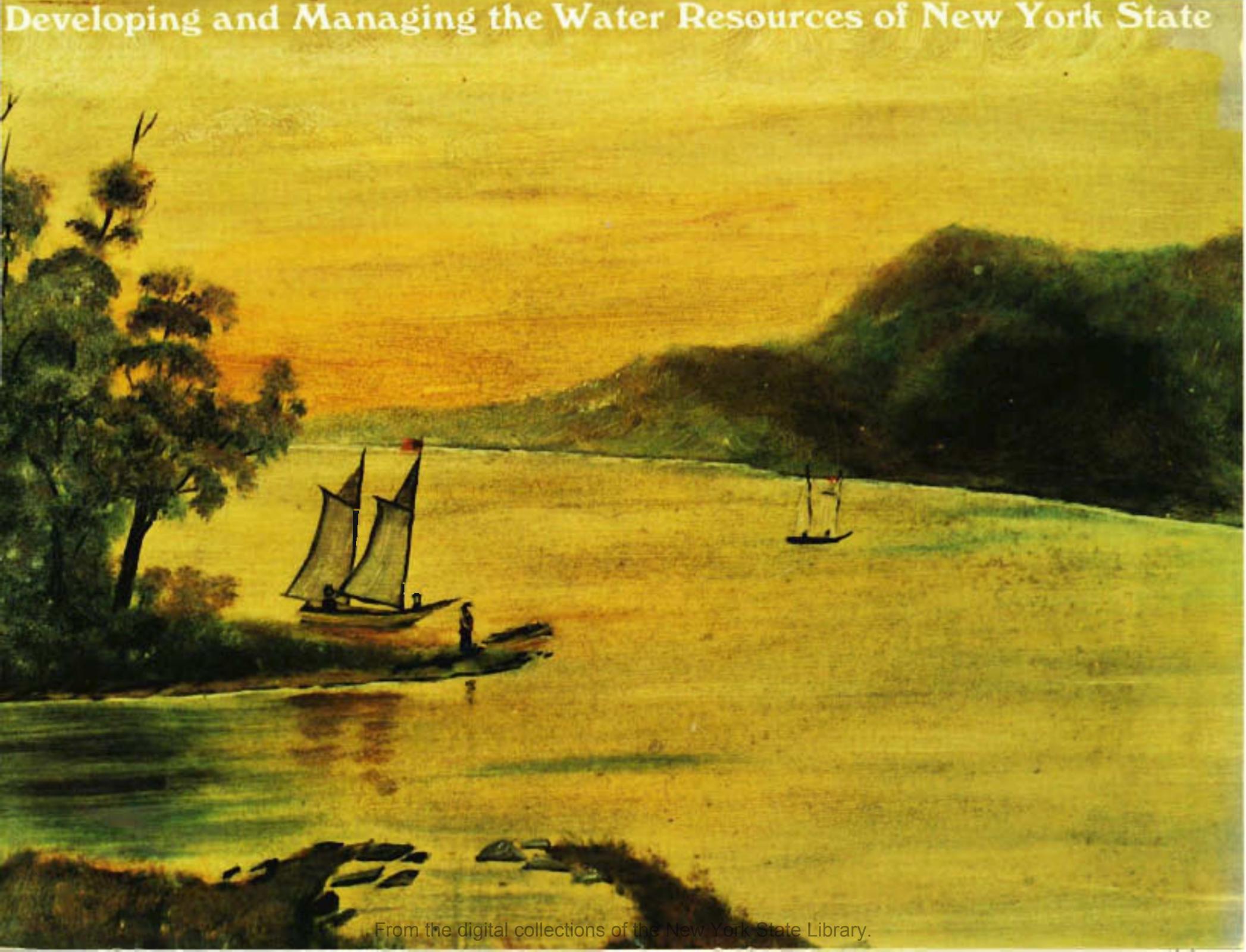
Developing and Managing the Water Resources of New York State



SUMMARY APPRAISAL

Developing and Managing the Water Resources of New York State

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INTRODUCTORY MESSAGE FROM THE GOVERNOR

In 1965, the voters of New York State approved a $1 billion dollar Pure Waters Bond Act to eliminate water pollution in the State's lakes, streams, and rivers. This massive clean-up, coupled with the severe effects of the extended drought in the northeastern United States, added new urgency to water resources planning in the State.

In late summer of 1965 I directed the Water Resources Commission to devise a program that would accelerate planning and development of the State's water resources. The Legislature approved the use of $860,000 from the State Emergency Fund to implement this action. The first step of this Accelerated Water Resources Program was taken with the completion of the reconnaissance studies on August 1, 1966.

This report, based on the reconnaissance studies, presents a program of needed action for the development of water resources in New York State. I commend it to your thoughtful consideration.

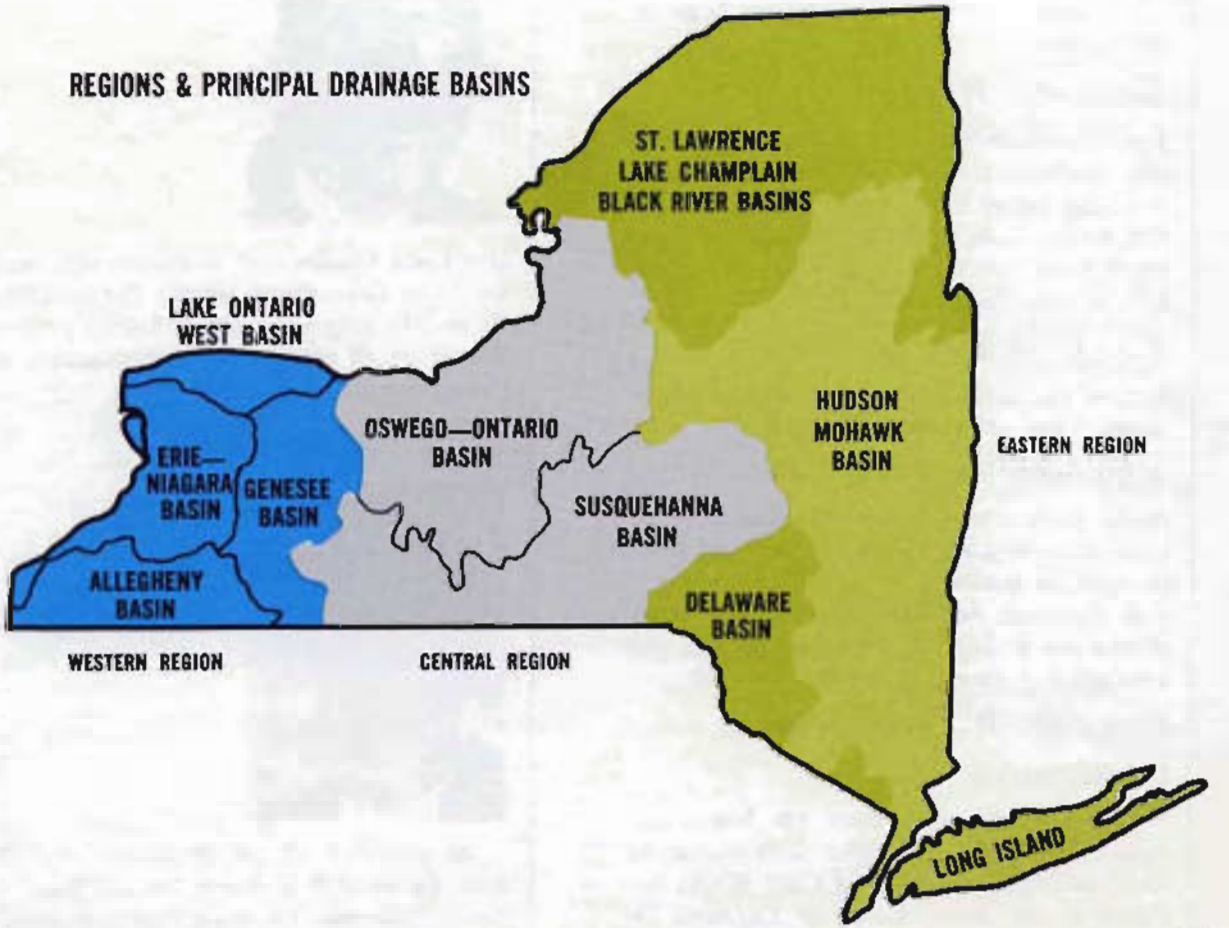
This summary appraisal contains the general framework of a plan of development for the Water Resources of New York State. It was prepared by the Conservation Department's Division of Water Resources for the Water Resources Commission.

The plan is based on the findings of four consultant engineering firms retained to develop initial recommendations for measures to meet short and long-term water needs. Reconnaissance studies considered these needs, availability of water, and potential reservoir sites. The results include generalized alternative development plans with preliminary estimates of costs.

The State was divided into four areas, following major river basin boundaries. In the Eastern Region one consisted of the Hudson-Mohawk and Long Island areas, and the other the St. Lawrence, Black, Delaware and Lake Champlain Basins. The third area included the Susquehanna and Oswego River Basins and Central and Eastern Lake Ontario drainage areas in the Central Region. The fourth area consisted of the Erie-Niagara, Genesee, Allegheny and Lake Ontario West Basins in the Western Region. The results are summarized by the three established regions of the Division of Water Resources to give recognition to major regional differences.

The reconnaissance efforts were deliberately limited in duration and scope. Certain fundamental assumptions constituted basic constraints on the framework of study

Many additional water resources planning studies are needed. They may be made under cooperative state-federal partnerships through joint efforts of state and local governments, by state or local agencies alone, and may utilize consultants. Study needs are defined in this report. However, positive action to develop and manage the State's water resources more effectively can not be deferred until all studies



are completed. Through reconnaissance studies, and others made heretofore, many items of basic information are available now. They provide a reasonably sound basis for judging the nature and scope of future water resources development required in New York State.

The areas of study and consultant firms involved were:

Eastern Region

Tippetts-Abbett-McCarthy-Stratton, Engineers and Architects, New York-Hudson-Mohawk and Long Island Areas
Uhl, Hall & Rich, Engineers, Boston—St. Lawrence River, Black River, Delaware River and Lake Champlain Basins

Central Region

Metcalf and Eddy, Engineers, Boston—Susquehanna River and Oswego River Basins

Western Region

Harza Engineers—Greeley and Hansen, Chicago—Erie-Niagara, Genesee River, and Allegheny River Basins

A Technical Advisory Board to provide direction and guidance to the reconnaissance and evaluation of the report was composed of:

Eugene W. Weber—Chairman

Now a consulting engineer, Mr. Weber culminated a distinguished public service career in 1965 as Deputy Director of Civil Works for Policy of the Army Corps of Engineers in Washington. He still serves as Commissioner on the International Joint Commission, United

States and Canada and as an alternate on the Interstate Commission on the Potomac River Basin. His long experience in federal programs related to all phases of water resources provided important guidance.

Harvey O. Banks

As president of the prominent consulting firm, Leeds, Hill & Jewett, Inc., of San Francisco, California, his water resources activities take him to all parts of the world. Mr. Banks was Director of the Department of Water Resources, California, during the period when the California Water Plan was developed. The resulting California Water Project involves an investment of about $3 billion. He is general consultant for the imaginative Texas Water Plan, and consultant to the Delaware River Basin Commission.

Edward J. Cleary

Dr. Cleary has been engaged in the engineering and administration of water resources for more than 30 years, notably in quality management. Since 1948 he has been executive director and chief engineer of the Ohio River Valley Water Sanitation Commission (ORSANCO), an interstate compact agency that has pioneered regional pollution control. Dr. Cleary conceived, and ORSANCO placed into operation, in 1960, a robot-monitor system making the Ohio River the first in the world under continuous day-and-night quality surveillance.

TECHNICAL ADVISORY BOARD SUMMARY REPORT

This is a summary of viewpoints which the members of the Technical Advisory Board have offered individually and collectively to the Division of Water Resources of the Conservation Department of the State of New York, relating to reports on "Reconnaissance of Water Resources Potentials", which were submitted in August 1966 by the several engineering firms under contract with the State.

In general, the Technical Advisory Board concludes that the reconnaissance reports accomplish their stated purpose, which is to provide fundamental information requisite to the acceleration of planning, development and management of the State's water resources. The Board's comments herein are directed to those actions it believes should be undertaken by the State through its Water Resources Commission and other appropriate State agencies as revealed or implied by the findings of the reconnaissance studies. In some instances the recommendations involve continuation or intensification of programs already underway. In others, new or appreciably modified activities are proposed. The Board has not attempted to specify the amount of effort to be allocated to various endeavors, but it does suggest that the orientation be relatively greater toward the policy, legal and institutional aspects of water resources management than on the associated physical and technical components where considerable progress has been made and is continuing.

State Water Policies

An essential component of the complex process of managing water resources is the formulation of rational water policies. These should be designed to reflect the public interest, facilitate realization of objectives, and promote equitable distribution of costs and benefits in the pursuit of such objectives. Water laws and the policies associated with their implementation require frequent re-examination to ascertain their adequacy in the light of changing conditions and social goals. While the State has been progressive in this respect, notably through initiation of analysis of riparian rights and in the promulgation of water quality standards, the reconnaissance reports highlight situations where legal and policy adjustments would broaden alternative choices for achieving efficient use of water resources. This is particularly true with respect to cost-sharing policies.

Specifically, it is recommended that the Division of Water Resources sponsor or otherwise arrange for continuing review of the legal framework and operating policies relating to the following:

(a) *Water rights.* It is of basic importance that procedures be devised to clarify existing water rights and to govern acquisition of new rights.

(b) *Control of withdrawals from ground and surface waters.* These sources of water and their uses are interdependent. Withdrawals along with reduction of high flows, augmentation of low flows, conveyance of flow to point of use and recharge of ground waters involve equity relationships that command identification of benefits and costs and their appropriate allocation.

(c) *Water Quality Management*—Reliance for maintaining water quality in New York State currently is centered on two techniques—high degree treatment at the source of waste discharges and low-flow augmentation, with low-flow augmentation considered as a possible supplement to treatment. Management of quality invites consideration of a range of technologic alternatives along with institutional arrangements to facilitate their financing, construction and operation. Policies should be explored that will encourage application of these alternatives.

(d) *Flood plain management.* The State's policies should be designed to facilitate achievement of the optimum combination of flood protection measures including non-structural measures such as flood plain management.

(e) *Acquisition of land.* The land necessary for development of future water projects and for optimum use of water areas for recreation

and related purposes should be acquired as soon as possible after the need is established.

(f) *Recreation*. The State should enunciate policies defining its role in developing and financing recreational facilities in conjunction with Federal, State and local water projects and at natural lakes and streams. A policy on recreational use of projects developed for water supply or multiple purposes is needed. Policies should be designed to encourage a "mix" of public and private development opportunities to use the State's waters for recreation purposes through arrangements involving public ownership, leases and easements.

(g) *Cost-sharing generally*. The State's policies should be designed to achieve the maximum practicable assumption of costs by beneficiaries.

Institutional Arrangements for Water Management

The procedures associated with efficient water management invite continuing adaption of authorizations and arrangements to meet changing requirements. This has been recognized in the State of New York in many ways, particularly with respect to planning efforts. Procedural practices must be responsive, of course, to current policies and objectives. The reconnaissance reports illuminate several areas wherein the State should consider new or modified arrangements for water resources management. Additional needs undoubtedly will be revealed as policy studies and planning activities are advanced.

At this time it seems clear that the State may profitably address itself to such matters as:

(a) Advance acquisition of land to facilitate ultimate development of reservoirs and other facilities needed for water and related resources management.

(b) Authorization of the formation of local or regional agencies to construct irrigation projects and to manage their financial and physical operations.

(c) Suitable arrangements or agencies to provide coordinated management of multiple-purpose operations such as reservoir and lake systems, the Barge Canal and other developments having multiple-purpose or regional effects.

(d) Provisions for interim financing by the State of costs for municipal and industrial water supply, recreation or other water-related activities, which ultimately would be paid for by beneficiaries.

Comprehensive Statewide Plan

While recognizing that action programs for water management will continue to involve decisions and responsibilities at many levels of government and the private sector, the State should continue its efforts to maintain an up to date, comprehensive, statewide framework plan as a basis for coordinated action to serve long-range as well as immediate needs. The planning effort should include appraisal of various alternatives for realization of the water resources potentials in each region of the State. Such appraisals should include consideration of international, regional and interstate aspects as well as intrastate requirements.

Regional Action Plans

Participation in the planning process by municipalities and other local agencies is necessary to resolve specific problems within their jurisdiction. Toward this end the State should continue to support regional, multiple-purpose water resources planning. A primary objective should be the delineation of action programs to meet requirements over the next decade in each region within the framework of the comprehensive, multiple-purpose State plan.

Collection and Evaluation of Basic Data

There is continuing need for additional information and knowledge about many aspects of the State's water resources. The reconnaissance studies identify certain deficiencies of data. The staff of the Division of Water Resources is aware of other information needs that should be satisfied to permit proper consideration of alternatives for future water management. Ample justification exists, therefore, for the State to carry out, support or otherwise arrange for systematic assembly and continuing evaluation of basic data and knowledge relating to:

(a) Ground water. This is of importance in view of the prospective greater use of ground water resources in the future.

(b) Inter-relationships of ground and surface water, including the influence on dry weather or base flows of more extensive use of ground water.

(c) Effect on future low flows of prospective depletions by upstream development and use.

(d) Assessment of the waste assimilative capacity of receiving waters.

(e) Saline water intrusion.

(f) Eutrophication of lakes and reservoirs.

(g) Prospective demand for use of water for various purposes, notably domestic and industrial supply, irrigation, recreation and fish and wildlife. For example, the reconnaissance reports emphasize the need for additional recreational opportunities but available data are insufficient for adequate forecasts of demand over time on a regional basis.

Special Studies

The reconnaissance reports and appraisals made by the Technical Advisory Board reveal a number of water development possibilities regarding which currently available information is too scanty to permit their evaluation as alternatives to other proposals. It is recommended therefore, that the State sponsor or otherwise arrange for systematic assembly of information and continuing evaluation of the potentialities of:

(a) Artificial recharge of aquifers.

(b) Induced aeration of streams and lakes.

(c) Low flow augmentation.

(d) Regulation of natural lakes for multiple purposes.

(e) Use of the Barge Canal for multiple purposes.

(f) Flood damage prevention by flood plain management measures such as regulations, flood proofing and other State or local action.

(g) Spray irrigation using effluent waters.

STATE SUMMARY

The total present water demands which can be identified on a quantitative basis are about 5,000 mgd. Future water use is expected to more than triple to about 18,000 mgd by 2020. This use is only a small fraction of the supplies available. Since most of the uses are nonconsumptive a great potential exists for more intensive utilization of the State's water resources.

ECONOMY AND POPULATION

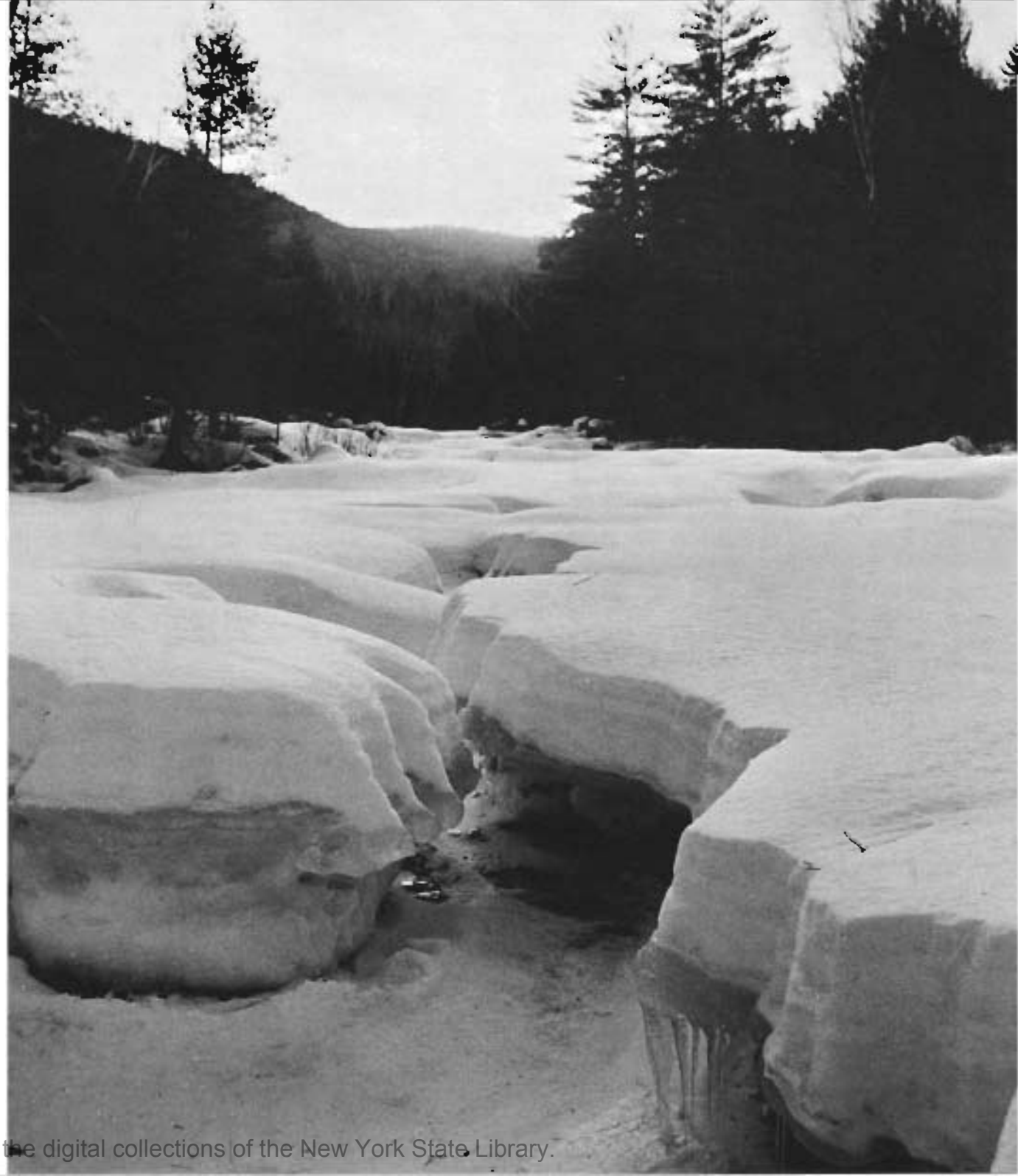
New York is the foremost industrial state leading all others in almost every segment of the economy. It is the greatest consumer market

in the country and the chief center for commerce and industry. Manufacturing occupies a leading place in the State's economy. The State's lead in wholesale trade is especially impressive. Foreign trade constitutes an important part of the State's commerce, principally handled in the Port of New York—the largest in the nation. Much of the nation's service business is carried on in New York State. New York City is the financial center of the world.

Farm business is substantial, although overshadowed by other segments of the State's economy. New York State is second in the production of dairy products and thirteenth in agricultural production. In line with the national pattern, farms in the State have been increasing in size and efficiency. The area under cultivation and the number of farms has declined. Increasing amounts of land have been taken over for suburban, residential, commercial and industrial developments.

New York State is growing rapidly in population. The State population increased about 2 million between 1950 and 1960 and over another million by mid-1966 when it reached an estimated 17.9 million. People are highly urbanized with about 85 percent living in 7 major metropolitan areas. Heavy population increases took place in the suburbs of New York City between 1950 and 1960. Nassau County's population almost doubled and the Suffolk County population more than doubled. Rockland and Westchester Counties near New York City also had substantial increases in population from 1950 to 1960. Nine upstate counties had increases exceeding 20 percent.

Natural advantages such as geographical location, topography, climate and resources have been major factors contributing to the State's development. Additional future development of available water resources can significantly enhance the economic and social well-being of people of the State.



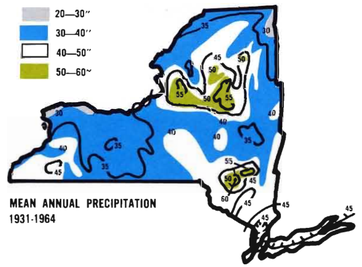
What We Have . . . . . .
WATER RESOURCES AVAILABILITY

New York State is rich in land and water resources. Average annual precipitation is 40 inches over the State area of 49,600 square miles, representing an average annual supply of 5,600 gallons per capita per day About half the water returns to the atmosphere by evaporation from land and water surfaces and by transpiration from vegetation. The remainder runs off through stream channels except for a small portion which percolates through the soil and becomes ground water.

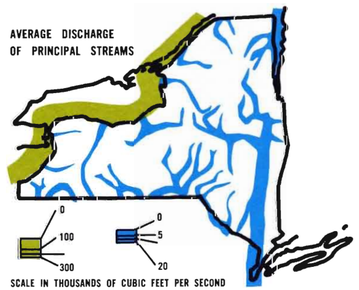
In addition to the annual supply—which distinguishes water as a renewable resource—there are enormous quantities in storage on more than 350 miles of water boundary and within the State. Freshwater supplies in the Great Lakes, Erie and Ontario, and Lake Champlain are shared with other states and Canada. The Atlantic Ocean has a great untapped potential as a saltwater and possible freshwater resource. Innumerable interior lakes dot the State, with more than 1,500 in the Adirondacks alone. The largest are Lake George, Lake Chautauqua, Oneida Lake and the major Finger Lakes: Canadaigua, Keuka, Skaneateles, Seneca and Cayuga. The total lake water surface area of 3,500,000 acres is equivalent to more than ten percent of the State's area.

Water moves through the State in a drainage system comprising 70,000 miles of rivers and streams. The Barge Canal system is a combination of water resources tying together over 40 percent of the State. There are also hundreds of miles of saltwater shoreline which have unique characteristics and potentialities.

Ground water supplies sufficient to meet small municipal and individual domestic needs are widespread. Large reservoirs of underground storage are located on Long Island, along the Mohawk and Susquehanna Rivers and in other areas. Many potentially large ground water supplies have not been quantitatively identified yet.



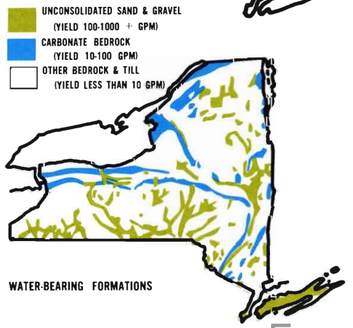
MEAN ANNUAL PRECIPITATION
1931-1964



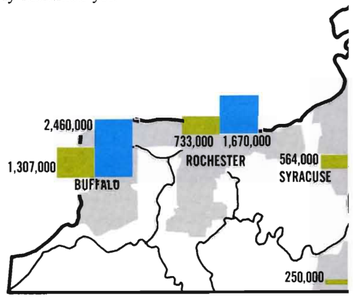
AVERAGE DISCHARGE
OF PRINCIPAL STREAMS

SCALE IN THOUSANDS OF CUBIC FEET PER SECOND

NEW YORK STATE
BARGE CANAL SYSTEM AND ITS
TRIBUTARY AREA



WATER-BEARING FORMATIONS



1960 POPULATION 16,782,304
(U.S. CENSUS BUREAU)

PROJECTED 2020 POPULATION 34,500,000
(COMPILED ON BASIS OF ALL AVAILABLE DATA)

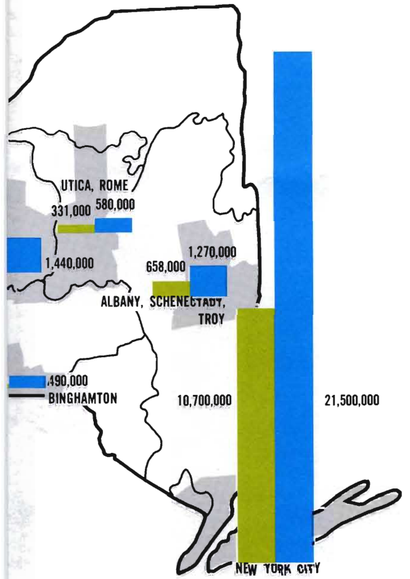
PROJECTED GROWTH OF STANDARD
METROPOLITAN STATISTICAL AREAS
(1966 SMSA Boundaries)

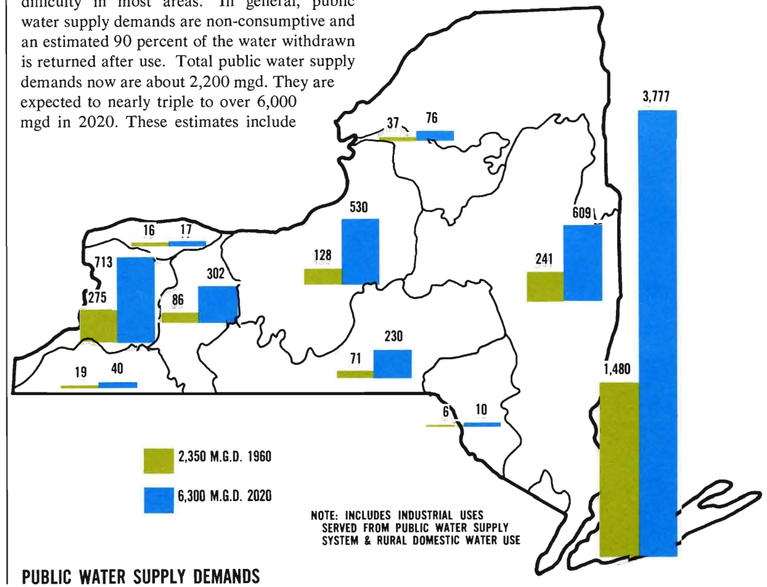
What We Need . . .
WATER DEMANDS

Only a small part of the total water resources available in the State are being used for withdrawal purposes. Nevertheless in some areas local supplies have been completely developed. The most notable example is New York City which taps sources many miles away for its water supply system. Likewise the Onondaga County water system extends about 30 miles to Lake Ontario for a source of supply Major use is made of water resources for non-consumptive purposes, including recreation, fish and wildlife, navigation, hydroelectric power generation and water transport and dilution. Considering all purposes the State's resources are subject to heavy demands.

Public water supply demands are of major importance in the total demands. They are concentrated in the major urban complexes, New York City, Buffalo-Niagara Falls, Syracuse, Rochester and others. Extensive supplies have been developed in these areas to take care of local needs. Most smaller communities also have public water supply systems. Individual needs can be taken care of without difficulty in most areas. In general, public water supply demands are non-consumptive and an estimated 90 percent of the water withdrawn is returned after use. Total public water supply demands now are about 2,200 mgd. They are expected to nearly triple to over 6,000 mgd in 2020. These estimates include industrial uses served from municipal systems and rural domestic water use.

Many industrial water demands are self-supplied, particularly in the larger water-using industries. The largest quantities are used industrially for cooling purposes at thermal-electric generating plants. Fortunately, this use is almost entirely non-consumptive. Limited quantities are consumed in industrial processing and lost by evaporation. Present self-supplied industrial water uses, generally exclusive of water used for cooling, are about 2,200 mgd. They are expected to about double to 4,500 mgd in 2020.





PUBLIC WATER SUPPLY DEMANDS

Agricultural . . . .

Agricultural water use includes water primarily for livestock and irrigation. The use is almost entirely consumptive but the total supplies used are relatively small. Future irrigation activities will place important local demands on the State's land and water resources, particularly in the central and western portions of the State. The total area presently irrigated in the State is about 97,000 acres. This is expected to increase six-fold to about half a million acres in 2020. Seasonal water use for irrigation is estimated to be about 12 inches on the area irrigated. On an annual basis, irrigation water use is expected to increase from 97,000 acre-feet at present to 494,000 acre-feet in 2020. For the 60-day use period, July and August, irrigation represents a water demand of 530 mgd and 2,680 mgd respectively

AREAS OF NEED FOR IRRIGATION WATER

Recreation . . . .

Water use for recreation, fish and wildlife, and related functions is expanding rapidly Water-based recreational facilities are particularly attractive, enticing people to travel far for their enjoyment. The modern highway system makes practically all New York areas accessible to large populations, not only from within but also from outside the State. Existing facilities in most parts of the State are overtaxed. Additional developments are needed adjoining lakes and streams and many new water areas are required closer to population centers.

RECREATION DEMANDS

AREAS GENERATING DEMAND AREAS OF SUPPLY

Power Demands . . .

Power demands are growing rapidly There will be a continually increasing demand for make-up water and cooling water in conventional and nuclear power plants. Pumped-storage hydroelectric projects with significant water requirements are also needed. There are presently in operation 182 hydroelectric power generation plants with an installed capacity of about 1 million kilowatts. A gradual reduction in these facilities is in prospect as old, obsolete plants reach the stage when major repairs are needed.

Lockage Water . . .

Commercial navigation is decreasing in the New York State Barge Canal System except in the Champlain Canal. Here traffic delays have been caused by low water periods. Recreational use of the canal system is expanding and the more frequent lockages of small craft more than make up for the reduced water requirements of commercial traffic.

Flood Damage . . .

Flood problems are acute in the Susquehanna River Basin and the Erie-Niagara Basin. Among others, Binghamton and Buffalo are significant damage centers. Reservoirs, channel improvements, levees and other control structures are applicable to these and other local problems. Effective flood plain management in conjunction with structural measures provides the ultimate best answer for reducing flood damages.

FLOOD DAMAGE CENTERS

Additional Supplies . . .

Additional supplies of water would help attain desirable water quality standards in streams and lakes. Greater dilution, waste assimilative capacity and transport capability in receiving streams are needed to supplement waste treatment measures. However, the required magnitude of additional flows is difficult to determine. A comparative analysis of alternative levels of waste treatment and regulated flows is needed to indicate the economically optimum combination.

Annual water demands identified quantitatively on a statewide basis include water used for public, self-supplied industrial and agricultural supplies. These demands total about 4,600 mgd at present and are expected to more than double to about 11,300 mgd by 2020. Included in the public water supply estimates is water used for industrial and commercial purposes from the public systems and rural domestic water use. Reliable estimates of self-supplied industrial water use are extremely difficult to develop because of the lack of consistent data. Water used for cooling purposes and thermal electric power generation is not included in the industrial water use estimates.

The present and projected total water demands that are quantified appeared to be only a small part of the total supplies available. Except for irrigation, major uses are non-consumptive, such as recreation, fish and wildlife, navigation and waste assimilation. Specific quantities of water used for non-consumptive purposes are difficult to determine.

In spite of these apparently limited overall demands, supply problems occur locally in various parts of the State, and they will intensify in the future in areas of concentrated water demands.

AREAS OF NEED
FOR WATER QUALITY IMPROVEMENT

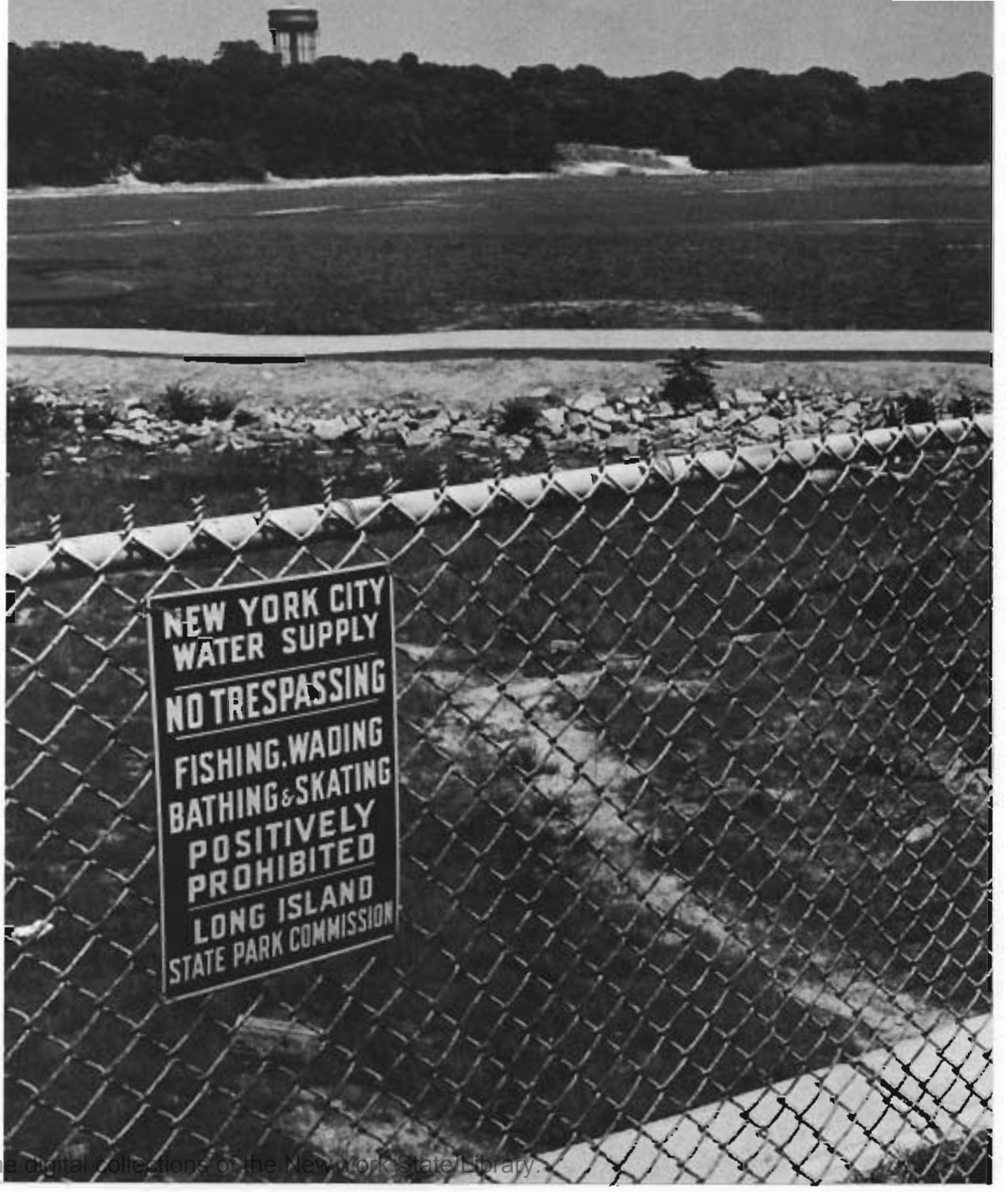
PROBLEMS AND SOLUTIONS

This New York City reservoir, empty during the peak of a recent summer drought, exemplifies New York State water resources problems, large and small, which must be responsive to the State's Accelerated Water Resources Program.

A complete definition of State water problems and their solution has not been made yet. However, the needs and potentials for water resources development have been determined on a regional basis. These, in turn, indicate the nature of probable solutions and the possible major elements of a comprehensive statewide water resources development plan. The ultimate objective is the effective management of our water resources.

The major water resources needs in the State are:

- Overall improvement of water quality
- Major new water supply sources for the New York City Metropolitan area
- Flood control for the Susquehanna River Basin
- Statewide flood plain management
- Improved management of the major lakes in the State
- Development of water-based recreation facilities
- Development of the Barge Canal System as a total water resource
- Flow regulation
- Irrigation water



Water Quality Management

The major step forward in water quality management was the Pure Waters Program, initiated in 1965 with public approval of a billion-dollar Pure Waters Bond Act. The statewide cooperative program to ensure that all waters will meet the stream classification standards established by the Water Resources Commission is well underway. As a result of the construction of adequate sewage and industrial waste treatment facilities anticipated under this program, presently polluted water supplies will attain a high enough quality to meet many short and long range water needs. Nevertheless, additional supplies must be developed to meet major water demands. Reservoir storage to implement low stream flows during natural low flow periods, will increase stream assimilation capacities and provide an important water quality management tool to supplement improved waste treatment.

Water Supply— New York City

Public water supply demands in the New York City Metropolitan Area (which include the city and five adjoining counties) are expected to increase from 1,500 mgd at present to about 4,000 mgd in 2020. Total available supplies are about 2,600 mgd. New sources must be developed to meet the future need for 1,400 mgd. Supplying this is equivalent to doubling the yield of the present New York City system.

The capital cost of New York City's present supply system is more than a billion dollars. These past developments indicate the scope of future efforts required to meet the area-wide needs and ultimately the regional needs extending into adjoining states.

The reconnaissance indicates further developments can be made in the Hudson River Basin to meet future needs. Supplies can be obtained by direct withdrawal from the river with treatment and upstream storage. Additional investigations are being made in a State-financed, inter-municipal public water supply study for the New York City-Westchester County area, giving consideration to within-basin sources, inter-basin diversions and system operation and management problems.

Flood Control Susquehanna River Basin

Flood control was one of the earliest recognized water problems in the Susquehanna River Basin. In recent years the flood hazard has been reduced by the construction of four flood control reservoirs and local protection works at 13 locations. Additional protection is still required to provide for continued development in the major valleys and to prevent over-topping of existing dikes and levees.

Flood damage in the basin is principally the result of the inundation of structures in urban areas and, to a lesser degree, of the inundation and erosion of agricultural lands, rural structures, bridges and important transportation routes, all concentrated in the valleys. A total of 52,600 acres, of which 5,450 acres were in urban areas, have been inundated by at least one of the three largest floods of record. In addition over 30 lives have been lost as a result of floods. The total flood damages that would result if the same areas flooded in 1935, 1936 and 1946 were inundated today is estimated at $125,000,000.

The original Corps of Engineers flood control plan for the Susquehanna River Basin included a combination of local protection works and flood control reservoirs. Most of the former have been built, but the need remains for additional flood storage reservoirs to prevent over-topping of local levees and flood walls and to provide protection to rural areas where local improvements are not feasible economically.

In addition to main stream flood protection, there is a need for flood prevention in small watersheds of the basin. The Soil Conservation Service is making a major effort to meet this need. These measures are a necessary part of an overall comprehensive program. They are complementary to, not a substitute for, main stream protection.

Statewide Flood Plain Management

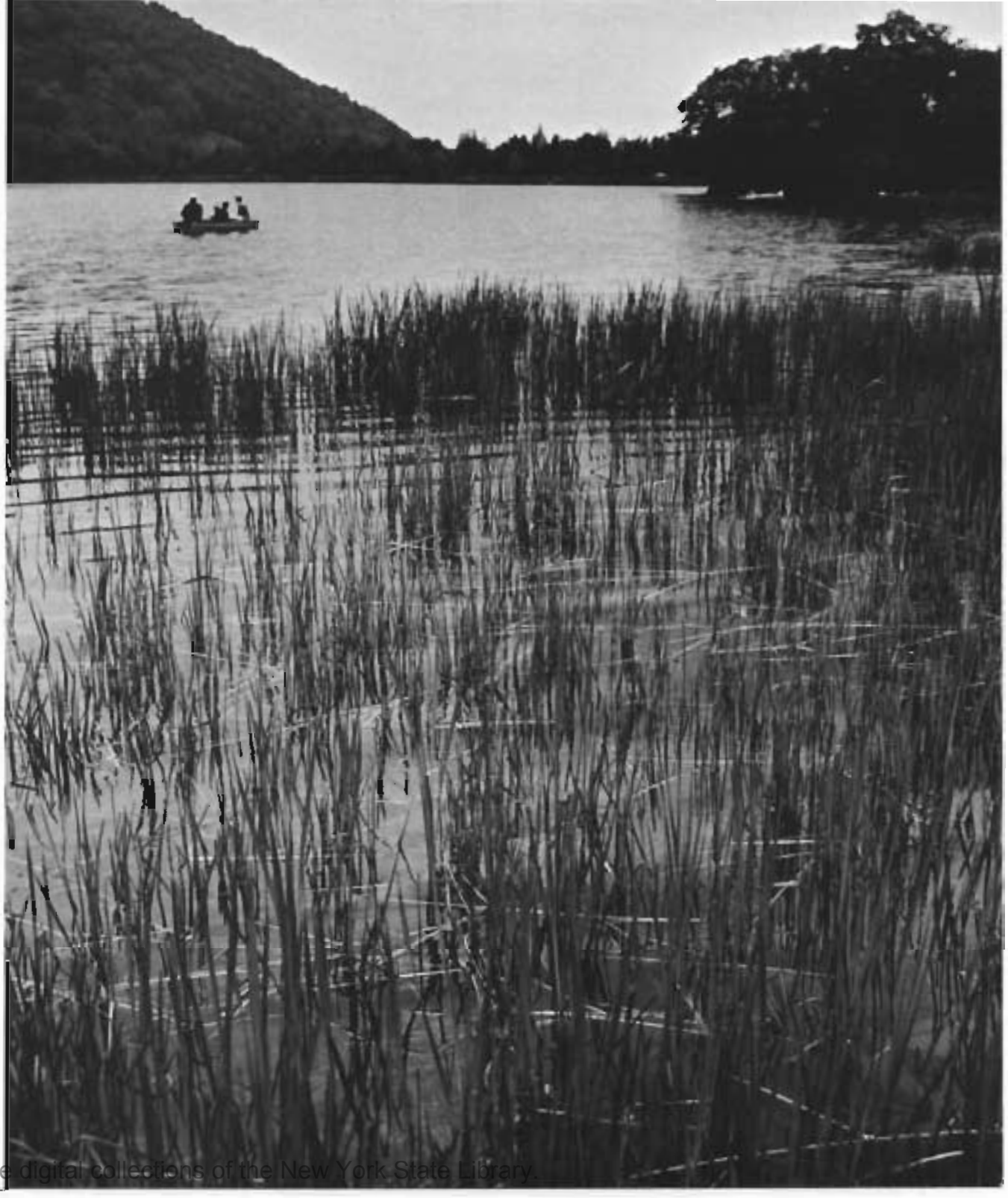
Other significant flood damage centers occur throughout the State. Upstream reservoirs and local protective works generally can provide solutions for specific problems. However, in many cases improvements cannot be justified economically. Even more serious is the continuing encroachment of damageable property in flood hazard areas. Although flooding has not been widespread in recent years during the drought, floods are certain to occur again. Potential future flood damages can be minimized only by intelligent management of flood plain areas giving full recognition to existing flood hazards. With the rapidly expanding population and continued economic growth in the State, flood plain areas must be utilized, but the developments must be prudent. A statewide flood plain management program must be implemented to forestall more serious future flood problems.

Lake Management

Lake management is a major need in all areas of the State. Lake Champlain, Lake George and Saratoga Lake in the Eastern Region, Oneida Lake and the Finger Lakes in the Central Region and Lake Chautauqua in the Western Region all have problems of pollution, weed growth, algae, sedimentation and lake level regulation. The many smaller lakes throughout the State, especially those used heavily for recreation and surrounded by summer cottages and full-time residences, have similar problems. Lake management problems are most severe in the Central Region where some Finger Lakes are also operated as part of the complex Barge Canal System. Conflicting interests compound the problem of lake level management.

Many of the State's lake problems have been intensified by man's economic progress. Urbanization, industrialization and agricultural activities can easily unbalance nature's delicate system. The use of water for human and industrial waste disposal is only one of the many possible influences. Agricultural drainage, increased sedimentation resulting from poor land development practices and even waste water treatment itself can also contribute to lake problems.

Solutions for lake problems are not obvious and will require extensive research and study. On individual lakes, studies and surveys are needed to determine the extent of eutrophication or change and to develop the steps necessary to slow the process. Attention must be given to the tributary waters as well as to the lakes themselves. Optimum stage-operating procedures must be determined and in some cases existing lake outlet structures must be improved or modified.

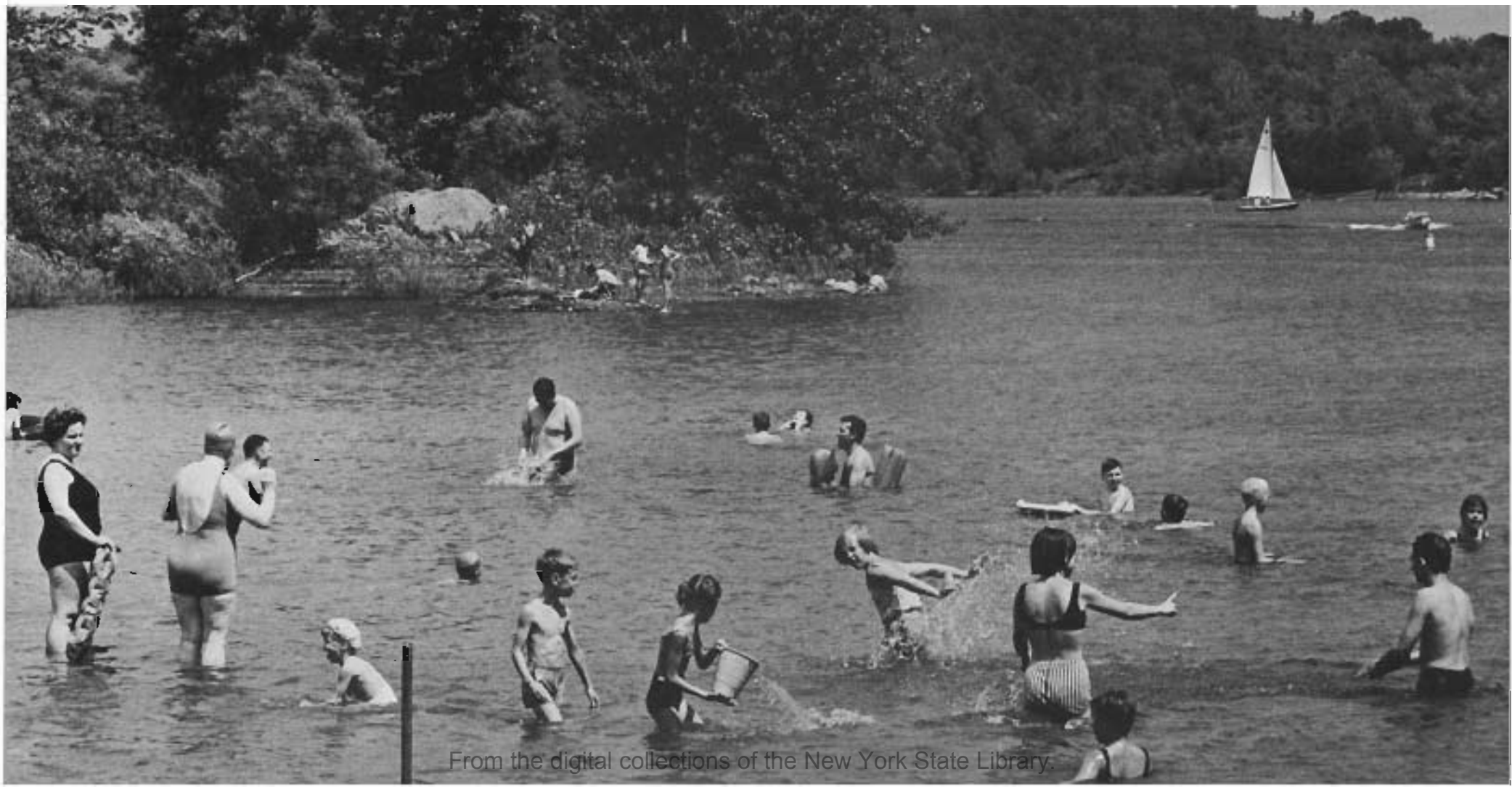


Water-based Recreation

General prosperity, increasing leisure time, and a constantly growing high-speed highway network have induced participation in outdoor recreation in proportions undreamed of only a decade ago. The greatest increase in recent years has been in water-based recreation.

New York's topography, climate and development provide opportunities for all forms of recreation. No part of the State is without access to a major resource area for outdoor recreation. In the Eastern Region there are the Adirondack peaks and lakes and the St. Lawrence River Valley in the north and mountain and seashore areas adjacent to the New York City Metropolitan Area. In the Central Region, there are the Finger Lakes and Lake Ontario and in the Western Region there are the Great Lakes and the Allegheny hills.

Within these major topographic areas there are many opportunities for additional recreational developments. Recreation in the Adirondacks, the Catskills and the Allegheny Plateau would be enhanced by usable reservoir areas. Additional park facilities are needed in the Finger Lakes area. Full advantage must be taken of the recreation potential of the Barge Canal System. In the Eastern Region along the scenic Hudson-Mohawk Rivers, five corridor sites have been identified for major recreational developments. Attractive recreational areas could be developed in other parts of the State in conjunction with multi-purpose reservoir construction.



Barge Canal System

The Barge Canal System is one of the most important water resources in New York State. It is associated with about 40 percent of the inland waters of the State with over 500 miles of canals and interconnected canalized lakes and rivers and 300 miles of feeder streams. Approximately half the area of the State is tributary to the Barge Canal System. Future use and allocation of the waters of the canal will have a profound effect on the development and management of the water resources of the State as a whole. The canal crosses several of the major river basins of the State, including the Mohawk, Oswego, Genesee and Erie-Niagara. It connects Lake Erie and Lake Ontario with the Hudson River and Lake Champlain via the Champlain Canal.

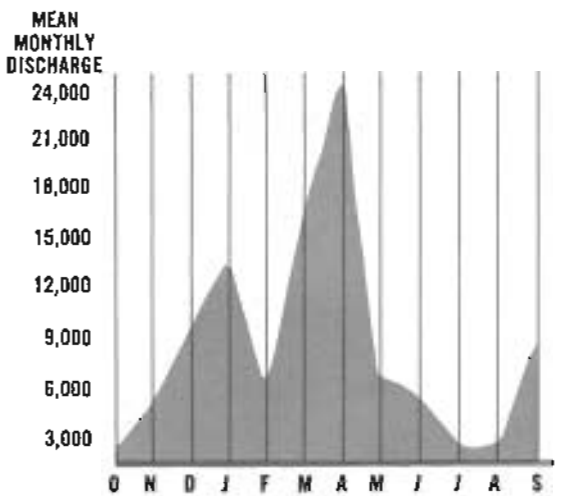
A comprehensive plan for multi-purpose development, use and management of the Barge Canal System is needed. A plan, developed under State leadership, also should evaluate the advantages of State ownership with appropriate participation by federal and other agencies.

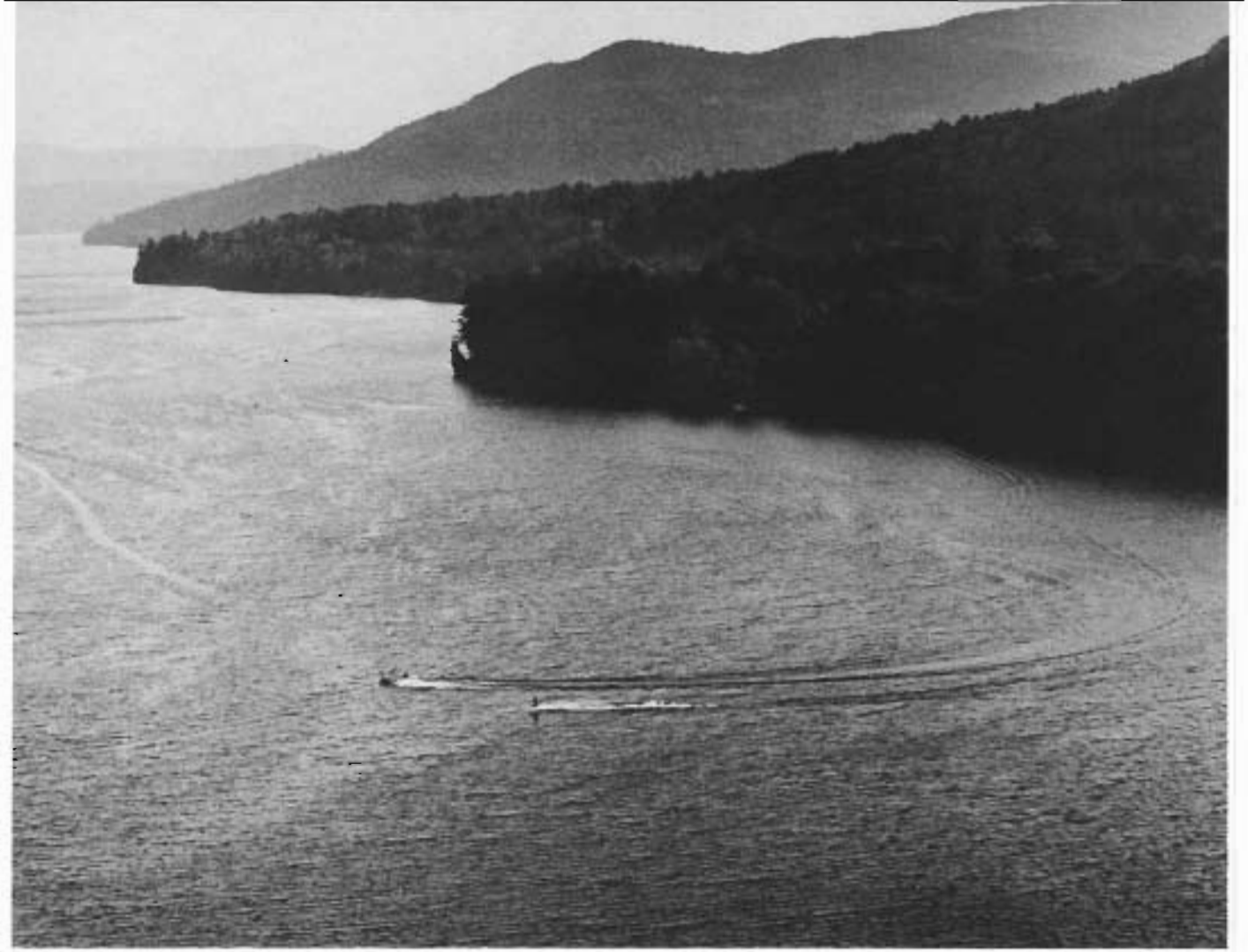
Flow Regulation

New York is a headwaters State with outward flow to the Atlantic Ocean, Ohio River, Great Lakes and St. Lawrence River. The streams have a characteristic pattern of high flow during the spring months, March, April and May, and low flow during the late summer and early fall. Much of the spring runoff is wasted and excessive flows may cause flood damages. The low flows later in the year limit the possibilities for effective surface water use. Reducing the range of these extremes will have multiple benefits by decreasing the adverse effects of high and low flows and providing water for additional uses and developments.

Sacandaga Reservoir in the Hudson River Basin is one of the first major multi-purpose reservoirs built in the nation. Multi-purpose development of water and related land resources is a basic concept today. Optimum development requires that reservoir storage be included for all reasonable compatible purposes which can be incorporated into an operational program.

TYPICAL HYDROGRAPH OF SUSQUEHANNA RIVER NEAR WAVERLY





Irrigation Water

If agricultural development is to keep pace with future demands, irrigation must be practiced in applicable areas of the State. Problems involved in supplying irrigated water are difficult. The use is almost entirely consumptive, and the needs are irregular, depending on rainfall. Irrigation water is needed during midsummer when stream flows are approaching low levels and withdrawals can cause drastic reduction in downstream supplies. Although small in absolute amount, future irrigation water use will be a significant demand on water in storage, stream flow or ground water. If food prices warrant, lands not now being considered for irrigation could be used for that purpose. To make irrigation part of multi-purpose management will require perfection of institutional arrangements and the resolution of legal problems.

THE PLAN

The primary objective of water resources planning in New York State is to provide a framework within which to allocate available resources in an optimum manner for meeting the needs and desires of the people of the State. The planning involves two basic considerations —quantity and quality. Adequate quantities of water of suitable quality must be supplied to meet present and future needs—if the State is to continue to grow and prosper. To meet this goal, an overall plan must include all significant potentials, such as development and utilization of ground water, better regulation and use of natural lakes and construction of surface reservoirs. The nature of an overall plan is emerging from the current basin and regional studies.

The most apparent need now is for additional major storage reservoirs to ameliorate the most critical water problems and to develop the greatest potential benefits. There are hundreds of possible reservoir sites in the State. However, good sites are limited. Through a series of progressively more stringent screening processes, the number of sites has been reduced to a relatively few which appear to be the most promising. Fifty-eight have been selected in this category. The potential reservoirs would have 6,200,000 acre-feet of storage and would add 153,000 acres to the State's water surface. The estimated capital cost of construction is $914,000,000.

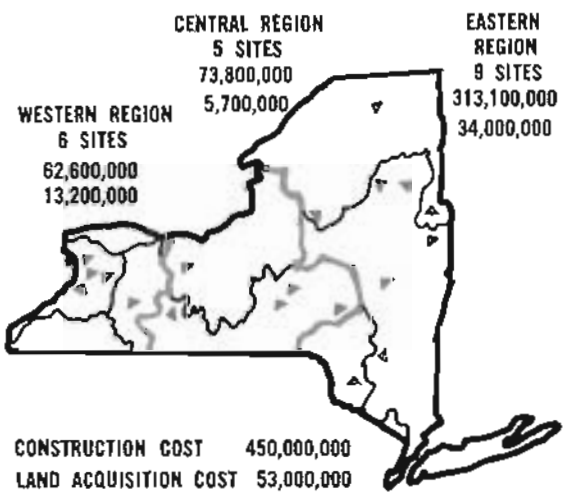
More detailed project feasibility studies may show some of these sites to be less desirable. Others may be scheduled for construction far into the future. Included in the suggested initial development plan are those sites likely to prove feasible after more intensive studies. Preliminary evaluations indicate these sites can meet certain well-defined needs and have outstanding capabilities for multi-purpose development. The suggested plan considers possible development of 20 reservoirs with 2,700,000 acre-feet of storage and 67,000 acres of water surface. The estimated present capital cost of construction is $450,000,000, including land acquisition costs but not those of related recreational facilities. The distribution of sites is shown on this page. The acquisition of any sites that may be within the Forest Preserve must be within the Constitution.

The plan shows the magnitude of investments which must be made if the State is to keep pace with its growing population by managing its basic natural resources to provide for continued economic growth. It is estimated that approximately one-third of the construction cost will be underwritten by federal funds.

The benefits of such a program would include major benefits for public water supply, recreation, fish and wildlife and flood control. Less extensive, but nevertheless important, benefits would be realized for agricultural water supply (irrigation), water quality control, hydroelectric power generation and navigation. Basic indirect benefits, such as stimulation of industrial growth and enhancement of adjoining shore areas, are potentially large. Under the Pure Waters Program, nearly $2 billion has been assigned to clean up our waters. The dimension of multi-purpose water resources capital construction seems a realistic additional investment to guarantee the success of the Pure Waters Program and to provide the basic foundation for continued economic growth and social well-being in the Empire State.

Implementation of the plan will require a major coordinated effort at all levels of public and private endeavor. New legal, financial and institutional arrangements will have to be developed to overcome the many obstacles involved. Imaginative and creative thinking will have to be applied to resolve formidable tech-

RESERVOIR DEVELOPMENT PROGRAM FIRST STAGE



nical and management problems. The public interest will have to supersede vested self-interests. The challenge is great, but it has been met in similar programs elsewhere. Modern concepts of water resources development indicate the direction of major efforts.

The planning, development and management of water resources is a responsibility shared by agencies at all levels of government—local, state and federal. On this premise many forces can be applied to move the program forward through successive stages. Regional Water Resources Planning and Development Boards created under existing State law (Part V, Article V of the Conservation Law) can develop comprehensive plans for the mananagement of water resources. The programs can be directed by the State Water Resources Commission, which is charged with coordinating State agency functions related to water resources and with formulating State policy. The member State agencies can provide major assistance in their various areas of responsibility.

Through the Water Resources Commission, Federal agency capabilities are brought to bear in State-directed planning endeavors. As a result of State efforts, Congress in 1966 authorized the Corps of Engineers to utilize federal funds to cooperate in New York State planning activities. A large joint program with the U. S. Geological Survey, in which the Federal government matches State funds, dollar for dollar, is underway. The Soil Conservation Service is providing direct support with federal funds to the Regional Board activities through cooperative arrangements.

Project financing, which is frequently a stumbling block, similarly can be expedited by cooperative effort. Existing national programs provide for payment of construction costs and cost-sharing for certain types of projects and for various project purposes. The Corps of Engineers and Soil Conservation Service are the major water resources project construction agencies in New York.

New areas of cooperation are in the process of being explored. For example, the State might undertake the responsibility for feasibility investigations and design for structures in a comprehensive river basin development plan evolved in cooperation among State and federal agencies, with the cost of these responsibilities later to be reimbursed through federal appropriation. This would, of course, involve prior agreement with the federal construction agency which would normally undertake these activities.

Another possibility is the obtaining of first instance funds from the Federal government for facility construction to meet special functions, such as recreation storage in reservoirs (CF the Federal Water Supply Act of 1958 water supply storage as needed).

The State has a primary interest in plan implementation and could assume an appropriate share of the cost. The citizens of the State recently demonstrated their concern for water resources by approving a $1 billion bond issue to fight water pollution. With water supplies of adequate quality the next logical objective is greater utilization through multi-purpose development. Local communities likewise have a major interest in projects in their vicinity and can be expected to share in the costs as well as benefits. The belief that project costs should be allocated among beneficiaries in proportion to their benefits is basically sound and widely acknowledged.

THE FIRST STEP

Historically, progress in water resources development has come by crisis and catastrophe instead of by planning. Floods have stimulated control works; droughts have fostered water supply developments. Between the crises there usually has been little action. The critical need is long-range planning for orderly development to meet foreseeable needs and to develop the full potential of water resources.

The planning process, precursor to development, is time-consuming. Comprehensive studies are required on a multitude of aspects. Basic data are frequently lacking and must be collected and analyzed. Major research, extensive field investigations, system analyses and model studies are required. It is imperative that these major planning efforts be completed as expeditiously as possible.

Meanwhile the increasing pressures of population and economic growth will imperil key reservoir sites. Often these sites are also the most suitable ones for other purposes, such as highway crossings, industrial plant locations, housing development and agriculture. Sites which were reported on most favorably 20 to 30 years ago have been preempted by other developments. At best, additional developments within potential project areas would make them more expensive and less economically feasible. At worst, they would make projects prohibitively expensive.

Thus, the FIRST STEP is

Reservation of Reservoir Sites—A program must be evolved and financing provided for acquisition or reservation of reservoir sites, including lands needed for public access to the water surface.

ADDITIONAL ACTION

Based upon the recommendations of the Technical Advisory Board and demonstrated needs, the following ADDITIONAL ACTIONS would insure optimum water resources development and management:

- *Comprehensive, Multi-purpose Planning.* Continue intrastate regional water resources planning (Part V, Article V of the Conservation Law); expedite interstate river basin surveys under federal management through more effective participation; and expand statewide long-range planning studies.
- *Feasibility Studies.* Undertake feasibility studies of individual projects required within the next ten to twenty years to meet immediate needs.
- *Storage in Federal Reservoirs for State Purposes.* Authorize the Water Resources Commission, as sole negotiating agent with the federal government, to grant formal assurances of local cooperation to the federal government for:

(1) inclusion of water-supply storage in federally-constructed, multi-purpose impoundments in accordance with the federal Water Supply Act of 1958 (Title III of Public Law 85-500).

(2) low-flow augmentation from federal reservoirs for water quality management, irrigation, recreation and enhancement of fish and wildlife resources.

- *Water Oriented Recreation and Enhancement of Fish and Wildlife Resources.* Re-evaluate the:

(1) Extent to which the State will bear the costs allocated to water-oriented recreation and enhancement of fish and wildlife resources for projects constructed by the State or by local agencies.

(2) Degree to which the State will bear the non-federal costs allocated to recreation and the enhancement of fish and wildlife resources for federal projects under the provisions of the Federal Water Project Recreation Act.

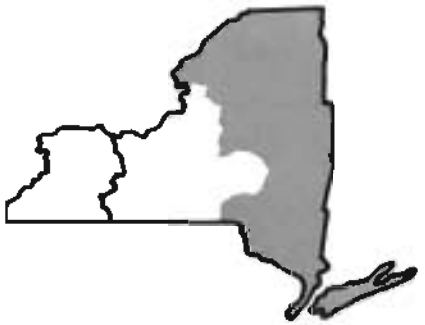
- *Irrigation.* Develop a policy regarding:

(1) Pricing of irrigation water supplied from reservoirs (federal, state and local) in which the State may have a financial interest.

(2) Securing repayment from irrigators who may individually divert from surface streams or pump ground water but who benefit from the stream flow regulation and low-flow augmentation provided.

(3) Withdrawal of water from the Barge Canal System.

- *Institutional Arrangements.* Review existing institutional possibilities and explore other kinds of regional and river basin agencies suited to serving local needs (including flood control, water supply, irrigation, recreation and other purposes) and yet responsive to State policies. This might include consideration of authorizing existing Regional Water Resources Planning and Development Boards (Part V, Article V of the Conservation Law) to undertake development and management of regional water resources.
- *Flood Plain Management.* Formulate comprehensive policy for management of flood plains to include designation of problem areas, floodway encroachment control, assistance with local flood plain management, review of public investment in the flood plain and land acquisition.
- *Water Rights.* Formulate in conjunction with appropriate committees of the Legislature a comprehensive water rights law covering both surface and ground waters with provisions for protection of vested rights and for issuance of permits and licenses for proposed storage, diversions and uses.
- *Basic Data.* Carry out needed programs of collection and evaluation and special studies recommended by the Technical Advisory Board.



EASTERN REGION

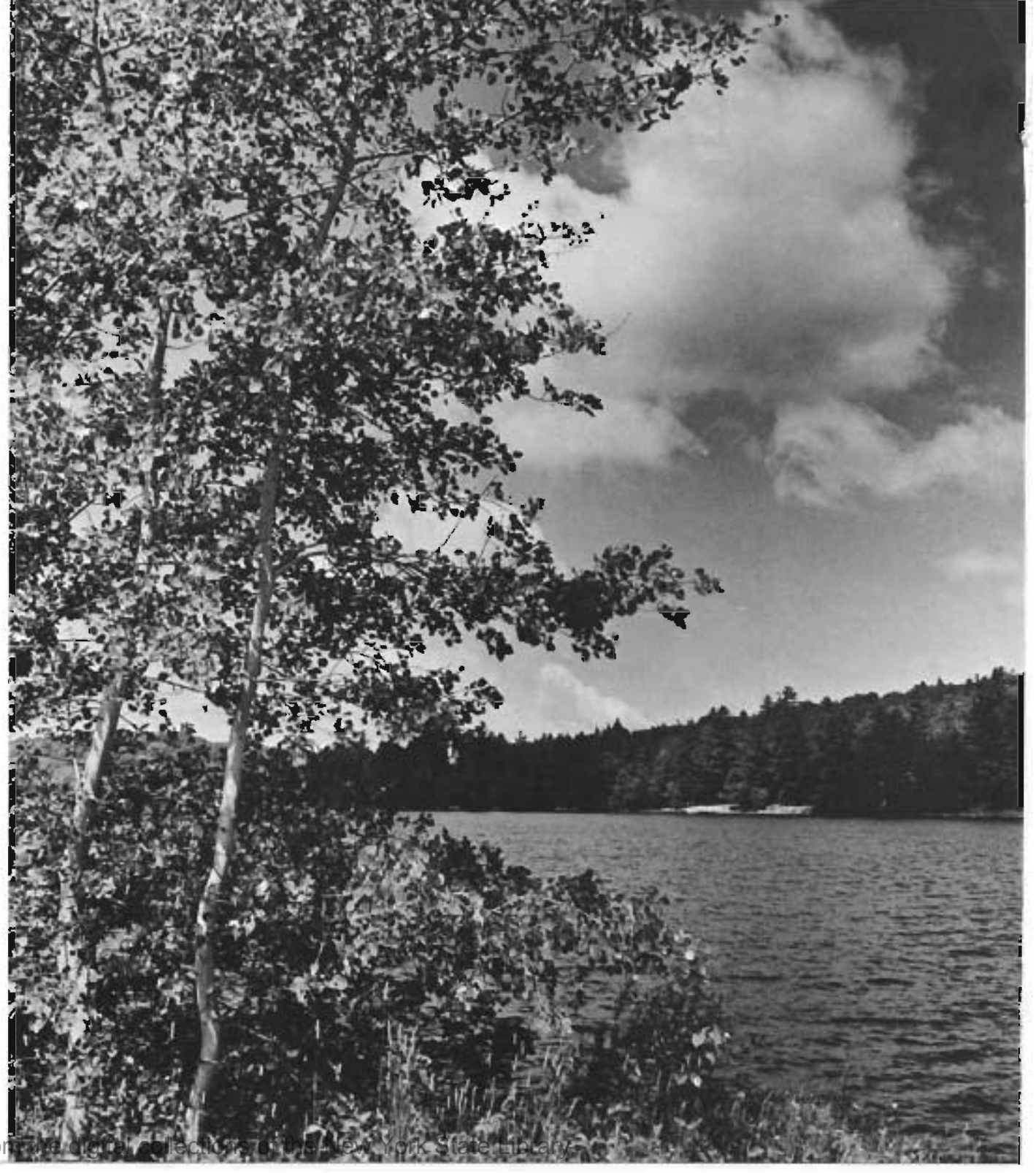
A. Physical Characteristics

The Eastern Region contains about 27,200 square miles or almost 60 percent of the area of New York State. It includes the New York City and Long Island areas and all or parts of five major drainage basins: the Hudson-Mohawk, St. Lawrence, Lake Champlain, Black and Delaware.

Dominant physical characteristics of the region are the mountainous areas, principally the Adirondacks and Catskills, and the large natural lakes including Lake Champlain and Lake George. Other features are the major river valleys, including the Hudson River tidal estuary, which extends from New York Bay to Albany, and the Atlantic Coastal Plain area of Long Island.

The Hudson River begins at Mt. Marcy, the highest mountain in the State, and flows generally south about 300 miles to New York Harbor.

The Mohawk River is the principal tributary. It originates in the southern Adirondack Mountain foothills and flows eastward about 155 miles to join the Hudson River near its mid-point. The total Hudson River Basin drainage area is about 13,400 square miles. Streams within the Black, St. Lawrence and



Lake Champlain Basins also rise in the rugged Adirondack Mountains. The area includes about 10,000 square miles with drainage into Lake Ontario, the St. Lawrence River and Lake Champlain. The Delaware River Basin consists of a roughly triangular area of about 2,400 square miles in the southern part of the region. Streams in the basin generally rise on the southern and western slopes of the Catskill Mountains. The Delaware River flows southeast out of New York State through New Jersey, Pennsylvania and Delaware into the Delaware Bay.

B. Economic Aspects

The Eastern Region embraces by far the largest segment of New York both in area and people. It includes both the most lightly and the most heavily populated areas in the State.

The New York Metropolitan Area is the major center of economic activity within the region. It ranks first in the country in major industrial and commercial activities and contains more than half the inhabitants of the region. The Albany-Troy-Schenectady Area, at the confluence of the Hudson and Mohawk Rivers, is the transportation hub and trading and service center for east-central New York State. It includes a manufacturing complex and is the State Capitol. The Utica-Rome area at the western end of the Mohawk River Basin is an industrialized urban corridor with a concentration of transportation and service facilities. Other rapidly growing centers of economic activity are at Newburgh, Beacon and Poughkeepsie in the mid-Hudson Valley; Glens Falls, Hudson Falls and Fort Edward in the upper Hudson Valley and Amsterdam on the Mohawk River. Watertown is the largest community outside the Hudson-Mohawk River Basin.

The remainder of the region is agricultural except for the mountainous areas which support recreational activities and specialized local industries. Dairy farms predominate in the rural areas, but highly specialized vegetable, fruit and poultry production is concentrated in areas of the Hudson River Valley and on Long Island.

The 1960 population of the Eastern Region was about 11,000,000 people. It is expected to more than double to about 25,000,000 by 2020 with the greatest growth occurring in the Metropolitan New York Area and through the Hudson-Mohawk Valley. Northern portions of the region are sparsely populated. Only Watertown, Plattsburgh, Ogdensburg and Massena have populations greater than 10,000. Population growth outside the major urban centers has been uneven, but everywhere less than the national average.

Transportation has been a key factor in development of the region. The Hudson-Mohawk River Valley has been heavily traveled since pioneer days and contains major navigation, railroad and highway routes. Construction of major highways through the northern part of the region and across the Delaware River Basin will accelerate future growth in these areas.

C. Climatology

The climate of the Eastern Region may be generally classified as moist-continental with long cold winters and short mild summers in the north portions. Higher temperatures prevail in the south, particularly near the ocean which has a moderating influence. Elevation has a more pronounced affect on temperature and precipitation than latitude, resulting in marked variations. Average annual temperatures vary from 40.3° at Lake Placid to 54.7° at LaGuardia Airport. Extremes of 50° below zero Fahrenheit have been reported in the Adirondacks and 105° above at other stations.

The higher elevations have greater precipitation than the lowlands. Average annual precipitation is more than 60 inches in parts of the Catskill Mountains and 50 to 60 inches in parts of the Adirondacks. The lowest average annual precipitation is about 30 inches occurring near the St. Lawrence River and at Lake Champlain. Average annual precipitation on Long Island is 40 to 45 inches. Average annual snowfall varies from up to 180 inches in the mountains to about 30 inches on Long Island.

Extreme variations in precipitation have been recorded in the region. Total annual precipitation has varied from 77.08 inches at Slide Mountain in the Catskills in 1955 to 20.68 inches at Albany in 1964. On a shorter term basis, heavy rainfall can occur during severe thunderstorms, intense cyclonic storms and hurricanes. A notable downpour was reported from Spier Falls in Saratoga County where 8.22 inches fell in a 3-hour period on July 22, 1919. Hurricanes have been responsible for some of the heaviest precipitation and most extensive flooding in the lower Hudson Valley and on Long Island. In 1955 Hurricane "Connie," which produced heavy widespread rainfall on August 12 and 13, was followed closely by Hurricane "Diane" on the 18th and 19th with 2 to 8 inches of rainfall over southeastern New York. Unprecedented flooding occurred.

The most notable drought in the region began in 1962 and has not yet officially ended. A precipitation deficiency of almost 50 inches has occurred in the Hudson Valley between January 1, 1962 and April 30, 1966. Deficiencies were less in the remainder of the region ranging down to about 14 inches in the St. Lawrence Valley. Near normal rainfall since April has eased the drought somewhat, except in the lower Hudson Valley and on Long Island.

D. Water Supplies

1. SURFACE WATER

Average annual runoff, like precipitation, is variable ranging from 35 inches in the high headwater areas to 15 inches or less in the valley around Albany. The Adirondack Mountains are one of the most important water supply areas in the State. Evaporation and transpiration losses are low because of the relatively cold climate, and there is a high percent of runoff during the summer months from the relatively impervious mountain slopes. Thirty to forty percent of the annual precipitation occurs as snow, a large part of which is held in storage and released in the late winter and early spring. Although located farther south, the Catskills have similar advantages. Because of higher average annual precipitation, the area produces the highest runoff in the State. By contrast, Long Island with its high infiltration rates has the least runoff, amounting to 6 to 8 inches annually.

The northern portion of the region contains many natural lakes. The largest are Lake Champlain with an area of 435 square miles, including 17 square miles in Canada, and Lake George with 44 square miles. The smaller lakes are concentrated in the central Adirondack area.

Many large reservoirs have been constructed in the region, primarily for public water supply, power generation and flood control. Sacandaga Reservoir in the upper Hudson River Basin is by far the largest. It has a surface area of almost 42 square miles and has 762,000 acre-feet of usable storage. It was completed in 1930 and is operated by the Hudson River-Black River Regulating District for power generation, flood control, recreation and low flow regulation. Indian Lake is another headwater reservoir of importance. It has a surface area of about 8 square miles and storage of 103,000 acre-feet, and it provides important flow regulation on the upper Hudson River. Delta and Hinckley Reservoirs are major multi-purpose reservoirs in the Mohawk River Basin. They provide water to the Barge Canal System and are used for public water supply and recreation. Seven other reservoirs with about 50,000 acre-feet of storage supply water to the Barge Canal from the Black River Basin. Many small reservoirs have been built in the mountainous areas for power generation.

There is a long history of reservoir construction for New York City water supply in the Eastern Region extending back into the 19th Century. The first reservoirs were built in the lower part of the Hudson River Basin in Westchester County, the largest being Kensico Reservoir on the Bronx River and New Croton Reservoir on the Croton River. The source of supply was later extended into the Catskills with construction of Ashokan, Rondout and Schoharie Reservoirs. In recent years the Delaware River Basin has become a major source of water supply with construction of Neversink, Pepacton and Cannonsville Reservoirs. The total system storage amounts to about 1.8 million acre-feet.

Surface water quality in the upland areas and throughout most of the northern part of the region is excellent, but serious pollution problems exist in the Hudson and Mohawk Rivers and principal tributaries. Municipal and industrial discharges from the Capital District grossly pollute the river at Albany and for about 50 miles downstream. Pollution has increased in the New York Metropolitan Area as a result of the population and industrial growth there. The upper Hudson and Mohawk Rivers are also polluted at various locations. Under the State's "Pure Waters" Program, a major effort is being directed at improving conditions.

2. GROUND WATER

Major ground water provinces exist in the Eastern Region principally along the Mohawk River and on Long Island.

The valley-flat areas along the Mohawk River are underlain by consolidated deposits of glacial till and outwash sand, gravel and clay. The highly permeable sand and gravel deposits, which are more than 200 feet deep in places, are capable of yielding large quantities of ground water. The water is derived from two sources, ground water slowly percolating toward the river and water infiltrating from the river through the hydraulic interconnection. Supplies totaling about 200 mgd can be developed from this source.

Long Island has vast amounts of ground water in storage. The U.S. Geological Survey estimates the fresh water reservoir has a storage capacity of 10 to 20 trillion gallons. The Island is completely surrounded with bodies of water and constitutes a basic hydrologic system which must be considered as a water supply unit. The Island is made up of unconsolidated deposits of sand, gravel and clay that were laid down in more or less parallel beds on the surface of hard crystalline bedrock.

The bedrock is exposed in northern Queens County and is more than 2,000 feet below the surface of the ground in southern Suffolk County. The beds of permeable sand and gravel, which are the best water producing formations, are more or less interconnected laterally and are separated from other strata by extensive beds of relatively impervious clay. The total potential for development of ground water supplies on Long Island is estimated at 1,200 mgd. All fresh ground water is derived from precipitation on the surface of the island. It is estimated that one-half the precipitation, or about 20 inches, infiltrates the soil and recharges the ground water during normal years.

Upland portions of the Eastern Region consist of relatively thin glacial till overlying crystalline rocks, shale, sandstone and limestone. The till and bedrock are generally poor water bearing formations and yield low to moderate supplies. Buried valleys which contain glacial deposits are located at scattered points throughout the region and are the most productive upland water bearing formations.

E. Water Demands

1. PUBLIC WATER SUPPLY

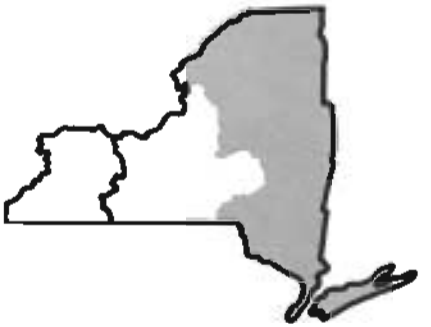
The New York City public water supply system, which services about 8,000,000 people, dwarfs the other systems in the region. Practically the entire water supply for the city is drawn from three systems: the Croton, Catskill and Delaware. The combined systems, with minor additions from other sources, provide a supply of about 1,400 mgd compared with present demands of about 1,200 mgd. On a metropolitan area basis, New York City water supplies and demands have been combined with those of five adjoining counties: Westchester, Putnam, Rockland, Nassau and Suffolk. Present water demands in the metropolitan area are 1,550 mgd compared with available supplies of 1,700 mgd. The present area population of 10,700,000 is expected to increase to 21,500,000 by 2020, increasing the overall demand to about 4,000 mgd. Local sources can supply about 900 mgd additional, indicating a future need for 1,400 mgd from new sources.

Other major public water supply systems are located throughout the region at the centers of population and industry. The City of Utica services 146,000 people with a present average demand of 21 mgd. The supply from Hinckley Reservoir and other surface sources, with a reliable yield of 50 mgd, is ample for future needs. The City of Albany supplies about 130,000 people with an average demand of 23 mgd. The present surface supplies are marginal. Other large cities, including Schenectady, Troy and Rome, have generally adequate supplies. Many suburban areas and smaller communities have experienced difficulties during the recent drought. A moderate expansion of local facilities can take care of present and future needs in most cases. In the lightly populated areas public water supply is not a major problem.

A high proportion of the Eastern Region's population is served by public water supplies. In the New York City area only about 300,000 persons, mostly in eastern Suffolk County, rely on private supplies. A large number of municipal agencies, water companies and water authorities are operating in Westchester, Nassau and Suffolk Counties. Total public water supply demands in the Eastern Region are about 1,800 mgd, including industrial uses served from municipal systems and rural domestic water use. They are expected to increase to about 4,500 mgd in 2020.

2. INDUSTRIAL WATER SUPPLY

An essential part of public water supply demands is for industrial water use. In many cases the major industrial water users have developed their own sources of supply. A



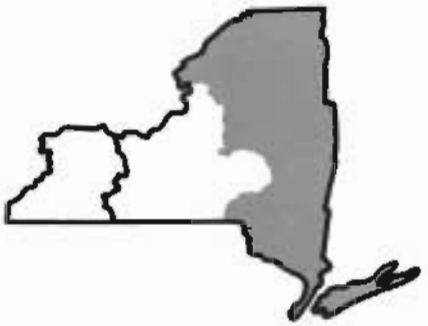
major part of the industrial water use is nonconsumptive, particularly water used for cooling purposes. Industrial water use is expected to increase, although some industries have reduced their water requirements by various techniques, such as recirculation and reuse.

Total self-supplied industrial water use in the region, generally exclusive of cooling water, is estimated to be about 1,100 mgd. Future industrial water demands are expected to be about twice as large, 2,400 mgd, by 2020 and will be concentrated in the urban areas.

3. AGRICULTURE

Agricultural water demands for livestock and irrigation, although important, are not a major part of the total water demands in the region. Farmstead needs are obtained from individual ground water sources which are generally adequate to supply the small quantities required. Livestock water supplies amounting to about 35 mgd probably will decrease in the future as urbanization and industrialization of the region increases.

Irrigation acreage is limited in the region. It is concentrated in eastern Long Island where vegetables, potatoes and sod are the principal crops irrigated. About 31,000 acres were irrigated in Suffolk County in 1959 at an annual rate of about 18 mgd. Only about 10,000 acres are irrigated in the remainder of the region. Unlike many uses, irrigation is essentially a



consumptive use. Other agricultural water demands unique to Long Island are duck farm requirements and the large number of golf courses which require irrigation on an average of 120 days each year. However, quantitatively, the amounts of water used for these purposes are not of major importance, amounting to about 35 mgd on an annual basis.

The potential for additional irrigation in the region is limited. Suffolk County is feeling the effects of rapid urban expansion and so there is little possibility of an increase in the agricultural acreage. Land which does remain in cultivation will be far more intensively farmed, and irrigation will increase on existing acreage. Similar population pressures in the Albany area, where there is an extensive acreage of sandy soils, preclude any great expansion of irrigation there. Agricultural production in northerly portions of the region is limited by climatic conditions, and supplemental irrigation is of questionable value. Any expansion of activity throughout the region is likely to occur along the major streams, particularly the Mohawk River and Schoharie Creek, where surface water supplies are abundant and valley areas are relatively wide.

4. RECREATION

Fish and Wildlife

Participation in outdoor recreation is increasing at a rapid rate, much faster than population growth. It is fostered by the general prosperity, increased leisure time and a constantly improving highway system. Most people are seeking water-based recreation such as water skiing, swimming, boating and fishing. Camping, picnicking and hiking, also very popular, are more attractive near water.

In addition to the large population within the region, there are major metropolitan centers outside the State which look to the area for recreational activities. With improved highway facilities much of the Eastern Region is within easy driving distance of New Jersey and Connecticut portions of the New York Metropolitan Area. The northern area is easily accessible from Montreal, Ottawa and other parts of southern Canada. The Adirondacks will become even more easily reached after completion of the Northway in 1967.

Water is by far the most important recreational resource. The Eastern Region is rich in water resources with a large number of rivers, streams, lakes and a saltwater shoreline. Many public and private developments, located primarily in the Adirondacks and Catskills and on Long Island, provide the opportunity for enjoyment of these water areas. Existing public facilities include 55 State parks, 4 of which are not yet developed. Public and private facilities include about 72 ski areas, 80 campsites and 31 boat launching sites, not counting many other boating facilities and marinas on Long Island.

Despite the existing facilities throughout the region, there is a growing need for additional well-planned recreational developments. Many existing lakes and streams have little or no development along their shores. Additional impoundments are needed in other areas to provide the opportunity for much needed facilities.

Fish and wildlife are a major importance in the Eastern Region, particularly in the Adirondacks and Catskills. Common small game include pheasant, cottontail rabbit, quail, grey squirrel, ruffed grouse and raccoon. Waterfowl and deer are abundant. Many furbearing animals such as bear, muskrat, skunk and beaver are common.

Trout, small-mouth bass, large-mouth bass, northern pike, and many pan-type fish abound in the lakes and streams of the region. Shad, striped bass, herring, sea sturgeon and eels are found in the Hudson River.

The New York City-Long Island Area is renowned for its salt-water fishing. From Battery Park, Sheepshead Bay and Captree all the way to Montauk Point, party boats, charter boats and private craft varying in size from rowboats to sleek 100-foot twin diesels take the sport fishermen in search of many saltwater species. Other sportsmen find surf fishing a favorite activity.

The wetlands of Long Island and their adjoining mud flats and shallow bay waters are important to the water fowl and shore bird populations. Long Island is a wintering area for waterfowl raised in Newfoundland and the Maritime Provinces of Canada. These inshore brackish water environments contain a delicate balance of salinity, temperature, currents, turbidity and other factors. They provide the right conditions for spawning, nursery and production areas for sport fishes, hard and soft shell clams, oysters, scallops, shrimp and bait fishes.

5. POWER GENERATION

Historically water power has been a significant aspect of water resources development within the region. Early plants developed direct drive mechanical power, but increasing use of electricity shifted emphasis to electric power generation using hydraulic and thermal sources. Because of the abundance of water and favorable topography, many hydroelectric facilities were built in the mountainous areas of the Eastern Region. A total of 144 plants with an

installed capacity of almost 845,000 kw are in operation today. The Raquette River, which drains into the St. Lawrence River, is so completely developed that it is called the "Work Horse" River.

The existing installations vary from old low-head plants of small capacity that are obsolete to modern plants of moderate capacity. The more productive older plants have been modernized and converted to automatic operation by remote control. These plants perform an important function in system regulation and in meeting peak load demands. The small plants are being retired from service gradually.

The potential for new conventional hydroelectric power generation facilities in the region is limited, although many power generation sites have been identified in the past. The stream flow and amount of storage or head available are so small that installations cannot compete economically with other methods. Favorable conditions for development exist where hydroelectric power generation can be included in multi-purpose projects.

Pumped-storage hydroelectric power sites were not inventoried in the reconnaissance. Potentials for development in the region may be considered in conjunction with major nuclear power plants to meet growing future power requirements.

6. NAVIGATION

Water-borne transportation provided the impetus for the early development of industry and commerce in the region and is still a major influence in the New York City and lower Hudson tidal waterways. Two major portions of the New York State Barge Canal system are located within the region. The Erie Canal segment extends from the Hudson River at Waterford through the Mohawk River Valley to the summit near Rome where it enters the Central Region. The Champlain Canal reach connects the Hudson River at Fort Edward to Lake Champlain at Whitehall. Lake Ontario, the St. Lawrence River and Lake Champlain are important navigation facilities bordering the region.

The lower Hudson River waterway will accommodate vessels of 32-foot draft to the Port of Albany. The New York Harbor is one of the best in the world with ample facilities for all types of ocean-going vessels.

The original Erie Canal, completed in 1825, was a major factor in the development of New York State and the country to the west. Successive improvements to the canal system have been made, but competition from railroads, highways and airlines have reduced commercial traffic volumes significantly. The Erie Canal traffic has dropped from a high of about 4,220,000 tons in 1936 to 1,510,000 tons in 1965. Traffic in the Champlain Canal reach has increased from about 550,000 tons in 1936 to 1,420,000 tons in 1965. Total Barge Canal System traffic has declined from a high of 5,210,000 tons in 1951 to 3,270,000 tons in 1965. Petroleum products account for most of

the tonnage. Vessels with drafts up to twelve feet can be accommodated. Locks are about 45 feet wide and 300 feet long.

Canal traffic is occasionally interrupted for short periods by flood flows. On the Champlain Canal, traffic delays are sometimes caused by low water. The most serious handicap is ice which forces closure of the system for about four months from December through March.

The use of navigable waterways by various types of pleasure craft is continually increasing. The Erie and Champlain Canals are important "legs" of a "triangle" cruise for pleasure boats. A circuit can be made from the Hudson River through the Erie Canal and Oswego River to Lake Ontario and then down the St. Lawrence River to Sorel, Canada, returning through the Champlain Waterway. The Barge Canal system offers great potential for additional recreational use and developments, and is a possible mechanism for regional water distribution and other functions.

7. FLOOD CONTROL

There are no major flood control problems in the Eastern Region; however, many local areas are subject to flooding. Marshes, natural lakes and man-made reservoirs provide adequate flow regulation on the major streams except for the Black River below Lyons Falls where periodic flooding occurs. In this reach principal damages are to agricultural lands and some accommodation with flooding has been made in the flood plain use. Other major flood problems have been resolved with protection works around the areas subject to flood damages.

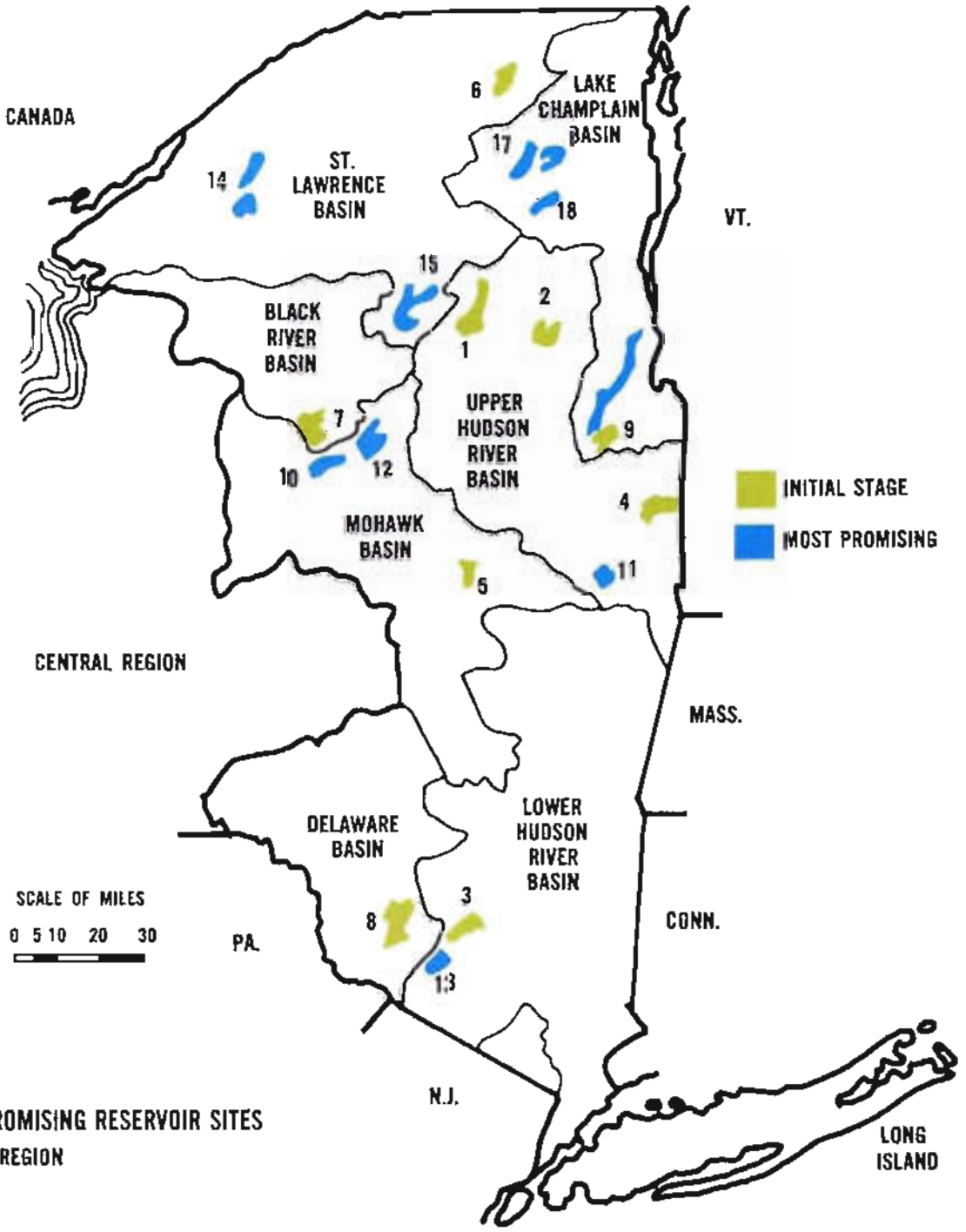
Sacandaga Reservoir controls runoff from about one-fourth of the upper Hudson River Basin. It is operated to store much of the high spring runoff from the tributary Adirondacks with an additional allocation of a relatively small part of the total storage specifically for flood control. Delta and Hinckley Reservoirs store most of the high spring runoff from the headwaters of the Mohawk River in the southern Adirondack foothills. The many lakes and reservoirs in the remainder of the Adirondacks provide significant regulation of runoff from spring snowmelt and summer storms. Additional storage for flood control alone is not justifiable, but may be important to provide additional protection as part of a multi-purpose project.

Minor flooding occurs in many local areas, but flood damages are not high enough to provide economic justification for construction of improvements or protective works. Use of these areas must be consistent with the flood hazards to forestall more serious future flood problems.

8. WATER QUALITY MANAGEMENT

Water quality management is a problem in the Hudson-Mohawk River Basin and in the New York City-Long Island Area because of the great concentrations of people, commerce and industry Large volumes of wastes are created in these areas, and discharge to streams has been a traditional method of disposal. In the remainder of the region, water quality problems are more localized and may be solved by construction of improved waste treatment facilities. The naturally regulated flow is reasonably adequate to provide dilution of the limited wastes.

The severe pollution conditions on the Hudson and Mohawk Rivers and tributary streams in the populated areas require construction of major waste treatment facilities. In conjunction with this effort, further augmentations of low flows may provide an additional method for meeting established stream quality standards. Existing storage facilities utilized for power generation and to provide water for navigation presently augment flows during the summer period when natural flows are lowest. During extreme drought years, releases from Sacandaga Reservoir furnish more than half the total flow at the confluence of the upper Hudson and Mohawk Rivers. The additional flow not only improves quality conditions, but also aids in maintaining the salinity front below the water supply intake at Poughkeepsie. The benefits of additional augmentation have not been established, but storage for this purpose can be provided at numerous sites in the Hudson River Basin.



MOST PROMISING RESERVOIR SITES
EASTERN REGION

F. General Water Development Resources Plan

1. APPROACH TO PROBLEMS

Planning for water resources development in the Eastern Region involves two principal water uses—public water supply and recreation. Public water supply demands vary almost directly with the population, which is expected to more than double in the region by 2020. Recreational water demands are increasing even more rapidly than the population.

The Albany-Troy-Schenectady Area and the Utica-Rome Area have population concentrations with major public water supply requirements that are being reasonably well met. Other smaller centers located in the northern portion of the region have surface water and ground water supplies that are generally adequate. Any supply problems are local in nature. In the mid-Hudson area, the major centers of Newburgh, Beacon and Poughkeepsie can obtain additional supplies from the Hudson River with proper treatment.

Ground water supplies are available in limited quantities throughout the major river valleys in the region. The Mohawk River Valley contains the largest supplies because of extensive highly permeable sand and gravel deposits. Only a small fraction of the total supplies have been developed. The principal area of ground water availability and supply is on Long Island. At present different parts of the Island are in different stages of ground water development. Kings County and northeastern Queens County now receive nearly all their water from the New York City municipal system. Deep wells are used in the remainder of Queens County with some indications of excessive withdrawals causing salt water intrusion. Western Nassau County is at a similar stage of development. Eastern Nassau County and Western Suffolk County are supplied mainly from deep wells with some local imbalances and some potential for additional supplies. Shallow, privately-owned wells predominate in eastern Suffolk County where large additional supplies can be developed. Local ground water supplies will be inadequate in parts of the Island within the next 10 years. For the Island as a whole, supplies are available to meet demands for 40 to 50 years, but large scale artificial re-charging will be required.

The greatest water supply problem in the region is in the New York City Metropolitan Area. The present Croton, Catskill and Delaware water supply systems for New York City proved scarcely adequate during the recent drought. Even with the addition of Cannonsville Reservoir, water supplies will be sufficient only to 1975-1980. Thereafter a major source of additional supply is required.

Surface waters offer the best potential for meeting future New York City needs. There are large potentials for additional development in the Hudson River Basin. A surplus of about 5,500 mgd is available in the basin. Use of significant quantities will require additional storage for flow regulation and control of the salinity front. Potential usable storage of over 2,500,000 acre-feet can be obtained in the basin by development of new reservoir sites and redevelopment of existing sites.

Many reservoir sites have been identified in the Eastern Region. Single-purpose recreational reservoirs and recreational facilities in conjunction with water supply reservoirs can be constructed at many locations. The abundance of surface water supplies and opportunities for multi-purpose development suggest a system of major reservoirs at key locations as the basic framework for a water resources development plan.

2. GENERAL PLAN

Seventeen reservoir sites in the Eastern Region appear to have the most potential merit

and are most favorable for development. Pertinent data for the sites are summarized in the map on the opposite page and Table 1.

Nine sites are located in the Hudson River Basin, three each are in the St. Lawrence River and Lake Champlain Basins and one each is in the Black River and Delaware River Basins. The total estimated capital cost of all developments is $517,000,000. The sites could provide 3,520,000 acre-feet of storage and 92,000 acres of water surface. It is estimated that associated recreational facilities would cost about $58,000,000.

The Gooley No. 1 site in the upper Hudson River Basin has the greatest potential for storage, but is followed closely by Forestport Reservoir in the Black River Basin and Hinckley redevelopment in the Mohawk River Basin. Although all the sites have potential for a variety of uses of storage, primary reservoir functions would be public water supply, recreation and possible export of water to adjoining basins.

Nine of the sites appear to have the most favorable characteristics for initial development. These sites are Gooley No. 1, Trout Brook, Ganahgote, Shushan and Fort Hunter in the Hudson River Basin, Huckleberry Marsh in the St. Lawrence River Basin, Halfway Lake in the Lake Champlain Basin, the McKeever Diversion—Forestport Reservoir in the Black River Basin and Bridgeville Reservoir in the Delaware River Basin.

The five Hudson River Basin projects have

an estimated cost of $223,000,000. They would provide 1,200,000 acre-feet of storage and 26,500 acres of water surface. Associated recreational facilities would cost about $21,-000,000.

The Gooley No. 1 site is one of seven possible sites in the same general location in the upper Hudson sub-basin. It has the lowest unit storage cost, but is representative of a project in this area. The site is in the Adirondack Park on the Hudson River one-half mile downstream from its confluence with the Indian River. Reservoir storage would be used primarily for water supply. A minimum regulated flow of 595 mgd could be obtained based on a storage-regulated flow relation for the critical 5-year drought period, 1961-1965. Releases into the Hudson River would provide additional benefits for water quality control, fish and wildlife, navigation and power generation en route to downstream municipal, industrial and agricultural water users. The adjoining area could be developed into an outstanding center for future recreation.

The Trout Brook site is in the same general area on a tributary of the Schroon River. This site, also, is in the Adirondack Park. The reservoir would be considerably smaller and would provide a minimum regulated flow of 74 mgd. The adjoining area has excellent recreation possibilities along the south shoreline facing wooded mountains to the north.

The Ganahgote site is in the lower Hudson sub-basin on Shawangunk Kill near its confluence with the Wallkill River. Few feasible reservoir sites remain in the area because of extensive urban and suburban developments. As a dual purpose water supply and recreation project the reservoir would provide a flow of 51 mgd. A major recreation area could be developed on the west shore opposite the dam site, with a commanding view of almost the entire lake and the steep Shawangunk Mountains to the west.

The Shushan site in the upper Hudson sub-basin is on the Batten Kill near Vermont in a predominantly rural area. The reservoir would provide a relatively large regulated flow amounting to 222 mgd. A recreational development at the west end of the reservoir would overlook the picturesque valley and provide a scenic view of the Green Mountains across the lake to the east.

The Fort Hunter site in the Mohawk River Basin is located on Schoharie Creek 2½ miles upstream from the Mohawk River. The reservoir would provide a large regulated flow of 306 mgd. A recreation area on the east shore would give a view of nearly the entire lake, and would be a major attraction near the Capital District.

The other four reservoir projects at widely different locations in the Eastern Region have an estimated capital cost of $90,000,000. They would provide 720,000 acre-feet of storage and 19,700 acres of water surface. Associated recreational facilities would cost about $15,-000,000.

The Huckleberry Marsh Reservoir on the Salmon River in the extreme north part of the region has been under consideration for about 10 years. The site offers great potential for recreational development in an area where needs are pressing and stimulus to the local economy would be extremely beneficial.

Halfway Lake is a relatively small reservoir which would be constructed by damming a small stream at the northern edge of Glens Falls. It would be connected to Lake George by a boat canal. The reservoir has great potential for recreational use in an area where existing facilities are inadequate for the large population within easy driving distance. Significant economic benefits would be realized by Glens Falls. The site also offers potential for other uses which may be incorporated into later stages of project development.

Bridgeville Reservoir on the Neversink River in the Delaware River Basin is another highly desirable recreation project in an area where demands are heavy. The shoreline would be about 17 miles long and access would be excellent. The reservoir could also serve as a source of additional water supply to local communities.

The McKeever Diversion-Forestport Reservoir in the Black River Basin is conceived as a multi-purpose project for recreation, power generation, flood control and stream flow regulation. Diversions to Hinckley Reservoir in the Mohawk River Basin also are possible as a later development stage.

Feasibility level investigations are needed to verify the engineering and economic feasibility of all the sites. If the selected sites are found unsatisfactory, alternates are available in the same general areas.

Based on the reconnaissance the most economical means of supplying water to meet the future deficiencies in the New York City Metropolitan Area would be by stage development of pumping from the lower Hudson River in conjunction with upland regulating storage to augment low water flows. Treatment of Hudson River wastes would be required at all stages. Between 1970 and 1980, 200 mgd could be obtained by pumping from the Hudson River at Kingston into the Catskill Aqueduct via Ashokan Reservoir. Between 1980 and

1990, an additional 300 mgd could be obtained from the Hudson River by pumping at Hyde Park into the Delaware Aqueduct. Between 1990 and 2020, the final increment of 800 mgd could be obtained by pumping from the Hudson River at Hyde Park into a new aqueduct. Within these stages, project elements such as pumping stations and treatment plants could be developed incrementally in synchronization with the increasing water demand. About 700,000 acre-feet of upland storage would be required to obtain the additional 1,300 mgd supply. The upland regulating storage would permit recreation development at the reservoirs and provide incidental flood control. The augmented low water flow in the Hudson River, as a result of reservoir releases, would be beneficial to recreation, fish and wildlife and navigation. The estimated cost of this program is about $700,000,000.

After 2020, additional demands of as much as 2,000 to 3,000 mgd could be supplied from the Hudson River by construction of a barrier dam and by utilizing the discharge otherwise needed to control the salinity in the open river. However, many problems are associated with barrier dam construction and would need to be solved. These include effects on water quality, fish and wildlife, navigation and flooding. Another alternative after 2020 is to augment low water flows still further by more upland storage regulation and further expansion of pumping from the lower Hudson River. The maximum additional supply obtainable by this means is from 1,000 to 1,500 mgd. Desalination is another potential means for obtaining additional water supplies for the area after 2020. Technological developments and further investigations and research during the intervening period can be used to good advantage to determine which is the most satisfactory method of meeting these extremely long-range needs.

TABLE 1 PERTINENT DATA FOR MOST PROMISING RESERVOIR SITES, EASTERN REGION

RESERVOIR	NO.	STREAM	DRAINAGE AREA SQ. MI.	STORAGE ACRE FEET	SURFACE AREA ACRES	LAND ACRES	ACQUISITION COST	CAPITAL COST RESERVOIR	CAPITAL COST RECREATION FACILITIES	POSSIBLE USES
HUDSON-MOHAWK RIVER BASIN										
*Gooley No. 1	1	Hudson River	619	554,000	14,500	16,000	$8,680,000	$57,653,000	$7,500,000	M, P, R
*Trout Brook	2	Trout Brook	90	68,400	1,750	23,000	1,340,000	13,758,000	4,012,000	M, R
*Ganahgote	3	Shawangunk Kill	142	89,100	3,500	3,850	3,160,000	15,740,000	3,138,000	M, R
*Shushan	4	Batten Kill	240	208,000	3,400	4,500	2,890,000	51,583,000	2,465,000	M, R
*Fort Hunter	5	Schoharie Creek	612	283,000	3,300	4,000	2,840,000	84,014,000	3,446,000	M, R, N, P
Hinckley	10	West Canada Creek	373	445,000	13,000			45,451,000	3,587,000	M, R
Schaghticoke	11	Hoosic River	645	175,000	2,500			32,159,000	2,822,000	M, R
Ohio Gorge	12	West Canada Creek	225	268,000	3,750			44,075,000	2,976,000	M, R
Bloomingburg	13	Shawangunk Kill	42	30,000	900			8,326,000	4,015,000	M, R
ST. LAWRENCE RIVER BASIN										
*Huckleberry Marsh	6	Salmon River	118	120,000	4,500	5,250	1,580,000	7,610,000	3,800,000	R, Q
Edwards Elm Creek	14	Oswegatchie River	320	25,000	600			13,420,000	3,780,000	R
Raquette Lake	15	Raquette River	193	249,000[1]	17,500			29,650,000	1,150,000	R, P, D
BLACK RIVER BASIN										
*McKeever Diversion Forestport	7	Moose River Black River	237	512,000	11,700	14,950	6,150,000	58,350,000	4,150,000	R, Q, P, F, D
DELAWARE RIVER BASIN										
*Bridgeville	8	Neversink River	190	63,000	1,600	2,100	1,050,000	8,000,000		R, M
LAKE CHAMPLAIN BASIN										
*Halfway Lake	9	Halfway Creek	40	26,500	1,900	2,400	6,350,000	16,350,000	5,150,000	R
Union Falls Redevelopment	17	Saranac River		350,000	6,050			20,200,000	2,900,000	R, M, P
Cherrypatch Pond	18	W. Br. Ausable River	117	53,000	1,800			10,850,000	2,650,000	R

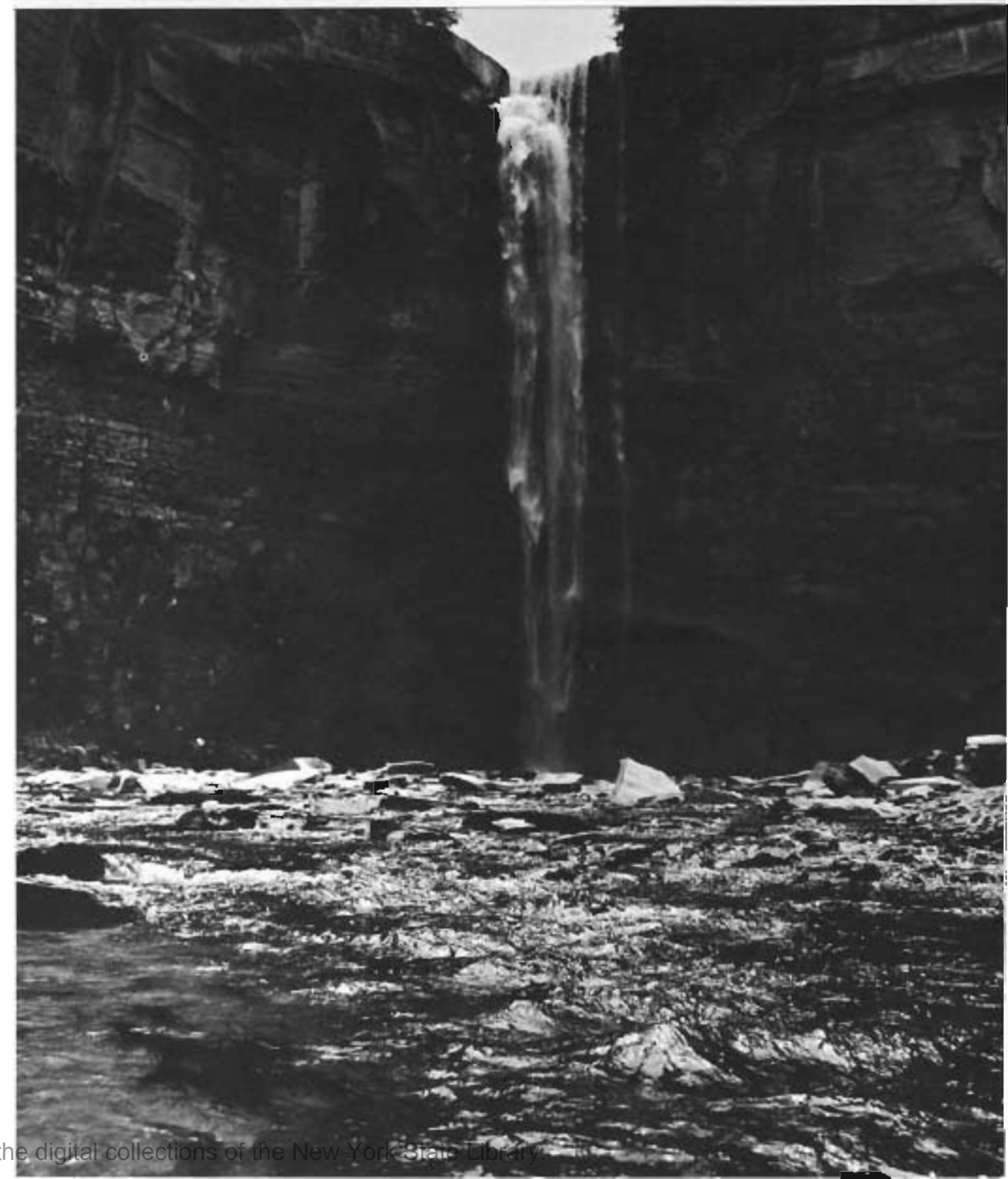
M—Municipal & Industrial Water Supply
F—Flood Control
Q—Water Quality Management
R—Recreation, Fish & Wildlife
P—Power
N—Navigation
D—Diversion
*Initial Development Site
[1]Average Annual Inflow (Ap)

CENTRAL REGION

A. Physical Characteristics

The Central Region includes about 13,000 square miles in central New York State. The region is almost equally divided between two major river basins. The southern half is drained by the Susquehanna River which flows through Pennsylvania and Maryland into Chesapeake Bay. The northern half is drained by the Oswego River and other tributary streams which flow into Lake Ontario.

The water resources of the two portions present an interesting contrast. The Susquehanna River Basin is characterized by broad, deeply eroded, steep-sided valleys and gently rolling upland country. Natural storage on this topography is limited, and marked extremes of flood flow and low flow occur frequently. The southern-most part of the Oswego River Basin has similar topography. However, most of the steep-sided valleys have been filled with glacial deposits which blocked the natural drainage and created a system of lakes. As a result, surface runoff is largely regulated by nature. The northern-most part of the Oswego River Basin and the direct Lake Ontario drainage contain low relief and many marshes which moderate potential runoff extremes.



B. Economic Aspects

The Central Region contains a number of major urban centers located within a predominantly rural area. These centers of economic activity have developed in the southern tier of counties and along the Barge Canal in the north. The 1960 population of the Central Region was more than 1,500,000, and long-range projections indicate the population will more than double by 2020. Syracuse and environs contain the bulk of population and economic activity in the region.

The Oswego-Ontario Basin has experienced a greater growth than the Susquehanna Basin and will have greater future growth. The growth rate in the Syracuse Metropolitan Area is expected to almost match that of the nation—one of the few places in the East to keep up with the national pace. The area has a strong industrial base, good transportation facilities and a strategic location with respect to eastern markets. Important population increases will occur in Ontario and Wayne Counties near Rochester. Significant economic growth also will occur in Seneca, Tompkins, Cortland, Cayuga and Oneida Counties. The Tompkins-Cortland area will grow largely because of Cornell University and Ithaca College and a small industrial complex.

Economic growth in the Susquehanna River Basin will be substantial with the greatest increases in the Binghamton and Elmira-Corning areas. Broome, Tioga, Chemung and Steuben Counties will have the greatest population increases. In spite of these increases, the present rural character of the basin will be maintained.

The rural economy is largely supported by agriculture. Dairying is the most widespread enterprise, but vegetable production is important in the Oswego Basin. The area along Lake Ontario is noted for its fruit industry. Agriculture will continue to be important to the economy of the region and a significant factor in water resources management.

C. Climatology

The climate of the Central Region is heavily influenced in the north portion by Lake Ontario. Temperature extremes are moderated by the lake, and snowfall is about 50 percent greater as a result of intense squalls which develop over the lake. Average precipitation varies from a low of 30 inches in the most western part of the Oswego Basin to over 40 inches in the eastern part. It reaches an extreme of nearly 60 inches on the Tug Hill plateau in Lewis County.

Extended droughts are rare in central New York. During the recent drought which has been experienced throughout the northeastern United States, rainfall in central New York averaged about 8 inches below normal. The worst drought of areawide intensity occurred during 1941. Individual hydrologic units within the region are affected by droughts of similar severity more frequently.

Flood-producing storms have occurred often in the Susquehanna River Basin. The heaviest precipitation recorded was over 14 inches in July 1935 in parts of the basin. Other notable rainfall amounts are 3 inches in 1 hour in the area of Broome County Airport, near Binghamton on June 14, 1960 and up to 7 inches in 3 hours at East Sidney Dam on July 29, 1961. Similar storms have been experienced in the Oswego-Ontario Basin. However, the flood conditions have not been as severe because of the flatter topography and regulating effects of the lakes. The heavy snow pack in the Oswego-Ontario Basin increases the spring flood hazard. For example, one of the greatest storms of record in the basin occurred in the spring of 1936 with about 5 inches of precipitation over a 5-day period. Concurrent melting of an unusually heavy snow cover intensified flooding effects.

D. Water Supplies

1. SURFACE WATER

Average annual runoff in the Central Region follows the precipitation pattern closely, varying from a low of 10 inches in the most western part to 45 inches on the Tug Hill plateau. Most of the region has average annual runoff of 15 to 20 inches.

Natural lakes are an important part of the region's surface water resources. These include the Finger Lakes and Oneida Lake which have a combined surface area of about 280 square miles, amounting to about 4 percent of the Oswego-Ontario Basin. In addition, Lake Ontario is available on the north. Principal lakes in the Susquehanna River Basin are Otsego and Canadarago. They constitute less than 1 percent of the drainage basin.

The only reservoirs of consequence in the Oswego-Ontario Basin are Salmon River Reservoir used to develop hydroelectric power and a small flood control reservoir on Onondaga Creek above Syracuse. In the Susquehanna River Basin 4 reservoirs have been constructed for flood control.

Flood runoff in the region is variable, ranging from 26 to 52 cfs per sm (cubic feet per second per square mile) in the eastern and western parts of the Susquehanna River Basin, respectively, to 7 cfs per sm in the Oswego-Ontario Basin. Instantaneous flows of about 1,000 cfs per sm have been observed on small watersheds throughout the region.

Low flows are also variable. On mainstreams in the Susquehanna River Basin they vary from 0.03 to 0.05 cfs per sm. On the Oswego River the low flows are about twice this amount. Smaller streams throughout the area may be completely dry occasionally.

Generally the quality of surface water resources in the region is adequate. Pollution has occurred in certain areas, but the State's "Pure Waters" Program should resolve most problems. The Oswego River at the junction of Seneca and Oneida Rivers is polluted by chemical constituents, particularly chlorides, and organic wastes. However, the waters are still suitable for a variety of uses.

2. GROUND WATER

Major ground water resources are available in the region. However, in the Oswego-Ontario Basin a major portion of the ground water resources are of only fair or poor quality. Good quality ground water is found in limited glacial sand and gravel deposits at scattered locations. Some of these deposits lie in areas where major economic development is anticipated, such as Ithaca, Canandaigua, Newark, Chittenango, Oneida and between Baldwinsville and Syracuse.

In the Susquehanna River Basin major quantities of good quality ground water are available from valley sand and gravel deposits along many of the major river channels. Areas with large ground water supplies include the major urban centers of Elmira, Corning and Binghamton and the expanding areas of Hornell, Bath, Waverly, Owego and Cortland. Large areas of sandstone deposits occur in the eastern part of the Susquehanna River Basin and in Chenango and Otsego Counties. These rock formations yield moderate amounts of good quality water. The total potential ground water supply amounts to several hundred mgd.

E. Water Demands

1. PUBLIC WATER SUPPLY

About two-thirds of the people in the Central Region are presently served by public water supply systems. Population growth will dictate expansion of existing systems as well as new development. Per capita water use also will increase in the future. As a result, public water supply demands will increase substantially. In the Susquehanna River Basin, the present use of 55 mgd is expected to increase to about 200 mgd by 2020. Ground water is a major source of supply at present and will continue to be in the future. Sound management of ground water resources will be needed to prevent pollution and excessive depletion. Further study of the interrelationships of surface and ground water appears needed in the Binghamton and Elmira areas. Present rural domestic water use is about 16 mgd and is expected to increase to about 27 mgd in 2020.

In the Oswego-Ontario Basin the public water supply demands are expected to increase from 105 mgd at present to 490 mgd in 2020. Most of the current demands are being met from surface water resources, although there is some use of ground water. Lake Ontario has been tapped as the source of supply for the urban area around Syracuse in Onondaga County and should be able to take care of future needs. Problem areas where planning and development are needed include the Canandaigua Lake service area, Oneida and Chittenango and the intervening area, and the Ithaca urban area. Present rural domestic use of about 23 mgd is expected to increase to about 40 mgd in 2020.

2. INDUSTRIAL WATER SUPPLY

Many industrial water demands are satisfied through public water supply systems. However, some of the larger water-using industries have developed their own water systems. Self-supplied industrial water use presently is over one-half billion gallons per day and will probably be more than one billion gallons per day by 2020. Industrial water use is concentrated in the major urban centers of Syracuse, Elmira, Corning and Binghamton where large volumes of surface and ground water supplies are available. Most industrial use is non-consumptive, and so the water can be reused if quality is managed effectively.

3. AGRICULTURE

The Oswego-Ontario Basin contains about 800,000 acres of fertile and moderately sloping land. Irrigation will be an important factor in more intensive utilization of these land resources. At present, about 16,000 acres are irrigated. The irrigated acreage is expected to increase to about 120,000 acres in 2020. The acreage will be used for vegetable production and other specialized high-value crops.

In the Susquehanna River Basin the most productive agricultural activity is concentrated in the flat valley areas with deep well-drained soils. The irrigation potential is great because of the readily available surface waters. Irrigation is expected to increase from 6,500 acres at present to about 37,000 acres in 2020.

4. RECREATION, FISH & WILDLIFE

Recreational use of the water resources of the Central Region is extremely important. A host of recreational opportunities are offered in the Oswego-Ontario Basin by the existing natural lakes, the Lake Ontario shoreline and the Barge Canal. Present water oriented recreation possibilities in the Susquehanna River Basin are limited. This contrast suggests that recreational plans be developed on a regional

basis to make maximum use of available resources.

Recreational demands have skyrocketed in recent years as a result of more leisure time and the economic well-being and greater mobility of the general public. As population increases in the future, recreational demands will continue to grow. The water and related land resources potentials of the Central Region provide excellent opportunities for satisfying many of these demands. Further enhancement of the natural lake resources and development of facilities along the Barge Canal are essential. Cross Lake and various locations along the alignment of the Erie Canal can be developed for picnicking, camping, boating and outdoor play areas as well as to preserve areas of historical value. Multi-purpose reservoirs developed near the major urban centers in the Susquehanna River Basin could satisfy many of the recreational needs of this part of the region.

Fishing and hunting are important recreational activities. Fish and wildlife abound in the Oswego-Ontario Basin in the natural lake areas, the Barge Canal and the marshlands adjacent to Lake Ontario. Waterfowl are abundant in the Montezuma National Wildlife Refuge and Howland Island. Fish and wildlife are limited in the Susquehanna River Basin. Regulation of stream flows and construction of new reservoirs offer the best potential for improvement of these limited resources.

5. POWER GENERATION

Hydroelectric power generation is important in the Oswego-Ontario Basin where the full economic potential of the naturally regulated system has been developed. Twenty-seven plants with a total generating capacity of 90,000 Kw are in operation in the Oswego-Ontario Basin. The principal plants in the Oswego Basin are 4 on the Oswego River and one on the Seneca River with a combined generating capacity of 51,000 Kw. A plant is located on Keuka Lake and uses flow diverted from Lamoka and Waneta Lakes in the headwaters of the Susquehanna River Basin. In the Ontario Basin, the two principal plants are located on the Salmon River and have a combined generating capacity of 32,000 Kw. These plants utilize releases from Salmon River Reservoir which has 61,000 acre-feet of storage. New conventional hydroelectric power developments in the Oswego-Ontario Basin have only limited future potential because of high development costs in comparison with other energy sources. However, there are some possibilities for pumped storage peaking plants within the basin. An atomic generating plant is now under construction at Nine Mile Point on Lake Ontario by Niagara Mohawk Power Corporation with commercial operation planned for 1968.

In the Susquehanna River Basin near Oneonta, Collier Station with a generating capacity of 3,800 Kw is the only major hydroelectric installation. Future developments may be feasible in conjunction with multi-purpose reservoir construction in special cases and for limited use.

6. NAVIGATION

Navigation in the Central Region is significant in the Oswego-Ontario Basin which contains an important component of the New York State Barge Canal system. The system involves use of the waters of the Oswego, Oneida and Seneca Rivers and Oneida, Cayuga, Seneca and Onondaga Lakes.

The Barge Canal has been carrying a decreasing volume of commercial traffic in recent years. Usage in 1965 amounted to about 1,850,000 tons in the Erie and Oswego divisions of the system. No major increase in commercial traffic is anticipated unless the Canal is substantially enlarged and modified or modes and vehicles are changed. Studies made to date show that the cost of a full modernization program would be substantial, probably in excess of 1 billion dollars. Justification for the required investment is uncertain pending further studies. Existing water supplies in the Oswego River appear sufficient to support commercial traffic in the order of magnitude of 10,000,000 tons per year.

Use of the Canal for recreational craft and fish and wildlife propagation is increasingly important. Reclamation of sections of the old Erie Canal may be desirable because of their historic value. Great increases in recreational craft lockage could create water supply problems on the Oswego River, Oneida River and the Oneida Lake-to-Rome portions of the Canal. Construction of recreation locks or ramps and recirculation of lock water could help reduce total water demands for lockages.

7. FLOOD CONTROL

The Susquehanna River Basin has suffered major flood damages many times. The most significant floods of record occurred in July 1935, March 1936 and May 1946 causing millions of dollars in damages. As a result, four flood control reservoirs and a number of local protection projects have been constructed. Because the reservoirs control only 7 percent of the drainage area, an additional volume of at least 150,000 acre-feet of storage is needed. Many smaller reservoirs may be justified to reduce tributary flood, erosion and sediment damages. Other measures such as proper upland and flood plain management are needed in a balanced program.

In the Oswego-Ontario Basin the large degree of regulation provided by the existing lakes, which control about 60 percent of the drainage area, has minimized historical flood damages on major river channels. Major damages have occurred on tributaries upstream from the lakes. Encroachment of lake shoreline developments into areas inundated by high levels has created damage potential. Problems upstream from the lakes can be solved by construction of local protection works or upland reservoirs. Lake shoreline problems and damages on major river channels can be minimized by sophisticated lake level regulation, flood warning systems, and flood plain development which is compatible with hazards.

8. WATER QUALITY MANAGEMENT

An effective water quality management program may include a number of management techniques in addition to installation of new and improved waste treatment facilities. Augmentation of low stream flows to provide greater capacity for waste assimilation is one possible alternative. Full implementation of New York State's "Pure Waters" Program will not eliminate the desirability of augmenting low flows in certain parts of the Central Region. The most important locations where consideration is needed in the Oswego-Ontario Basin are the Barge Canal at Newark in Wayne County, the Seneca River at Seneca Falls, the Owasco Lake outlet below Auburn, Oneida Creek below Oneida and Oswego River at Fulton. In the Susquehanna River Basin the areas include the Canisteo River below Hornell, the Chemung River at Elmira, the Tioughnioga River below Cortland and the Susquehanna River at Binghamton. Flow augmentation may be achieved by lake regulation in the Oswego-Ontario Basin and by reservoir development in the Susquehanna River Basin.

The quality of water in existing lakes is an important consideration. Quality degradation to varying degrees is in progress as indicated by greater algae blooms at more frequent intervals and proliferation of other aquatic vegetation. Oneida Lake appears to be in an advanced stage of eutrophication now, and the rate is increasing at the northerly and southerly ends of Cayuga Lake. Man's activities on the lakes and surrounding land areas undoubtedly contribute to this trend.

The complicated relationships of lake environment are imperfectly understood. Nature's balances are delicate and disruptions in water quality can have serious immediate repercussions. Besides Oneida and Cayuga, Onondaga and Seneca Lakes also appear critical in this regard.

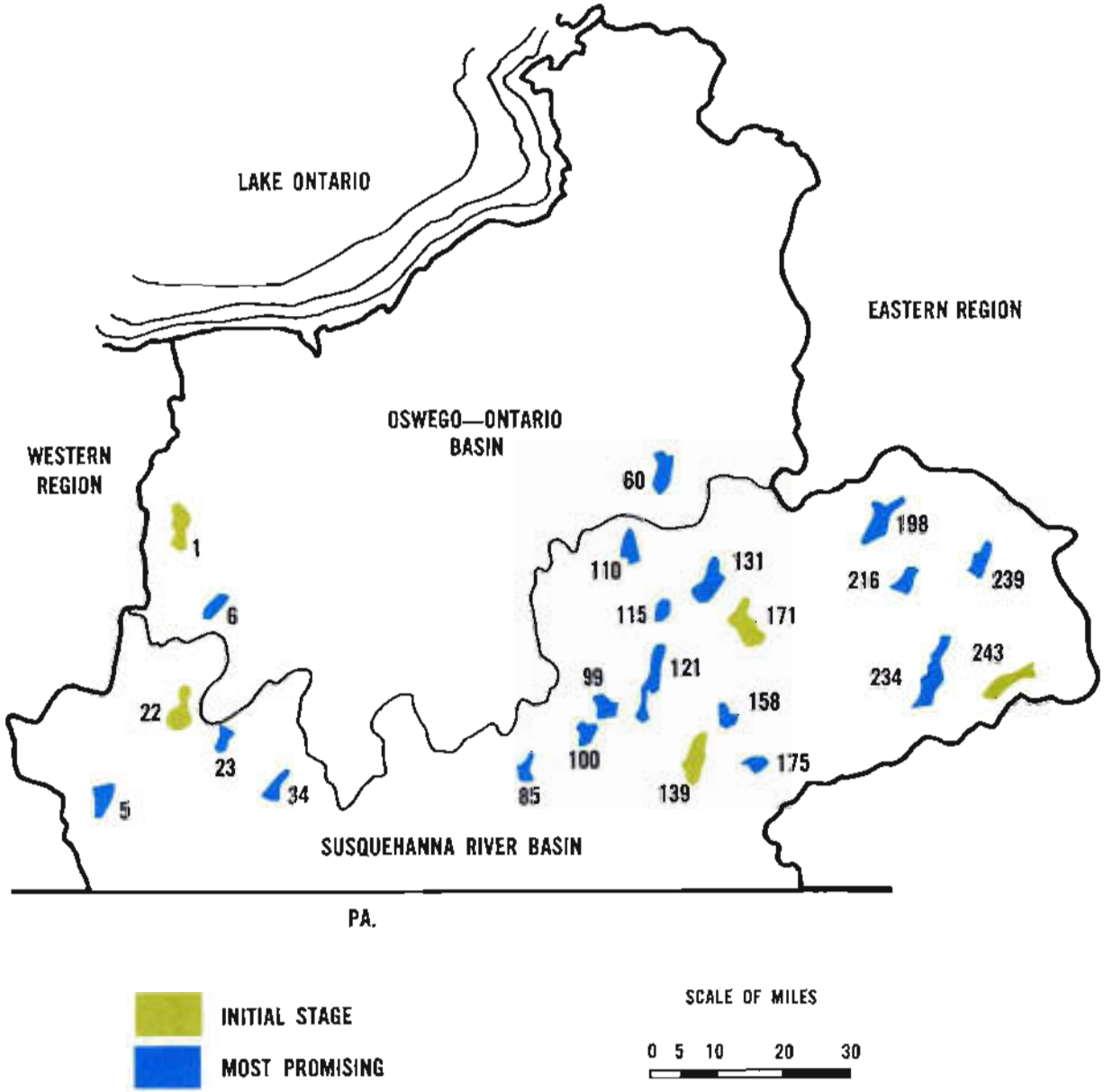
F. Generalized Water Resources Development Plan

1. APPROACH TO PROBLEMS

Planning for optimum utilization of the water resources in the Central Region must be directed toward several objectives. In the Susquehanna River Basin, surface water storage is needed to reduce flood flows and to augment low flows. A long-term development program for construction of multi-purpose reservoirs must be formulated in this basin. In the Oswego-Ontario Basin, surface water storage is already available within the natural lake system. Planning objectives must be directed towards formulation of an effective lake management program. Throughout the region, important ground water resources exist. These resources can be developed economically to serve local water supply needs, but development and management plans must be fashioned carefully to avoid excessive depletions of both ground and surface water resources. Objective consideration must also be given to the future utilization of Lake Ontario as a source of water supply in the northern part of the region.

There are a large number of reservoir sites in the Susquehanna River Basin. Nearly 200 of them have been identified and evaluated on a preliminary basis. No one site can satisfy the multiple long-range needs of the basin in terms of flood control, water supply, water quality control, recreation and fish and wildlife. Instead, development must be in the form of a reservoir system for the basin.

To a limited extent, additional multi-purpose reservoirs are needed within the Oswego-



MOST PROMISING RESERVOIR SITES
CENTRAL REGION

Ontario Basin to supplement the existing lakes. However, other more significant opportunities for water resources management are available in the lake system. Lake level control is needed in a manner that will compromise the competing interests satisfactorily These interests can best be defined within four categories.

—Those who prefer to retain low lake levels to reduce flood hazards

—Those who desire minimum lake levels for navigation most of the year

—Those who would like highest possible levels in early summer so releases can be made for water quality control during late summer and fall dry periods

—Those who want stable lake levels at least through the summer and preferably most of the year for recreation

At present several independent entities are involved in regulation of the lake system. Most of them represent local or single-purpose interests and the uncoordinated operation results in adverse effects on some aspect of lake use almost continually Protection and improvement of lake environments is another important part of lake management.

2. GENERAL PLAN

Twenty reservoir sites have been identified in the Susquehanna River Basin as having the greatest potential for multi-purpose development within a comprehensive basin system. Pertinent data for the sites are summarized in the map on this page and Table 2.

The estimated cost of total development is $218,000,000 on the basis of current price levels. The sites would provide about 800,000 acre-feet of storage and 25,000 acres of water surface. The storage would be adequate to meet all foreseeable water needs within the basin through 2020. About 70 percent of the storage would be used for stream regulation to provide water for public water supply, irrigation, fish

and wildlife and water quality control. Twenty-five percent of the storage is needed for flood control. The remaining five percent would be retained in conservation pools for recreational use.

The largest reservoir would be located on Charlotte Creek (No 243). It would have 127,000 acre-feet of storage and cost $23,700,000. The smallest reservoir would be on Ludlow Creek. It would have 10,300 acre-feet of storage and cost $2,000,000.

The system of reservoirs can be implemented by stages on a long-term basis because immediate construction at all the sites is not required. The most urgent present need is for flood protection to reduce flood damages which are inhibiting economic growth in the basin. Four of the twenty reservoirs would provide significant flood control benefits and are in the first-stage development category. The sites are Five Mile Creek (No. 22), South Plymouth (No. 171), Davenport Center (No. 243) and Genegantslet Creek (No. 139). The estimated cost of reservoir construction is $67,000,000.

The Five Mile Creek site is one of only four in the Chemung River Sub-basin. Site potentials in this basin are limited. The reservoir would provide flood protection on the Cohocton River above Bath and would help reduce flood flows at Corning and Elmira on the main stem. Because of the extremes of low flow in the area, part of the storage might need to be allocated to water quality control.

The South Plymouth and Genegantslet Creek sites are in the Chenango River Basin. The South Plymouth Reservoir would provide partial flood protection for the Chenango River from an upstream tributary and has a potential for water quality control benefits. The Genegantslet Creek site would help to control flood conditions in the lower part of the river and, also, assist in water quality control. Storage is about 50 percent more expensive at this lower basin site, however.

The main stem sub-basin of the Susquehanna River has substantially higher runoff and more potential reservoir sites than the Chemung Sub-basin. There is an immediate need for flood protection in the highly developed area around Binghamton. The Charlotte Creek site would provide a substantial amount of the required flood control storage and could help insure adequate low flows at Binghamton.

The remaining projects should be carried forward at a reasonably rapid pace to provide the additional flood protection required and other benefits. However, this plan would not completely develop the water resources potential of the Susquehanna River Basin. Surplus water will remain after the projects are completed, particularly in the Susquehanna main stem sub-basin. Efforts should be made to promote economic growth in the basin to utilize the valuable water resources. As an alternative, possibilities for export of water to other areas of the State should be studied.

In the Oswego-Ontario Basin three sites have been identified as having the greatest potential for multi-purpose development. Pertinent data for the sites are summarized in Table 2. The total cost of reservoir construction is about $15,000,000.

Two sites are in the western part of the basin and one is in the eastern part near Cazenovia Lake. All sites could provide flood control storage. The Bristol Center site (No. 1) on Mud Creek would provide a source of water supply for domestic or other uses in Ontario and Wayne Counties and water for irrigation in Mud Creek Valley. The Potter site (No. 6) on Flint Creek would initially be used for irrigation, but some storage might be allocated to public water supply for future local urban development. The Oran site (No. 60) on Limestone Creek may be needed in the future to serve the growing area in Madison County east of Syracuse. The Bristol Center site is the only one having sufficiently well-defined needs

to be included in the initial development phase. The reservoir would cost about $7,000,00.

On a regional basis the general development plan would include 23 reservoirs having an estimated total cost of $233,000,000. The initial phase includes 5 reservoirs costing about $74,000,000. About 90 percent of the required development costs are in the Susquehanna River Basin. Only limited capital investments are needed to meet water resources needs in the Oswego-Ontario Basin. There, lake regulation is the key to the major surface water problems. The lakes have a tremendous capacity for flood control and are strategically located for water quality control for the bulk of the heavily populated urban areas. Minor works are needed for their physical control. The greatest need is for assigning responsibility to an existing or new agency to develop and maintain a coordinated program of operational control.

Management of the lake system of the Oswego River Basin to achieve maximum benefit will require implementation of several concepts. These concepts will involve the coordinated storage and release of flood water, and coordinated release of water from storage during dry seasons of the year. Such coordination may require investments in computerized systems for data collection, collation and interpretation. The accomplishments of such coordination will include minimization of flood damages to properties adjacent to major river channels and major lake shorelines, minimization of lake level fluctuation throughout the year, and equitable apportionment of releases for maintenance of flows in major river channels. Careful consideration must be given to the design of the organizational mechanism by which such coordination will be achieved.

TABLE 2 PERTINENT DATA FOR MOST PROMISING RESERVOIR SITES, CENTRAL REGION

RESERVOIR NAME	NO.	STREAM	DRAINAGE AREA SQ. MI.	STORAGE ACRE FEET	SURFACE AREA ACRES	LAND ACRES	ACQUISITION COST	CAPITAL COST	POSSIBLE USE
SUSQUEHANNA RIVER BASIN									
*Five Mile Creek	22	Five Mile Creek	66.0	51,000	1,440	2,300	108,000	$16,589,000	F, Q
*South Plymouth	171	Canasawacta Creek	57.0	38,000	820	1,400	786,000	11,269,000	F, Q
*Davenport Center	243	Charlotte Creek	164.0	127,000	2,850	4,500	2,761,000	23,703,000	F, Q
*Genegantslet	139	Genegantslet Creek	95.0	34,000	1,010	1,600	1,551,000	15,260,000	F, Q
Creek	5	Bennetts Creek	59.0	45,600	765			15,575,000	Q
	23	Smith Run	13.4	12,100				9,800,000	Q
	34	Meads Creek	44.0	34,100	805			10,600,000	Q, R
	85	Owego Creek	77.0	23,100				8,474,000	R
	99	Jennings Creek	14.1	30,900	470			8,147,000	Q
	100	Culver Creek	10.9	13,100	314			6,220,000	Q
	110	W. Br. Tioughnioga Creek	36.4	44,200	1,100			7,885,000	F, Q
	115	Mud Creek	29.7	17,800	512			4,275,000	Q
	121	Otselic River	255.0	68,600				12,400,000	Q, R
	131	Otselic River	54.0	41,800	1,360			10,277,000	Q
	158	Ludlow Creek	5.9	10,300	364			2,008,000	R
	175	Wilkins Brook	10.9	24,000	350			7,824,000	Q
	198	Unadilla River	107.5	80,000	3,000			16,472,000	F, Q
	216	Wharton Creek	45.2	34,600	940			5,707,000	Q
	234	Otego Creek	108.0	65,000				23,600,000	F, Q, R
	239	Fly Creek	10.0	11,100	318			2,432,000	Q
OSWEGO-ONTARIO BASIN									
*Bristol Center	1	Mud Creek	29.4	39,400	1,400	2,200	450,000	6,958,000	F, M, I
Potter	6	Flint Creek	20.0	28,000	930			3,792,000	F, M, I
Oran	60	Limestone Creek	46.8	20,400	682			4,100,000	F, M

M—Municipal & Industrial Water Supply
F—Flood Control
Q—Water Quality Management
R—Recreation, Fish & Wildlife
I—Irrigation
*Initial Development Site

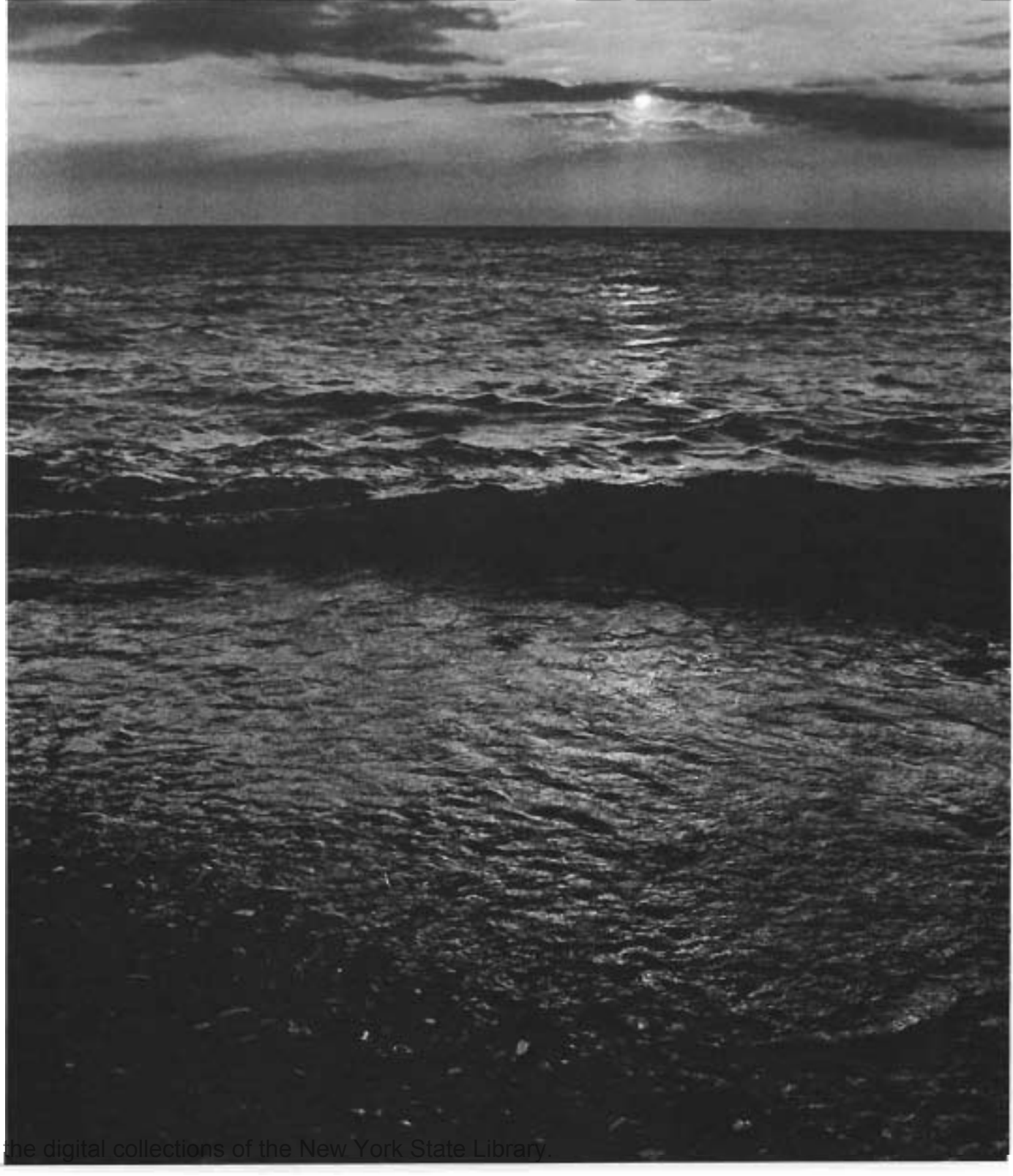
WESTERN REGION

A. Physical Characteristics

The Western Region includes all of the area of New York State west of an approximately north-south line just east of Rochester. The total area of the region is about 7,820 square miles.

The southern half of the region contains the generally wooded rolling hills and broad valleys of the Allegheny highlands which give way to rolling farm land to the south and east of Buffalo. The Niagara Escarpment stretches across the northern part of the region. A broad lake plain parallels the Lake Ontario shore, and a narrower plain lies along the Lake Erie shore. All of the region was glaciated and is covered with drift. Buried glacial valleys are characteristic of the region.

The region includes four major river basins. These are the Erie-Niagara Basin of 2,350 square miles draining into Lake Erie and the Niagara River, the Genesee River Basin of 2,480 square miles draining into Lake Ontario, the Lake Ontario West Basin of 1,100 square miles draining directly into the lake and the Allegheny River Basin of 1,900 square miles draining through Pennsylvania into the Ohio River.



Almost unlimited water supplies are available to the western and northern parts of the region from Lake Erie, the Niagara River and Lake Ontario. Inland water resources are moderately used at present and there is a large potential for additional developments.

B. Economic Aspects

The Buffalo-Niagara Falls and Rochester Metropolitan Areas dominate the economy of Western New York. There are relatively small secondary employment centers in or near Lockport, Batavia, Dunkirk, Jamestown and Olean. Growth will be concentrated in the large metropolitan areas. The Rochester complex, particularly, is burgeoning and prospects are that present trends will continue. Employment in Metropolitan Rochester is expected to grow two and a half times by 2020 and in the Buffalo Metropolitan complex should about double.

The 1960 population of the Western Region was about 2,400,000 and it is expected to increase to about 4,100,000 by the year 2020. The Buffalo-Niagara Falls and Rochester Metropolitan Areas account for a major share of the population. Expansion of these areas will have a significant effect on the population growth in the Lake Ontario West Basin also. Economic growth in the remainder of the region will occur principally in the smaller areas of industrial concentrations.

Large portions of the region will remain agricultural in character. Dairying is a principal agricultural activity except in the plain areas along Lake Erie and Lake Ontario. Here climatic and soil conditions are favorable for fruit and vegetable production.

C. Climatology

The Great Lakes exert a tempering influence on the climate of adjoining areas, but this effect is reduced in the inland areas. Average annual precipitation is variable depending upon proximity to the lakes and elevation and ranges from about 30 inches in the north portion of the Erie-Niagara Basin to 48 inches in the Allegheny River Basin. Most of the region has 30 to 40 inches of average annual precipitation. About 40 percent of the precipitation occurs during the growing season which varies in length from 120 to 165 days. Snowfall also is extremely variable ranging from 40 inches in the northern part of the Genesee River Basin to 105 in the Allegheny River Basin. Much of the area has average annual snowfall of 80 to 90 inches.

Droughts have been noted frequently in the region. However, precipitation deficiencies during the 1962-66 drought have been low along Lake Erie and Lake Ontario, amounting to about 9 inches. The remainder of the region has had a deficiency of about 20 inches.

Heavy precipitation occurs frequently during severe thunderstorms. Notable local rains in recent years include 1.50 inches in 20 minutes at Colden in Erie County on June 12, 1959 and almost 4 inches in 5 hours at Buffalo on August 7, 1963.

D. Water Supplies

1. SURFACE WATER

Average annual runoff is directly related to average annual precipitation and ranges from 14 inches for the Lake Ontario West Basin to 22 inches for the Allegheny River Basin. Other average annual runoff amounts are 15 inches for the Genesee River Basin and 18 inches for the Erie-Niagara Basin. Runoff percentages vary from 45 to 55 percent of average annual precipitation. The seasonal distribution of runoff for the Erie-Niagara Basin is typical of the Western Region. About 50 percent occurs during the February to April snowmelt period and only about 6 percent occurs during the summer months, June through August.

Lake Chautauqua with 12,700 acres of surface area is the largest interior lake in the Western Region. It is located in the Allegheny River Basin as is Cuba Lake with 450 acres. The Genesee River Basin contains the Little Finger Lakes, Conesus, Hemlock, Canadice and Honeoye. There are no major natural lakes in the Erie-Niagara and Lake Ontario West Basins.

Two major reservoirs are located in the Western Region. Mt. Morris Reservoir on the Genesee River about 32 miles southwest of Rochester was completed in 1953 by the Corps of Engineers. The project provides for flood control and other purposes with a storage capacity of 337,000 acre-feet to control runoff from a drainage area of 1,017 square miles. Allegheny Reservoir on the Allegheny River extends into New York State from the dam location in Pennsylvania. The project which is being constructed by the Corps of Engineers is near completion. The reservoir will be operated for flood control and low water supplementation. It controls a drainage area of 2,180 square miles and provides 1,180,000 acre-feet of gross storage.

The quality of surface waters in the Western Region is generally good. Stream pollution occurs mainly in the major urban areas of Buffalo-Niagara Falls and Rochester where the metropolitan streams and adjoining lake areas receive large waste discharges. A stream pollution problem also exists at Jamestown in the Allegheny River Basin. The State's "Pure Waters" Program is directed at correcting these conditions. Generally, quality is not a constraint on major uses of the surface waters of the region.

2. GROUND WATER

Major ground water resources are available in the Western Region. The most promising potential for large withdrawals exists in uncon-

solidated glacial outwash deposits in partially buried valleys in various portions of the region. These deposits are located mainly in the southern and eastern portions of the Erie-Niagara Basin, in the central portion of the Genesee River Basin and throughout the Allegheny River Basin. They have not been identified in the Lake Ontario West Basin. Ground water obtained from these deposits is generally hard and moderately mineralized. In the north portion of the Erie-Niagara and Genesee River Basins, ground water is obtained from shallow formations, but is highly mineralized.

The potential yield of ground water on a regional basis is estimated at 500 mgd. The potential is somewhat greater in the Allegheny River Basin and lower in the Lake Ontario West Basin than in the other basins. Total pumpage at present is about 40 mgd.

E. Water Demands

1. PUBLIC WATER SUPPLY

Public water supply systems have been extensively developed in the Western Region and provide service to the majority of residents and to many industrial and commercial water users. There are 111 existing municipal water supply systems in the region. The average annual public water supply requirements in the region in 1960 amounted to about 380 mgd and are expected to increase to about 1,050 mgd in 2020. Rural requirements are expected to increase from 15 mgd in 1960 to 20 mgd in 2020.

The largest public water supply systems are located in the Buffalo-Niagara Falls Metropolitan Area where four serve 100,000 persons or more. The seven largest municipal systems in the area account for about 254 mgd or 93 percent of the total municipal water use in the Erie-Niagara Basin. By 2020 the areas served by these systems are expected to require 673 mgd. Lake Erie and the Niagara River are the present water sources for the Buffalo-Niagara Falls Metropolitan Area and the City of Dunkirk. Other systems in the Basin use ground water and inland surface water sources. Average annual public water supply use in the Basin amounted to 268 mgd in 1960 and is expected to increase to about 700 mgd in 2020.

The Genesee River Basin has 41 existing public water supply systems. However, only two of them, the City of Rochester and Monroe County Water Authority, serve populations of more than 10,000 persons. The present public water supply system for Rochester provides 54 mgd of which about two-thirds is obtained from Hemlock and Canadice Lakes and the remainder from Lake Ontario. The Monroe County Water Authority supplies about 20 mgd obtained from Lake Ontario. Average annual requirements for the Genesee River Basin amounted to 82 mgd in 1960 and is expected to increase to almost 300 mgd in 2020.

The Lake Ontario West Basin is presently served by nine public water supply systems. The two largest systems are the Monroe County Water Authority and the Niagara County Water District which provides service from outside the Basin. Present and future average annual requirements are about 14 mgd and 20 mgd, respectively.

The Allegheny River Basin has 27 public water supply systems, but only two serve more than 10,000 persons. These are in the Cities of Jamestown and Olean. Average annual public water supply requirements for the Basin were 16 mgd in 1960 and are expected to increase to about 36 mgd in 2020.

2. INDUSTRIAL WATER SUPPLY

Industrial water requirements are met partly by industry-owned systems and partly by purchases from municipal systems. The regional industrial water requirement in 1960 was 525 mgd with about 90 percent of the demand in the Erie-Niagara Basin. Industrial water use is expected to increase to about one billion gallons per day in 2020. These estimates are exclusive of industrial cooling water requirements which are almost entirely non-consumptive.

By far the greatest industrial water use occurs in the Buffalo-Niagara Falls Metropolitan Areas where the primary metals and chemical industries account for about 80 percent of the total industrial requirements in the Erie-Niagara Basin. Water is obtained by direct pumping from Lake Erie and the Niagara River. The Eastman Kodak Company in Rochester is another large water user accounting for about 50 percent of the self-supplied industrial water use in the Genesee River Basin. In the Allegheny River Basin, industrial water use is concentrated around the Cities of Jamestown, Olean and Salamanca. Privately-owned wells are the principal source. In the Lake Ontario West Basin, industrial requirements are relatively small and are supplied from privately-owned wells and from surface sources such as the Barge Canal and Lake Ontario.

3. AGRICULTURE

Supplemental irrigation for improving yields of high-value crops is currently being used on about 33,000 acres in the Western Region. There are 875,000 acres suitable for irrigation, but the future need for irrigated acreage is estimated at about 300,000 acres. Rainfall in

an average year is deficient in supplying the water required for obtaining optimum crop yields. Depending on the crop and location, an annual supply of 10 to 20 inches of irrigation water is needed, except in the Allegheny River Basin. There only 1.6 inches of supplemental irrigation water is required in four out of five years.

In the Erie-Niagara Basin, about 6,000 acres are presently irrigated with average annual applications of about one foot. All the systems are privately developed, generally on individual farms. Sprinklers are used to apply water obtained from wells or nearby streams. The future need for irrigation in the basin is estimated at 81,000 acres requiring about 83,000 acre-feet of water.

In the Genesee River Basin, about 3,000 acres are presently irrigated and the future need is estimated at 129,000 acres requiring about 160,000 acre-feet of water.

Only about 430 acres are presently irrigated in the Allegheny River Basin. Part of the water is supplied for frost protection. The climate, soils and topography impose severe limitations on crop production in the basin and little future expansion in irrigation is expected.

The Lake Ontario West Basin contains the greatest acreage of land presently irrigated, amounting to 24,000 acres. Annual water use is estimated at 24,000 acre-feet. Some irrigation water supplies are obtained from the Barge Canal. The future need is estimated at 87,000 acres requiring about 103,000 acre-feet of water.

4. RECREATION, FISH AND WILDLIFE

Water-oriented recreation includes fishing, picnicking, swimming and boating. The most urgent needs for facilities are generated by the urban concentrations in the Buffalo-Niagara Falls and Rochester Metropolitan Areas. Lake Erie and Lake Ontario can supply part of the boating demand, but their use by small craft is severely limited by hazardous wind conditions.

Inland recreational facilities in the region are located mostly in the Allegheny River Basin. They include Lake Chautauqua, Cuba Lake, the Allegheny River Reservoir and Allegheny State Park. Allegheny River Reservoir when completed will include a broad variety of recreational facilities. The recreation plan includes 4,000 acres in New York State which will be developed to provide optimum recreational use to the year 2000.

Trout and warm-water fisheries are located throughout the region. Cattaraugus Creek in the Erie-Niagara Basin, the upper reaches of the Genesee River and its tributaries and several Allegheny River tributaries are the principal trout streams. Warm-water fishing is available in most streams and rivers. There are also many small lakes and ponds which are fished heavily. The Erie-Niagara Basin contains 21 lakes and ponds with 788 surface acres. In the Genesee River Basin about 6,000 acres on four principal lakes, Honeoye, Conesus, Silver and Rushford, are accessible for public fishing. In the Allegheny River Basin, muskalonge fishing on 12,700-acre Lake Chautauqua is reported to be among the finest in the nation. Other fishing lakes are Cuba, Bear, Cassadaga and Findley Lakes.

Wildlife are relatively abundant throughout the region away from the major urban centers.

5. POWER GENERATION

The Western Region has extensive power system interconnections. Transmission facilities of the Power Authority of the State of New York, the Hydroelectric Power Commission of Ontario and various utilities are interconnected for efficient use of generating facilities. Besides the Power Authority installations on the Niagara River, there are eleven hydroelectric power generating plants in the region. They have a combined installed capacity of about 61,000 Kw. Six of the plants, with a total installed capacity of about 49,000 Kw, are in the Genesee River Basin, including three in the Rochester area. The latter are owned by the Rochester Gas and Electric Corporation which also owns Rushford Lake on Caneadea Creek. The 25,000 acre-foot lake is operated to augment low flows for the power facilities. Four small plants are in the Lake Ontario West Basin and use supplemental flows of surplus water from the Barge Canal. The remaining plant is a 500 Kw installation on Cattaraugus Creek in the Erie-Niagara Basin.

The potential for new conventional hydroelectric power projects is small except in the Genesee River Basin where the Corps of Engineers is presently studying the feasibility of a conventional or pumped storage project as part of a comprehensive basin study. Other pos-

sible sites for pumped storage projects have been identified. A 380,000 Kw pumped storage plant is presently under construction in conjunction with Allegheny River Reservoir south of the State line.

6. NAVIGATION

The economy of the northern and western portions of the region is strongly influenced by water-borne commerce using the Great Lakes, St. Lawrence Seaway and the Barge Canal. Barge Canal commercial traffic between Tonawanda and Rochester has diminished, but pleasure craft use is steadily increasing. The Barge Canal crosses the Genesee River at grade upstream from Rochester Harbor without any connection to that port. The Canal is used as a transmission facility for irrigation water and supplies water for industrial use. It offers further opportunities for interbasin water transfers.

The possibility of a canal across western New York State to link Lake Erie and Lake Ontario is under study by the Corps of Engineers.

7. FLOOD CONTROL

Flood damages in the Western Region are centered in the metropolitan areas. The larger floods are usually caused by a combination of rainfall and snowmelt. Damaging floods also occur from winter or spring rains on frozen ground and local damages are often caused by ice jams. Intense summer rains may also produce severe flooding.

In the Erie-Niagara Basin, the most significant average annual flood damages are estimated at $600,000 based on 1965 price levels. Except for Tonawanda Creek, flooding problems are concentrated in the urbanized downstream reaches of streams draining into the Buffalo metropolitan area. Estimated average annual flood damages are about $114,000 on Cazenovia Creek near Buffalo and about $30,000 on Cayuga Creek and Buffalo Creek.

In August 1963, Scajaquada Creek caused estimated flood damages of $511,000 at Buffalo and Cheektowaga. Tonawanda Creek downstream from Batavia has a flat gradient and flows through an area of low relief and poor natural drainage. Overflow causes widespread inundation and extensive damage. Average annual flood damages near Batavia and Rapids are estimated at $230,000. Tributary streams, such as Ellicott Creek, Ransom Creek and Black Creek have also experienced damaging floods.

In the Genesee River Basin, existing Mt. Morris Reservoir controls 44 percent of the Genesee River drainage area and reduces flood stages between the dam and the mouth. However, urban growth is taking place south of Rochester along the river. If the flood plain is not managed properly, future flood damages are likely to occur. Other problem areas are located in agricultural reaches along the Genesee River and other creeks in the basin. Average annual flood damages are estimated at $410,000.

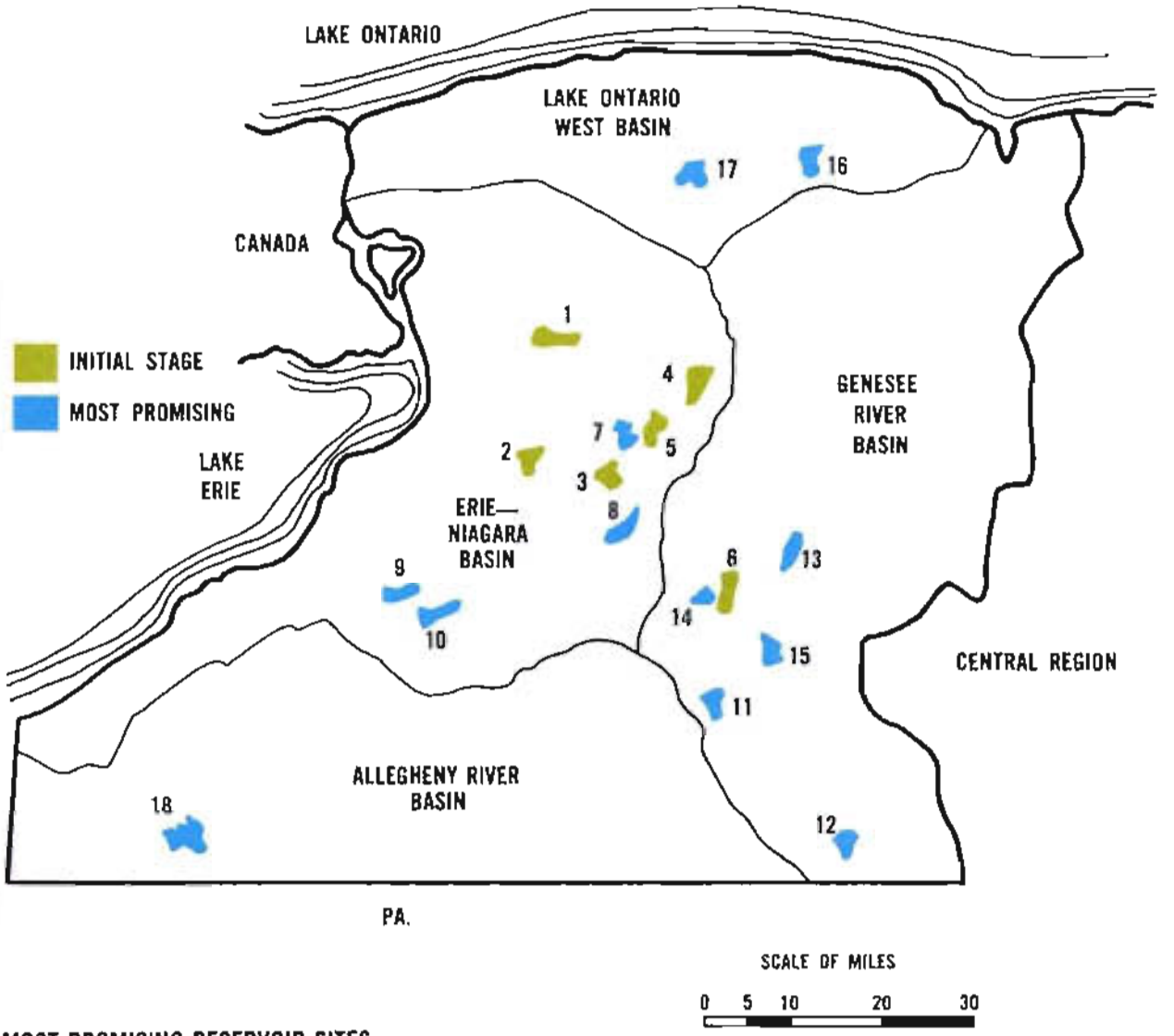
Flood damages in the Allegheny River Basin are of a localized nature and generally are neither frequent nor of large magnitude except at Lake Chautauqua. A number of local flood protection projects have been constructed along the Allegheny River and its tributaries. In addition, watershed improvement programs being implemented in the Ischua Creek and Conewango Creek Watersheds will substantially reduce average annual flood damages. A serious flood problem exists along the shores of Lake Chautauqua where average annual primary flood damages have been estimated by the Corps of Engineers to be $308,000. In addition, considerable damage is caused by low water levels which reduce the utility of commercial and recreational docking and bathing facilities during the recreation season. Average annual flood damages in the Allegheny River Basin are estimated at $650,000.

No estimates are available of flood damage in the Lake Ontario West Basin. Flooding is relatively infrequent and minor except for the area above Medina in the vicinity of West Shelby where periodic flooding occurs along Oak Orchard Creek.

8. WATER QUALITY MANAGEMENT

Water quality management involves consideration of all forms of pollution of streams and lakes. Historically the principal concern has been with discharge of biologically degradable material and its effect on dissolved oxygen available in the waterway. Attention has also been focused on the discharge of toxic industrial wastes. More recently, the less obvious pollutants, such as nitrogen and phosphates which affect algae growths, have gained prominence along with other dissolved mineral salts and heat pollution from cooling water discharges.

The State Water Resources Commission has classified the streams in the region as to their best usage in the interest of the public. Using these classifications and specified minimum dissolved oxygen contents, preliminary estimates have been made of the effects of present and future biochemical oxygen demand discharges on the streams in the region. It is indicated that augmentation during periods of minimum stream flow should be considered for waste assimilation at the following locations in the Erie-Niagara Basin: Amherst and Alden on Ellicott Creek, Depew and Lancaster on Cayuga



MOST PROMISING RESERVOIR SITES
WESTERN REGION

Creek, Cheektowaga on Scajaquada Creek, East Aurora on Cazenovia Creek, Gowanda on Cattaraugus Creek, Elma on Buffalo Creek and Batavia on Tonawanda Creek. The Genesee River and Honeoye Creek in the vicinity of Rochester and Cassadaga Creek in the Allegheny River Basin also have potential for providing flow augmentation benefits.

F. General Water Resources Development Plan

1. APPROACH TO PROBLEMS

Major alternatives exist for development and utilization of water resources of the Western Region. One of the principal questions is the future use of the Great Lakes for water supply to the Buffalo-Niagara Falls and Rochester Metropolitan Areas as contrasted with development and use of inland reservoirs. In other areas, a choice may be available between ground and surface water supplies for municipal, industrial or irrigation use. Multi-purpose development of reservoir sites requires the allocation of available storage to various competing uses. Water quality management also involves alternatives of improved treatment methods or low flow augmentation. Local flood damages may be alleviated by a variety of measures including channel improvements, levees, flood plain regulations and flood control storage.

The projected increases in municipal water supply demands for the Buffalo-Niagara Falls and Rochester Metropolitan Areas can be met entirely from the Great Lakes and Niagara River. However, four inland reservoirs, Sandridge, Spring Brook, Wales and Bennington, can supply water economically to the Buffalo Area because of the savings in pumping costs. Although they would not take care of all future needs, they would supply a substantial part of the expected growth in municipal demand. In the Rochester Area large inland reservoirs are competitive with Lake Ontario because of the cost of transmission facilities.

Where available, the use of a ground water source for small public water supplies, private domestic supplies and for irrigation is almost always more economical than development of a

surface water supply. Domestic, municipal and industrial water supplies outside the major metropolitan areas are, in general, currently being supplied from ground water.

Local areas of high probable ground water yield are coincident with about 25,000 acres of irrigable land in the Erie-Niagara Basin and 55,000 acres in the Genesee River Basin. Economical supplies can be obtained from ground water in these areas.

Irrigation and municipal water supply are competing water uses. With substantial surpluses of agricultural land and water, there is more freedom in location of developments for irrigation than for municipal water supply which has a relatively fixed service area. This suggests use of potential reservoir sites nearer the metropolitan areas for municipal water supply and use of more distant sites for irrigation. Recreational developments in conjunction with municipal water supply reservoirs is more compatible because of smaller summer drawdowns and closer proximity to the major population centers. Surface water developments for irrigation in the Lake Ontario West Basin have significant economic advantages because of the high value of potential crops and the availability of the Barge Canal for gravity conveyance.

Reservoirs in the Western Region can usually be used for flood control without an appreciable incremental cost because floods generally occur at times when the reservoirs can be drawn down without significantly impairing their functioning for other purposes. Low flow augmentation to achieve water quality control in some instances also can be achieved without conflict with other uses.

For development of surface water resources, a total of 517 reservoir sites have been identified and evaluated. Estimates which indicate the order of magnitude of project costs have been derived for the sites through a series of successive screening processes. Potential benefits have been evaluated qualitatively considering a number of potential reservoir uses.

2. GENERAL PLAN

Eighteen reservoir sites in the Western Region are the most promising on the basis of estimated costs and potential benefits determined in the reconnaissance study. Pertinent data for the sites are summarized in the map on page 49 and Table 3.

Nine sites are located in the Erie-Niagara Basin, seven are in the Genesee River Basin, two are in the Lake Ontario West Basin and one is in the Allegheny River Basin. The estimated total capital cost of all the developments is $164,000,000. They would provide 1,800,000 acre-feet of storage and 34,000 acres of water surface.

By far the greatest storage, 840,000 acre-feet, could be developed on Cattaraugus Creek. The next largest sites are Portage and Belfast in the Genesee River Basin. Those in the Lake Ontario West Basin and Allegheny River Basin are relatively small. All the sites have potential for multi-purpose development, except Site 7-2 in the Genesee River Basin which has limited storage capacity and is suitable for recreation only.

On the basis of preliminary benefit-cost evaluations, eleven of the sites have favorable ratios, that is, project benefits exceed the cost of development. Six of these sites appear to be the most favorable for initial development. These sites are Sandridge, Spring Brook, Wales, Linden and Sierks in the Erie-Niagara Basin and Portage in the Genesee River Basin.

The estimated total capital cost of the most favorable Erie-Niagara projects is $38,000,000. They would provide 199,000 acre-feet of storage and 6,400 acres of water surface.

The Sandridge site has a good potential for multi-purpose development. The reservoir controls about 50 percent of the drainage area and would provide flood protection to the lower reaches of Ellicott Creek. Usable storage could be applied to meeting irrigation requirements in the Tonawanda sub-basin and municipal and industrial water supply requirements of the Erie County Water Authority. The site also offers good potential for recreational development, due to its physical characteristics and its proximity to population centers. The reservoir could be a good warm-water fishing lake.

The estimated capital cost of Portage Reservoir in the Genesee River Basin is $25,000,000. The reservoir would have 283,000 acre-feet of storage and a surface area of 6,500 acres. The Portage site has the largest potential storage in the basin. It is well suited for multi-

purpose development and would be an excellent recreational facility. Unit costs of storage are relatively low.

The six reservoirs in the region have an estimated total capital cost of $63,000,000. Additional studies are needed to determine more definitely the engineering and economic feasibility of development of the sites. Another immediate step, involving use of available ground water supplies, could be the rapid expansion of supplemental irrigation in the Erie-Niagara and Genesee River Basins. This could begin as soon as estimated supplies are verified by feasibility-level investigations.

The Spring Brook site could be developed for recreation, flood control and public water supply. The reservoir, close to Buffalo, would be a good recreational facility. It controls nearly 90 percent of the watershed above the reach of Cazenovia Creek which experiences flood damages. Regulated flow could be used for public water supply.

The Wales site has the largest storage capacity and could be developed at a relatively low unit cost. The reservoir is close to Buffalo and would be a good recreational facility. It controls about half the Buffalo Creek watershed and could provide flood control. Part of the storage can be allocated for public water supply.

The Linden site is relatively small but has favorable cost characteristics and is suitable for multi-purpose development. It would assist in alleviating flood damages at Batavia. The usable storage could help satisfy irrigation requirements in the Tonawanda sub-basin as well as municipal and industrial water requirements for the City of Batavia. Development of the reservoir for recreation is favorable because of the nearby population centers.

The Sierks site is also located in the Tonawanda sub-basin. It could be developed as an alternate to the Linden site or in conjunction with it. Although the reservoir would be about 50 percent greater, the unit cost of development is substantially higher. The Sierks site would provide the same kind of multi-purpose benefits as Linden.

TABLE 3 PERTINENT DATA FOR MOST PROMISING RESERVOIR SITES, WESTERN REGION

RESERVOIR	NO.	STREAM	DRAINAGE AREA SQ. MI.	STORAGE ACRE FEET	SURFACE AREA ACRES	LAND ACRES	ACQUISITION COST	CAPITAL COST	POSSIBLE USE
ERIE-NIAGARA BASIN									
*Sandridge	1	Ellicott Creek	35.0	27,000	1,450	1,800	$2,000,000	$ 6,890,000	M, F, Q, R, I
*Spring Brook	2	Cazenovia Creek	121.5	52,300	1,400	1,700	2,200,000	12,200,000	M, F, R
*Wales	3	Buffalo Creek	77.9	71,500	1,750	2,100	1,400,000	6,210,000	M, Q, R
*Linden	4	Little Tonawanda Creek	21.4	19,200	890	1,100	250,000	1,750,000	M, F, R, I
*Sierks	5	Tonawanda Creek	61.7	28,800	925	1,100	800,000	10,600,000	M, F, Q, R, I
Bennington	7	Cayuga Creek	32.0	26,400	700			5,710,000	M, Q, R
Arcade Center	8	Cattaraugus Creek	24.9	31,800	830			5,830,000	R, I
Bagdad	9	Clear Creek	20.0	15,100	360			2,110,000	R, I
Zoar	10	Cattaraugus Creek	317.9	840,000	8,600			28,000,000	M, F, R, I, P
GENESEE RIVER BASIN									
*Portage	6	Genesee River	985.0	283,000	6,500	7,800	6,500,000	24,900,000	M, F, Q, R, I, P
Belfast	11	Genesee River	580.0	188,000	4,500			26,600,000	M, F, Q, R, I, P
Stannard	12	Genesee River	168.0	93,500	2,300			15,600,000	M, F, Q, R, I, P
Tuscarora	13	Keshequa Creek	68.0	43,000	1,000			4,090,000	F, R, I
Wiscoy	14	Wiscoy Creek	108.0	39,000	800			6,690,000	M, Q, R, I, P
Site 7-2	15	Black Creek (Allegheny County)	15.7	12,500	1,170			1,630,000	R
LAKE ONTARIO WEST BASIN									
Sandy Site No. 3	16	Sandy Creek	19.7	9,000	350			2,210,000	I, R
Oak Orchard No. 2	17	Otter Creek	9.7	5,800	400			962,000	I, R
ALLEGHENY RIVER BASIN									
Chautauqua No. 11	18	Goose Creek	12.8	14,000	500			1,560,000	M, F, R

M—Municipal & Industrial Water Supply
F—Flood Control
Q—Water Quality Management
R—Recreation, Fish & Wildlife
I—Irrigation
P—Power
*Initial Development Site

AGENCIES RESPONSIBLE FOR NEW YORK'S WATER RESOURCES

THE WATER RESOURCES COMMISSION— Coordinator and Policy Maker

Finding workable solutions to the State's problems in water resources management is the responsibility of the New York State Water Resources Commission. Because of the diversity of agencies involved with water-related activities, the Commission is particularly designed to formulate policy and coordinate the State's efforts in all water resource endeavors.

The **Commissioner of Conservation**, whose Department is responsible for the conservation of water and related land resources in New York State, is Chairman of the Commission.

Serving with him are Commissioners of six agencies that have specific tasks associated with water:

The **Commissioner of Health**, whose agency safeguards public health through water quality surveillance, sanitary control of water supplies and pollution abatement and control.

The **Commissioner** of the newly-created **Department of Transportation**, which is now responsible for all aspects of transportation and for the operation and maintenance of the State's Barge Canal System, consisting of some 500 miles of canals and waterways.

The **Commissioner of the Department of Agriculture and Markets**, who has the responsibility of overseeing the production, processing and distribution of the State's agricultural products and who is interested in meeting present and future water needs of farmers.

The **Attorney General** who advises the Commission on all legal matters, and who, as head of the **Department of Law**, handles all legal actions, proceedings and appeals that involve determinations of the Commission.

The **Commissioner of Commerce**, whose agency is concerned with industrial development and location of business firms in the State, as well as the attraction of tourists, and who is therefore concerned with industrial and recreational uses of water in the State.

The **Commissioner of the Office for Local Government**, whose agency aids localities in developing more effective services, and who, as a member of the Commission, is concerned with aiding localities in planning for future water resources needs and in improving their water supply facilities and combating pollution.

Four lay **Advisory Members** appointed by the Governor, represent the interests of **Agriculture, Industry, Political Subdivisions** and **Sportsmen.**

NEW YORK STATE WATER RESOURCES COMMISSION

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J. Burch McMorran, Commissioner of Transportation
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Hollis S. Ingraham, M.D., Commissioner of Health
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STATE OF NEW YORK CONSERVATION DEPARTMENT DIVISION OF WATER RESOURCES

The Conservation Department's Division of Water Resources is the Commission's action arm. The Division implements Commission policy and directs Statewide water resources planning.

The Division makes technical appraisals of specific projects that affect water resources and its recommendations serve as the basis for Commission action.

The Division also serves as a clearing house for information for State agencies and for the public on the State's water resources.

In addition the Division of Water Resources conducts regional, interstate, and state-federal planning studies; provides flood plain management assistance and direction; coordinates State water resources activities and administers regulatory functions such as public water supply, stream protection and power licenses.

To permit a decentralized approach to these activities, the State is divided into three areas, each having a regional office with district offices at appropriate locations. These local offices provide staff services to the Regional Boards and perform and coordinate regional water resources planning activities.

STAFF

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Hudson River Scene by an Unknown American Primitive Painter-circa 1850