

## **MAJOR ADDITIONS AND REINFORCEMENTS REQUIRED TO MEET FUTURE DEMANDS OF PROVIDENCE WATER WORKS**

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(Presented at a meeting of the Hydraulics Section, B.S.C.E., on May 5, 1965.)

The Water Works of the City of Providence, although municipally owned and controlled, operates in the capacity of a metropolitan district. In addition to Providence, it serves the City of Cranston along with the Towns of North Providence and Johnston from a distribution system owned and maintained by Providence. The City of Warwick, the East Smithfield Water District, the Town of Smithfield and the Kent County Water Authority purchase water from the City but control and operate their own distribution system. In 1962, enabling legislation was passed that permits the City of East Providence to receive Providence water and this community should be connected to our system by 1967. When this tie-in takes place, the water district will be serving, in whole or in part, four cities and five towns representing over 45 percent of the population of the State. Under the 1915 Water Act, the Towns of Scituate, Foster and Glocester are entitled to receive water from our system, but at the present time there is no public water supply in any of these communities. The area of all cities and towns that may obtain water from Providence totals 390.80 square miles or around 36 percent of the land area of Rhode Island.

Providence obtains its water from a surface supply located on the north branch of the Pawtuxet River. Water is impounded in the main Scituate Reservoir and five smaller reservoirs from a drainage basin that contains 92.8 square miles. This is about 9 percent of the land area of the State of Rhode Island and about five times the area of the City of Providence. The City owns in fee 23.93 square miles or about 25 percent of the entire catchment area. The total capacity of all reservoirs at their respective spillway elevations is 41,268 million gallons. The main Scituate Reservoir has a capacity of 37,011 million

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gallons and is capable of impounding 400 million gallons for every square mile of drainage area.

The annual rainfall on the watershed based on the 49-year average is 48.25 inches with a maximum of 66.28 inches for the 1958 fiscal year and a minimum of 33.43 inches in 1957. The yearly runoff, or water actually collected in the reservoir, based on the same period, is 24.86 inches with a maximum of 35.92 inches in 1956 and a minimum of only 12.02 inches for the year 1930. Every inch of runoff is equivalent to 1,612.75 million gallons. The average daily yield over the last 49 years is 109.77 million gallons. However, we cannot plan that this quantity of water will always be available. We 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 but under State statute, we are compelled to release 12 million gallons daily to mills below Gainer Dam leaving 72 million gallons daily for water supply purposes.

According to the department's long range studies, our average daily consumption plus plant usage, compensatory water to the mills and the requirements of East Providence will reach the limits of the "Estimated Safe Yield" by the year 1983. This means that Providence must have available a supplementary source of water ready for operation as of that date. Unfortunately, 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.

The most desirable project consists of Big and Wood Rivers. The first is located on the south branch of the Pawtuxet and the other, which would be a diversionary reservoir, is on the Pawcatuck River basin. The watershed for this combination would have a drainage area of 65.66 square miles, a storage capacity of 33,265 million gallons, equivalent to 507 million gallons of storage per square mile, and an "Estimated Safe Yield" of 61.3 million gallons daily. This could be expanded at some future date to include the Flat River also located on the south branch of the Pawtuxet. The addition of Flat River would increase the drainage area to 94.46 square miles, storage capacity would be 35,140 million gallons, equal to 372 million gallons per square mile, and the "Estimated Safe Yield" would be 83 million gal-

lons daily. Flat River, like Wood River, would be a diversionary reservoir.

In 1962, a referendum was submitted to the voters of Rhode Island covering the acquisition of land for the eventual development of Big and Wood River Reservoirs. It was rejected by the voters. In 1964, a similar referendum, with some modifications in the Act, was presented for the second time and was approved by a small majority. It carried an appropriation of \$5,000,000 for land acquisition only. If the State of Rhode Island intends to assume a leading role in the coordination and development of our surface water resources, they should proceed within the next few years with the actual development of both reservoir sites. Past experience proves that it usually requires twelve to fifteen years to complete major projects of this nature. Such a program would enable the City of Providence and other communities to purchase water from the State on a wholesale basis. If the State fails to recognize its responsibility, the City of Providence will have no choice but to proceed on its own and obtain legislative authority to develop Big and Wood River Reservoirs.

Since the start of the Scituate supply in 1926, water has been conveyed by gravity from the intakes at the dam through twin 60-inch aqueducts as far as the junction chamber where they converge into a single 94-inch aqueduct to the Water Purification Works. Up to the present time, no pumping whatsoever has been required between the Reservoir and the Plant. In discussing the capacity of this aqueduct, we cannot consider the average daily requirements. It must be capable of delivering sufficient quantities to meet the maximum day's demand. Our records show that the maximum day is about 194 percent of the average, so for general design purposes we use 200 percent. In other words, where we show the reservoir capable of producing an average of 72 million gallons daily for water supply purposes, we must be able to deliver through the aqueduct twice this volume to meet the maximum daily demand, or 144 million gallons.

It is anticipated that the City of East Providence will connect into our system around the latter part of 1967 and at that time our estimated maximum daily demand will reach 105 million gallons. In order to convey this volume of water to the Plant, Scituate Reservoir cannot drop below elevation 272.2 or about 12 feet lower than the spillway elevation of 284.0. If drought conditions should occur in 1967 similar to what took place from April, 1910 to October, 1911,

the actual level in Scituate Reservoir would drop to elevation 266.6, or 5.6 feet below the level required for gravity flow without pumping, based on an average daily water supply requirement of 52.5 million gallons plus 12 million gallons to the mills.

Within the next few years, the department will be compelled to construct a pumping station at the base of Gainer Dam capable of delivering about 150 million gallons daily from the reservoir to the Plant. An additional source of power, in addition to that supplied by the local power company, will be required as the output from our Hydro Station would be negligible under these low water conditions. It is our intention to finance this capital improvement from our Water Depreciation and Extension Fund thereby eliminating the necessity of a bond issue.

The Water Purification Works is all electric and is operated from a Power Control Center and a Central Control Board located on the first floor of the Central Operations and Control Building. Two sources of power are available, one from the Hydro Electric Station and the other from the local power company. As the Hydro Station will be inoperative during periods of low runoff, we will plan to obtain power from the supplementary system at the proposed new pumping station.

The Water Purification Works must have sufficient filter capacity to treat the draft of the maximum day from Scituate Reservoir which will be 144 million gallons. At present, we have 14 rapid sand filters, each capable of filtering 7.5 million gallons daily or a total of 105 million gallons daily. We have space to add four additional units of 7.5 million gallons each which will bring the plant output to 135 million gallons per day. In order to reach the required capacity of 144 million gallons daily with 18 filters, we will be required to increase the rate of filtration from 3 gallons per square foot per minute to 3.2 gallons. This will not affect the quality of the effluent whatsoever but will reduce the length of filter runs.

When East Providence comes into the system, the maximum day will equal our existing plant capacity in the year 1967. Plans are now being prepared by the department's Engineering Division to increase the number of filters to eighteen. The cost of this new construction together with other plant improvements is estimated to be \$2,500,000. This project is covered by a bond issue approved by the voters of Providence at the last general election. It is now pending ratification of the Rhode Island General Assembly.

Just as the aqueduct must have the capacity to deliver the maximum draft of 144 million gallons daily from the reservoir to the plant and the plant have sufficient filter capacity to treat that volume of water, we must have a transmission system that is capable of delivering this quantity of water, the maximum daily demand, from the filter plant into the system. At present, the tunnel and aqueduct that transports the water from the plant to the siphon chamber in the City of Cranston is able to deliver only 100 million gallons daily. On June 27, 1963, we established a new record for the maximum day of 87.215 million gallons and if East Providence was being supplied, it would total 95 million gallons. Our maximum demand will reach the limits of this single tunnel and aqueduct within the next few years. The present tunnel and aqueduct was designed by the department's engineers in 1916 and at that time, our average daily consumption was only 17.75 million gallons and the maximum day 22.92 million gallons. They displayed excellent judgment in designing this facility for a capacity of 100 million gallons.

Our studies show that by the year 2001 the maximum daily demand will reach 173 million gallons. Scituate Reservoir can supply 144 million gallons daily and the remainder will have to come from the Big and Wood Rivers development. It is anticipated that the first section will be a surface aqueduct 6'-6" in diameter running from the plant in Scituate to the Riverpoint section of West Warwick, a distance of 22,750 feet. This will be capable of conveying an additional 44 million gallons daily from the present plant. At this point, it will eventually converge with the reinforcement from Big and Wood Rivers, will be 8'-6" in diameter, and will run for an approximate distance of 27,300 ft. to the Budlong Road section of Cranston. Instead of limiting the capacity to 73 million gallons daily, it will be designed for 100 million gallons daily, thereby providing a total of 200 million gallons daily from both the existing and proposed construction. The cost of the new aqueduct is estimated to be \$10,500,000 and the bond issue was approved by the voters at the last general election. Ratification is expected at this session of the General Assembly along with the approval of a land condemnation act.

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