGY-all hydroelectric energy other than FIRM ENERGY.

SPINNING RESERVE-generating units operating at no load or at partial load with excess capacity readily available to support additional load.

STEAM-ELECTRIC PLANT-a plant in which the prime movers (turbines) connected to the generators are driven by steam.

SURPLUS POWER-generating capacity which is not needed on system at the time it is available.

SYSTEM, ELECTRIC-the physically connected generation, transmission, distribution, and other faciltiies operated as an integral unit under one control, management or operating supervision.

TAILWATER LEVEL-the water level measured in the tailrace area immediately downstream from a hydro plant.

THERMAL PLANT-a generating plant which uses heat to produce electricity. Such plants may burn coal, gas, oil, or use nuclear energy to produce thermal energy.

TRANSMISSION-the act or process of transporting electric energy in bulk.

TURBINE-the part of a generating unit which is spun by the force of water or steam to drive an electric generator. The turbine usually consists of a series of curved vanes or blades on a central spindle.

Impulse Turbines-an impulse turbine is one having one or more free jets discharging into an aerated space and impinging on the buckets of the runner, means of controlling the rate of flow, a housing and a discharge passage. The water supplies energy to the runner in kinetic form.

Reaction Turbine-a reaction turbine is one having a water supply case, a mechanism for controlling the quantity of water and for distributing it equally over the entire runner intake, and a draft tube. The water supplies energy to the runner in kinetic form.

Francis Turbine-a reaction turbine having a runner with a large number of fixed buckets, usually nine or more, to which the water is supplied in a whirling radial direction and can be designed for operating heads ranging from 50 feet to 2,000 feet.

Adjustable-Blade Propeller Turbine (KAPLAN)-a reaction turbine having a runner with a small number of blades, usually four to eight, to which the water is supplied in a whirling axial direction. The blades are angularly adjustable in the hub.

Fixed-Blade Propeller Turbine-a reaction turbine having a runner with a small number of blades, usually four to eight, to which the water is supplied in a whirling axial direction. The blades are rigidly fastened to the hub.

UNIT EFFICIENCY-the combined overall efficiency of a hydraulic turbine and its driven generator.

UPRATING-increasing the generating capacity of a hydropower plant by either replacing existing equipment with new equipment or making improvements to the existing equipment.

WATT-the rate of energy transfer equivalent to one ampere under a pressure of one volt at unity power factor.

WHEELING-transportation of electricity by a utility over its lines for another utility; also includes the receipt from and delivery to another system of like amounts but not necessarily the same energy.

APPENDICES

A. EXISTING ENERGY SYSTEMS A-1

B. LISTING OF SITES B-1

APPENDIX A
EXISTING ENERGY SYSTEMS

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A-1	GENERAL LOCATION OF PUBLIC-OWNED AND COOPERATIVE SYSTEMS, MAAC REGION, 1979	A-6

Exhibit A-I
OWNERSHIP, CAPABILITY AND DISTRIBUTION OF CUSTOMERS
UTILITY SYSTEMS WITHIN MAAC

Name	* Map Key	Installed Capacity (kw)	Net Generating Capability (mwh)	Peak Demand (kw)	Customers: Residential	Commercial	Industrial	Other	Total
DELAWARE									
Investor--Owned									
Delmarva Power & Light Co.			2,099		155,375	16,212	506	149	172,242
Public (Non-Federal)[1/]									
Clayton Municipal Light and Power Plant	8	0	0	1,086					
Dover Municipal Power Plant	9	171,200	500,452	93,000	11,223	1,722	25	3	12,973
Lewes Board of Public Works	10	3,438	513	7,300	1,735	200	65		2,000
Middletown Municipal Light and Water Department	11	0	0	3,258					
Milford Electric Department	12	0	0	15,700	2.902				3,400[2/]
Newark Electric Department	13	0	0	37,685	6,788	650	16	1	7,455
New Castle Board, Water and Light Commission	14	0	0	4,079					
Seaford Light & Power Dept.	15	7,302	0	9,305	2,121	312			2,433
Smyrna Electric Department	16	0	0	6,165	1,641	195	43		1,879
Cooperatives									
Delaware Electric Coop, Inc.	B	0	0	1.086	26.952	528	229		27,709
DISTRICT OF COLUMBIA									
Investor--Owned									
Potomac Electric Power Co.					423,016	49,347	431	176	472,970
Public (Non-Federal)									
None									
Cooperatives									
None									
MARYLAND									
Investor--Owned									
Baltimore Gas & Elec. Co.			4,843		734,186	74,626	1,355		810,167
Conowingo Power Company					21,833	2,233	78	17	24,161
Delmarva Power & Light Company of Maryland			259		69 898	9,238	313	293	79,742

Exhibit A-I (Continued)
OWNERSHIP, CAPABILITY AND DISTRIBUTION OF CUSTOMERS
UTILITY SYSTEMS WITHIN MAAC

Name	* Map Key	Installed Capacity (kw)	Net Generating Capability (mwh)	Peak Demand (kw)	Customers: Residential	Commercial	Industrial	Other	Total
MARYLAND									
Public (Non-Federal)[3]									
Berlin Municipal Elec. Pl.	17	3,592	6,520	5,523	1,012	154	17	5	1,188
Centreville Electric Dept.	18	0	0	7,900					
Easton Utilities Commission	19	47,210	64,053	23,000	4,002				5,228[2]
St. Michaels Utilities Comm	20	0	0	9,100	1,925	299		1	2,225
Cooperatives									
Choptank Elec. Coop., Inc.	D	0	0	69,000	21,630	1,113	131		22,874
Southern Maryland Electrical Cooperative, Inc.	E	0	0	226,000	51,226	4,193	419	26	55,864
NEW JERSEY									
Investor--Owned									
Atlantic City Electric Co.			1,504		315,344			688	362,131[2]
Deepwater Operating Co.									
General Public Utilities (GPU)[4]									
Jersey Central Power and Light Company[4]			3,375		605,439	64,731	2,510	851	673,531
Public Service Electric and Gas Company			9,993		1,468,924	185,444	7,974	4,400	1,666,742
Public (Non-Federal)[5]									
Butler Municipal Electric Light & Power Department	1	0	0	20,450	7,140	690			7,830
Lavallette Electric Dept.	2	0	0	4,062					
Madison Electric Department	3	0	0	15,840	4,708	555			5,263
Milltown Electric Dept.	4	0	0	10,000	2,378	138	18		2,534
Park Ridge Department of Public Utilities	47	0	0	8,500	2,708	321	1	38	3,068
Pemberton Electric Dept.	48	0	0	1,290	400	47	3		450
Seaside Heights Borough Electric Department	5	0	0	10,170	1,200	600			1,800
South River Utility	6	2,200	0	11,770					4,588[2]
Vineland Electric Utility[5]	7	110,050	259,472	73,500	13,275	2,172	93	4	15,544
Cooperatives[6]									
Sussex Rural Electric Coop.	A	0	0	17,280	6,802	138	12	160	7,112

Exhibit A-I (Continued)
OWNERSHIP, CAPABILITY AND DISTRIBUTION OF CUSTOMERS
UTILITY SYSTEMS WITHIN MAAC

Name	* Map Key	Installed Capacity (kw)	Net Generating Capability (mwh)	Peak Demand (kw)	Customers: Residential	Commercial	Industrial	Other	Total
PENNSYLVANIA									
Investor--Owned									
Citizens Electric Company					4,076	732	25	292	5,125
Elkland Electric Company					711	120	9	41	881
Hershey Electric Company									
Metropolitan Edison Company 4/			2,144		311,151	35,607	2,220	2,576	351,554
Pennsylvania Electric Co. 4/			2,888		443,447	53,133	4,757	645	501,982
Pennsylvania Power & Light Company			6,877		855,454	109,977	6,147	1,415	972,993
Philadelphia Electric Co.					1,137,020	113,712	5,702	2,399	1,258,833
Philadelphia Electric Power Company									
Pike County Light & Power Co.					2,458	453		5	2,916
Rockingham Light, Heat & Power Company									
Safe Harbor Water Power Coop.									
Susquehanna Electric Company			512						
Susquehanna Power Company									
UGI Corporation			64		48,407	5,173	218	57	53,855
Wellsboro Electric Company					3,759	556	13	1	4,329
Public (Non-Federal)									
Berlin Municipal Light Sys.	21	0	0	2,112	681	68	11		760
Blakely Borough Municipal Light Plant	22	0	0	6,800	2,721	145	21		2,887
Catawissa Municipal Light Department	23	0	0	1,811	710		18		728
Duncannon Light & Power Department	24	0	0	1,409					803 2/
East Conemaugh Municipal Light System	25	0	0	1,016	900	6			906
Ephrata Power Plant	26	4,240	0	16,430	3,883	588	21		4,492
Girard Municipal Light Dept	27	0	0	4,128	890	122	36		1,048
Goldsboro Borough Utility Department	28	0	0	364					218 2/
Hatfield Municipal Electric Plant	29	0	0	2,690	991	113	19		1,123
Hooversville Borough Electric Light Company	30	0	0	672					
Kutztown Municipal Light & Power Company	31	0	0	7,140	1,525	253	9	25	1,812
Lansdale Elec. Dept.	32	0	0	24,500	5,775	667	184	60	6,686

Exhibit A-I (Continued)
OWNERSHIP, CAPABILITY AND DISTRIBUTION OF CUSTOMERS
UTILITY SYSTEMS WITHIN MAAC

Name	* Map Key	Installed Capacity (kw)	Net Generating Capability (mwh)	Peak Demand (kw)	Customers Residential	Commercial	Industrial	Other	Total
PENNSYLVANIA									
Public (Non-Federal)									
Lehighton Light & Power Department	33	0	0	5,800					
Lewisberry Borough Council	34	0	0	300	2,260	403	29		2,692
Middletown Muncicpal Electric Department	35	0	0	11,800	3,249	306	7	47	3,609
Mifflinburg Light Dept.	36	0	0	7,608	1,460	27	6	7	1,500
Olyphant Borough Elec. Pl.	37	0	0	3,815	1,919	148	8		2,075
Perkasie Electric Dept.	38	0	0	6,104	1,962	277	24		2,263
Quakertown Municipal Electric Department	39	0	0	17,000	3,202	434	85	68	3,789
Royalton Municipal Electric Light System	40	0	0	516					
Schuylkill Haven Borough Utilities	41	0	0	7,600	2,409	279	24	26	2,738
Smethport Electric Dept.	42	0	0	1,800	745	186			931
St. Clair Borough Electric Light Department	43	0	0	1,944	1,921	82	9	36	2,048
Summerhill Municipal Light Plant	44	0	0	552					273 2/
Watsontown Electric Dept.	45	0	0	2,200	924	109	4		1,037
Weatherly Borough Elec Dept	46	2,000	0	5,216	1,028	5	5		1,038
Cooperatives 6/									
Adams Electric Coop., Inc.	G	0	0	53,211	13,363	403	26	1,198	14,990
Allegheny Elec. Coop., Inc. 6	F								
Bedford Rural Elec. Coop, Inc	H	0	0	18,678	4,877	264	35	1,156	6,332
Central Electric Coop., Inc.	I	0	0	33,256	18,166	947	65		19,178
Claverack Rural Electric Cooperative, Inc.	J	0	0	30,621					
New Enterprises Rural Electric Cooperative	K	0	0	7,870	11,192	194		4	11,390
Northwestern Rural Electric Cooperative		0	0	40,143	13,395	540	68	112	14,115
Somerset Rural Electric Cooperative, Inc.	L	0	0	28,307	8.017				8,545 2/
Southwest Central Rural Electric Cooperative	M	0	0	45,299	14,625	547	41	919	16,132
Sullivan County Rural Electric Cooperative	N	0	0	8,670	1,950	19	124	2,052	4,145
Tri County Rural Electric Cooperative, Inc.	O	0	0	24,732	7,670	179	16	5,332	13,197

Exhibit A-1 (Continued)
OWNERSHIP, CAPABILITY AND DISTRIBUTION OF CUSTOMERS
UTILITY SYSTEMS WITHIN MAAC

Name	* Map Key	Installed Capacity (kw)	Net Generating Capability (mwh)	Peak Demand (kw)	Customers				
					Residential	Commercial	Industrial	Other	Total
PENNSYLVANIA									
Cooperatives									
United Electric Coop., Inc.	P	0	0	23,851	13,148	541	53	163	13,905
Valley Rural Electric Cooperative, Inc.	Q	0	0	35,464	9,939	530	40	2,423	12,932
Warren Electric Coop., Inc.	R	0	0	8,205	6,766			35	7,311[2]
TOTAL PENNSYLVANIA									
VIRGINIA									
Investor--Owned									
Delmarva Power & Light Company of Virginia			50		11,729	2,073	33	50	13,885
Public (Non-Federal)									
None									
Cooperatives									
A & N Electric Cooperative					7,173	378	27	109	7,687
Accomack--Northampton Electric Cooperative		3,153	1,527	21,603					

Source: Compiled from Electrical World Directory of Electric Utilities, McGraw Hill Publications Co., 88th Edition, 1979-1980.

1/ The Public, Non-Federal or Municipals' utilities in the State of Delaware are represented in the MAAC system by the City of Dover, an associated member of MAAC.
2/ Combined figures for commercial and industrial customers are included in the total.
3/ The Public, Non-Federal or Municipals utilities in the State of Maryland are represented in the MAAC system by the Easton Utilities Commission, an associated member of MAAC.
4/ Jersey Central Power & Light Company, Metropolitan Edison and Pennsylvania Electric Companies are subsidiaries of General Public Utilities Corporation (GPU).
5/ The Public, Non-Federal or Municipals' Utilities in the State of New Jersey are represented in the MAAC system by the City of Vineland Electric Utility.
6/ New Jersey and Pennsylvania Cooperatives are represented in the MAAC system by Allegheny Electric Cooperative.
* Locations of utilities are delineated on Figure A-1.

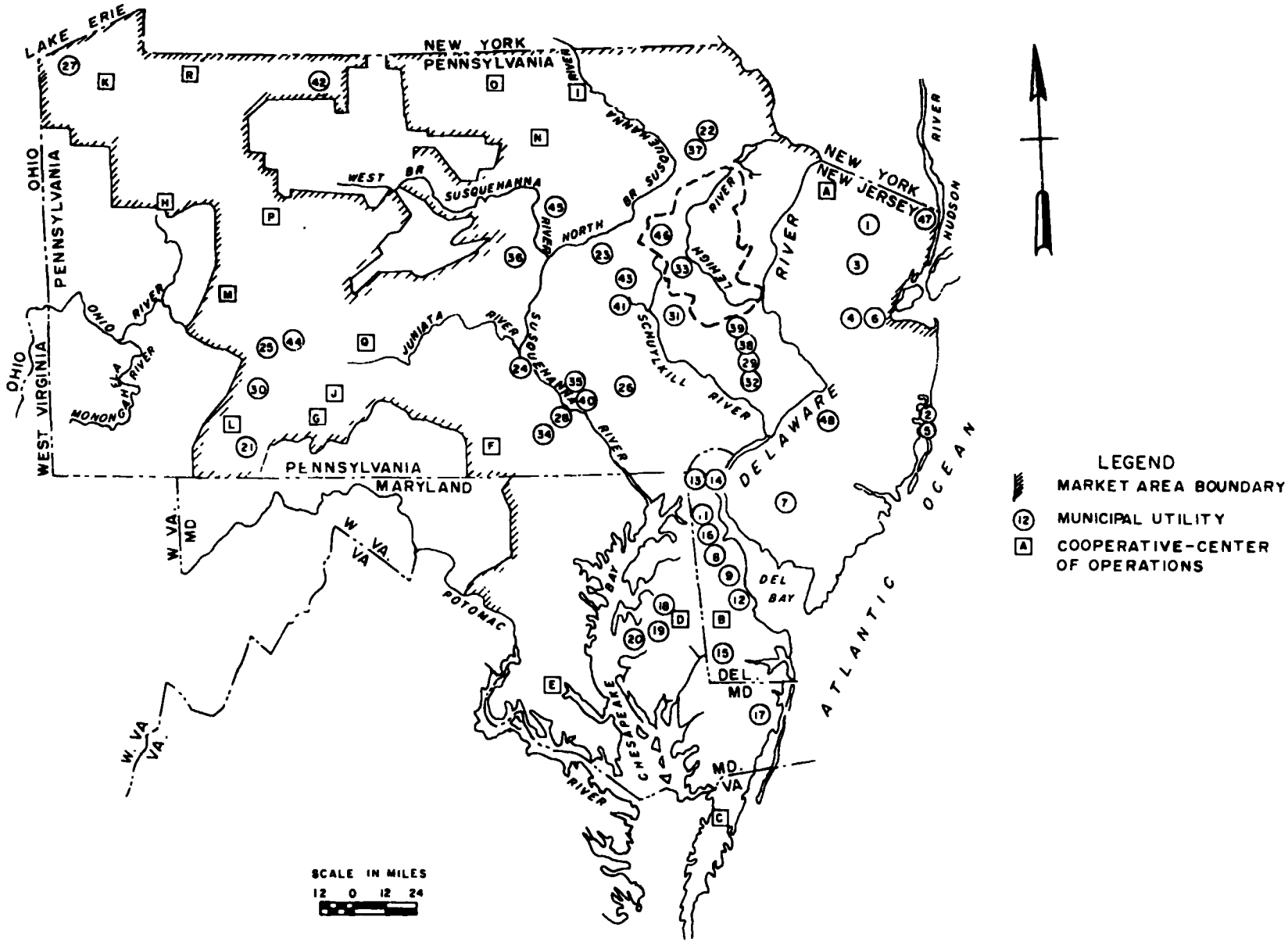

Figure A-1
GENERAL LOCATION OF PUBLIC-OWNED AND COOPERATIVE SYSTEMS
MAAC REGION, 1979

APPENDIX B
LISTING OF SITES

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Exhibit B-1 1/

INCREMENTAL HYDROELECTRIC POWER POTENTIAL, IDENTIFIED DURING STAGE 3

SITE ID NUMBER ACTV. INV. (1)	PROJECT NAME PRIMARY CO. NAME OF STREAM OWNER (2)	LATITUDE LONGITUDE DW.AREA (D M.M) (D M.M) (SQ.MI) (3)	PROJ.PURP. STATUS AVE. G (CFS) (4)	DAM HT MX.STOR. PWR. HD. (FT) (AC FT) (FT) (5)	EXIST.CAP. INC. CAP. TOT. CAP. (KW) (KW) (KW) (6)	EXIST.ENRG INC.ENERGY TOT.ENERGY (MWH) (MWH) (MWH) (7)	ANUL. COST ENERGY COST (1000 $) ($/MWH) (8)
MDCMAR0005	PRETTY BOYDAM	39 37.5	SR	155.0	0	0	224.77
2	BALTIMORE GUNPOWDER RIV	76 42.9	OP	93000	1790	7875	28.542
	BALT CITY DPR	80	80.0	134.9	1790	7875	
MDCMAR0016	BRIGHTON DAM	39 11.6	S	62.0	0	0	94.567
2	MONTGOMERY PATUXENT RIVE	77 0.4	OP	22400	379	1771	53.381
	ASH SUN SALT COMP	79	80.0	52.7	379	1771	
NJCMAR8032	UNION LAKEDAM	39 24.1	RH	35.0	0	0	180. 7
2	CUMBERLAND MAURICE RIVER	75 3.2	IS	15000	888	5017	35.891
	NAMA MFG. CO.	218	-327.6	26.9	888	5017	
NJCMAN0009	OAK RIDGE RESERVOIR DAM	41 2.3	S	60.0	0	0	306.39
2	MORRIS PEQUANNOCKRIV	74 30.0	OP	13220	4255	10398	29.464
	NEWARK MUNICIPAL UTILITY	180	52.0	55.9	4255	10398	
NJBMAN0028	LITTLE FALLS	40 53.0		52.0	2400	10000	423.29
2	PASSAIC PASSAIC	74 13.4		0	7585	14337	29.523
		750	-1152.9	35.9	9985	24337	
NJHMAN0029	SUN HYDRO	40 55.0		15.0	0	0	1414.8
2	PASSAIC PASSAIC	74 11.9		0	14942	45314	31.223
		785	-1206.7	67.9	14942	45314	
PACMAR0038	BLUE MARSH	40 22.7	CSR	98.0	0	0	146.80
2	BERKS TULPEHOCKEN C	76 1.6	UC	105480	1098	6338	23.162
	CAEN-NAP	175	272.0	53.8	1098	6338	
PAAMAR0050	FELIX DAM	40 23.5	R	24.0	0	0	275.42
2	BERKS SCHUYLKILLRIV	75 58.0	IS	1450	1576	9588	28.723
	PA DER	647	-1565.6	18.9	1576	9588	
PACMAR0037	LAKE ONTELAUNEE	40 26.8	SR	51.5	0	0	197.23
2	BERKS MAIDEN CREEK	75 55.7	OP	25600	1608	4544	43.402
	CITY OF READING	192	298.0	40.2	1608	4544	

1/ See pages B-7 through B-9 for an explanation of codes and symbols.

Exhibit B-1 (Continued) [1/]

INCREMENTAL HYDROELECTRIC POWER POTENTIAL, IDENTIFIED DURING STAGE 3

SITE ID NUMBER ACTV. INV. (1)	PROJECT NAME PRIMARY CO. NAME OF STREAM OWNER (2)	LATITUDE LONGITUDE DR. AREA (D M.M) (D M.M) (SQ.MI) (3)	PROJ. PURP. STATUS AVE. Q (CFS) (4)	DAM HT MX. STOR. PWR. HD. (FT) (AC FT) (FT) (5)	EXIST. CAP. INC. CAP. TOT. CAP. (KW) (KW) (KW) (6)	EXIST. ENRG INC. ENERGY TOT. ENERGY (GWH) (GWH) (GWH) (7)	ANUL. COST ENERGY COST (1000 $) ($/MWH) (8)
PAANAP0031	MEA KEENSVILLE DAM	40 34.1	DR	17.0	0	0	199.48
2	BERKS SCHUYLKILLRIV	75 59.3	IS	570	639	3780	52.880.
	PA DER	340	-675.8	14.0	639	3780	
PACNAP0041	BLOCKHOUSE STATE PARK DAM	40 28.2	R	116.0	0	0	143. 5
2	BUCKS TOHICKON CREE	75 11.2	OP	57000	959	3068	46.619
	DER	73	107.0	94.5	959	3068	
PACNAP0047	BELTZVILLE	40 51.9	CSRO	170.0	0	0	263.21
2	CARBON POHOPOCO CREE	75 38.2	OP	94310	2291	10915	24.115
	DAER KAP	96	160.0	125.8	2291	10915	
PACNAP0049	PENN FOREST DAM	40 55.7	S	145.0	0	0	95.552
2	CARBON WILD CREEK	75 33.7	OP	26220	495	2487	38.420
	BETHLEHEM MUN AUTHORITY	16	35.0	129.0	495	2487	
PACNAR0052	OCTORARO	39 47.9	S	62.0	0	0	113. 0
2	CHESTER OCTORARO CREE	76 2.6	OP	27600	501	2623	43. 80
	CHESTER MUN AUTHORITY	140	180.0	41.7	501	2623	
PACNAR0056	CURWENSVILLE	40 57.6	CR	131.0	0	0	221.28
2	CLEARFIELD WEST BRANCH S	78 31.4	OP	209000	1375	6539	33.841
	DAENNAB	365	639.0	26.0	1375	6539	
PACNAR0061	ALVIN R BUSH DAM	41 26.4	CR	165.0	0	0	197.16
2	CLINTON KETTLE CREEK	77 55.6	OP	117000	1323	5160	38.209
	DAENNAB	226	366.0	32.3	1323	5160	
PAONAB0059	KEATING	41 12.2	COPH	363.0	0	0	28596
2	CLINTON WHR SLSO	77 55.1	IS	1625000	423580	520713	54.917
		1574	2625.0	319.3	423580	520713	
PACORP0079	PYMATUNINGRESERVOIR DAM	41 50.1	R	56.0	0	0	183.89
2	CRAWFORD SHENANGO RIVE	80 27.7	OP	18800	1314	4160	44.202
	DER	160	199.0	37.9	1314	4160	

[1/] See pages B-7 through B-9 for an explanation of codes and symbols.

Exhibit B-1 (Continued) [1/]

INCREMENTAL HYDROELECTRIC POWER POTENTIAL, IDENTIFIED DURING STAGE 3

SITE ID NUMBER ACTV. INV. (1)	PROJECT NAME PRIMARY CO. NAME OF STREAM OWNER (2)	LATITUDE LONGITUDE DR.AREA (D M.M) (D M.M) (SQ.MI) (3)	PROJ.PURP. STATUS AVE. Q (CFS) (4)	DAM HT MX.STRM. PWR. LD. (FT) (AC FT) (FT) (5)	EXIST.CAP. INC. CAP. TOT. CAP. (KW) (KW) (KW) (6)	EXIST.ENRG INC.ENERGY TOT.ENERGY (MWH) (MWH) (MWH) (7)	ANUL. COST ENERGY COST (1000 $) ($/MWH) (8)
PACORP0094	TIONESTA DAM	41 28.4	CR	154.0	0	0	484.94
2	FOREST TIONESTA CREE	79 26.8	OP	133400	7229	20198	24. 9
	DAEN ORP	478	669.0	41.8	7229	20198	
PACMAB0072	RAYSTOWN	40 26.0	CR	221.0	0	0	1114.0
2	HUNTINGDON RAYSTOWN BR	78 0.0	OP	871000	21257	84740	13.146
	DAENNAB	960	1112.0	178.3	21257	84740	
PAMMAB0073	WARRIOR RIDGE	40 32.3	R	50.0	0	0	531.21
2	HUNTINGDON JUNIATA RIVER	78 1.9	OP	9000	4468	17798	18.609
	PA ELECTRIC COMPANY	837	1067.0	42.9	4468	17798	
PACORP0098	CONEMAUGH RIVER DAM	40 28.0	C	137.0	0	0	704. 4
2	INDIANA CONEMAUGH RIV	79 22.0	OP	274000	8000	33100	21.270
	DAEN ORP	1351	2342.0	26.1	8000	33100	
PAAORP0100	TWO LICK CREEK DAM	40 35.7	O	90.0	0	0	180.20
2	INDIANA TWO LICK CREE	79 5.9	OP	17000	1219	4343	41.408
	PENNA ELECTRIC CO	74	108.0	77.9	1219	4343	
PAINAB0081	HOLTWOOD	39 49.5	R	55.0	107200	590000	5263.7
2	LANCASTER SUSQUEHANNA	76 20.0	OP	19000	121767	385185	13.665
	PENN POWER+ LIGHT C O	20786	37500.0	53.3	228967	975185	
PAINAB0082	SAFE HARBOR	39 55.2	R	75.0	226500	920000	6471.6
2	LANCASTER SUSQUEHANNA	76 23.5	OP	140000	175141	131599	49.176
	SAFE HARBOR WATER PRCOR	26090	37000.0	52.7	401641	1051599	
PAANAP9001	ALLENTOWN DAM	40 36.4	R	6.1	0	0	396.86
2	LEHIGH LEHIGH R.	75 27.2		0	1757	8940	44.391
	PADER	1129	-2111.0	6.1	1757	8940	
PACNAP005R	FRANCIS E WALTER	41 6.7	CRO	234.0	0	0	489.12
2	LUZERNE LEHIGH RIVER	75 43.3	OP	149700	8306	21722	22.516
	DAEN-NAP	288	581.0	59.7	8306	21722	

[1/] See pages B-7 through B-9 for an explanation of codes and symbols.

Exhibit B-1 (Continued)[1/]

INCREMENTAL HYDROELECTRIC POWER POTENTIAL, IDENTIFIED DURING STAGE 3

SITE ID NUMBER ACTV. INV. (1)	PROJECT NAME PRIMARY CO. NAME OF STREAM OWNER (2)	LATITUDE LONGITUDE DR.AREA (D M.M) (D M.M) (SQ.MI) (3)	PROJ.PURP. STATUS AVE. Q (CFS) (4)	DAM HT MX.STOR. PWR. HD. (FT) (AC FT) (FT) (5)	EXIST.CAP. INC. CAP. TOT. CAP. (KW) (KW) (KW) (6)	EXIST.ENRG INC.ENERGY TOT.ENERGY (MWH) (MWH) (MWH) (7)	ANUL. COST ENERGY COST (1000 $) ($/MWH) (8)
PACNAP8021	P.E. WALTER MODIFICATION	41 6.7	CSR	265.0	0	0	1169.2
2	LUZERNE LEHIGH RIVER	75 43.5	SA	240000	24678	64287	18.187
	DAM-NAP	288	-606.1	184.6	24678	64287	
PAANAR9991	HEPBURN STREET DAM	41 13.9	H	15.0	0	0	835.88
2	LYCOMING WEST BRANCH S	77 0.5	OP	1	6357	36235	23.68
	PA. DEPT. OF ENV. RES.	5682	8864.0	15.0	6357	36235	
PACNAR0091	LITTLE PINE CREEK DAM	41 21.5	OP	115.0	0	0	163.81
2	LYCOMING LITTLE PINE C	77 21.3	OP	24800	812	3262	50.218
	PA DER	165	250.0	27.9	812	3262	
PACNAP0059	POCONO DAM	41 5.7	H	46.0	0	0	167.47
2	MONROE TOBYHANNA CRE	75 52.5	OP	5405	1125	3742	44.746
	POCONO LAKE PRESERVE	75	158.0	34.2	1125	3742	
PAANAP8028	BLACK ROCK DAM	40 8.8	D	11.0	0	0	348.66
2	MONTGOMERY SCHUYLKILL RIV	75 30.4	IS	620	1383	8149	42.785
	PHIL. ELEC. CO.	1296	-2127.9	9.0	1383	8149	
PACNAP0062	GREEN LANE RESERVOIR DAM	40 20.5	S	87.0	0	0	153.72
2	MONTGOMERY PERKIOMEN CRE	75 28.8	OP	44000	828	2697	56.999
	PHILA SUBURBAN WATER CO	71	97.0	67.5	828	2697	
PAANAP8027	NORRISTOWN DAM	40 7.0	S	12.0	0	0	351.42
2	MONTGOMERY SCHUYLKILL RIV	75 21.4	IS	2000	1404	7165	49.47
	PHIL. ELEC. CO.	1765	-2499.6	7.0	1404	7165	
PAANAP8029	VINCENT DAM	40 12.4	SHO	12.0	0	0	268.64
2	MONTGOMERY SCHUYLKILL RIV	75 34.0	IS	660	942	5587	51.664
	PA DER	1150	-1888.2	7.0	942	5587	
PAANAP8023	CHAIN DAM (NO. 8 DAM)	40 39.6		9.6	0	0	373.57
2	NORTHAMPTON LEHIGH RIVER	75 14.3	IS	2000	1625	10292	36.296
	PA DER	1323	-2473.7	10.4	1625	10292	

[1/] See pages B-7 through B-9 for an explanation of codes and symbols.

Exhibit B-1 (Continued)[1/]

INCREMENTAL HYDROELECTRIC POWER POTENTIAL, IDENTIFIED DURING STAGE 3

SITE ID NUMBER ACTV. INV. (1)	PROJECT NAME PRIMARY CO. NAME OF STREAM OWNER (2)	LATITUDE LONGITUDE DR. AREA (D M.M) (D M.M) (SQ MI) (3)	PROJ. PURP. STATUS AVE. Q (CFS) (4)	DAM HT MX. STOR. PWR. HD. (FT) (AC FT) (FT) (5)	EXIST. CAP. INC. CAP. TOT. CAP. (KW) (KW) (KW) (6)	EXIST. ENRG INC. ENERGY TOT. ENERGY (MWH) (MWH) (MWH) (7)	ANUL. COST ENERGY COST (1000 $) ($/MWH) (8)
PAAAAP0022	FASTON DAM	40 40.8	R	11.5	0	0	386.24
2	NORTHAMPTON LEHIGH RIVER	75 49.7	IS	2000	1835	11621	33.237
	PA DER	1364	-2495.9	11.5	1835	11621	
PAAAAP0024	TREICHLERSMAN (NO. 4 DAM)	40 43.8	NR	10.3	0	0	354.58
2	NORTHAMPTON LEHIGH RIVER	75 33.0	IS	2000	1428	8279	42.829
	THREE RI BOAT ASSOC	913	-1913.5	10.0	1428	8279	
PAAAAP0063	FAIRMOUNT DAM	39 57.7	RS	21.0	0	0	420.30
2	PHILADELPHIA SCHUYLKILLRIV	75 11.1	OP	2810	2850	14834	28.332
	CITY OF PHILADELPHIA	1893	2911.0	17.4	2850	14834	
PAAAAP0225	FLAT ROCK DAM	40 2.5	D	12.0	0	0	486.42
2	PHILADELPHIA SCHUYLKILLRIV	75 15.0	IS	2760	3716	18397	26.440
	PA DER	1809	-2561.9	17.0	3716	18397	
PAAAAP9992	WOSSERS DAM	40 46.0	W	32.0	0	0	156.69
2	SNYDER MIDDLE CREEK	76 52.5	OP	154	654	3595	43.585
	PA FISH COMMISSION	163	244.0	25.0	654	3595	
PAADKP0127	QUEMAHONING DAM	40 10.8	S	100.0	0	0	203.6
2	SOMERSET QUEMAHONING C	78 56.5	OP	91000	1504	5192	39.108
	BETHLEHEM STEEL CO	92	767.0	84.9	1504	5192	
PAAAAP0142	COWANESQUERES	41 59.4	CRO	154.0	0	0	236.41
2	TIOGA COWANESQUERIV	77 9.5	OP	95490	2394	6363	37.150
	DAENNAR	298	290.0	44.9	2394	6363	
PACNAB0144	HAMMOND DAM	41 53.0	CRO	122.0	0	0	182.98
2	TIOGA CROOKED CR	77 11.0	UC	63000	1155	3368	54.330
	DAEN NAR	122	112.0	33.1	1155	3368	
PACNAB0145	TIOGA DAM	41 55.4	CRO	140.0	0	0	267.91
2	TIOGA TIOGA RIVER	77 7.1	UC	62000	3393	8477	31.604
	DAEN NAR	280	333.0	52.3	3393	8477	

[1/] See pages B-7 through B-9 for an explanation of codes and symbols.

Exhibit B-1 (Continued) 1/

INCREMENTAL HYDROELECTRIC POWER POTENTIAL, IDENTIFIED DURING STAGE 3

SITE ID NUMBER ACTV. INV. (1)	PROJECT NAME PRIMARY CO. NAME OF STREAM OWNER (2)	LATITUDE LONGITUDE DR. AREA (D M.M) (D M.M) (SQ.MI) (3)	PROJ. PURP. STATUS AVE. G (CFS) (4)	GROSS HD. MAX. STOR. PER. HD. (FT) (AC FT) (FT) (5)	EXIST. CAP. INC. CAP. TOT. CAP. (KW) (KW) (KW) (6)	EXIST. ENRG INC. ENERGY TOT. ENERGY (MWH) (MWH) (MWH) (7)	ANNUL. COST ENERGY COST (1000 $) ($/MWH) (8)
PACNAP80159	PROMPTON DAM-MODIFIED	41 35.5	CRS	142.0	0	0	170.64
2	WAYNE LACKAWAXEN RIV	75 19.6	IS	69000	1238	4793	35.601
	DAM-NAP	NO	-114.8	93.7	1238	4793	
PAMNA89980	OAKLAND	42 00.0	H	9.5	0	0	551,000
	SUSQUEHANNA SUSQUEHANNA	76 35.9	OP	9.0	3000	12200	45.200
		2018	3309.0	0	3000	12200	
PAYNAR99849	YORK HAVEN	40 6.4	H	23.6	19600	115000	6333.2
2	YORK SUSQUEHANNA	76 42.4	OP	8000	86136	228354	27.734
	METROPOLITAN EDISON	24973	35000.0	17.2	105736	343354	

1/ See pages B-7 through B-9 for an explanation of codes and symbols.

Exhibit B-1 (Continued)
INCREMENTAL HYDROELECTRIC POWER POTENTIAL, IDENTIFIED DURING STAGE 3

DESCRIPTION OF TABULATED DATA

Column 1

Identification number of sites in active file. It indicates the type and status of structures, State and Corps of Engineers' division and district office's jurisdictional area where structures or sites are located.

Example: MD C NAB 0003

- 0003 — Sequential Number within each District
- NAB — District Code (See table below)
- C — Type and Status Code (See table below)
- MD — State Code (Postal Abbreviation)

STATUS AND TYPE

Status of Waterway Structure	Type of Operation: Run of River	Diversion	Reservoir	Reservoir with Diversion
Existing	A	B	C	D
Existing with Power	G	H	I	J
Existing with Retired Power Plant	M	N	O	P
Breached	S	T	U	V
Breached with Retired Power Plant	Y	Z	Ø	1
Undeveloped	4	5	6	7

DISTRICT CODES

North Atlantic Division

NAB	Baltimore District
NAN	New York District
NAO	Norfolk District
NAP	Philadelphia District

Ohio River Division

ORP	Pittsburgh District

Column 2

Identification of site by name, location and ownership (only the first characters 29 of a possible 40 characters are printed).

Exhibit B-I (Continued)
INCREMENTAL HYDROELECTRIC POWER POTENTIAL, IDENTIFIED DURING STAGE 3

DESCRIPTION OF TABULATED DATA (Continued)

Column 2 (Cont'd)

- First Line - Names of existing dams or potential sites.
- Second Line - Name of County and Stream where existing projects or potential sites are located.
- Third Line - Ownership of existing projects or potential sites. Ownership of Corps of Engineers' projects are designated as follows:

OWNERSHIP CODES

DAEN NAD	North Atlantic Division
DAEN NAB	Baltimore District
DAEN NAN	New York District
DAEN NAO	Norfolk District
DAEN NAP	Philadelphia District
DAEN ORD	Ohio River Division
DAEN ORP	Pittsburgh District

Column 3

Identification of project location by latitude and longitude, and drainage area.

- First and Second Lines - Latitude and longitude designated in degrees, minutes and tenths of minutes.
- Third Line - Drainage area of the watershed upstream of the site in square miles.

Column 4

Identification of authorized project purposes status and average annual inflow.

- First Line - Project Purposes as follows:

H = Hydroelectric	R = Recreation
C = Flood Control	D = Debris Control
N = Navigation	P = Farm Pond
S = Water Supply	O = Other

- Second Line - Project status as follows:

IS = Identified Site	SA = Authorized Study
UC = Under Construction	OP = Project in Operation

DESCRIPTION OF TABULATED DATA (Continued)

Column 4 (Cont'd)

- Third Line - Average annual inflow in CFS. Negative values indicate machine determined values based on a drainage area ratio of the project or site to the representative gage.

Column 5

Identification of height of dam, maximum storage of reservoir and net power head.

- First Line - Physical height of dam above streambed in feet.
- Second Line - Maximum storage space in the reservoir associated with the hydraulic height of the dam in acre-feet.
- Third Line - Normal net power head where available, otherwise weighted net power head were determined by computer program by use of flow-duration procedure or by monthly sequential analysis.

Column 6

Identification of capacities in kilowatts for existing projects or potential sites.

- First line - Existing capacity for sites.
- Second Line - Incremental capacity estimated for projects or sites.
- Third Line - Total capacity estimated for the projects or sites (existing plus incremental).

Column 7

Identification of energy output estimated for projects or sites in megawatt-hours.

- First Line - Existing energy for projects or sites.
- Second Line - Incremental or additional average annual energy estimated for projects or sites.
- Third - Total average annual energy estimated for the projects or sites.

Column 8

Indicates magnitude of cost estimated for projects or sites.

- First Line - Total annual cost in Thousands of dollars ($1,000).
- Second Line - Cost per megawatt-hours of incremental potential.

Exhibit B-2
SIZE OF SITES RETAINED IN ACTIVE INVENTORY

Location and Name of Site	Stream	Capacity: Small (.05-15 MW)	Capacity: Intermediate (15-25 MW)	Capacity: Large Greater than 25 MW	ENERGY MWH	MILLS/KWH
Maryland						
Brighton Dam	PATUXENT R	0.38			1,771	53.381
Pretty Boy Dam	GUNPOWDER R	1.79			7,875	28.542
New Jersey						
Little Falls	PASSAIC R	7.58			14,337	29.523
Oak Ridge	PEQUANNOCK R	4.26			10,398	29.464
Sum Hydro	PASSAIC R	14.94			45,314	31.223
Union Lake Dam	MAURICE R	0.89			5,017	35.891
Pennsylvania						
Allentown	LEHIGH R	1.76			8,940	44.391
Alvin R. Bush	KETTLE CREEK	1.32			5,160	38.209
Beltzville	POHOPOCO CREEK	2.29			10,915	24.115
Black Rock Dam	SCHUYLKILL R	1.38			8,140	82.785
Blue Marsh	TULPEHOCKE	1.10			6,338	23.162
Chain Dam	LEHIGH R	1.62			10,292	36.296
Conemaugh	CONEMAUGH R	8.00			33,100	25.774
Cowanesque	COWANESQUE R	2.39			6,363	37.150
Curwensville	W. BR. SUSQ. R	1.38			6,539	33.841
Easton Dam	LEHIGH R	1.84			11,621	33.237
Fairmount	SCHUYLKILL R	2.85			14,834	28.332
Felix Dam	SCHUYLKILL R	1.58			9,588	28.723
Flat Rock Dam	SCHUYLKILL R	3.72			18,397	26.440
Francis E. Walter 1/	LEHIGH R	8.31			21,722	22.516
Francis E. Walter 1/	LEHIGH R		16.37		42,565	18.187
Green Lane	PERKIOMEN R	0.83			2,697	56.999
Hammond Dam	CROOKED CREEK	1.16			3,368	54.330
Hepburn St. Dam	W. BR. SUSQ. R	6.36			36,235	23.680
Holtwood	SUSQUEHANNA R			121.77	385,185	22.100
Keating	W.BR. SUSQ. R			423.58	520,713	54.917
Lake Ontelaunee	MAIDEN CREEK	1.61			4,544	43.402

Exhibit B-2 (Continued)
SIZE OF SITES RETAINED IN ACTIVE INVENTORY

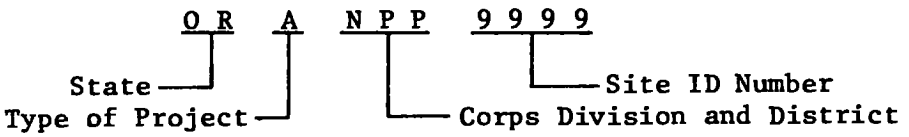
Location and Name of Site	Stream	Capacity: Small (.05-15 MW)	Capacity: Intermediate (15-25 MW)	Capacity: Large Greater than 25 MW	ENERGY MWH	MILLS/KWH
Pennsylvania (Cont'd)						
Little Pine Ck. Dam	LITTLE PINE CREEK	0.81			3,262	50.218
Mussers Dam	MIDDLE CREEK	0.65			3,595	43.585
New Kernsville	SCHUYLKILL R	0.64			3,780	32.880
Nockamixon	TOHICKON CREEK	0.96			3,068	46.619
Norristown Dam	SCHUYLKILL R	1.40			7,165	49.470
Oakland	SUSQUEHANNA R	3.00			13,200	45.190
Octorao	OCTORARO CREEK	0.30			3,623	43.800
Penn Forest Dam	WILD CREEK	0.50			2,487	38.420
Pocono Dam	TOBYHANNA	1.12			3,742	44.746
Prompton Dam	LACKAWAXEN R	1.24			4,793	35.601
Pymatuning	SHENANGO R	1.31			4,160	44.202
Quemamoning	QUEMAMONING CREEK	1.50			5,192	39.108
Raystown	RAYSTOWN BR		21.26		84,740	13.146
Safe Harbor	SUSQUEHANNA			175.14	131,599	49.176
Tioga Dam	TIOGA R	3.39			8,477	31.604
Tionesta Dam	TIONESTA CREEK	7.23			20,198	24.900
Treichlers	LEHIGH R	1.43			8,279	42.829
Two Lick Creek	TWO LICK CREEK	1.22			4,343	41.488
Vincent Dam	SCHUYLKILL R	0.94			5,587	51.664
Warrior River	JUNIATA R	4.47			17,798	18.609
York Haven	SUSQUEHANNA			32.00	140,000	28.900
Total		114.49	37.63	752.49	1,729,056	

1/ A total capacity of 24.7 MW at the existing project based on the authorized modification for water supply development at the site was adjusted to reflect 8.3 MW that can possibly be developed before 1990 prior to construction of the water supply modification. This is reflected under the near term category. The remaining 16.4 MW is designated for long term development.

NHS MAPS

Two maps are inserted into the adjacent pocket. One is an index map and one is a site location map. The primary purpose of the index map is to show the National Electric Reliability Council (NERC) regions, the Corps of Engineers division and district boundaries, and Corps office locations. A separate regional report and accompanying site location map has been prepared for each of the NERC regions depicted on the index map.

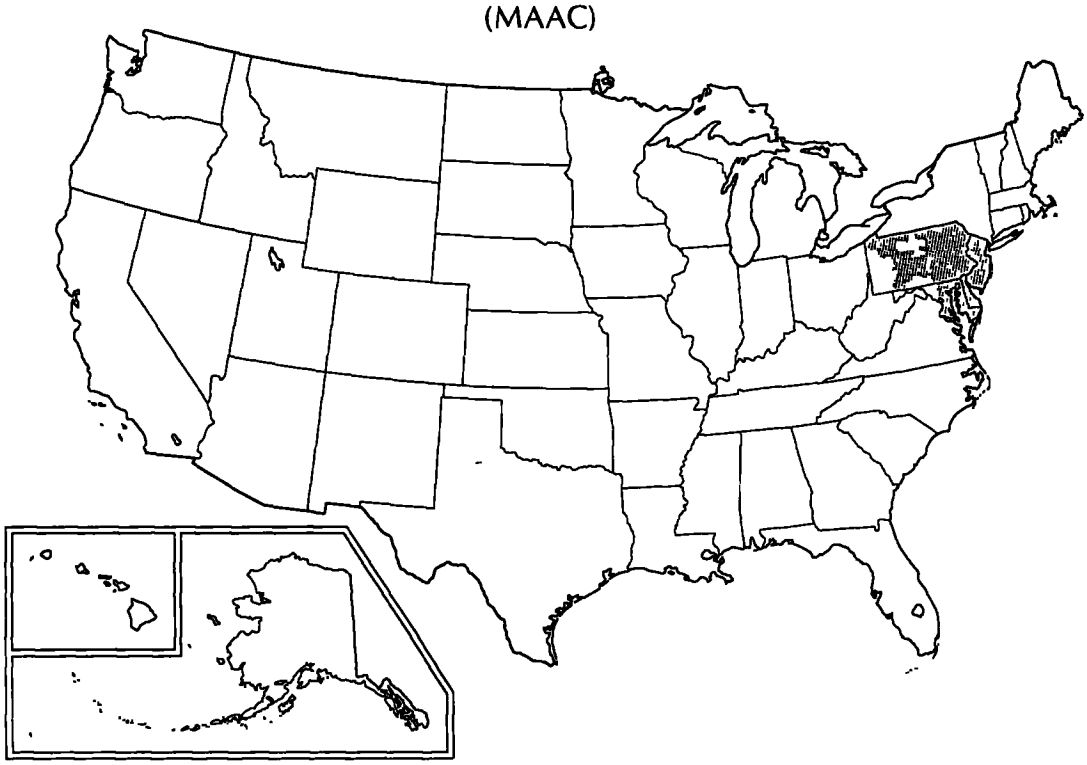
The second map shows existing and potential hydroelectric site locations for the subject region and is intended to provide general information to the reader about the sites. The size of a project is depicted by the diameter of the circle and the type of project by color. Each site symbol on the map is labeled with a four digit number which corresponds to a ten character National Hydroelectric Power Resources Study site identification code. Each part of the 10 character ID code helps to narrow down the source of information for that site. For example, a typical site identification code is shown below:

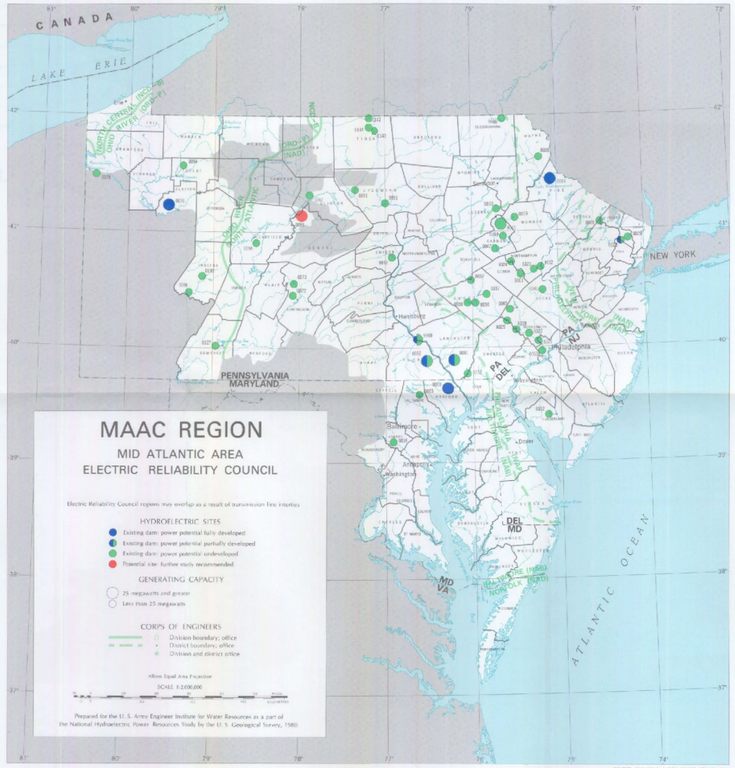


Consequently, for more information about a site, one needs to determine from the map a site's state and county, the Corps division and district, and the four digit number. With the site ID number, the site can then be located in the list of sites in the regional report or in Volume XII of the NHS final report. If more detailed information is desired, the appropriate Corps division and/or district office may be contacted.

NATIONAL HYDROELECTRIC POWER RESOURCES STUDY

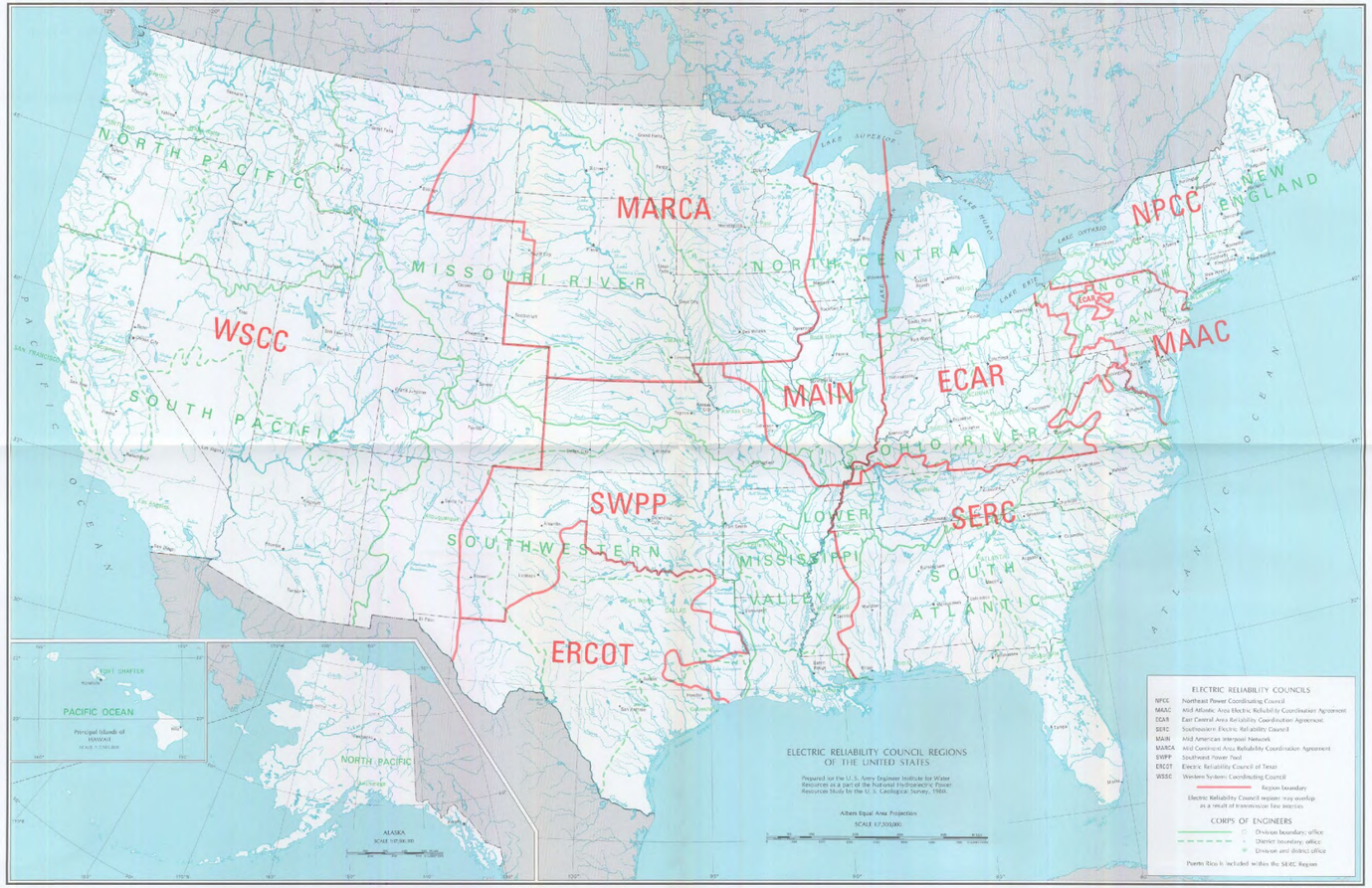
MID ATLANTIC AREA ELECTRIC RELIABILITY COUNCIL (MAAC)




CANADA
LAKE ERIE
NEW YORK
PENNSYLVANIA
MARYLAND
Harrisburg
Philadelphia
Dover
Annapolis
Washington
Salisbury
ATLANTIC OCEAN
MAAC REGION
MID ATLANTIC AREA
ELECTRIC RELIABILITY COUNCIL
Electric Reliability Council regions may overlap as a result of transmission tie interties
HYDROELECTRIC SITES
Existing dam: power potential fully developed
Existing dam: power potential partially developed
Existing dam: power potential undeveloped
Potential site: further study recommended
GENERATING CAPACITY
25 megawatts and greater
Less than 25 megawatts
CORPS OF ENGINEERS
Division boundary, office
District boundary, office
Division and district office
Albers Equal Area Projection
SCALE 1:2,000,000
Prepared for the U. S. Army Engineer Institute for Water Resources as a part of the National Hydroelectric Power Resources Study by the U. S. Geological Survey, 1980

NATIONAL HYDROELECTRIC POWER RESOURCES STUDY

INDEX TO NATIONAL ELECTRIC RELIABILITY COUNCIL REGIONS


ELECTRIC RELIABILITY COUNCIL REGIONS
OF THE UNITED STATES
Prepared for the U. S. Army Engineer Institute for Water Resources as a part of the National Hydroelectric Power Resources Study by the U. S. Geological Survey, 1980.
Albers Equal Area Projection
SCALE 1:7,500,000
ELECTRIC RELIABILITY COUNCILS
NPCC Northeast Power Coordinating Council
MAAC Mid Atlantic Area Electric Reliability Coordination Agreement
ECAR East Central Area Reliability Coordination Agreement
SERC Southeastern Electric Reliability Council
MAIN Mid American Interpool Network
MARCA Mid Continent Area Reliability Coordination Agreement
SWPP Southwest Power Pool
ERCOT Electric Reliability Council of Texas
WSSC Western Systems Coordinating Council
Region boundary
Electric Reliability Council regions may overlap as a result of transmission line interties
CORPS OF ENGINEERS
Division boundary; office
District boundary; office
Division and district office
Puerto Rico is included within the SERC Region
MARCA
NPCC
WSCC
MAIN
ECAR
MAAC
SWPP
SERC
ERCOT
NORTH PACIFIC
MISSOURI RIVER
NORTH CENTRAL
NEW ENGLAND
SOUTH PACIFIC
OHIO RIVER
SOUTHWESTERN
LOWER MISSISSIPPI VALLEY
SOUTH ATLANTIC
NORTH ATLANTIC
PACIFIC OCEAN
ATLANTIC OCEAN
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
FORT SHAFTER
PACIFIC OCEAN
Principal Islands of HAWAII
SCALE 1:2,500,000
NORTH PACIFIC
ALASKA
SCALE 1:10,000,000