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THE ASSOCIATION was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of over **1 000** men. Its membership is divided into two principal classes, viz.: MEMBERS and ASSOCIATES. Members are divided into two classes, viz.: RESIDENT and NON-RESIDENT, — the former comprising those residing within the limits of New England, while the latter class includes those residing elsewhere. The INITIATION fee for the former class is FIVE dollars; for the latter, THREE dollars. The annual dues for both classes of Active membership are THREE dollars. Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for ASSOCIATE membership is TEN dollars, and the annual dues FIFTEEN dollars. This Association has six regular meetings each year, all of which, except the annual convention in September, are held at Boston.

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HARTFORD WATER WORKS, PAST AND PRESENT.

BY W. E. JOHNSON, DIVISION ENGINEER, RESERVOIR DIVISION.

[*Read September 18, 1917.*]

The following paper has for its object a brief sketch of the growth and development of the Hartford Water Works from its incorporation to the present time, covering a period of more than half a century.

During the early part of this period the supply was taken by pumps from the Connecticut River, and later by gravity from a drainage area on the eastern slope of Talcott Mountain in the towns of West Hartford, Farmington, and Bloomfield.

Previous to the adoption of the plan for a water supply from the Connecticut River with pumps operated by steam power and located to the north of the city, various projects were considered. One of these, which attracted considerable attention and was favored by many, was to construct a canal from Hartford to Windsor Locks, located about twelve miles up the Connecticut River, and utilize a portion of the water thus obtained in developing power to be used in pumping water to an elevated reservoir from which the city would take its supply.

The Hartford Water Works was incorporated in 1853. In that year surveys, plans, and estimates were made and contracts let with the approval of the Common Council. The following year construction began.

The first annual report of the Board of Water Commissioners is dated April 23, 1855. This report is principally devoted to a statement of the situation and condition of the works when they accepted office, disclaiming credit for the work, as undertaken, and giving to their predecessors all the merits or demerits of the plan. The report consists of ten printed pages, and considerable space is given to criticizing the action of the previous board, pointing out mistakes and lack of judgment of the Common Council, engineer, and prominent citizens.

The plant as built consisted of a pumping station on the Connecticut River at the foot of Pleasant Street, a sixteen-inch force main one and one-fourth miles long, and a distributing reservoir at an elevated position in the western part of the city now known as the Garden Street Reservoir.

The pump was comprised of four cylinders set vertically, in which operated two lifting pistons containing the valves, the upper piston being operated by a hollow piston rod through which the rod of the lower set of valves worked. The cylinders had an internal diameter of 19 in. and a 16-in. stroke. The pumps were driven by gears having hard-wood teeth working from pinions on the main engine shaft. The bottom of the cylinders was located about 10 ft. above mean low water in the river, and they received the water through a 24-in. conduit extending from the pump well to an intake in the channel of the river, a distance of 140 ft.

The engine was of the condensing beam type, with cylinder 32 in. in diameter and 60-in. stroke. The engine and pump were built and installed by the Woodruff and Beach Iron Works, of Hartford, Conn.

The Garden Street Reservoir has a flow line elevation of 125 ft. above mean low water in the river, and was originally considered to be of sufficient elevation and capacity for a long period of time. The maximum depth was 30 ft. and the capacity 8 000 000 gal. It was soon apparent that the capacity of the reservoir was insufficient and the elevation such that the reservoir had to be kept practically full to give the required pressure, thereby necessitating the operating of the pumps longer and at more frequent intervals.

The pumps were first put in operation October 20, 1855, and continued to supply the city until the gravity supply was put in operation in 1867.

As early as 1857 the board found that there was a much higher consumption of water than the conditions warranted, attributed to waste from defective and improper plumbing and because during the cold season the water was left running to prevent freezing. They advised a general use of stop and waste valves on the services, and the appointment of an inspector whose duties would be to superintend the placing of new house connections and the

inspection of house plumbing and fixtures. They stated emphatically that, with the present capacity of the works, the necessity of checking the waste was of vital importance.

During the early period of the water supply, there seems to have been but little reliable data as to the approximate number of persons supplied with water, the water rates being based on the number of outlets and fixtures in the houses. The annual report of March 1, 1863, gives an estimate that the population supplied about 26 000, making a per capita consumption of over 51 gal. In the following table is given the average daily consumption by years from 1857 to 1866 inclusive, which were compiled from the pump duties.

TABLE OF CONSUMPTIONS.

Year ending March 1.	Average Daily Consumption. Mil. Gals.
1857 (10 months)	.34
1858	.51
1859	.66
1860	.78
1861	.90
1862	1.10
1863	1.35
1864	1.54
1865	1.84
1866	2.15

In 1858 the board began investigations relative to an increased supply of water. Their report on the subject was submitted to the Common Council in April, 1860. This report recommended a supply of water by gravity from the hills to the west of the city, and urged the Common Council to take immediate action on the matter of an additional water supply. In succeeding years the board continued its investigation and called attention to the vital question of an additional supply.

There seems to have been, at an early date, a diversity of opinion and much discussion in the city whether new pumps with a reservoir at a more elevated position or a gravity supply from

Talcott Mountain should be adopted. The following paragraph, taken from the report of 1864, indicated the interest aroused in the public concerning the additional water supply.

"It is much to be regretted that, in so vitally important a matter as an additional supply of pure and wholesome water for the daily use of our growing city, attempts should be made to bias the public judgment in favor of, or against, this or that project, by anonymous and irresponsible writers who have neither investigated nor have means of investigating a subject of this character; and unless the voting class will have the wisdom to discard, utterly, all representations made upon this subject by anonymous and ignorant or interested parties, and base their action upon the authenticated results of careful investigations, made by experienced, skillful, and responsible engineers of known integrity and ability, we shall be very liable to fall into a very grave mistake in the matter and discover our error when it is too late to correct it."

It was during this period that all possible means for utilizing the total capacity of the pump and conserving the supply was made. The size of the air chambers on the pump was increased, the speed of the pump accelerated about twenty-five per cent., a thorough investigation relating to leakage from the force main and distribution was made, and later the supply was pumped directly into the distribution. The result of the last mentioned was to furnish unsatisfactory and turbid water, which probably had the effect of hastening the action tending toward a new and additional supply.

In May, 1861, the Common Council authorized the board to employ such assistants as needed to re-examine and report anew on the various projects for a water supply for the city. In consequence of which, the board employed competent engineers and chemists to advise with them, and, although extensive investigations and reports were made and submitted to the council, no definite results were obtained.

The question was finally brought to a definite conclusion in the fall of 1864, when it was referred by the court of Common Council to a city vote, and was decided in favor of a supply by gravity from Trout Brook by a vote of 1 510 for and 508 against the project.

The plan for an additional supply submitted by the Board was approved by the court October 11, 1865, and contemplated impounding and taking water from Trout Brook in the town of West Hartford, and immediate steps were taken to carry out the plan.

At the very beginning of the gravity project the board was confronted with many obstacles in form of injunctions, lack of uniform action in the two branches of the Common Council, and want of adequate legislative rights.

In March, 1865, the board petitioned the General Assembly for an amendment to the city charter which would enable them to take water from Trout Brook in the town of West Hartford, which was finally granted.

The new supply by gravity was obtained by storing water from Trout Brook drainage area on Talcott Mountain. A dam was constructed a short distance below the junction of three branches of the stream, having a flow line elevation of 260.0 ft. above mean low water in the Connecticut River at Hartford.

Water was first introduced in the city from this source in January, 1867.

The following year Reservoir No. 2, located on the upper portion of the drainage area, was built, and an additional watershed of .8 square miles was added by means of a canal connecting Mountain Stream with Trout Brook. In 1870, the dam of this reservoir was raised five feet, increasing the capacity to 284 million gallons. Reservoir No. 3 joins Reservoir No. 2 on the south, with a water line at a slightly higher elevation, and was constructed in 1875, having a capacity of 146 million gallons. In 1880, Reservoir No. 4 was added to the system. This reservoir has a capacity of over 600 million gallons, and is located on a new drainage area, southwest of the original watershed. The water in this reservoir is conveyed to Reservoir No. 1 by a 24-in. cast-iron pipe. The yield of this reservoir was increased by the addition of Dead Swamp Canal two years later; this canal was not extended to its ultimate length until 1905, and now drains a watershed of 2.08 square miles. Reservoir No. 5, located between Reservoirs No. 1 and No. 2, was constructed in 1884. The last reservoir of the present system, known as the " Tumble-Down Brook Reservoir," or Reservoir No. 6, was built on a watershed joining Trout Brook

drainage area on the north. This reservoir added 765 million gallons to the storage, and is connected with Reservoir No. 5 by a 24-in. vitrified pipe line, and was completed in 1896.

The aggregate storage of the six reservoirs is 2 036 million gallons, and takes the water from a drainage area of 11.92 square miles, of which .68 square miles is water surface.

The safe yield of the present works has been estimated at 7.5 million gallons per day. In 1916 the average daily consumption was more than 10.5 million gallons. These figures indicate the importance of the new works now about brought to completion for the city of Hartford.