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PRESENT SCITUATE SUPPLY
AND
FUTURE SURFACE WATER
SUPPLY DEVELOPMENTS

THE CITY OF PROVIDENCE

WATER SUPPLY BOARD

552 ACADEMY AVENUE
PROVIDENCE 8, R. I.

April 13, 1962

To the Honorable, The City Council
of the City of Providence
City Hall
Providence, Rhode Island

Gentlemen:

In accordance with City Council Resolution #201 dated March 16, 1962, we are submitting a report on "Present Scituate Supply and Future Surface Water Developments" which was approved by the Water Supply Board at their meeting held on Friday, April 13, 1962.

The report describes our present Scituate supply located on the north branch of the Pawtuxet River together with an outline of the treatment methods and processes employed at the Purification Works. The three drainage basins that may be developed for public water supply reservoirs do not possess the favorable characteristics of Scituate in relationship to their respective yields. The two developments on the Branch River watershed, a tributary to the Blackstone, have an estimated safe yield of only 42.30 million gallons daily as compared with slightly over 84 million gallons daily for Scituate. The developments on the Pawtuxet and Pawcatuck Rivers combined will produce an estimated safe yield of 60.50 million gallons daily. However, all of the above quantity, like Scituate, will not be available for water supply purposes.

All of these developments were contained in the 1952 report submitted to the State Water Resources Commission by Charles A. Maguire and Associates and the more recent report submitted in 1957 from Metcalf and Eddy to the Water Resource Coordinating Board.

Yours very truly,

Philip J. Holton, Jr.

Philip J. Holton, Jr.
Chief Engineer

IN CITY COUNCIL
APR 19 1962
READ:
WHEREUPON IT IS ORDERED THAT
THE SAME BE RECEIVED.
D. Everett Whelan
CLERK

PJH:kam

PRESENT SCITUATE SUPPLY
AND
FUTURE SURFACE WATER
SUPPLY DEVELOPMENTS

Impounding Reservoirs

The present supply, known as Scituate Reservoir, is located on the north branch of the Pawtuxet River. Water is impounded in this reservoir from a drainage basin that contains 92.8 square miles. This represents about 9% of the land area of the State of Rhode Island and is more than five times the area of the City of Providence. The City owns in fee 23.93 square miles or about 25% of the entire drainage area. The largest portion of the watershed lies in the Town of Scituate while smaller portions are in the Towns of Foster, Glocester, Johnston, Smithfield and the City of Cranston.

In addition to the main Scituate Reservoir, there are five smaller reservoirs, all tributary to the main body. They are Moswansicut, Regulating, Ponaganset, Barden and Westconnaug. The total capacities of these reservoirs at their respective spillway elevations are as follows:

Scituate		37,011	million gallons
Moswansicut		1,781	" "
Regulating		428	" "
Ponagansett		742	" "
Barden		853	" "
Westconnaug		453	" "
	Total	41,268	million gallons

The available capacities of these reservoirs are as follows:

Scituate		36,611	million gallons
Moswansicut		715	" "
Regulating		421	" "
Ponaganset		693	" "
Barden		853	" "
Westconnaug		453	" "
	Total	39,746	million gallons

The following table shows the area of water surface for all the reservoirs:

Scituate	3,390	acres
Moswansicut	282	"
Regulating	242	"
Ponaganset	229	"
Barden	240	"
Westconnaug	174	"
Total	4,557	acres

The water surface of Scituate Reservoir of 3,390 acres is equivalent to 5.3 square miles and for all the reservoirs combined 7.12 square miles. The main reservoir is capable of impounding about 400 million gallons for every square mile of drainage area.

Rainfall, Runoff and Yield

The annual rainfall on the watershed, based on the 46-year average (1915-1961), is 48.58 inches; with a maximum yearly rainfall of 66.28 inches for the fiscal year ending in 1958 and a yearly minimum of 33.43 inches for the year ending 1957. The rainfall is measured at five gauging stations located at Rocky Hill, Hopkins Mills, North Scituate, Westcott and Gainer Dam.

The yearly runoff, or actual water collected in the reservoir, based on the same average period, is 25.17 inches; with a maximum annual runoff of 35.92 inches for the year ending 1956 and a minimum of only 12.02 inches for the year 1930. Every inch of runoff is equivalent to 1,612,750,000 gallons.

The average daily yield based on the 46-year period is 111.14 million gallons. However, you cannot plan that this quantity of water will always be available. You are limited to what is known as the "Estimated

Safe Yield". This is the maximum dependable draft which can be made continually upon a source of water supply during a period of extended drought when the greatest deficiency in runoff is likely to occur. The Estimated Safe Yield of the Scituate supply is 84.02 million gallons daily.

Water Purification Works

Water from Scituate Reservoir for use at the Purification Works may be drawn through three separate intakes at the gate house, located on Gainer Memorial Dam. The lower intake draws water from elevation 213 to 220; the intermediate from elevation 225 to 240 and the upper intake between elevation 252 and 277. Although the water obtainable from the upper and intermediate intakes is ordinarily good in quality, better results are accomplished in the treatment process by drawing from the lower intake. In addition, the temperature of the water delivered into the system is much lower.

Water from Scituate Reservoir to the plant requires no pumping whatsoever. It flows by gravity from the gate house structure to the Purification Works through two 60" steel pipes, which converge into a single 94" conduit before reaching the plant. The single aqueduct extends to the influent chamber, where a solution of Ferric Sulphate is added as a coagulant. The chemically treated water then enters the next step in the treatment process known as influent aeration. This operation is designed to remove Carbon Dioxide from the raw water because of its corrosive properties. At the same time, other dissolved gases are removed, since their presence in the water would produce disagreeable tastes and odors. The intimate contact between the water and the oxygen of the air causes a certain amount of oxidation to take place. This is valuable in removing dissolved Iron and Manganese, because both of these substances require oxidation to their highest form in order to be rendered insoluble in the coagulation and sedimentation processes which follow.

From the influent aerators, the water continues under gravity head through a conduit to the mixer; which consists of a large, circular well, the tangentially entering stream of which can be regulated to produce the desired velocities to insure thorough mixing of the chemicals. Quicklime, which has been properly slaked, is introduced into the water just ahead of the mixer. This increases the Hydrogen-Ion, or pH, content of the water, changing it from an acid to an alkaline water. This is necessary in the removal of Iron and Manganese, which cannot be removed at a low pH, and affords a better degree of coagulation by increasing the specific gravity of the ferric hydroxide floc. It produces water of a less corrosive nature, and serves as an effective sterilizing agent by virtue of its oxidizing powers.

The next step, coagulation, is so closely allied with sedimentation that they may be considered together. Coagulation is the addition of a chemical to the water, which forms an insoluble hydroxide; and sedimentation is the passage of the coagulated water through basins at relatively low velocities, so that the floc or precipitate formed by the coagulant will settle to the bottom of the basin, leaving a comparatively clear water at the top. The floc commences to form at the mixer, and the coagulated water enters the north basin, which has a capacity of 45.14 million gallons. Baffles are provided to prevent short circuiting of the flow, and after traveling around the baffle, the water crosses into the south basin which has a capacity of 115.07 million gallons. The combined storage of both basins, 160.21 million gallons, provides about three days retention at the ordinary influent rate, which has a favorable effect on the amount of coagulant necessary to produce a water of desired quality for filtration.

All that has been done to the water in the aeration, coagulation and sedimentation process has been for the purpose of preparing it for the next important operation which is filtration. The filters consist of concrete tanks in the bottom of which are a series of collector pipes. These pipes are covered by large gravel and then by layers of successively smaller sizes of gravel for a total depth of 18 inches. Above the gravel is a layer of fine sand approximately 30 inches in depth. Water for filtration is drawn from the top of the sedimentation basins into the filters through a large concrete conduit. When filtration is to be started, the effluents from the collector pipes are opened and the water passes through the sand, then through the gravel into the collector pipes and through a main effluent line to the clear well. During the passage through the sand, the remaining or smaller particles of floc, which has failed to settle in the sedimentation basins, adheres to the sand and are removed, consequently producing a practically colorless water. Finally, as the water flows from the clear well into the main aqueduct, it is chlorinated to destroy any remaining bacteria and to insure a safe drinking water. At this same location, Sodium Silicofluoride is added for the purpose of reducing dental caries in growing children.

When the plant was originally built, it contained ten filters, each with a capacity of 4.4 million gallons daily. With the continued growth of the system, the peak demands during the summer months soon exceeded the total capacity of the plant. Under the circumstances, a contract was awarded in 1938 to construct four additional units, which were completed in the summer of 1940. This increased the operating output of the plant from 44 million gallons daily to 61.6 million gallons daily. In 1954 after years of extensive experiments were conducted, the filters were rebuilt using a coarser grained sand that increased their capacity to 105 million gallons daily. (See Figure 1 - Diagrammatic Layout)

Communities Entitled to Water

Figure 2 is a map of the entire State of Rhode Island showing the main Scituate Reservoir, its five tributary reservoirs, the limits of the watershed and the cities and towns entitled to receive water from this supply under the provisions of the original act passed by the General Assembly in 1915 or the amended act passed in 1936. The following is a list of these communities and their relative areas:

Coventry	62.87	square miles
Cranston	28.20	" "
Glocester	56.51	" "
Johnston	25.09	" "
North Providence	5.90	" "
Providence	18.91	" "
Scituate	55.28	" "
Smithfield	27.60	" "
Warwick	36.26	" "
West Warwick	8.18	" "
Foster	52.15	" "
Total	376.95	square miles

These eleven cities and towns represent about 36% of the land area of the State.

At present we are serving three of the above cities and five towns that represent a population, based on the 1960 Census, of 383,134 which is approximately 45% of the entire State. The three towns that do not receive water from the Scituate supply are Foster, Glocester and Scituate. In the past the City has offered to supply East Providence as well as the Bristol County Water Company serving Barrington, Warren and Bristol. These proposals were officially submitted in 1949, 1953 and 1959. Woonsocket was offered the same opportunity in 1953 and 1959.

Consumption

The raw water withdrawn from Scituate Reservoir and delivered to the Purification Works during the last fiscal year averaged 50.14 million gallons daily. To this must be added 12 million gallons daily that must be discharged to the mills below Gainer Dam in accordance with State statute. This brings the total to over 62 million gallons daily. Deducting this from the Estimated Safe Yield of 84 million gallons daily leaves a surplus of only 22 million gallons daily to take care of future growth as well as the demand of new industries.

The system cannot confine its operations to average daily demands. It must be capable of meeting peak loads as they occur on a daily or hourly basis, the same as all other utilities. The maximum peak day was established on June 17, 1957 when 84.70 million gallons was consumed plus plant consumption. On this same day, there were three hourly periods when water was consumed at the rate of over 131 million gallons daily. According to the department's long range studies, Providence daily requirements will reach the Estimated Safe Yield by 1980 and it will be necessary to obtain a supplementary source of water along with additional filter capacity, tunnels and aqueducts in advance of that date. (See Figure 3)

Additional Surface Water Developments

Since the completion of the Scituate supply, which was placed in operation in 1926, there have been no major water supply developments from that date. The development of our water resources is an indispensable part of our State's economy and if the State of Rhode Island is to meet the expanding requirements of residential, commercial and industrial water demands, it is urgent that they take the necessary steps to acquire the sites for additional surface water developments similar to the Scituate supply. Rhode Island cannot lay claim to an abundance of drainage basins. The entire State contains only eight principal catchment areas with three holding favorable potential for the development of surface water supply reservoirs. (See Figure 4)

The following is a list of the eight major drainage basins and the area of their watersheds:

Blackstone River	476.8	square	miles
Pawtuxet River	237.2	"	"
Woonasquatucket River	55.5	"	"
Pawcatuck River	306.4	"	"
Ten Mile River	56.5	"	"
Moosup River	89.2	"	"
Five Mile River	76.7	"	"
Moshassuck River	22.1	"	"

Seventy-four percent of the Blackstone River watershed is in Mass.; all of the drainage area of the Pawtuxet River, the Woonasquatucket River and the Moshassuck River is in Rhode Island; about eighty percent of the Pawcatuck lies within the State and the remainder in Conn.; ninety percent of the Ten Mile is in Mass.; only forty-five percent of the Moosup and twenty-three percent of the Five Mile is in Rhode Island with the remaining portions being in the State of Conn.

Branch River

Chepachet and Smith-Sayles-Keech

The Branch River, a tributary to the Blackstone, lends itself to economic development for storing substantial quantities of water. One possibility is the construction of an impounding reservoir on the Chepachet River by building a dam at elevation 400. The flow from two small existing reservoirs known as Smith-Sayles and Keech Pond would discharge into Chepachet Reservoir. This group would lie within a watershed containing 20.62 square miles. Chepachet Reservoir would have a flowed area of 812 acres equivalent to 1.27 square miles and the storage is estimated to be 7,000 million gallons equal to 340 million gallons of storage for every square mile of drainage area. The two small reservoirs tributary to Chepachet have a flowed area of about 230 acres or 0.36 square miles and contain about 350 million gallons in storage. The dependable or Estimated Safe Yield will be 17.90 million gallons daily. (See Figure 5)

Nipmuc and Wilson

Another favorable combination on the Branch River watershed is the development of an impounding reservoir by constructing a dam at elevation 410 on the Nipmuc River. The drainage area represents 16.59 square miles with a flowed area of 979 acres or 1.53 square miles. The storage will be approximately 9,180 million gallons equivalent to 554 million gallons of storage for each square mile of drainage area. The Estimated Safe Yield will be 15.80 million gallons daily. The existing Wilson Reservoir located on Clear River would act as a diversion reservoir in conjunction with Nipmuc by building a gravity aqueduct between both bodies of water. Wilson will remain at its present spillway elevation 439 and the watershed will total 12.02 square miles. The present flowed area is around 435 acres or 0.68 square miles and the storage about 150 million gallons. This group would contain a total drainage area of 28.61 square miles and the flowed or surface area would total 1,414 acres or 2.21 square miles. The gross storage would be approximately 9,330 million gallons equal to 320 million gallons of storage for each square mile of watershed. The Estimated Safe Yield would be 24.40 million gallons daily. (See Figure 6)

The total production from all these reservoirs on the Branch River, based on the Estimated Safe Yield, would be 42.30 million gallons daily or approximately 50% of the dependable or Estimated Safe Yield of our present Scituate supply. From this total, it will be necessary to deduct certain quantities that must be discharged daily into the different rivers to compensate the riparian owners below the dams. The volume of compensation water would be established either by State statute or by the courts.

Pawtuxet River and Pawcatuck River

Big River

The next combination involves two drainage basins located in the westerly part of the State. One is the so-called Big River Reservoir located on the south branch of the Pawtuxet River. A dam would be constructed on Big River at elevation 300 and the watershed would contain 29.64 square miles. The flowed area would be about 3,480 acres or 5.44 square miles and the total storage 27,240 million gallons. This would be equivalent to 920 million gallons of storage for each square mile of drainage area and the Estimated Safe Yield would be 26.40 million gallons daily. (See Figure 7)

Wood River

Wood River is a tributary to the Pawcatuck and would be used as a diversion reservoir in connection with Big River. The watershed contains 36 square miles and the flowed area 915 acres or 1.43 square miles. Storage would total 5,965 million gallons equal to 166 million gallons of storage for each square mile of drainage area. The Estimated Safe Yield will be 25.60 million gallons daily. All water would have to be pumped from Wood River for storage in Big River. This would be somewhat costly, as compared to the gravity flow from Scituate Reservoir, but absolutely essential in order to justify the development of Big River. Peak runoff from the Wood River would establish a pumping demand of around 7,700 kilowatts and would result in an annual power bill of $170,000. (See Figure 8)

The combined drainage areas of Big and Wood Rivers would total 65.64 square miles and the flowed area about 4,400 acres or 6.87 square miles. The total storage would amount to 33,205 million gallons equal to 505 million gallons of storage for each square mile of drainage area. The dependable or Estimated Safe Yield would be 60.50 million gallons daily.

Here again, it would be necessary to discharge certain quantities daily to the riparian owners below the respective dams that would reduce the quantity available for water supply purposes. The following is a summary of the total potential of surface water developments on these three basins based on the Estimated Safe Yield:

Chepachet and Smith-Sayles-Keech	17.90 mil. gal. daily
Nipmuc and Wilson	24.40 " " "
Big and Wood River	60.50 " " "
Total	102.80 mil. gal. daily

This is about 22% in excess of the Estimated Safe Yield of our present Scituate supply. As it is necessary to release certain quantities daily to the properties below Scituate Dam, it is safe to estimate that the total quantity available for water supply purposes from the above developments would be reduced from 102.80 million gallons daily to approximately 90 million gallons daily.

Pending State Legislation

Water developments, in general, have not kept pace with growing needs. According to the U. S. Commerce Department, water use is growing three times as fast as population. Reports have shown that in many sections shortages are man-made and not always from the lack of water. It is the failure of officials to develop their supplies to keep abreast with the population growth and the rapid increase in the standard of living.

As early as 1951, the State Administration recognized that it was necessary for them to engage in the business of water development. In that year, the General Assembly passed a resolution creating a special Commission to study the water resources and facilities of the State of Rhode Island and to make recommendations for their full development. A comprehensive report dated January, 1952 prepared by Charles A. Maguire and Associates, retained by the Commission, was submitted to the Governor. In August, 1957 Metcalf and Eddy submitted another report, "Upon the Feasibility of Development of the Water Resources of Rhode Island".

Legislation sponsored by the Water Resource Coordinating Board has been introduced in the legislature in 1960, 1961 and again at the present session. This legislation requests authority to issue bonds in the amount of $5,000,000, subject to the approval of the voters, to enable the State to acquire land in connection with the ultimate development of Big River and Wood River Reservoirs. No doubt, the Board will proceed with similar requests for legislative action in regard to the acquisition of sites in the northwestern part of the State located on the Branch River basin. This would include Chepachet, and Smith-Sayles-Keech along with Nipmuc and Wilson.

Conclusion

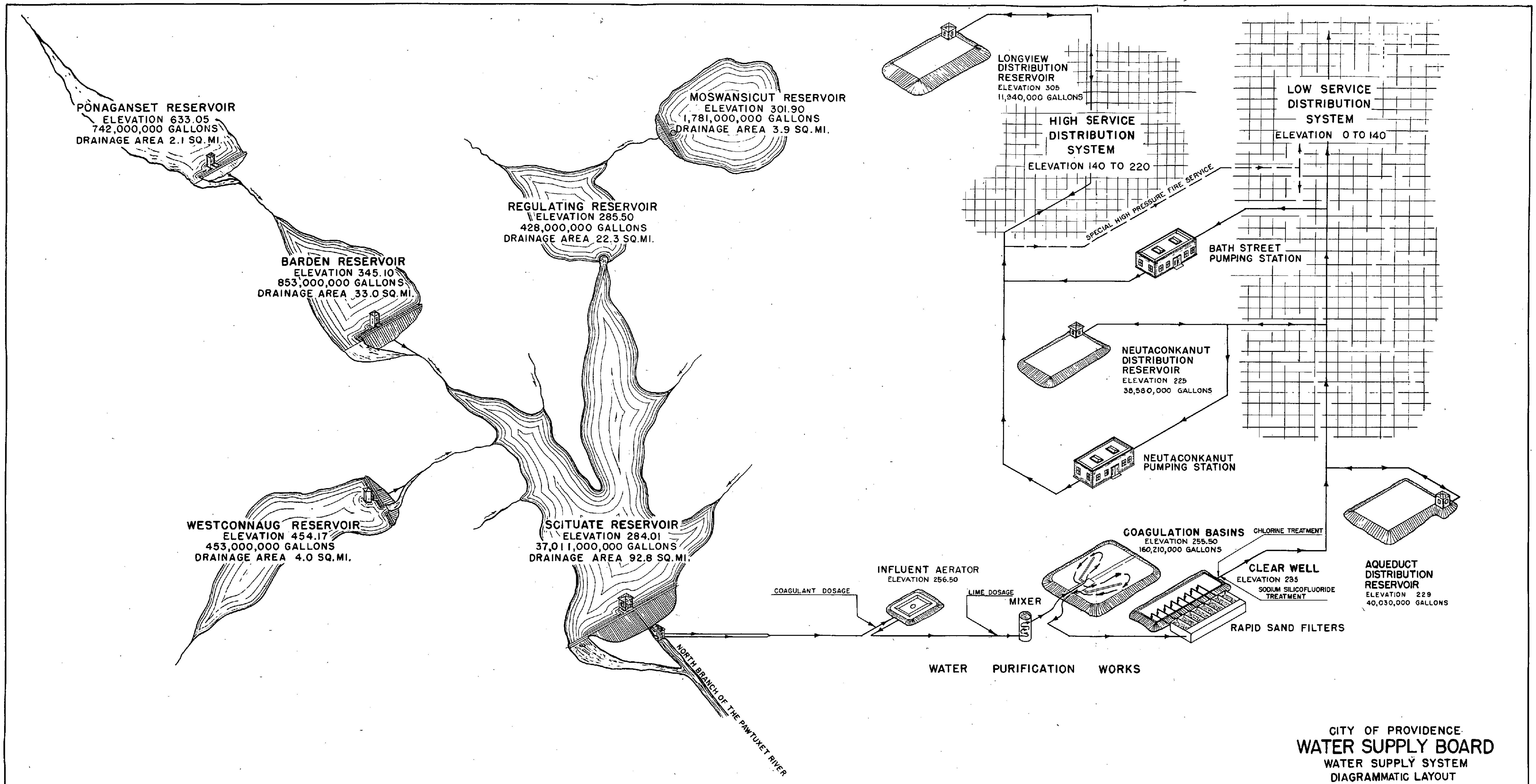
Providence has a vital interest in the Big River and Wood River Development as this would be our logical as well as economical choice to supplement our present source around 1980 when daily consumption, plus the quantity of water discharged to the mills below Gainer Dam, reaches the Estimated Safe Yield of 84 million gallons daily. The south branch of the Pawtuxet River, within which the Big River is located, was studied extensively by the original Water Supply Board but was eventually abandoned in preference to the development of our present Scituate Reservoir located on the north branch of the Pawtuxet. The possibility of developing the upper reaches of the south branch of the Pawtuxet River has been reviewed periodically by the department in connection with our own long range studies.

If the State continues to recognize that it must officially assume a leading role in the coordination and development of its limited surface water resources and proceeds to obtain the necessary appropriations covering their complete development, then the City of Providence could agree to purchase water from these State facilities along with other interested communities on a wholesale basis. If the State fails to recognize this responsibility, the City will have no choice but to proceed on its own and obtain legislative authority that will enable them to develop both Big and Wood River Reservoirs together with all appurtenant works such as water purification works, tunnels and aqueducts.

Philip J. Holton, Jr.
Chief Engineer

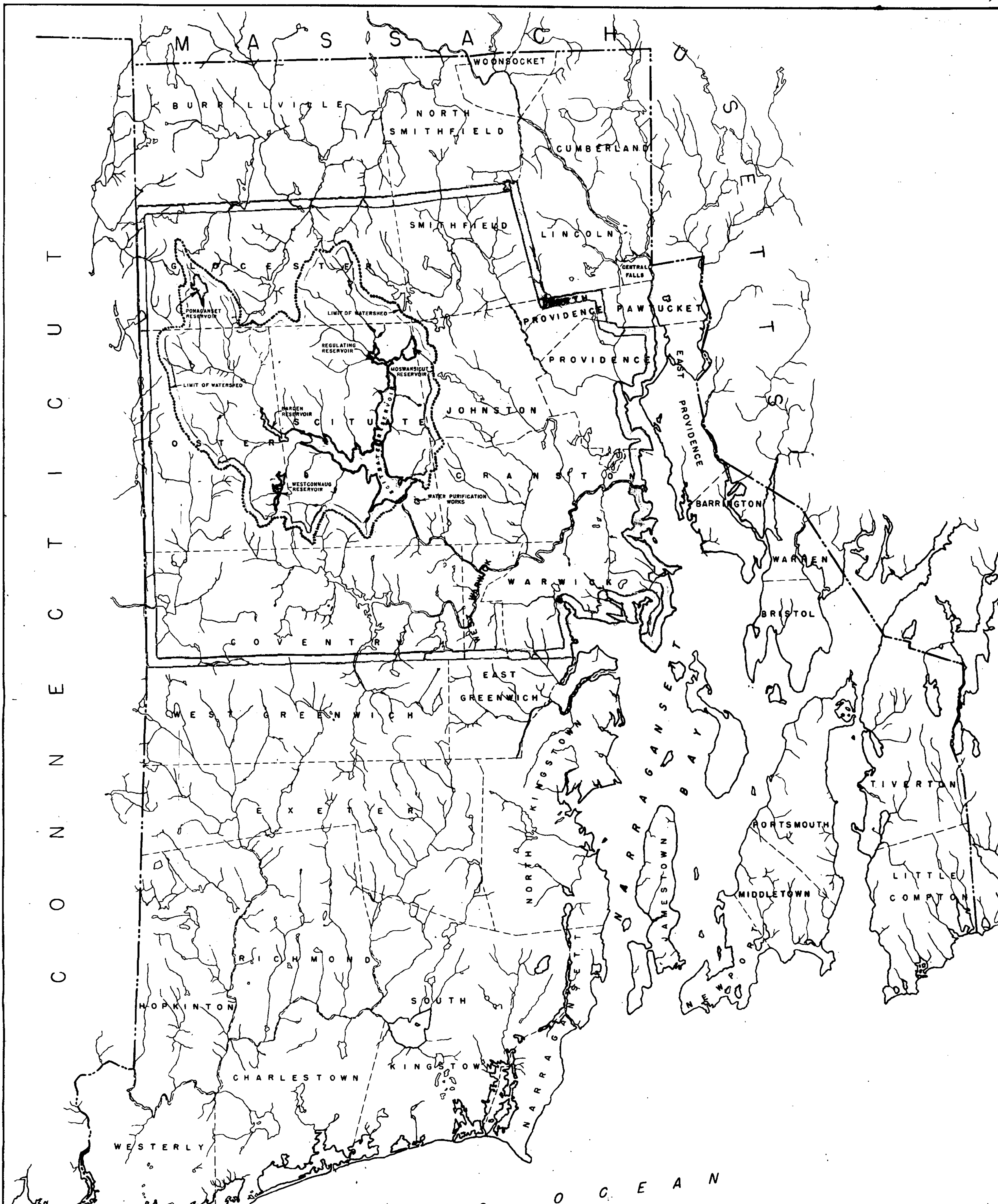
April 9, 1962

PJH:kam



CITY OF PROVIDENCE
WATER SUPPLY BOARD
WATER SUPPLY SYSTEM
DIAGRAMMATIC LAYOUT
JULY, 1945
FIGURE - 1

REV. 4-2-1962



CITIES AND TOWNS ENTITLED TO RECEIVE WATER FROM SCITUATE RESERVOIR

FIGURE - 2

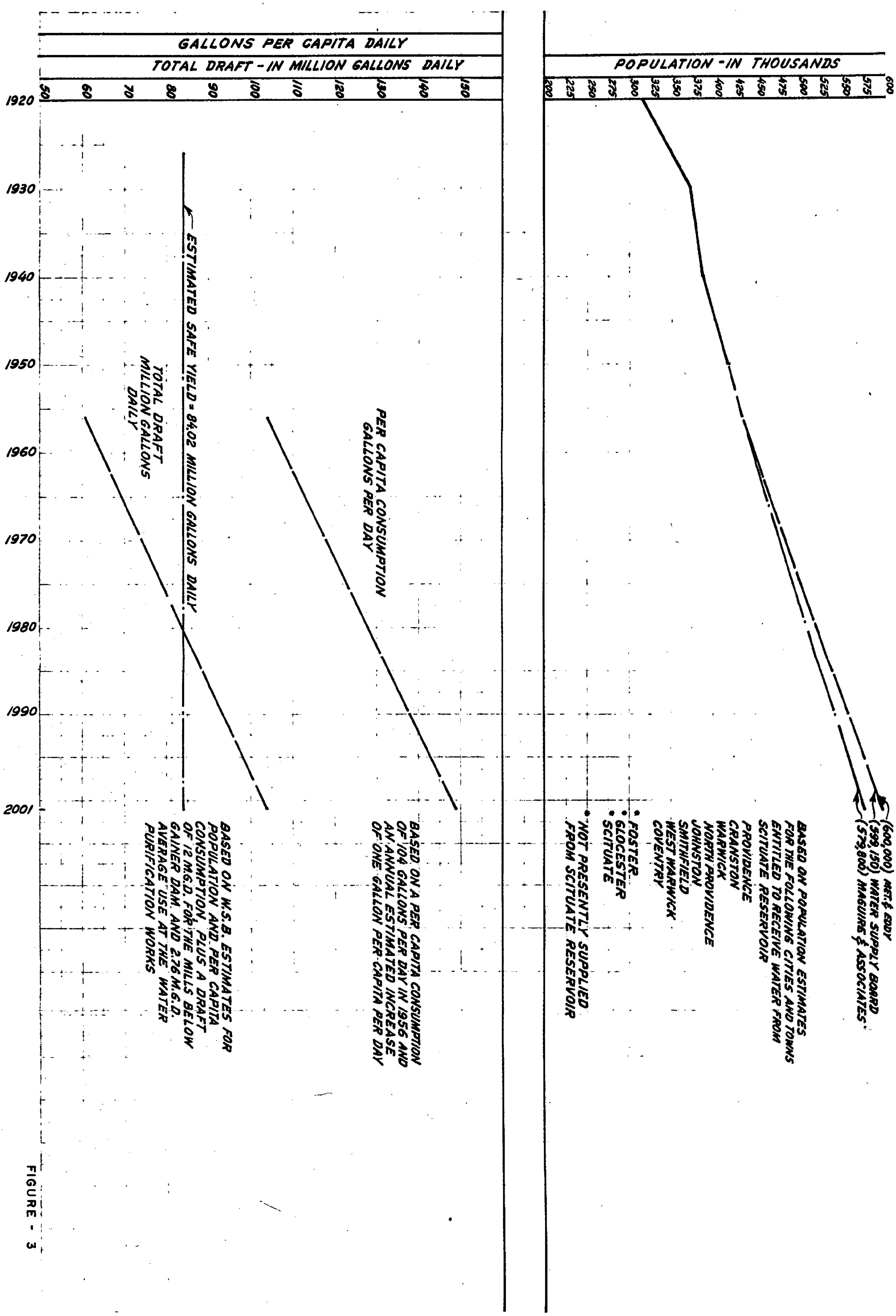
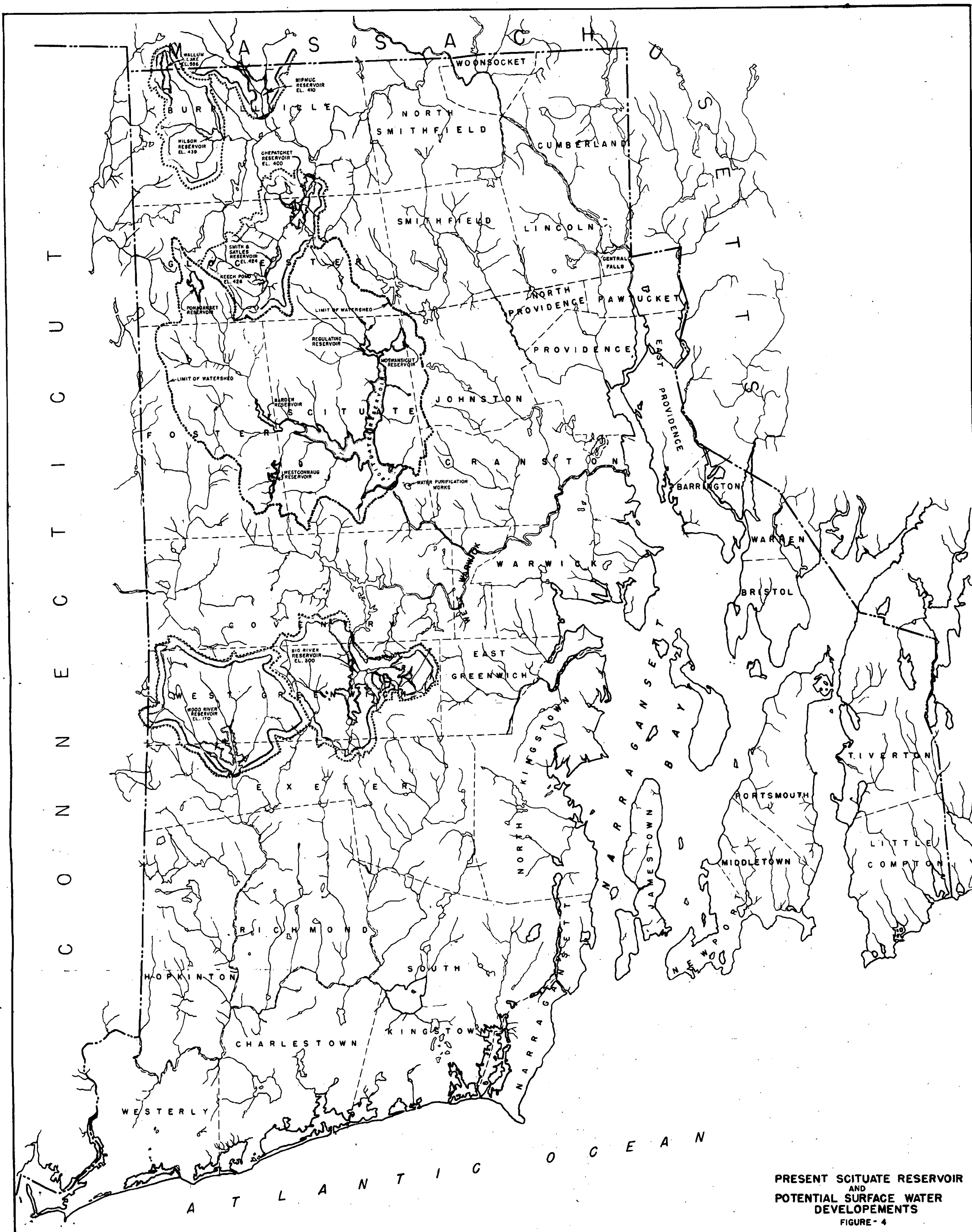
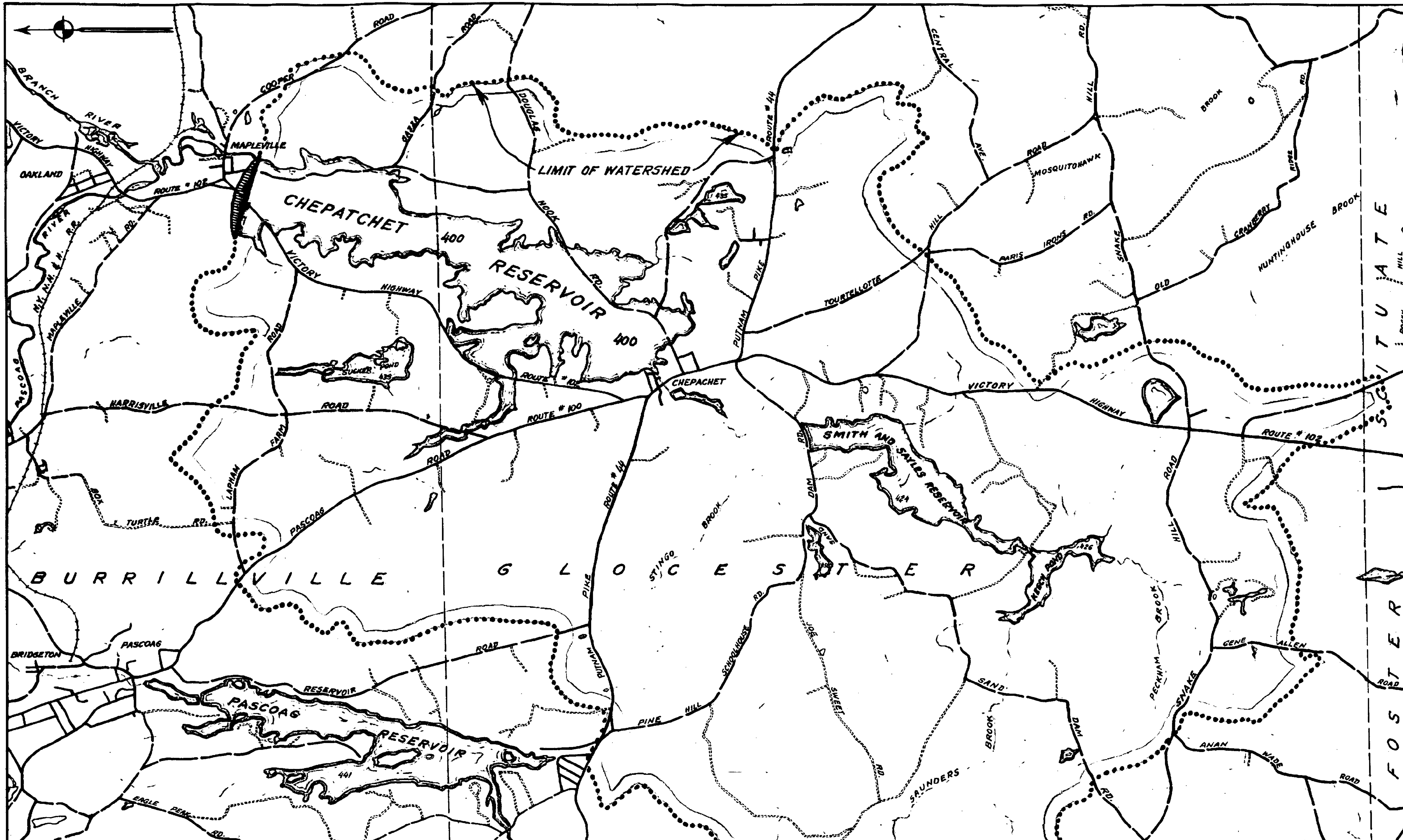

GALLONS PER CAPITA DAILY
TOTAL DRAFT - IN MILLION GALLONS DAILY
POPULATION - IN THOUSANDS
ESTIMATED SAFE YIELD = 84.02 MILLION GALLONS DAILY
TOTAL DRAFT MILLION GALLONS DAILY
PER CAPITA CONSUMPTION GALLONS PER DAY
BASED ON W.S.B. ESTIMATES FOR POPULATION AND PER CAPITA CONSUMPTION PLUS A DRAFT OF 12 M.G.D. FOR THE MILLS BELOW GAINER DAM, AND 2.76 M.G.D. AVERAGE USE AT THE WATER PURIFICATION WORKS
BASED ON A PER CAPITA CONSUMPTION OF 104 GALLONS PER DAY IN 1956 AND AN ANNUAL ESTIMATED INCREASE OF ONE GALLON PER CAPITA PER DAY
(600,000) MET. & EDDY
(599,150) WATER SUPPLY BOARD
(579,800) MAGUIRE & ASSOCIATES
BASED ON POPULATION ESTIMATES FOR THE FOLLOWING CITIES AND TOWNS ENTITLED TO RECEIVE WATER FROM SCITUATE RESERVOIR
PROVIDENCE
CRANSTON
WARWICK
NORTH PROVIDENCE
JOHNSTON
SMITHFIELD
WEST WARWICK
COVENTRY
* FOSTER
* GLOCESTER
* SCITUATE
* NOT PRESENTLY SUPPLIED FROM SCITUATE RESERVOIR

FIGURE - 3

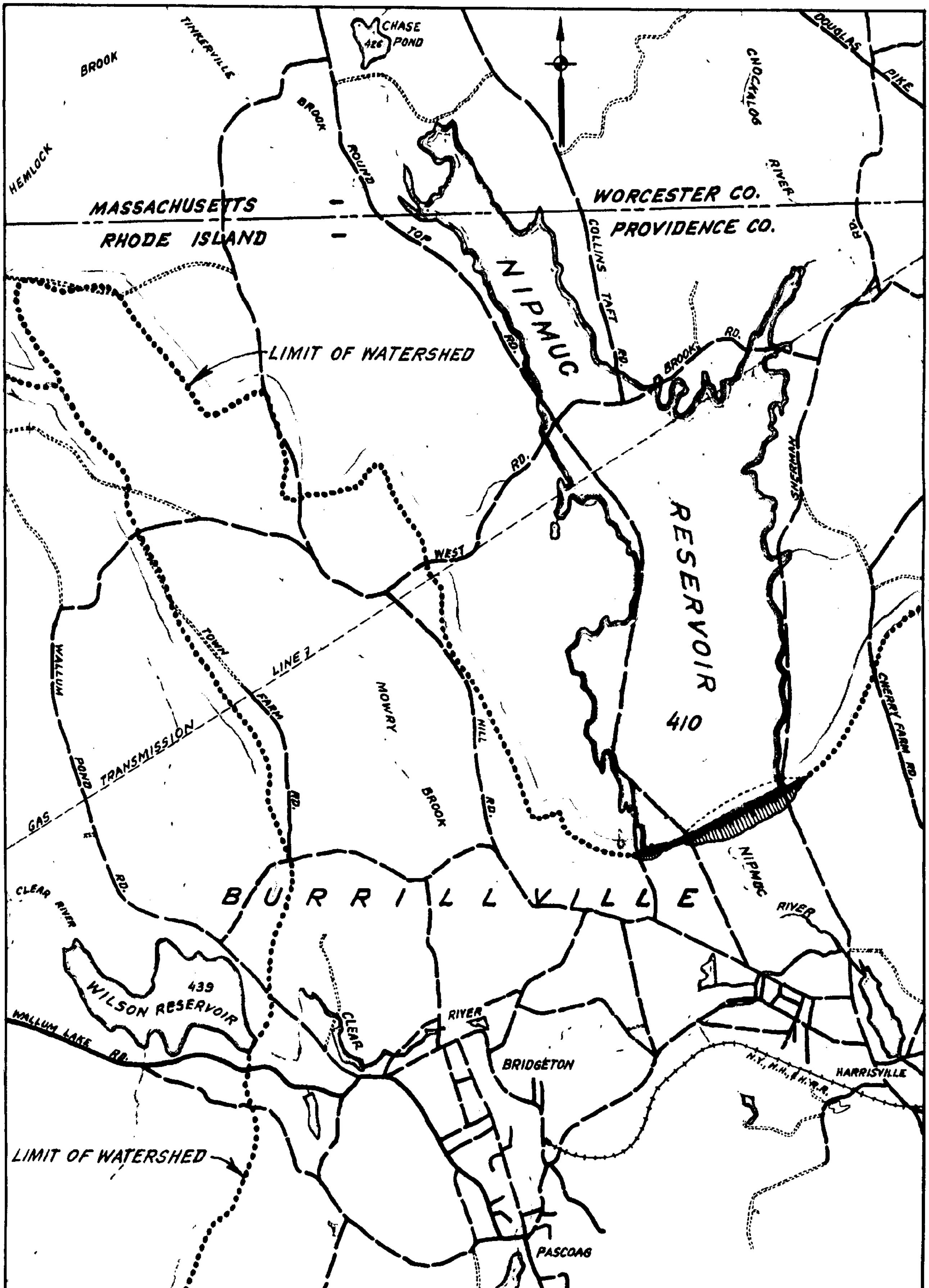


PRESENT SCITUATE RESERVOIR AND POTENTIAL SURFACE WATER DEVELOPEMENTS
FIGURE - 4



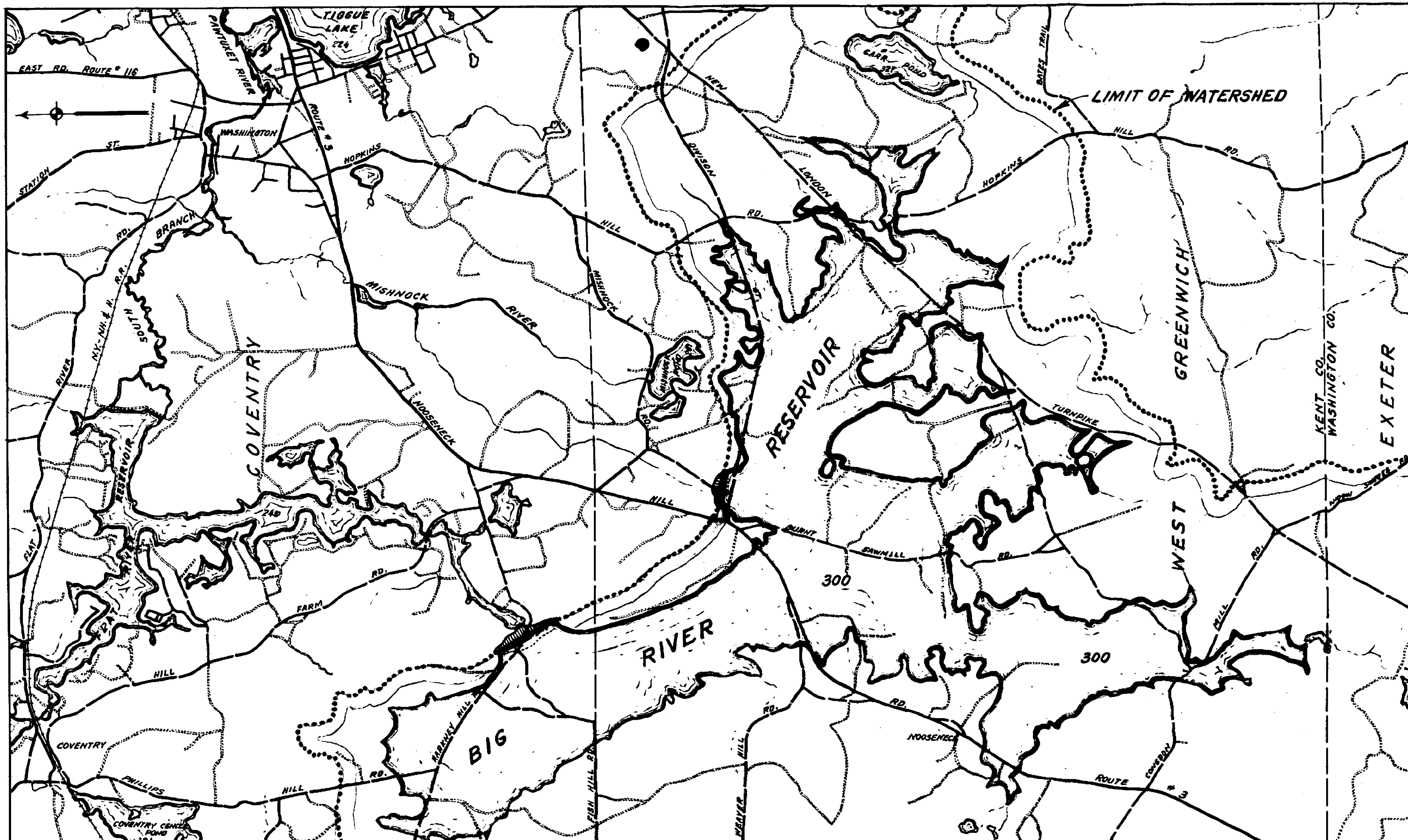
CHEPATCHET AND SMITH-SAYLES-KEECH RESERVOIRS

FIGURE - 5

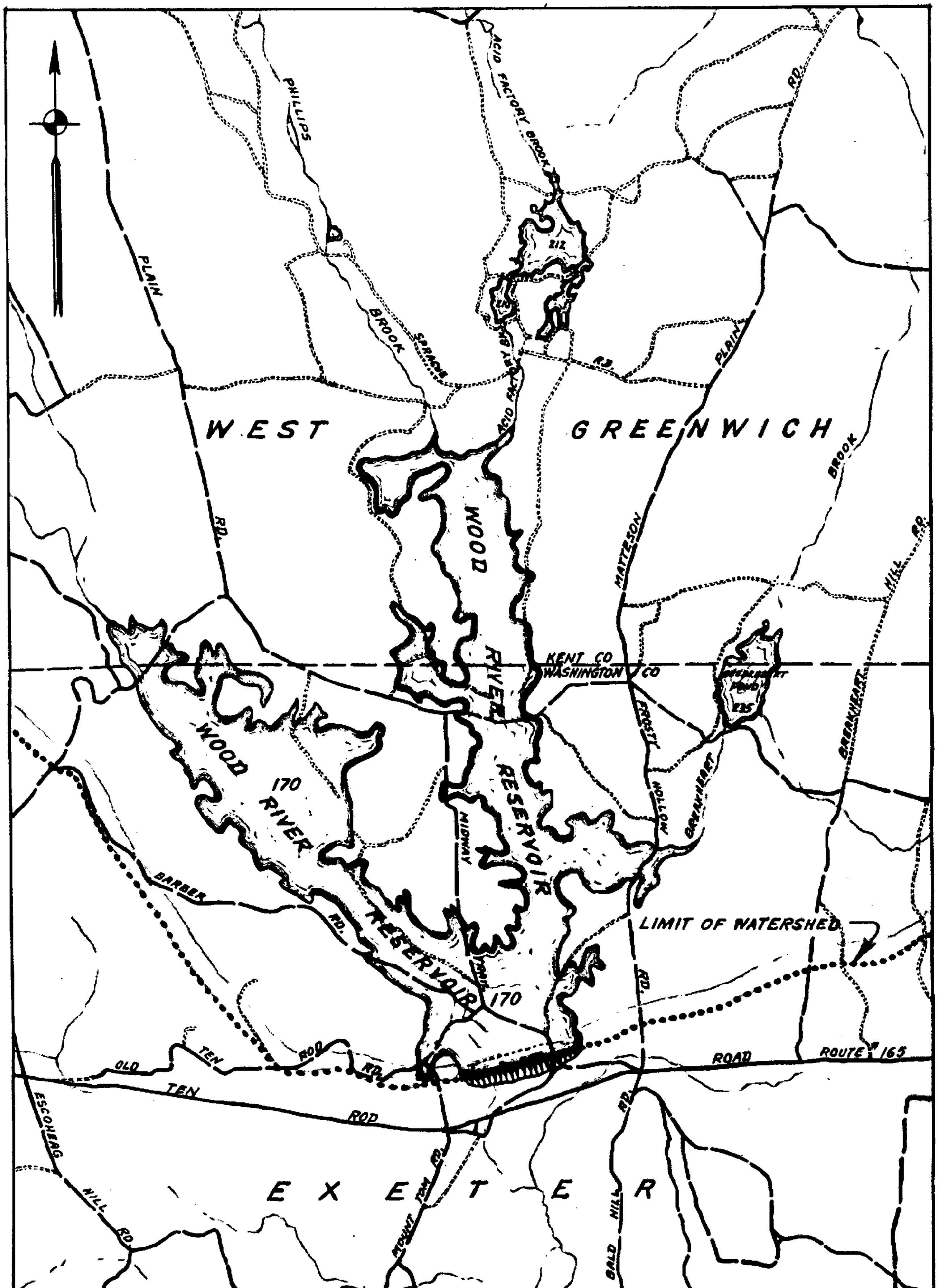


NIPMUC AND WILSON RESERVOIRS

FIGURE - 6



BIG RIVER RESERVOIR
FIGURE - 7



WOOD RIVER RESERVOIR

FIGURE - 8