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HISTORY AND ENGINEERING OF ROCHESTER'S WATER SUPPLY IN ITS FIRST CENTURY

BY

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HEMLOCK LAKE
View looking southwest from Bald Hill

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CONTENTS

Introduction

The purpose of this paper is to make an available record of the water service in the first century of a prosperous American city. This city was incorporated in 1834 with an area of about 6¼ square miles and a population of about 15,000. Its domestic supply for the first 42 years until 1876, when its area had increased to about 7½ square miles and its population to about 75,000, was from wells and springs. The water for fire protection up to the year 1874 was from the Genesee River, the Erie Canal and the water power canals. These supplies were supplemented for a part of the time by cisterns located in different parts of the city and supplied through cast iron pipes connected with the Erie Canal and the power canals.

In 1872 the City was authorized by the Legislature to construct a public water supply, and after careful investigation very wisely selected Hemlock Lake, one of a series of four parallel lakes at a distance of about 30 miles from the City, having an elevation of nearly 400 feet above the general elevation of the City, as the source of supply. The quality of water for domestic use was unexcelled by any supply in America. Canadice Lake situated easterly and about 200 feet above Hemlock Lake, the outlet of which originally ran into Hemlock Lake, was also taken over as part of the domestic supply.

The other two lakes mentioned, Conesus Lake to the west of Hemlock Lake and somewhat lower in elevation, and Honeoye Lake to the east and lower than Hemlock Lake, were also considered as additional sources of supply. The paper details the work of increasing the original supply.

The territory involved in this writing is mapped in detail in the following sheets of the Topographic Map of New York, published by the United States Geological Survey: Rochester, Caledonia, Honeoye, Canandaigua, Portage, Nunda, Wayland, Naples.

General Data

Rochester is situated in the County of Monroe, State of New York. The center of the city is about seven miles south of Lake Ontario. It lies in latitude 43° 8′ N. and longitude 77° 42′ W. The central portion of the city is about 263 feet above mean lake level of Ontario and 510 feet above mean tide water. The city is bisected by the Genesee River, which flows through it from south to north. The river has three falls and several rapids within the corporate limits, having an aggregate descent of about 257 feet, affording power to many manufactories. The drainage area of the river at Rochester is 2,365 square miles.

It is the third city in New York State, both in point of population and industrial importance. The total area is about 35 square miles; total length of streets about 520 miles, and the total length paved about 400 miles, or about 77 per cent.

Population by the U. S. Census 1930:

Rochester City	328,132
Metropolitan District	398,591

Water Systems in Use

There are three systems of water works supplying the City;

1st. A gravity system of potable water owned and operated by the City and commonly known as the "Domestic System."

2nd. A direct pumping system, taking water from the Genesee River, commonly known as the "Holly System," which is owned and operated by the City, for fire purposes only.

3rd. A pumping system of potable water taken from Lake Ontario, owned and operated by the Rochester and Lake Ontario Water Company and commonly known as the "Ontario System." This company supplies all of the 23rd and 24th wards, parts of the 20th, 15th and 10th wards on the west side of the City; also parts of the 18th, 21st and 22nd wards on the east side of the City.

Domestic System

The source of the gravity system is Hemlock Lake, situated in the hilly district 30 miles south and about 386 feet above the general level of the city. (Frontispiece, plate 22.)

The area of this lake at ordinary low water is 1,828 acres.
Average depth in the middle—65 feet.
Catchment area, including water surface—48.00 square miles.
The total catchment area tributary to Hemlock Lake, including Canadice Lake is 66.20 square miles.
Capacity of present systems—30,000,000 gallons per day.
(Hazen, Eddy and Fisher Report)
Use in 1930 ..... 30,100,000 gallons per day
Use in 1929 ..... 31,527,000 gallons per day

There are three reservoirs connected with the system: A storage reservoir at Rush, about nine miles south of the center of the city and 224 feet above the general elevation thereof, having a capacity of 63½ million gallons; and two distributing reservoirs, situated on the southern border of the city, and both about 110 feet above the general elevation of the city.

The old distributing reservoir, known as Mt. Hope or Highland Reservoir, has a capacity of 22½ million gallons; the new Cobb's Hill Reservoir, put into service August 20, 1909, has a capacity of 144 million gallons.

This potable water supply is brought to the city by three gravity conduits:

Conduit I, from Hemlock Lake to Rush Reservoir, constructed during the years 1873–1875, is composed of 9.62 miles of 36-inch riveted wrought iron pipe $\frac{3}{16}$ inch thick, and 2.92 miles of 24-inch riveted wrought iron pipe $\frac{3}{16}$ inch and $\frac{1}{4}$ inch thick, and the balance, 6.83 miles, is 24-inch cast iron pipe. The second section, from Rush Reservoir to Highland Reservoir consists of 8.86 miles of 24-inch cast iron pipe. The total length is 28.23 miles and the daily capacity about 6,500,000 gallons.

Conduit II, from Overflow No. 1, about 2¼ miles north of Hemlock Lake, to Highland Reservoir, with connections at Rush Reservoir, is a 38-inch riveted steel pipe 26.19 miles in length and was built during the years 1893–1894. This pipe is made of steel plates $\frac{1}{4}$ inch, $\frac{5}{16}$ inch and $\frac{3}{8}$ inch thick. Water is brought from Hemlock Lake to Overflow No. 1 through a 6-foot brick horseshoe shaped

tunnel 2.25 miles in length. The daily capacity of Conduit II is about 16,500,000 gallons.

Conduit III, from Overflow No. 1 to Pinnacle T, with connections at Rush Reservoir, was built during the years 1914–1918 and is composed of 7.75 miles of 37-inch cast iron pipe and 17.74 miles of 37-inch Lock Bar steel pipe $\frac{1}{4}$ inch and $\frac{5}{16}$ inch thick. From Pinnacle T to Cobb's Hill Reservoir the pipe line consists of 1.57 miles of 36-inch cast iron pipe laid in 1905–1906. The total length of Conduit III is 27.06 miles and the daily capacity is about 19,000,000 gallons. The total daily delivering capacity of the three conduits is 42,000,000 gallons.

Two lines of 36-inch pipe lead from each of the distributing reservoirs, extending in a generally northerly direction, with successive reductions to 30, 24, 20 and 16-inch pipe. Secondary feeders of 12 and 16 inches in diameter complete loops about generally large areas. Minor distributors are of 10, 8, 6 and 4-inch pipes. The so-called Charlotte System consists of the mains in the former village of Charlotte which were acquired by annexation. Water is purchased by the City from the Rochester and Lake Ontario Water Co. and distributed to the consumers.

The total miles of distributing mains to January 1, 1931, are as follows:

Domestic System	492.75	miles
Holly System	25.40	miles
Charlotte System	9.75	miles
Ontario System	32.90	miles
Total	580.8	miles

Meterological Observations, Runoff Record and Conduit Gaugings by the Water Department

Rainfall records have been kept for 52 years at Mt. Hope Reservoir, Rush Reservoir and Hemlock Lake, the average for 48 years, Mt. Hope Reservoir 29.15 inches; Rush Reservoir 26.47 inches; Hemlock Lake 28.45 inches (Compared with U. S. Station at Rochester, N. Y., of 32.41 inches).

Temperature records for the same period and for the same average, 48 years, Mt. Hope Reservoir, air 48.14°F. and water 49.76°F.; Rush Reservoir, 41 years, average of 37 years, air 45.57°F.; Hem-

lock Lake 52 years, average 48 years, air 48.32°F., water 50.86°F.

Evaporation records at Mt. Hope Reservoir commenced in 1896 and have been continued to date. The average evaporation for the floating tub for 31 years was 31.83 inches. The average precipitation for the same time was 32.58 inches.

Runoff records of Hemlock and Canadice lakes, based on gaugings maintained for 30 years, is an average of 37,000,000 gallons per day. Hazen, Eddy and Fisher Report.

Gaugings of Water Works Conduits

The different sections of each of the three Rochester Water Works Conduits were gauged soon after completion and in general these measurements of flow have been made annually since 1894. Tables are published showing the date of gauging, the duration, the character of the conduit, its length, the loss of head, the velocity, the discharge in cubic feet per second, and also gallons per day and the coefficient in the formula $c = V \div \sqrt{Rs}$.

History of the Water Supply

First Period—1834-1872

The history of water supply in this City since its incorporation in 1834 may be divided into five periods. The first period may be characterized as the period when efforts of the City authorities were centered upon getting a water supply from private corporations. This period may also be subdivided into two divisions, the first from 1834 to 1852. A private water company was incorporated under the name of the Rochester Water Works Company in 1835. Nothing was accomplished by this company and its charter expired in 1852.

Mention may be made of the efforts of Elisha Johnson, a former Mayor, who submitted a report by resolution of the Council in 1838, in which he urged the great importance of the construction of water works and recommended the taking of water from the Genesee River a short distance south of the City, etc. Nothing was done with this report.

The second division of the first period, a period of 20 years from 1852 to 1872, was chiefly occupied by the City authorities in an endeavor to obtain a water supply through a private company or-

ganized in 1852.[1] During this period several contracts were executed, upon the recommendation of special committees of the Council, between the Council and the private water company. All of them failed by reason of the private company not carrying out its part of the contract.

In the valedictory message of Mayor Scrantom in March 29, 1861, he said: "The contract for a supply of pure water, executed under the sanction of this Board, and to which validity has been given by the Legislature of the State, affords me the highest gratification, and the completion of the works contemplated by that contract, will give me a satisfaction equal to any that I have experienced in connection with matters of public import." This contract was never carried out.

The several committees making the investigations and reports lacked any definite engineering information relative to a suitable plan for a water supply. The only action by the Council with reference to an engineering report was first in March 22, 1853, where the City Surveyor was directed to make necessary surveys and investigations for a feasible plan for obtaining water and constructing works at an expense not exceeding $300. This resolution was modified so that the report should be made by a special committee; and nothing was done under it. The only other engineering report was by Daniel Marsh, who was at one time Engineer for the private company. This report was made under a resolution adopted by the Council requesting the Water Works Company to report the expense of a survey from Hemlock Lake to the City.

The Committee on March 20, 1860, submitted a report that they had received three propositions; first Mr. Silas Cornell proposed to survey one route with maps for $250; Mr. Penny one route with

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[1] The Common Council in 1859 adopted, after considerable discussion, an ordinance for laying cast iron water pipes six inches in diameter connecting Childs basin of the Erie Canal with reservoirs in some of the city streets for increasing fire protection. These reservoirs were generally 10 feet wide by 20 feet long and the bottom 16 feet below the surface of the streets.

The ordinance also provided for repairing three old reservoirs which will be supplied by said pipe.

The estimated cost of constructing three new reservoirs 8 x 16 feet in the clear and 14 feet below the level of the street, laying an iron water pipe from Childs basin to Mumford Street and repairing those in Ann Street, was $2,384.

In February 15, 1859, George B. Harris, Chief Engineer of the Fire Department, reported that the covering of the reservoir in front of the City Hall was unsafe, liable at any time to fall in, and also reported that the reservoir leaked at the rate of one inch in depth per hour.

maps, etc., for $150; and Mr. Marsh proposed to furnish a complete system of surveys, etc., for a sum not exceeding $500. The Committee recommended that the work be given to Mr. Marsh, which report was approved by the Council at the same meeting.

The report of Mr. Marsh provided plans and estimates for five distinct plans, one, Lake Ontario; two, the Genesee River at the Rapids; three, Little Black Creek; four, Outlet of Honeoye Lake near Smithtown; and five, by taking water directly from Hemlock Lake in a 16″ pipe to a distributing reservoir. Three kinds of pipe were presented for consideration, namely, one, iron pipe; two, cement pipe with a frame of sheet iron; and three, banded wood pipe laid in cement, and the comparative cost of each was presented. No action leading to a public water supply was taken on this report.

On December 26, 1865, Mr. D. D. T. Moore, Mayor, called attention of the Council to the fact that the contract of the City with the Rochester Water Works Company for a supply of water, etc., expires with the current year and suggested the propriety of renewing the contract for a limited period; and if the Company failed to commence their works the coming season that it might be advisable for the City to undertake the important enterprise. The Committee reported on January 9, 1866, against granting a renewal, and said in conclusion of their report, "your Committee is of the opinion that if this contract was not given to this Company five years ago, Rochester would be supplied to-day with water works."

On June 2, 1869, a resolution was introduced "That the Board of Common Council of the City of Rochester will heartily cooperate with the Rochester Water Works Company in the construction and completion of said works." Prior to this, however, on January 8, 1867, Ald. Kelley introduced a resolution which was adopted, in which he stated, for the purpose of setting at rest all anxiety and uneasiness on the part of the taxpayers of the City with reference thereto, "Be it resolved that it is the firm and unaltered purpose of this Board that under no circumstances and upon no consideration whatever will the Board of Common Council at any time entertain favorably a proposition to issue the bonds of the City for any amount for the purpose of taking stock in the said Water Works Company." After considerable discussion the resolution was adopted, 21 to 4.

In this connection it might be interesting to include a remonstrance by a large number of citizens against taking stock or loan-

ing moneys to the Rochester Water Works Company. A large public meeting was held at the City Hall on Monday evening, October 8, 1855, in which it was resolved among other things, "that we regard with anxiety and alarm the proposal of a scheme which will so largely increase the enormous burden of taxation, by which the enterprise and prosperity of our city are already depressed." The present funded debt of the City is $446,000. The proposed measure will add now $350,000, making the whole debt $796,000. The population at this time was about 42,000.

The Charter of the Water Works Company provided that the Company might issue bonds to the amount of $800,000 and the same amount in stock. The City was also authorized to take $150,000 of stock in the Company and also to loan the Company the proceeds of an issue of $200,000 in bonds.

Construction Work of the "Water Works Company"—Mr. Tubbs in an article in Peck's History of Rochester gives a report made to the Water Company's stockholders December 2, 1871, by McRee Swift, a Civil Engineer, from which the following extracts are taken:

"The works, so far as completed, consist of:

First—a canal eighteen hundred feet long by twenty feet wide, by seven deep at the lake with the weir partially constructed, as above referred to.

Second—a wooden conduit twenty-four inches in diameter by sixteen and one fourth miles.

Third—a reservoir about two thirds completed near East Henrietta. This reservoir measures, at the middle of the embankment, seven hundred by eight hundred feet and is twenty-one feet deep, and, when completed and filled to within three feet of top, will contain 70,000,000 gallons, a supply for twenty days at a full estimate for consumption.

Fourth—a small distributing reservoir on the outskirts of the city, too small for purposes of a reservoir. . . .

Fifth—seven and one-half miles of cast iron distributing pipe in the city, and six miles of wrought iron (lined with and laid in hydraulic cement) distributing pipe, all with partial appendages of gates, hydrants, etc.

Sixth—a farm of one hundred and ten acres near the lake, with mill and houses upon it, and which cost $21,000, upon which $10,500 is paid.

Seventh—a plat of fifty acres near East Henrietta, upon which the large distributing reservoir is located, and lastly the right of way across private property, at the upper end of conduit for a distance of about four and one-half miles."

"From the examination I was enabled to make, I am forced to conclude that the wooden pipe cannot be relied upon." [2]

Mr. Swift's estimate of the total value of work done was $222,738. His estimate for completing the work ready for use was $410,067.

The bondholders evidently came to the conclusion that they had been badly swindled, and proceedings were commenced to foreclose the mortgage on the water-works property, given to secure payment of the bonds. It appears that a sale had been fully consummated early in 1872, as on the 28th day of May, 1872, Thomas B. Rand and Associates presented a memorial to the Common Council, representing that they had become the owners of the lands, property, estate, reservoirs, pipes, rights of land and water, water works, fixtures and appurtenances and the rights and franchises of the Rochester Water Works. They stated that they have become satisfied that the wooden conduit pipe laid from Smithtown to the city is not sufficient and needs to be relaid of iron. They offered to complete the works during the year 1872 and 1873 to the amount of 40 miles of distribution and to connect hydrants thereto each four hundred feet, etc.

A contract was finally drawn and presented to the Common Council, which provided that the compensation to be paid by the City for such use of water should be $70,000 per annum for four hundred hydrants and $100 per annum for each fire hydrant exceeding that number.

Mr. Thomas B. Rand and Associates, soon after their purchase of the assets of the old company, organized a new company under the title of the Rochester Water Company. It made strenuous attempts to dispose of its property to the Water Commissioners at prices ranging from $250,000 to $90,000, and finally on the 18th day of August 1882, the City made a purchase of all the property of the Rochester Water Company for the sum of $26,000, a falling off in value, even from the $223,000 estimated by McRee Swift in 1871.

The ruins of the projected reservoir are indicated on the Rochester topographic sheet, one and one-half miles east of north of the existing Rush Reservoir. And another relic is a 24-inch cast iron gate, for the wooden conduit, figure 1.

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[2] Some of the farmers along the line said that the wooden pipe wouldn't hold white beans, let alone water.

SECOND PERIOD—1872–1890

Public Water Supply. This period covers construction, maintenance and operation of the original public supply. The works were constructed by and maintained under the charge of J. Nelson Tubbs, who was appointed Chief Engineer on May 7, 1872.

In 1872, Chapter 387, entitled "An act to supply the City of Rochester with pure and wholesome water," was passed by the Legislature. Mayor A. Carter Wilder appointed five citizens as

Figure 1. **IRON GATE**
Intended for use in the wooden conduit. 24-inch

commissioners, Roswell Hart, Edward M. Smith, William H. Bowman, Charles C. Morse and Gilman H. Perkins. Soon after the organization of the Board at a meeting held May 7, 1872, Isaac F. Quimby was appointed Consulting Engineer for the Commission.

The plan proposed by the Commissioners may be summarized as follows: To furnish from Hemlock Lake a supply of 4,500,000 gallons of water per day through an iron conduit, or one of iron for the greater part of the distance and the balance of brick, with a storage reservoir in Rush and a distributing reservoir on the Mt.

Hope range of hills near the City; also to furnish a supply of water from the Genesee River by direct pressure on the Holly direct pressure plan, for the furnishing of light, power and for suppression of fires on the compactly built portions of the City, the water to be distributed through 40 miles of cast iron pipes in the streets of the City. The estimated cost of the combined system was $2,184,000.

The Mayor promptly approved of the plan proposed by the Water Commissioners and directed the Chief Engineer to prepare plans, etc., for a public letting of the whole work. Mr. Tubbs said:

"Soon thereafter Emil Kuichling, who had just completed an engineering course of study in the Polytechnic School at Carlsruhe, in Germany, was appointed Principal Assistant Engineer, a position which he has retained to this date, giving evidence during the whole period of service of most excellent training and a remarkable aptitude for his profession and great ability in the practical working out of the ever-varying problems of water-works construction and management."

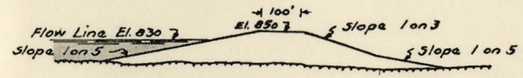
A contract for the construction of the Hemlock Lake System was awarded on the 12th day of April 1873, to James McDonald of Willsborough Falls. A contract for the construction and setting in place of the pumping machinery in connection with the Holly system had been previously executed February 27, 1873, with the Holly Manufacturing Company of Lockport, N. Y.

The work of laying the mains in the streets was commenced early in the summer of 1873, and continued up to about January 1, 1874. In cases where both Holly and Hemlock mains were laid in the same street they were laid in the same trench. The Holly System was so far completed that on and after January 1, 1874, it was brought into use for the extinguishment of fires.

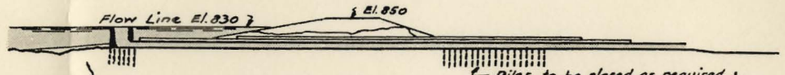
Official Test of the Holly System. The official test of the Holly System is described by Mr. Tubbs in a supplementary report dated February 20, 1874. A test occurred on February 18 the same year.

"The hydrants used for throwing fire streams were located on East and West Main streets, between the Erie Canal and North Street. The first test consisted in throwing 14 fire streams at once, alternately by the pumps operated by water power and by steam, the change from one to the other set of machinery not being observable by those watching the streams. The height of these streams, determined by instrumental observation, varied from 131 to 152

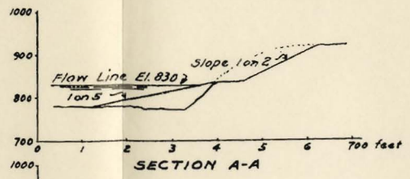
Total drainage area of Honeoye Creek,
from State Engineer's Report, 1925 --- 273.3 sq. mi.
Catchment area above proposed dam --- 187.0 sq. mi.
Combined catchment area for
Canadice Lake and Hemlock Lake --- 65.0 sq. mi.



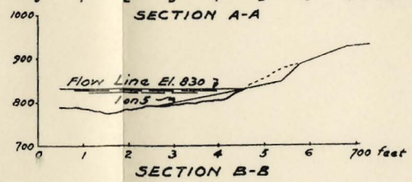
TYPICAL SECTION OF DAM
SCALE 100 0 100 200 300 FEET



SECTION THROUGH SPILLWAY AND INTAKE
SCALE 100 0 100 200 300 FEET



SECTION A-A



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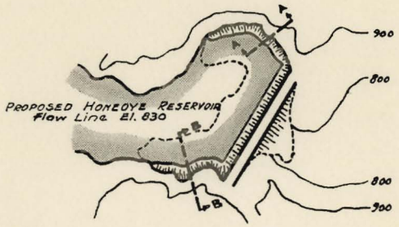


PROPOSED DAM
SCALE 0 500 1000 1500 FEET

NOTE - This plan is intended to show the general nature of the project and not exact locations or any other details.

SCALE 1 ½ 0 1 2 3 4 5 6 MILES

ROCHESTER WATER WORKS

MAP SHOWING PRESENT WATER SUPPLY AND POSSIBLE FUTURE SUPPLY FROM HONEOYE LAKE & CREEK AS RECOMMENDED BY HARRISON P. EDDY & ALLEN HAZEN.

Scales as indicated. Jan. 26, 1932.

P.A.C.

feet. During this test the pressure at the pumps was maintained at 120 pounds per square inch. The second test of fire streams consisted in throwing thirty streams at once. . . . The height of the streams was about the same as in the previous test and the pressure maintained at the pumps was 135 pounds per square inch. Water was discharged at the rate of 8,220 gallons per minute. The third test consisted in throwing a two-inch stream in front of the court house. Although at no time fully vertical, yet, when it most nearly approached that condition, the observations showed an elevation of 210.34 feet. The pressure maintained at the pumps was 165 pounds per square inch and the discharge was at the rate of 1,215 gallons per minute. The fourth test was a three-inch vertical stream, thrown from a point near the corner of State and West Main streets, during which a pressure of 175 pounds per square inch was maintained at the pumps. The discharge was at the rate of 2,778 gallons per minute and the elevation reached by the stream was 285.98 feet."

"Another test consisted in throwing a four-inch vertical stream to an elevation of 294.4 feet. The rate of discharge was 4,938 gallons per minute and the pressure at the pumps was 175 and at the stand pipe 165 pounds per square inch. A second test of the four-inch stream consisted in throwing the same horizontally a distance of 465 feet, only the solid jets of water being measured. The final test consisted of throwing a five-inch vertical stream to an elevation of 256.8 feet, discharging at the rate of 6,463 gallons per minute. As this stream was intended to show volume and not height the pressure at the pumps was only raised to 140 pounds. . . . It is believed that this was the most remarkable exhibition of large streams ever made in any country, and as such it attracted widespread attention from hydraulic engineers, compelling the introduction of larger factors in the hydraulic formulas used to determine the results to be obtained from large streams, with liberal-sized pumping mains."

Mr. Tubbs gives the total cost of the works to April 1, 1884:

Proceeds of water bonds issued for constructing	$3,182,000
Paid for two additional water rights on Brown's race	7,500
Raised by taxation for pipe extension and other miscellaneous expenses	466,549
Total	$3,656,049

Water Famine. Mr. Tubbs in his report dated April 1, 1889, under the heading "Existing conditions which render an additional water supply necessary," said "During the extreme cold of January and February, 1885, the draft upon the water mains and the reserve water in the two reservoirs became so great, that I felt compelled to call the attention of the Executive Board to the imminence of a water famine unless stern repressive measures were at once adopted to check the waste. A vigorous house to house inspection was at once instituted. . . . During the extreme heat of each succeeding summer and the coldest part of each winter up to 1887, there were periods when the uses of water were greater than any possible supply through the conduit, . . ."

Under another heading "The remedy for existing conditions," he said: "Two plans have been suggested, one of which proposes a reduction in the amount of water used and wasted from the present system by the immediate and universal application of meters to all water services. The other is the construction of another conduit for conveying additional water from either Hemlock Lake or some other source of supply."

Mr. Tubbs then proceeds to discuss the different sources of an additional supply, and estimates and recommends a daily supply of 10,000,000 gallons of water from Hemlock Lake by means of a combined pumping and gravity plan.

The plans of Mr. Tubbs for a pumping and gravity system did not appear to be generally accepted and the matter was submitted on February 16, 1889, to the well known engineers, Messrs. A. Fteley of New York, and J. T. Fanning of Minneapolis, for investigation. Several new surveys were made under their direction and on May 14, 1889, they reported in favor of either Hemlock Lake or Conesus Lake as a proper source, and that the new conduit should have a capacity of 15,000,000 gallons per day. While their plans differed in detail from those of Mr. Tubbs, they agreed with the latter as to the source and required quantity.

No definite action upon these reports was taken by the municipal authorities, and the agitation of the subject was briskly continued by the promoters of other plans. Meanwhile it became evident that temporary relief would be needed, even if the construction of a new conduit to Hemlock Lake were authorized. The only remedy to prevent the depletion of the reservoirs was to restrict the consumption in the city to the delivery of the conduit, by suitably throttling

for a portion of the day a few of the stop-valves in the principal mains at the foot of the hill on which the distributing reservoir is situated. This plan was accordingly adopted in June 1890, and was retained with some modifications until August 1894.

In June 1890 a close gauging of the flow of the conduit into Rush Reservoir was made, which revealed the fact that its actual delivery was then only about 6,730,000 gallons per day. The facts are well stated in quotation from two reports by Mr. Kuichling in later years. In his report to the Executive Board, published in 1901, he says:

"Water from Hemlock Lake was first delivered into Rush Reservoir on January 22, 1876, and into Mt. Hope on the day following. Gaugings of the capacity of the conduit were undertaken soon afterward by L. L. Nichols, C.E., one of the Assistant Engineers employed for construction of the works. The result of several gaugings indicated that the conduit was delivering from Hemlock Lake into Rush Reservoir 9,000,000 gallons per day."

And from his report in 1894 and 1895, on the same subject:

"It should be remarked that up to June 1890 it had been taken for granted that no appreciable diminution in the discharging capacity of the old conduit had occurred, and that it was still continuing to deliver about 9,000,000 gallons per day. At that time, however, a close gauging of its flow into Rush Reservoir was made which revealed the fact that its actual delivery was then only about 6,730,000 gallons per day. The discrepancy between these two discharges could not be accounted for by leakage or abstraction of water from any portion of the conduit, and hence it was evident that its efficiency had become impaired."

On July 18, 1890, Mr. Tubbs resigned his position as Chief Engineer and from that date to September 6, 1890, Mr. George W. Rafter was Acting Chief Engineer. On September 6 Mr. Emil Kuichling was appointed Chief Engineer. At that time a very heated discussion was going on as to the reasons for the loss of delivery in the conduit, with propositions, plans and projects for increasing the supply. Various explanations were given by numerous correspondents in the local press for months after the fact was announced. The public discussion and agitation is indicated in an article in the Post Express of August 9, 1890. Referring to the position of Chief Engineer it said:

"If Emil Kuichling ever comes to Rochester to accept the position of Chief Engineer of the Water Works it will be on conditions named by him; and one of the conditions will be that every architect, the Chamber of Commerce, and every crank in town shall not be his superior officer, and that his opinion

on strictly engineering subjects shall go and not be modified to suit the ideas of every newspaper correspondent."

Third Period

September 6, 1890 to December 31, 1899

Additional Supply. The third period includes the construction of the second conduit from Hemlock Lake to the City. During this period work was under the charge of an Executive Board of three members. Mr. Emil Kuichling was the Chief Engineer during this period. Mr. Kuichling, as stated, was appointed Chief Engineer on September 6, 1890. Early in October 1890 he was requested to investigate the various general plans for a permanent additional water supply which had previously been submitted by other engineers heretofore mentioned, and to make such further examinations as he might deem necessary.

After a careful investigation of various sources of supply the preference was finally given to Hemlock Lake by all the municipal authorities on June 16, 1891. A bill was introduced in the Legislature early in 1891 allowing the City to take an additional water supply from Hemlock Lake or Conesus Lake, and to bond itself for the necessary cost in the sum of $1,750,000. This bill failed of passage. A new bill similar to the one above mentioned was introduced early in 1892 and became a law on April 20, 1892.

Mr. A. Fteley, Chief Engineer of the Croton Aqueduct Commission was retained as Consulting Engineer by the Executive Board.

Description of Plans. The plans for the new conduit contemplated the construction of a brick conduit of horseshoe shape construction about six feet in diameter on a grade of one in 4,000 from Hemlock Lake northerly for a distance of about 12,000 feet. Seventy-five hundred feet of this was in tunnel. A screenhouse was to be built at the shore from which a steel intake pipe five feet in diameter and 1,600 feet long was to be extended into the lake to where the water was about 35 feet deep. The invert of the brick conduit in the gate house was to be about 17 feet below the low water level of the lake. From an overflow chamber at the end of the brick conduit the water was to be conducted either in a 36″ cast iron or a 38″ steel pipe conduit laid on a continuous hydraulic grade of about 1 in 570 for the total distance of nearly 26½ miles to its terminus in the city reservoir.

Bids were requested from contractors for the masonry conduit and the pipe work separately, the letting to take place on December

23, 1892. Contract for the brick conduit and tunnel was let to William H. Jones & Sons of Rochester at an aggregate amount based on estimated quantities of $292,518.11. The contract for the pipe was awarded by the Executive Board on January 12 to the firm of Moffett, Hodgkins & Clark Company for $857,552.50, based on estimated quantities. The Company refused to accept the award and immediately secured an injunction preventing the Executive Board from declaring them in default and proceeding with the collection of the money on a bond of $90,000. The Company claimed that it had made an error in its bid due to too short a time to figure the contract.[3]

The Executive Board on January 20, 1893, awarded the contract to the next lowest bidder, Whitmore, Rauber & Vicinus of this city at the amount of the proposal computed from the prices and estimated quantities $1,123,920.

The work of manufacturing the steel pipes was divided equally between the East Jersey Pipe Works of Paterson, N. J., and the Rochester Bridge & Iron Works of this City. For the first named works the plates were made by the Carnegie Steel Company and for the second by the Paxton Rolling Mill at Harrisburg, Pa. Four classes of pipe formed of three different thickness of plate were manufactured and arranged according to the water pressure to which they would be subjected in the line of the conduit. The thicknesses of the plate used were $\frac{1}{4}$", $\frac{5}{16}$" and $\frac{3}{8}$". Pipes were generally furnished in lengths of $27\frac{1}{3}$ feet.

Coating of Steel Pipe. Mr. Kuichling gave much study to the matter of preparing and applying a coating mixture to the smooth surface of the steel plates which would be durable, hard, tough and adhesive at all ordinary temperatures. Every effort was made to obtain materials of the best quality and also to apply the coating in the most approved manner.

The first half of the work done by the East Jersey Pipe Company

[3] The case entitled Moffett, Hodgkins & Clarke Company, Petitioners, vs. City of Rochester, George W. Aldridge, William W. W. Barnard and John U. Schroth, composing the Executive Board of the City of Rochester.

The case went first to the United States Circuit Court in which the decision was against the City. An appeal was taken to the Circuit Court of Appeals, which reversed the decision of the Circuit Court and decided in favor of the City. The Contractors appealed from the Circuit Court of Appeals to the United States Supreme Court, which Court on May 20, 1900, reversed the decree of the Circuit Court of Appeals and affirmed that of the Circuit Court, which was in favor of the Contractor. The opinion was delivered by Justice McKenna.

was coated with California asphalt. That not proving satisfactory the second half was coated with a mixture of refined Trinidad asphalt and the best grade of coal tar, producing the same coating as had been applied to the old conduit laid in 1873. The remaining half of the pipe, constructed and laid by the Rochester Bridge & Iron Works, was coated under the direction of Prof. A. H. Sabin, by a process devised by him which was expected would be superior to any existing coating.

The new gate house and intake pipe at the lake was constructed by Chambers & Casey of this City. The total cost of the work up to January 1, 1896, was $1,776,911.86.

Temporary Additional Water Supply from Brighton Wells. A contract between the City and a private corporation known as the Rochester Water Supply Company was executed, and on July 12, 1893 the said Company commenced delivering about 500,000 gallons per day into Mt. Hope Reservoir from six artesian wells in the Town of Brighton. This supply continued until October 4, 1894.

Completion of the Second Conduit. On August 24, 1894, the water by the second conduit was first let into Rush Reservoir, and on October 9, 1894, into Mt. Hope Reservoir.

Reinforcement of Distributing Mains. Mr. Kuichling early in 1894 made plans for a new system of large distributing mains that had reference to the anticipated future growth of the city. The new mains were mostly 36″ and 30″ in diameter. The estimated cost of the work proposed for immediate construction was about $500,000. The diameters of the new mains were computed on the basis that with 150,000 persons using water at the rate of 150 gallons per head per day during the hours of greatest consumption, together with the discharge of 25 fire streams, each of 225 gallons per minute, the loss of head in said mains will be such as to leave a pressure from 18 to 25 pounds per square inch at the highest point in the city except in the immediate vicinity of the reservoir. Plans for the enlargement of the domestic mains in the city in addition to distributing mains were also prepared.

Fourth Period

January 1900 to January 1926

Administration. During this period the City was under the provisions of what is known as the Uniform Charter of cities of the

second class. The former Executive Board was abolished. The general care and management of the Water Works came under the Commissioner of Public Works, the maintenance and operation under a Superintendent of Water Works and the engineering and construction under the City Engineer. Mr. Emil Kuichling, Chief Engineer and Superintendent of the Water Works prior to 1900, not desiring to continue longer in the service of the City retired and opened an office as Consulting Engineer in New York City.

Special Studies and Activities of the City Engineer. The work in the Water Works field during this period was:

First, a study of electrolysis in the water pipe system. Prior to this time the matter had been taken up to some extent by Mr. Kuichling. In 1900 the City Engineer made the most extensive study of the subject that had been made by any city. In his report was included a summary of what had been done in the way of investigations of proposed remedies in some 25 other cities. The policy then adopted was to carry on these investigations with the cooperation of the Street Railway, the Gas & Electric Company and the Telephone & Telegraph companies.

Mr. Joseph E. Putnam, Electrical Engineer for the City, was in charge of the electrical features of the investigation. Mr. Beekman C. Little, Superintendent of Water Works, also cooperated. Studies and investigations were continued for several years, and Albert B. Herrick, a Specialist on this subject, was employed to continue the studies and to suggest remedies. It should be stated that so far as known none of the water mains were affected, the only damage being to comparatively few of the services. The remedy applied in this City, as elsewhere, *was to see to it that sufficient unbroken capacity for the electric return current was provided.*

Second. Another extensive study was made of the corrosion of the steel pipe laid in 1893 and 1894. The steel plate of these pipes was from $\frac{1}{4}''$ to $\frac{3}{8}''$ in thickness. The corrosion consisted in small perforations from the outside at places where the coating had failed to protect the pipe. The pitting of the plate was first discovered in 1900. A very thorough examination of all portions of the conduit where these pittings had occurred was made under the supervision of the Principal Assistant Engineer, Mr. John F. Skinner. The late Prof. F. L. Kortright of the Department of Chemistry, of the West Virginia University, a Chemist of 15 years practical experience,

trained in this country and in the schools of Carlsruhe and Zurich, was employed in this investigation.

Up to January 1, 1914, a total of 727 of these perforations were discovered and between 6 and 7 miles of the total of 26 miles of steel pipe had been recoated with a coating recommended by Mr. Kortright. The result of these investigations, and the remedies applied, were described in the reports of the City Engineer from 1900 up to the year 1914, and also published in a special report in 1913. This investigation was one of the most extensive that had been carried on on this subject. The effect of the pipe coating recommended by Mr. Kortright in preventing corrosion is shown by the fact that in this recoated portion, which was in that part of the line most susceptible to corrosion, only 198 perforations had occurred in 18 years, from 1914 to 1932, or an average of less than one per month.

In 1918 the steel portion of a third conduit 17¾ miles in length was completed on which the coating recommended by Prof. Kortright was used.

Third. The construction of a distributing reservoir on Cobb's Hill, as recommended by Mr. Kuichling for many years, was completed in 1908. This reservoir, when full at the same elevation as Mt. Hope Reservoir, has a capacity of 144,000,000 gallons. The area of water surface when the reservoir is full to the crest of the overflow is 18.2 acres. The plans for this work containing some novel features were described in the City Engineer's reports. The design and construction were under the general charge of John F. Skinner, Principal Assistant Engineer. The late Frederick P. Stearns was employed as Consulting Engineer with reference to special conditions of the lining. The accompanying sketch, plate 24, shows interesting features of the work.

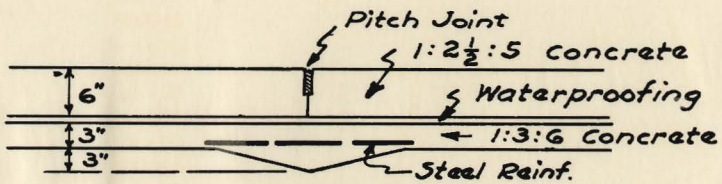
Fourth. The extension of the distributing water mains and enlargement of the street system. In 1905 the National Board of Fire Underwriters' Committee of Twenty submitted a report on the fire conditions in Rochester. The City Engineer, at the request of Mayor Cutler, prepared a concise discussion of the report to show to what extent these recommendations had already been anticipated by the City. This report dated April 1, 1905, was printed in pamphlet form for distribution and discussed the requirements of the National Board of Fire Underwriters and gave in detail the improvements made in the domestic and Holly systems up to that time, and also the plans for future construction. The report re-

DEPARTMENT OF PUBLIC WORKS
ROCHESTER, N. Y.

COBB'S HILL RESERVOIR

SECTION OF CONCRETE RETAINING WALL AND CONCRETE LINING OF BOTTOM.

SCALE: 1"=5' 1-16-32



SECTION AT JOINT
Scale: 1" = 2'

NOTE:

The wall was constructed in separate blocks of mass concrete 20 ft. long and foundation course 18 in. thick, laid in blocks 10 ft. long.

The reservoir was lined with concrete throughout. The bottom consisted of a 3-in. course of conc. laid continuously in long strips 14 ft. wide; to this the waterproofing was applied, consisting of six moppings of hot coal tar pitch and five layers of single-ply coal tar felt. Above this came the top layer of concrete 6-in. thick, laid in 12-ft. squares with pitch joints. The 3-in. bottom layer was thickened to 6 inches beneath the joints in the top layer, and steel reinforcement placed transversely to the line of the joint.

P.A.C.

ferred also to betterments of the Holly system which included doubling the actual capacity.

The Committee of Twenty carefully considered the report and in conclusion said with reference to the Water Supply, that "the statements of improvements already made, together with improvements in progress and contemplated, show that the Water Works and Fire Department were being maintained and developed in keeping with the increase in population and business of the City, and as far as practicable, substantially along the lines recommended by the Committee of the National Board."

Fifth. This study related to sanitation of the Hemlock Lake water.

Chapter 1018 of the Laws of 1895 provided for the "sanitary protection of the sources of water supply of the City of Rochester by the acquisition by said City of real property and interests therein necessary for that purpose and the abatement and removal of sources of pollution."

Commissioners were appointed by the Supreme Court to carry out the provisions of this act. The first Commission was composed of Ira L. Otis, Chairman, Sol Wile, Secretary, and Charles T. Chapin. H. N. Schlick later succeeded Mr. Otis. The Commission entered upon its duties in 1895 and on June 30, 1902, submitted its final report to J. Y. McClintock, Commissioner of Public Works.

The Commission purchased 187 parcels of land having a frontage on the lake of 73,572 feet, 94.4% of the total frontage on both sides of the lake. The purchase also included five hotels, 107 cottages, 121 barns and other buildings. The total cost of this purchase was $336,634.94.

The Commission also reported the amount of property unbought fronting on the lake, a total of 20 parcels having a frontage of 4,347 feet. Also included in these parcels were 14 cottages, 24 barns and other buildings.

Report of This Commission

Henry N. Schlick,
Charles T. Chapin,
Sol Wile,
Commissioners.

HEMLOCK LAKE COMMISSION
241 Powers Block
Rochester, N. Y., June 30, 1902.

To the Honorable J. Y. McClintock
Commissioner of Public Works of the
City of Rochester

Dear Sir:

The Hemlock Lake Commission herewith submits its report as follows:

There has been placed to the credit of this Commission with the City Treasurer, viz.:

From the sale of bonds	$200,000.00
Premium on sale of bonds	11,650.00
Appropriation from Common Council	165,000.00
From the sale of buildings	1,245.44
Making a total of	$377,895.44

Our disbursements in full have been orders drawn on the City Treasurer, viz.:

Boat account	519.20
Expense account	3,453.74
Furniture account	105.00
Highway account	3,978.10
Land account	336,634.94
Rent account	1,504.36
Salaries, Clerk	750.00
Salaries, Commissioners	18,895.00
Search account	8,454.13
Stationery account	147.75
Survey account	2,026.63
Total	$376,468.85
Balance	1,426.59

Statement "A" hereto annexed is a detailed itemized statement of the several accounts representing our disbursements in full, showing to whom and amount paid; the lands account showing in addition the number of feet frontage and buildings included in purchases.

The balance of $1,426.59
to our credit is covered by our order on City Treasurer accompanying this report.

CANADICE LAKE
View at foot of lake, looking south

Herewith attached is certificate from City Treasurer of this date, showing total amount placed to the credit of the Commission and balance on hand.

There are no unpaid bills of the Commission.

Statement "B," hereto annexed, is a list of the properties fronting on Lake unpurchased, with number of buildings.

All our vouchers, books, deeds, searches and other properties belonging to the city are subject to your order, and we request a full and complete examination of the same.

Respectfully submitted,

Henry N. Schlick,
Sol Wile,
Chas. T. Chapin.

Sixth. The dike at the north end of Hemlock Lake was raised five feet providing additional capacity in the lake and avoiding the necessity of drawing the lake down as was previously contemplated.

Seventh. Canadice Lake (plate 25) from the time of construction of the original works had been considered as a part of Rochester's water supply. The outlet discharged into the Hemlock Lake outlet below the lake. No use of the water of Canadice Lake could be made in the City's supply until a connection between the two lakes was constructed.

In 1912, owing to the increase in population and use of water, a contract was awarded for the construction of a concrete dam and basin in the outlet of Canadice Lake near the main highway to Hemlock Lake and a 5-foot reinforced concrete pipe from this basin for a distance of about 4000 feet into Hemlock Lake. Extensive purchases of land bordering on Canadice Lake and its outlet were made prior to taking the water into Hemlock Lake. The water from Canadice Lake was also chlorinated before discharging into Hemlock Lake.

The water from Canadice Lake was turned into Hemlock Lake February 6, 1919.

It was also observed that the City was rapidly approaching the capacity of Conduits I and II and that immediate steps should be taken for the construction of the third conduit as originally contemplated. It may be noted here that the capacity of Conduits I and II corresponded substantially with the safe yield of Hemlock Lake alone.

The additional water supply of 1892 to 1894 provided for a brick conduit six feet in diameter, mostly in tunnel, from the lake to a point about 12,000 feet northerly. This conduit was of sufficient

capacity to take the entire yield of the catchment area of both Hemlock and Canadice lakes. At the end of this brick conduit an overflow structure was erected. The second conduit of 38″ steel pipe began at this overflow and extended to Highland Reservoir in the City. At the time of the construction of this second conduit it was realized that an additional conduit would be required later and the right of way necessary for both conduits was secured for the entire distance.

Eighth. The third conduit was constructed in three general contracts.

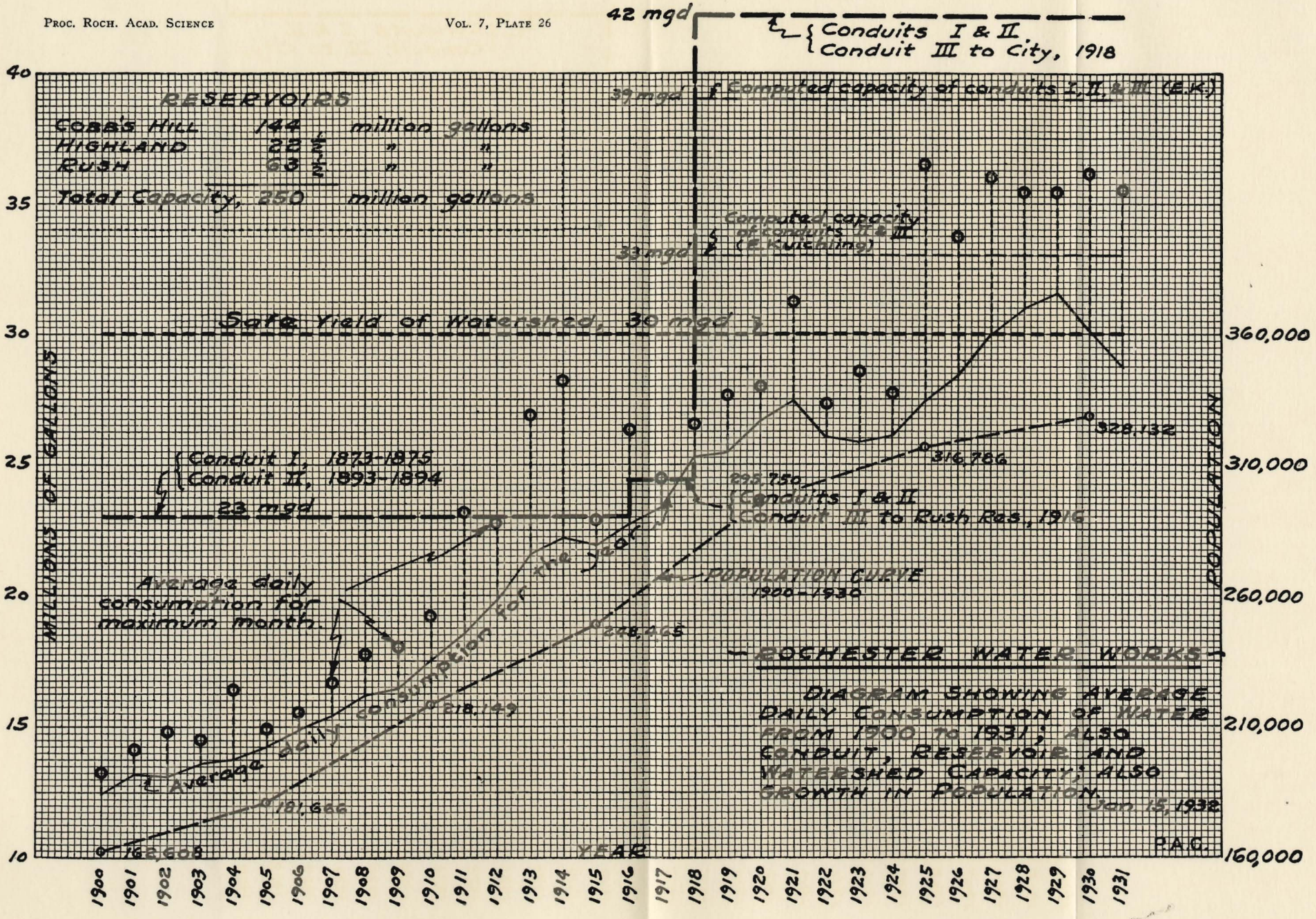
Contract No. 1, extending from the overflow at the end of the brick conduit known as Overflow No. 1, to Factory Hollow, a distance of about 7.755 miles, was awarded on March 18, 1914, to the R. T. Ford Company for a 37″ cast iron pipe laid parallel to and 10 feet west of Conduit II, being cross-connected at four points. The work was started early in April 1914 and completed the following November.

Contract No. 2, extending from the north end of the cast iron pipe at Factory Hollow to Rush Reservoir, a distance of about 9.603 miles, was awarded on May 10, 1916, to the T. A. Gillespie Company for a 37″ Lock-bar steel pipe having plates $\frac{1}{4}$″ and $\frac{5}{16}$″ thick, laid parallel to and 10 feet west of Conduit II. The work was completed in December 1916.

The contract price for the 37″ steel Lock-bar pipe was $44,235 less than the bid for cast iron pipe, or about $4,600 per mile. The average operating head on this part of the line is more than double that of the section south of Factory Hollow, which was constructed in 1914 of cast iron. The lock-bar pipe avoids the longitudinal rivets and develops the full strength of the plate.

Contract No. 3, extending from Rush Reservoir to the Pinnacle T on Clinton Avenue South, was awarded on March 15, 1917, to the T. A. Gillespie Company and consisted of about 8.143 miles of 37″ Lock-bar steel pipe laid parallel to and 10 feet west of Conduit II outside of the public roads and on the west side of the Henrietta Road and Clinton Avenue South. Owing to the difficulty of procuring steel on account of the War the work was delayed and completed late in 1918.

The plans and specifications for this conduit and its appurtenances, including the coating, were prepared by the Principal Assistant Engineer, Mr. John F. Skinner. Mr. Skinner also supervised


42 mgd
Conduits I & II
Conduit III to City, 1918
RESERVOIRS
Cobb's Hill 144 million gallons
Highland 22 " "
Rush 63 " "
Total Capacity, 250 million gallons
39 mgd
Computed capacity of conduits I, II, & III (E.K.)
33 mgd
Computed capacity of conduits I & II (E.Kuichling)
Safe Yield of Watershed, 30 mgd
Conduit I, 1873-1875
Conduit II, 1893-1894
23 mgd
Average daily consumption for maximum month.
Average daily consumption for the year
POPULATION CURVE 1900-1930
328,132
316,786
295,750
Conduits I & II
Conduit III to Rush Res., 1916
228,665
218,149
181,666
162,608
ROCHESTER WATER WORKS
DIAGRAM SHOWING AVERAGE DAILY CONSUMPTION OF WATER FROM 1900 TO 1931; ALSO CONDUIT, RESERVOIR AND WATERSHED CAPACITY; ALSO GROWTH IN POPULATION
Jan 15, 1932
P.A.C.
MILLIONS OF GALLONS
POPULATION
YEAR
40
35
30
25
20
15
10
360,000
310,000
260,000
210,000
160,000
1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931

the construction until the 15th of September 1918, when he entered the United States War Service as Sanitary Engineer. From this time until its completion the work was under the supervision of Irving E. Matthews, Second Deputy City Engineer. The estimated cost of this line, including the three contracts, is approximately $1,550,000.

The Pinnacle T in Clinton Avenue referred to is where the second conduit branches off to Highland Reservoir, and where a cast iron main was laid in 1908, which now connects both the second and third conduits directly with Cobb's Hill Reservoir. The length of this cast iron pipe was 1.57 miles.

It will be noted that after completing the third conduit the next consideration should be toward increasing the capacity of the watershed and studies by the Engineering Deparment under the general direction of Mr. Skinner were made with a view of using Conesus Lake as an additional supply. Also studies relating to the use of Honeoye Lake were made.

Ninth. The capacity of the watershed is shown in the diagram, plate 26.

This diagram shows the average daily consumption for the years from 1900 to 1931; also the maximum daily average for any month during the same period. The diagram also shows that the total actual capacity of the three completed conduits is 42,000,000 gallons per day. This amount is 3,000,000 gallons more than the estimated capacity by Mr. Kuichling. The diagram also gives the capacity of the three reservoirs, also the population curve from 1900 to 1930.

The safe yield of the watershed of Hemlock and Canadice lakes, as estimated by Hazen, Eddy and Fisher is also shown on the diagram at 30,000,000 gallons per day. It will be noted that the actual use exceeded this yield for the years 1928 and 1929.

It may also be stated that in a report of a survey of the Rochester Water Works submitted to the Board of Trustees of the Rochester Bureau of Municipal Research in April 1921, it was said that an addition to the water supply was then imperative. The report stated "The conditions which the City now faces will become more acute as time goes on and the Water Works can ill afford to postpone the day upon which additional supply will be available. Gambling with conditions and trusting to chance cannot be done with the lives of citizens at stake. Preliminary work for additional

supply is under way and the work should be pushed to a conclusion without delay."

In 1926 the late Allen Hazen and Harrison P. Eddy were employed to investigate additional sources of supply. The writer, as Consulting Engineer, was associated in this work. A brief extract from the report on this subject is included in the Fifth Period.

Fifth Period

January 1926 to January 1932

The present condition of the City's water supply and the necessity for an increase, also recommendations for the additional work, is summarized in the following extracts from the Report of the Consulting Engineers, Allen Hazen, Harrison P. Eddy, and Edwin A. Fisher, made to the City Engineer.

Engineers' Report on Additional Supply

"March 7, 1927

Mr. C. Arthur Poole,
City Engineer,
Rochester, N. Y.

Dear Sir:

On February 23, 1926, you asked us to advise you with reference to the water supply of Rochester, and particularly to aid in determining the most advantageous additional source of supply and the method of its development.

* * * * *

Conclusions

After investigation we find that the present water consumption has reached the safe capacity of the present sources and that steps should be taken at once to provide additional supply.

Of the several sources which are available, we believe that the development of a large storage reservoir on Honeoye Creek near West Bloomfield will be the best and in the long run the most economical and satisfactory. With the present supply it will be adequate to serve the city until it approaches a population of 1,000,000.

That part of the total plant required for early construction will cost about $12,000,000 and a moderate increase in water rates will be necessary.

Present Supply Conditions

* * * * *

The present population of the city is 320,000 within the city limits, and there is a further population of 23,000 in villages and suburban communities not far beyond those limits."

Uses of Water

Works	Total-Output Millions of Gallons Daily	Industrial Uses Millions of Gallons Daily
City of Rochester	28	7
Rochester and Lake Ontario Water Company	7	5
Eastman Kodak Works	6	6
	41	18

Rochester and Lake Ontario Water Company

"The present population of the city is 320,000 within the city limits, and there is a further population of 23,000 in villages and suburban communities not far beyond those limits."

"The city works does not supply the entire population of the City of Rochester and for a complete statement the Rochester and Lake Ontario Water Company must be included. This company supplies most of the previously mentioned population of 23,000 beyond the city limits and some population that is farther away to the Eastward. It also supplies a substantial population in parts of the city that have been recently annexed and to which the city pipes do not reach.

This company takes water from Lake Ontario and filters it. The present output of roughly 7 mgd is all that can be handled comfortably by the present works. It sells some water to the city and it has been necessary for the City to sell water to the Company from time to time to meet peak loads. Of the total output of the Company's plant about three fourths goes to industrial takers and railroads. A little more than half its output is sold within the city limits.

The City of Rochester may some day take over the plant of the Water Company. If that plant was all within the city limits there would be every reason why this should be done at once.

If the City does take this plant, it should take it all and not split it on artificial lines leaving a smaller plant in the possession of the Company.

If the Company's plant should be absorbed before a new water supply is obtained, it would continue to operate as at present and there would be no reduction in supply and no considerable added load at the moment for the gravity works.

On the other hand, if the Company's plant should be taken over when a large addition to the gravity supply is available, it would furnish additional market for the new water and its revenues would help to pay for it.

The program presented must be elastic enough, as we believe it is, to fit with any contingency likely to arise in this regard.

Eastman Kodak Supply

It is also to be mentioned that the Eastman Kodak Company has a plant taking water from Lake Ontario, with filtration and with an average output of 6 or 7 mgd, used mainly for process water in manufacturing film. The Eastman Kodak Company has special and unusual requirements in regard to

quality, which are met by its supply. It may therefore be assumed that this service will be continued and also that various other industries will continue to get process water independently from the Genesee River, and no provision for these uses need be made in plans for future water supply."

Future Requirements

The estimated quantities to be provided in million gallons per day will be as follows:

Year	Population supplied by present city plant	Entire population, urban district
1926	28	35
1930	31	39
1940	42	53
1950	57	72
1960	76	95

Capacity of the Present Works

* * * * *

For the present purposes we may consider these improvements as effective and the capacity of the present system to be 31,000,000 gallons.

The improvements referred to were the raising of the dike five feet, such construction as would permit of lowering the lake three feet lower than it had been in the past; also a diversion of the Carney Hollow water of about 1,000,000 gallons per day. This diversion has not been completed and the effective capacity of the present system is then 30,000,000 gallons per day instead of 31,000,000.

Other Sources of Supply

"Conesus Lake is directly west of Hemlock Lake and for more than a generation it has been accepted by the people of Rochester as the next probable addition to the Rochester water supply. . . .

Conesus Lake is larger than Hemlock Lake, and it has a greater catchment area, namely 67.0 square miles. . . .

If the storage is limited to about 6 feet, i. e., to a range of six feet between high and low water in the lake, the yield to be counted on is estimated at 20,000,000 gallons. Twice as much storage, i. e., 12 feet, would be needed to get a full development up to a possible maximum of about 25,000,000 gallons.

* * * * *

From the standpoint of quantity Conesus Lake does not provide adequately for future growth. When cities build new works it is desirable to get sources that will maintain service for longer periods.

* * * * *

Considering the matter from a standpoint of what we consider to be the inevitable future development, we are not willing to recommend the use of Conesus Lake with the cottages remaining, even with filtration.

The estimated cost of acquiring all the cottages and moving them and developing the lake so that it would be comparable in its occupation and purity with Hemlock and Canadice Lakes, is clearly greater than is warranted by the amount of water that can be obtained from it."

The estimated cost of development of Conesus Lake project for 25,000,000 gallons per day is $11,662,800.

Genesee River

"A reservoir above Portage has been proposed for water power purposes and it may be built some day. . . . If it should be built at some time for power purposes, the City of Rochester, on proper arrangements being made, might become a partner in the enterprise and take such quantities of additional water as needed from this source.

* * * * *

For the present, this source is too large and too distant and the first installment would cost too much money to permit its serious consideration at this time, but looking to a remote future it is not at all impossible that it may be part of Rochester's ultimate supply."

Canandaigua Lake

"This lake is much larger than Hemlock Lake and has a catchment area of 186 square miles.

* * * * *

A supply from Canandaigua Lake would not be satisfactory unless strong measures were taken to control both the quality and quantity of the water, and the present uses of the lake for other purposes are such that full control would be very difficult.

A rough preliminary study indicated that works would cost much more than for other possible sources."

Lake Ontario

"Lake Ontario is an obvious source of future water supply.

* * * * *

One great handicap in the use of Lake Ontario water is the pumping. The cost of pumping will be much greater in this case because of the unusual elevation of the city above the lake. Most of the cities that use lake water are elevated but little above the lakes and it is necessary to pump only against the pressures actually required for ordinary service."

The first installment of works would cost $8,400,000. The heavy pumping cost is a great handicap to this project.

Honeoye Creek

"Honeoye Lake has been considered as a possible source of supply and has attractive features, but by itself is not large enough. Honeoye Lake is

a comparatively small lake but in a valley that is as large as that which holds Canandaigua Lake.

* * * * *

The plan that we propose is to build a reservoir, or in reality, a lake that would include and raise Honeoye Lake. The dam would be a short distance above Factory Hollow on a site that has been surveyed and bored by your assistants.

This dam will control a catchment area of 187 square miles which includes all the catchment area now used for water supply by the City of Rochester and also Honeoye Lake and a very considerable area downstream from it.

* * * * *

The population per square mile on the added area is 26, which is practically the same as it is upon the present catchment area and there would thus be no lowering of present standards with respect to freedom from pollution."

Reservoirs

"The reservoir to be formed by this dam will have an area of 12.5 square miles, being 15 miles long and averaging ¾ of a mile wide. The average depth of water, not including the water now in Honeoye Lake, which cannot be drawn, will be 26 feet, and the capacity 68 billion gallons, of which 45 billions are in the upper 20 feet, and considered available.

* * * * *

The areas and capacities shown in the following table have been calculated from this map: (Plate 26. This map had been compiled from several maps of the district.)

TABLE NO. 4—AREA AND CAPACITY OF PROPOSED RESERVOIR

Elevation Above Sea level	Rochester Water Works datum	Area in square miles	Capacity in billions of gallons excluding water now in Honeoye Lake which cannot be drawn	Average depth in feet
785	277	0.7	0.4	3
790	282	1.4	1.5	5
795	287	2.3	3.4	7
800 (a)	292	3.3–6.6	6.3	8
805	297	8.0	13.9	9
810	302	9.0	22.8	12
815	307	10.1	32.8	15
820	312	11.0	43.8	19
825	317	11.5	55.5	23
830 (b)	322	12.5	68.0	26
835	327	13.7	81.7	29
840 (c)	332	14.7	96.5	33

(a) Present level of Honeoye Lake.
(b) Proposed flow line of reservoir.
(c) Proposed extreme possible flood height.

	Billion Gallons
The proposed range to be used for water supply, 810–830, holds	45.2
Add storage in Hemlock and Canadice lakes when present proposed arrangements are complete	11.5
Total net storage in proposed system	56.7

This amounts to more than one year run-off from the tributary area of 187 (or 219) square miles.

Quality of Water

"Water from Hemlock and Canadice lakes will be delivered as at present to the limit of the capacity of the source and of the present pipes. For some years most of the required supply will come from them. Additional water will be taken from the new reservoir as needed.

The water entering the proposed reservoir will be in every respect equal to the water entering Hemlock and Canadice lakes, . . ."

Quantity of Water to Be Obtained

". . . With Honeoye Reservoir built as proposed, the safe capacity of the combined system is estimated at 85 mgd, sufficient to last at the assumed rate of growth for the entire city, including the area in and outside the city now supplied by the Water Company, until 1957.

The addition of the headwaters of Ganargua Creek above South Bloomfield would add a further 15 mgd, bringing the total to 100 mgd."

Filters

* * * * *

"We do not propose to discuss the advantages of filters, but merely to point out that there is an adequate site for the construction of filters for the entire proposed supply including the present supply, located so that water will flow to them from present and proposed reservoirs by gravity, and, in turn, from the filters to the present service reservoirs through existing pipe lines which pass close to the proposed filter site, and also through additional pipe lines laid in future as they may be required."

The estimated cost of this supply and the first instalment for early construction is $12,000,000 and the cost of the whole project, including future construction is $23,000,000.

"The exigencies of the situation require that the construction program of new works be carried forward rapidly. We have not attempted to work the matter out in detail, but a moderate increase in present water rates will apparently be necessary under these conditions."

Recommendation

"Taking all the conditions into consideration, we recommend that the City

adopt the development of a gravity supply on Honeoye Creek substantially as outlined in this report.

Respectfully submitted,
Harrison P. Eddy,
Allen Hazen,
Edwin A. Fisher."

ACTION BY THE CITY ON THE HONEOYE VALLEY WATER PROJECT

The foregoing report of Hazen, Eddy and Fisher was transmitted by the City Engineer, C. Arthur Poole, to His Honor the Mayor, Martin B. O'Neil, and by him transmitted to the Common Council on April 1, 1927.

On April 26, 1927, the Common Council adopted Ordinance No. 388, Authorizing Additional Water Supply and Authorizing the Mayor to Make a Petition to the Water Supply Commission of the State of New York for Approval of Said Additional Water Supply Project.

"Be it ordained by the Common Council of the City of Rochester, as follows:

Section 1. This Council hereby authorizes the construction and erection for municipal purposes of the necessary works for an addition to the present water supply of this city in accordance with the general plan or project recommended in a report dated March 7, 1927, submitted by Allen Hazen, Harrison P. Eddy and Edwin A. Fisher, to the City Engineer of Rochester, and the accompanying general plans on file in the office of the City Engineer, when said plans are approved by the New York State Water Supply Commission, or any extension or modification thereof that may be approved by said Water Supply Commission. Such works include all construction of any name or nature necessary to provide an abundant supply of wholesome water for public and private use and its protection against contamination, including treatment by filtration or otherwise which may be deemed necessary or desirable; also the acquisition of real estate, easements and water rights necessary or proper in carrying out said works, including any lands or easements required for the sanitary protection of said water supply; also the payment of all legal damages.

Sec. 2. The Mayor is hereby authorized to prepare and submit to the Water Supply Commission of the State of New York, a petition for the approval of the said Water Supply Commission to the project for additional water supply for the City of Rochester, authorized by section 1 of this ordinance.

Sec. 3. This ordinance shall take effect immediately."

Adopted unanimously.

PETITION TO THE WATER POWER AND SUPPLY COMMISSION

On April 29, 1927, a petition under authority of the foregoing ordinance was presented to the New York State Water Power and

Control Commission. In this petition the conclusions of the Consulting Engineers heretofore stated were given, together with other information relating to the matter and accompanied by four exhibits. The petition was signed by Martin B. O'Neil as Mayor, Harold W. Baker, Commissioner of Public Works, and C. Arthur Poole, City Engineer.

The New York State Water Power and Control Commission gave extended hearings on the project during the year 1927, and on December 14 gave a conditional approval. The main condition was that final decision on this application should be held in abeyance and the City of Rochester be given a reasonable time in which to apply to the Legislature for relief, and thereafter to submit a modified scheme for the determination and payment of direct and indirect damages.

On April 17, 1928, a supplemental petition was presented to the New York State Water Power and Control Commission. This petition was amendatory and supplemental to the petition heretofore presented to and filed in the office of the Commission on the 30th day of April 1927 and thereafter designated as Application No. 439.

The Supplemental Petition was signed by the City Manager and the Commissioner of Public Works.

Attention was called to a recent enactment of the Legislature which was signed by the Governor of the State of New York on the 6th day of April, 1920, and immediately thereafter became a law, being Chapter 862 of the Laws of 1928. The petitioner further represented that the said Legislative action complies completely with the suggestion heretofore made by the Commission, and asks that the Commission grant the petition.

APPLICATION GRANTED BY THE COMMISSION

Hearings were held on the supplemental petition by the Commission during the early part of 1928, and on June 22, 1928, the Water Power and Control Commission made a final decision granting the application of the City which should be modified to conform to the following conditions:

1. Mud or Ganargua Creek as a source of an additional water supply for the City of Rochester, is eliminated entirely from this project.
2. Detailed plans and specifications for any structure to be built under authority of this decision must be submitted to this Commission for approval before work is started.
3. The City must have procured the enactment by the State Department of

Health of rules and regulations for the sanitary protection of the additional watershed, etc.

4. Water drawn from the Honeoye reservoir shall be filtered. The Commission will, in the future, consider applications from the City for modifications of this condition, etc.

5. All the water shall be sterilized.

6. On order of the Commission the applicant shall install and operate approved apparatus for the future purification of the water, etc.

7. Nothing in this decision and approval contained shall be held to bar any community on the watershed of Honeoye Creek above the proposed dam from obtaining a supply of water from sources on said watershed, etc.

8. Nothing in this decision contained shall be held to authorize the City of Rochester to supply or distribute water outside of or for use outside of the limits of that city except with the further consent and approval of this Commission.

9. Damages shall be determined and paid in accordance with the provisions of Section 527 of the Conservation Law.

10. Within two years of the date of this decision the City must submit to this Commission for its approval maps showing the outside boundaries of the lands proposed to be acquired about Honeoye Lake, etc.

11. Where any highway, or part of a highway, which is to be submerged is to be relocated, such relocation must be completed before water may be impounded, etc.

12. After the dam on Honeoye Creek is completed the City of Rochester shall allow water to escape over or through the outlet works of this structure in amount such that the flow of Honeoye Creek at Honeoye Falls shall not be less than seven cubic feet per second for each thousand persons dwelling in that village. The City may conserve a part of this water for its own use if it shall construct, maintain and operate at its own expense sewage disposal and waste treatment works, etc.

The Commission further determines and decides as follows:

1. That the application, maps and plans submitted are modified as set forth above and, as so modified, are the plans hereinafter mentioned.

2. That the plans proposed are justified by public necessity.

3. That said plans provide for the proper and safe construction of all work connected therewith.

4. That said plans provide for the proper protection of the supply, etc.

5. That said plans are just and equitable to the other municipalities, etc.

6. That said plans make fair and equitable provisions for the determination and payment of any and all legal damages to persons and property, both direct and indirect, which will result from the execution of said plans or the acquiring of said lands.

WHEREFORE, The Water Power and Control Commission does hereby approve the said application, maps and plans of the City of Rochester as thus modified. Dated at Albany this 22nd day of June 1928, and signed by the Water Power and Control Commission, Alexander Macdonald, Conservation Commissioner-Chairman, F. S. Greene, Superintendent of Public Works; Albert J. Danaher, Assistant Attorney General.

Appeal by Ontario County. The Board of Supervisors of Ontario County appealed to the Appellate Division from the decision of the Water Power and Control Commission and the Appellate Division unanimously confirmed the determinations of the Water Power and Control Commission on January 1930.

From this decision the Board of Supervisors of Ontario County appealed to the Court of Appeals, which appeal was argued on the 14th day of October 1930 by Earle S. Warner, Esq., Counsel for the Petitioner and George B. Draper, Esq., Deputy Corporation Counsel of the City of Rochester and by Frederick D. Colson, Esq., Assistant Attorney of Counsel for the Water Power and Control Commission to the Court of Appeals on the 18th day of November 1930.

Decision of the Court of Appeals. Ordered and adjudged that the judgment and order so appealed from be affirmed with costs.

Judgment was filed and entered in the office of the County Clerk of Albany County on the 29th day of September 1930.

The Water Supply and Power Control Commission extended the date for filing maps and land required for the reservoir to November 29, 1932, and for the complete taking of lands to November 29, 1938.

Personnel

References and Acknowledgements

In addition to the personal recollections of the writer from his relations in some measure to the water supply of the City of Rochester for the past 40 years, the following publications and papers are referred to:

Current Proceedings of the Common Council as far as available from 1834 to date.

Public Works and City Engineers' Reports.

Peck's History of Rochester, 1884.

Papers and reports of J. Nelson Tubbs.

Papers and reports of Emil Kuichling.

Papers and reports of John F. Skinner, including a Report on the Steel Plate Pipe Conduit No. II, published in book form in 1913.

Paper by Irving E. Matthews, published in the Proceedings of the New York Section of the American Water Works Association, March, 1928.

Reports of Edwin A. Fisher, City Engineer, to Hon. James G. Cutler, Mayor, 1904 to 1908.

Reports of Hazen, Eddy and Fisher on Additional Water Supply, March 7, 1927.

Report of the Rochester Bureau of Municipal Research.

Message of Mayor Rodenbeck, November 28, 1903.

Mention should also be made of the suggestions relative to matter to be included in this paper and its arrangement by Dr. Herman L. Fairchild, Professor Emeritus of the University of Rochester.

PARTIAL LIST OF ENGINEERS CONNECTED WITH THE WATER SUPPLY

Daniel Marsh, at one time Chief Engineer of the Rochester Water Company.

J. Nelson Tubbs, Chief Engineer and Superintendent of the Rochester Water Works, 1872 to July 18, 1889.

I. F. Quimby, Consulting Engineer, construction of original works.

George W. Rafter, Assistant Engineer and Acting Chief Engineer, July 18, 1889 to September 6, 1889.

Emil Kuichling, Principal Assistant to Mr. Tubbs in the original water works construction, and Chief Engineer and Superintendent from September 6, 1889 to January 1, 1900.

Edwin A. Fisher, Principal Assistant Engineer in construction of additional water supply, 1893 to 1896, City Engineer 1896 to 1914, Consulting Engineer 1914 to 1927, retired.

Frederick T. Elwood, City Engineer, 1914 to May 8, 1917.

C. Arthur Poole, City Engineer, 1918 to January 1928, Consulting Engineer 1928 to January 1, 1932, City Manager 1932.

H. L. Howe, City Engineer, 1928 to 1932, Mechanical and Electrical Engineer 1932.

I. E. Matthews, Superintendent of Water Works, 1926 to 1932, City Engineer, 1932.

John F. Skinner, Assistant to Chief Engineer, 1891 to 1900, Special W. W. Assistant Engineer, 1900 to 1903, Special Assistant Engineer, 1903 to 1905, Principal Assistant Engineer, 1905 to 1923, Deputy City Engineer, 1923 to 1928, Sanitary Engineer, 1928 to 1932.

Frederick P. Stearns, Consulting Engineer on Cobb's Hill Reservoir.

LeGrand Brown, Assistant Engineer, Additional Water Supply, part time, 1891 to 1895, Deputy City Engineer, July 1, 1919 to February 8, 1923.

Gaylord Thompson, Assistant Engineer in Charge of Contract No. 1, Additional Water Supply Construction, 1893 to 1895.

Walter H. Sears, Principal Assistant Engineer, 1892 to 1893.

Alphonse Fteley, Consulting Engineer, 1892 to 1895.

Commissioners of Public Works

J. Herbert Grant, 1900 to 1902.
J. Y. McClintock, 1902 to 1903.
Thomas J. Neville, 1903 to 1906.
Frederick T. Elwood, 1906 to 1912.
Herbert W. Pierce, 1912 to 1924.
Harold W. Baker, 1924 to 1932.
John G. Ellendt, 1932.

Superintendents of Water Works

George A. Hotchkin, 1900 to 1902.
Beekman C. Little, 1902 to 1926.
Irving E. Matthews, 1926 to 1932.

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8. Aboriginal Cultures and Chronology of the Genesee Country. By A. C. Parker. pp. 243–283, plates 90–96. 1929 ..... .50
9. Title-page, Officers of the Academy and of the Sections, Contents.
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3. History and Engineering of Rochester's Water Supply in its First Century. By Edwin A. Fisher. pp. 59–95. plates 22–26. 1932 ..... 1.00