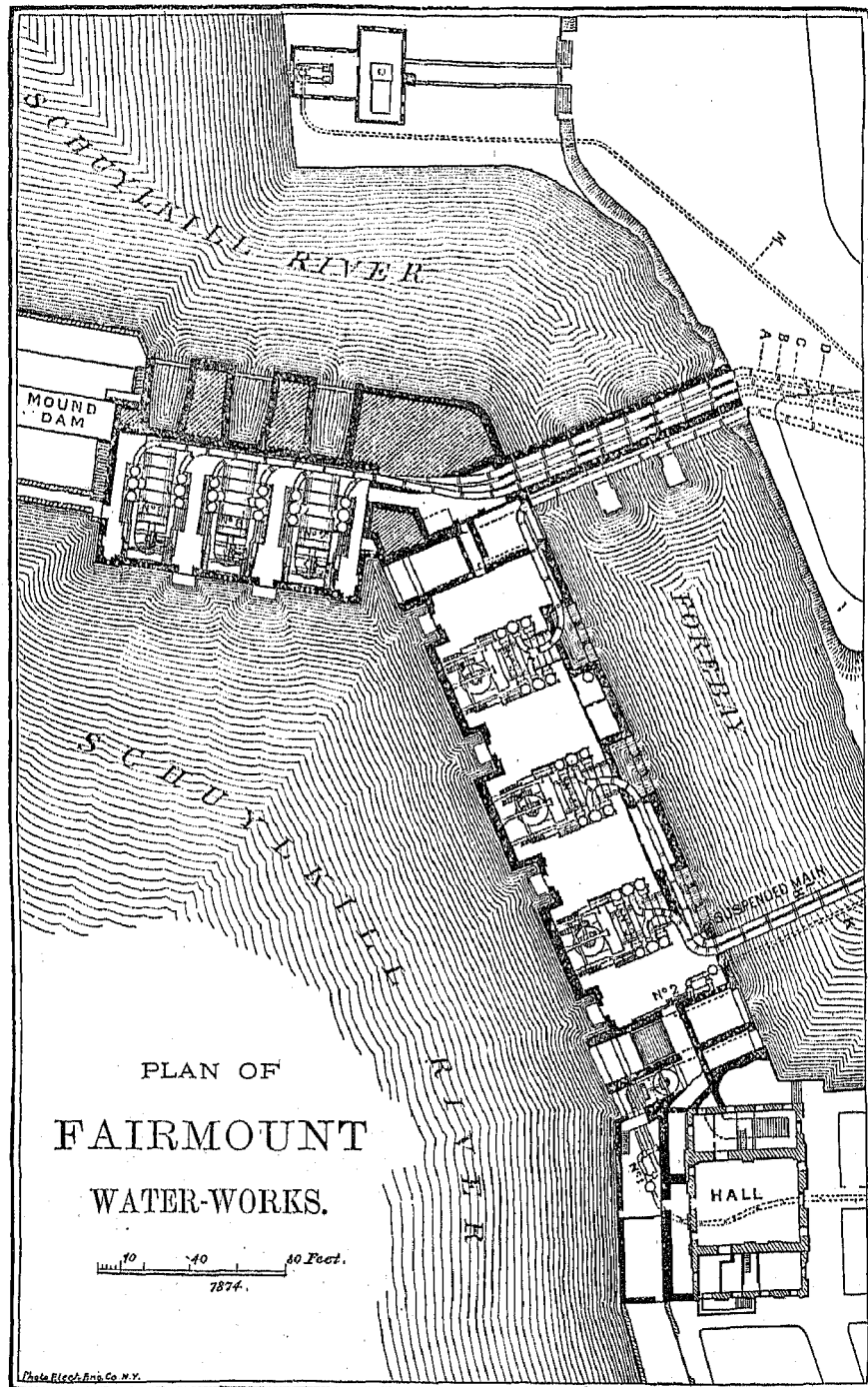


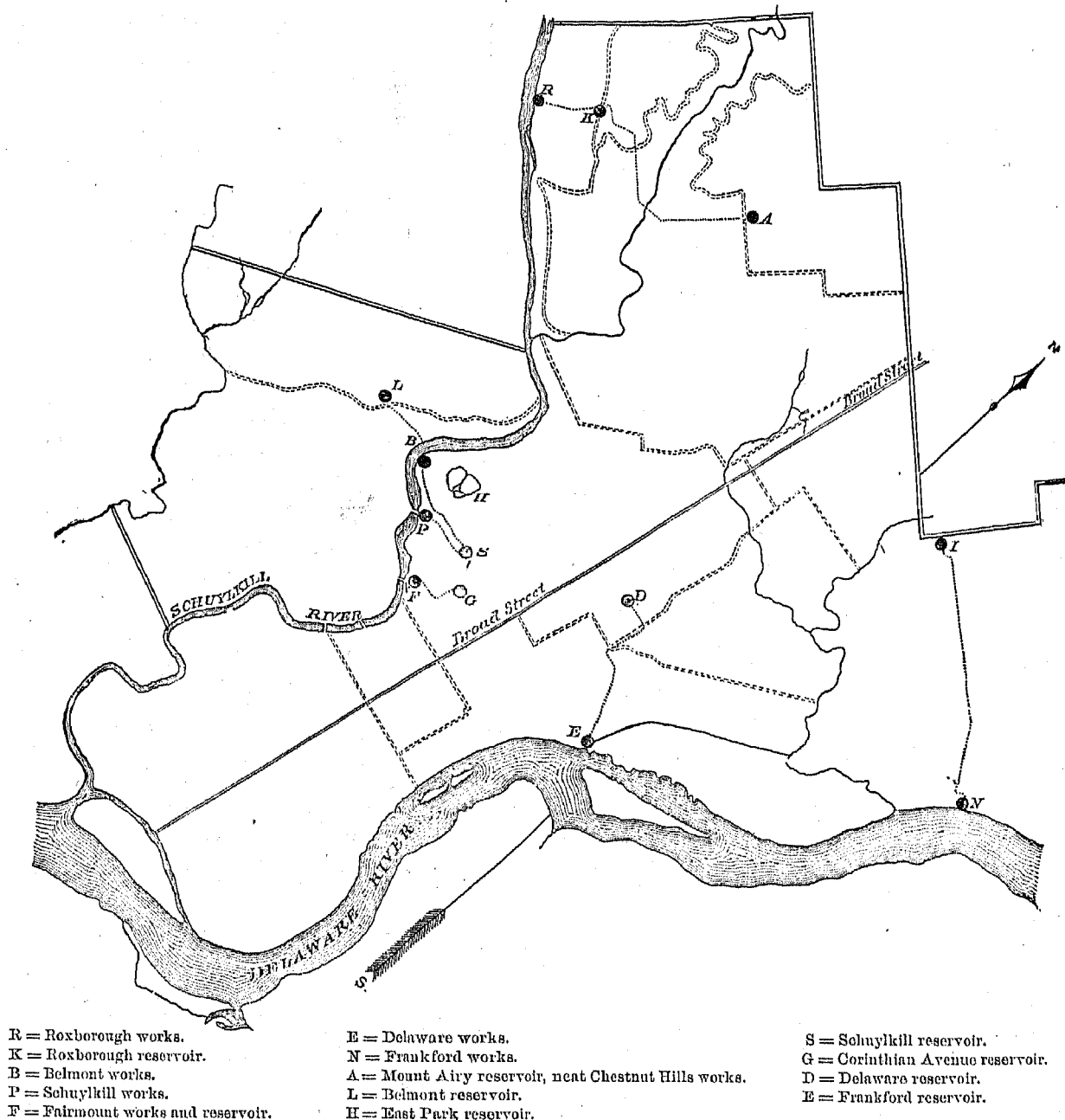
8.—COMBINATIONS.

PHILADELPHIA, PENNSYLVANIA.

Philadelphia contains, according to the recent census, a population of 847,170, and lies on the west bank of the Delaware river, about 100 miles from its mouth, at its junction with the Schuylkill river. Between the two lies the main and older portion of the city. The greater part of the city is on low level ground. Parts of the suburbs



are, however, considerably elevated. The average height of the main portion above datum is 40 feet. The substratum of the city is largely made up of alluvial deposit. The city is rectangular in plan, with the principal streets running east and west, and is chiefly a manufacturing and residence city. Water was first introduced into the main streets in 1801, the supply being derived from the Schuylkill river. The works consisted, first, of a basin on the Schuylkill river, 84 feet wide by 200 feet long, the bottom being 3 feet below low-water level; second, another basin 40 feet wide and 160 feet long, receiving water from the first, through a sluice; third, an oval tunnel 6 feet high and 300 feet long; fourth, a well 10 feet in diameter and 39 feet deep, serving as a pump-well. From this the water was

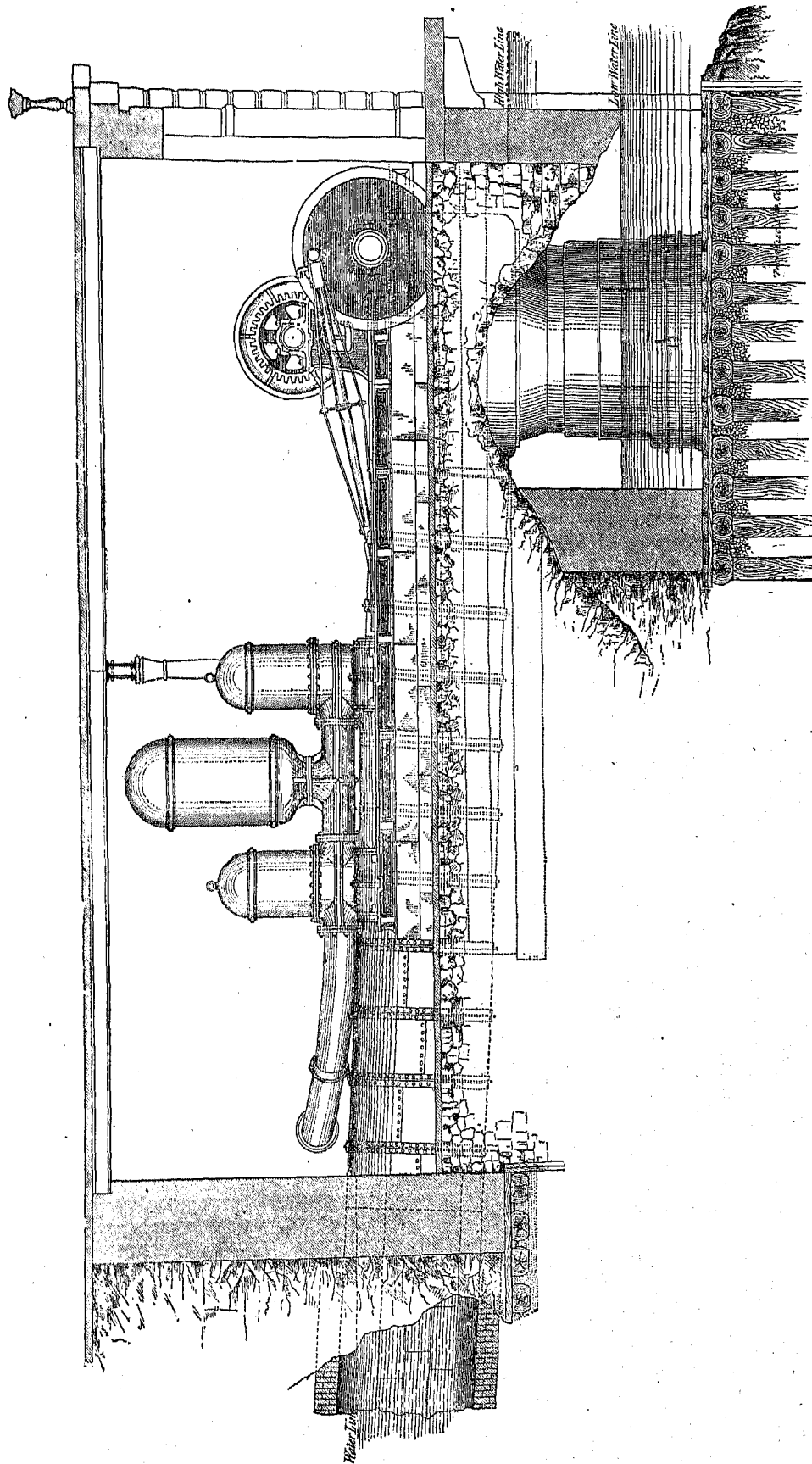


MAP OF THE PHILADELPHIA WATER-WORKS.

pumped up into two wooden tanks of a capacity of 20,800 gallons, situated in Centre square, from whence bored wooden logs distributed it. These pumping-engines have since been removed. In 1812 works were built at Fairmount, pumping into a reservoir located 102 feet above the river and having a capacity of 3,250,000 gallons. In 1818 water-power was proposed at Fairmount, and put in operation in 1822. A dam, from 17 to 18 feet wide, was built, filled with stones obliquely across the river, of a total length of 1,600 feet, giving a head of water of 13 feet; cost, \$150,000. It was rebuilt in 1843; and in 1865, 450 feet of crib were placed in front of its highest part. In 1872 a new dam was built in front, the space between them being filled with concrete. At this station there are used at present seven Geyelin turbine wheels and one breast-wheel, arranged as shown in the cut on page 125. There are now eight pumping-stations, known as the Schuylkill, the Belmont, the Delaware, the Roxborough, the Auxiliary Roxborough, the Chestnut Hill, the Frankford, and the Fairmount pumping-stations. They will be described separately.

THE FAIRMOUNT WORKS.

The sizes and details of the wheels used at this station are given in the table on page 128.



Wheels and pumps at the Fairmount works.

No. of wheel.	Kind of wheel.	Diameter.	PUMP.				GALLONS CAPACITY.		Strokes per minute.	Gallons per day.
			Diameter.	Diameter.	Area of pump.	Stroke.	Pump.	Wheel.		
		Feet.	Inches.	Inches.	Inches.	Inches.				
1	Turbine	7	16	.....	201.00	72	121.40	122.11	12	2,110,000
2	Breast (width, 15 feet).	15	16	.....	201.00	54	91.75	91.75	14½	1,387,200
3	Turbine	10½	22	22	380.13	72	230.84	401.68	8	5,318,553
4	do	10½	22	22	380.13	72	230.84	401.68	8	5,318,553
5	do	10½	22	22	380.13	72	230.84	401.68	8	5,318,553
6	(Removed)									
7	Turbine	9	18½	18½	266.08	72	161.95	323.90	11	5,130,570
8	do	9	18½	18½	266.08	72	161.95	323.90	11	5,130,570
9	do	9	18½	18½	267.90	72	163.09	326.18	11	5,160,090

Pumps 3, 4, and 5 are similar to each other, and Nos. 7, 8, and 9 are alike. Nos. 1 and 2 have one pump-cylinder each. The others have two each.

An account of the work performed in 1879 is given below:

Wheels Nos. 1, 3, and 4 deliver water into Fairmount reservoir. Lift, 90 feet.

Wheel No. 1—122 gallons per revolution; buckets 13 inches wide, 10 inches deep:

Hours run	3,158
Hours stopped for high or low water or for full reservoir	5,602
Number of revolutions	2,207,625
Gallons pumped	269,330,250
Average gallons per 24 hours	2,046,840
Revolutions per minute	11.6

Wheel No. 3—461 gallons per revolution; buckets 15 inches wide, 17 inches deep:

Hours run	6,568
Hours stopped for high or low water or for full reservoir	2,096
Hours stopped for repairs	96
Number of revolutions	3,770,795
Gallons pumped	1,738,336,495
Average gallons per 24 hours	6,352,008
Revolutions per minute	9.5

Wheel No. 4—461 gallons per revolution:

Hours run	4,146
Hours stopped for high or low water or for full reservoir	1,735
Hours stopped for repairs	2,879
Number of revolutions	2,922,693
Gallons pumped	1,346,361,473
Average gallons per 24 hours	7,793,683
Revolutions per minute	11.7

Wheels Nos. 5, 7, 8, and 9 deliver water into Corinthian Avenue reservoir.

Wheel No. 5—461 gallons per revolution:

Hours run	5,291
Hours stopped for high or low water or for full reservoir	3,469
Number of revolutions	2,809,570
Gallons pumped	1,295,211,870
Average gallons per 24 hours	5,875,070
Revolutions per minute	8.8

Wheel No. 7—325 gallons per revolution:

Hours run	3,536
Hours stopped for high or low water or for full reservoir	3,832
Hours stopped for repairs	1,302
Number of revolutions	2,306,292
Gallons pumped	749,544,900
Average gallons per 24 hours	5,087,400
Revolutions per minute	10.8

Wheel No. 8—325 gallons per revolution:

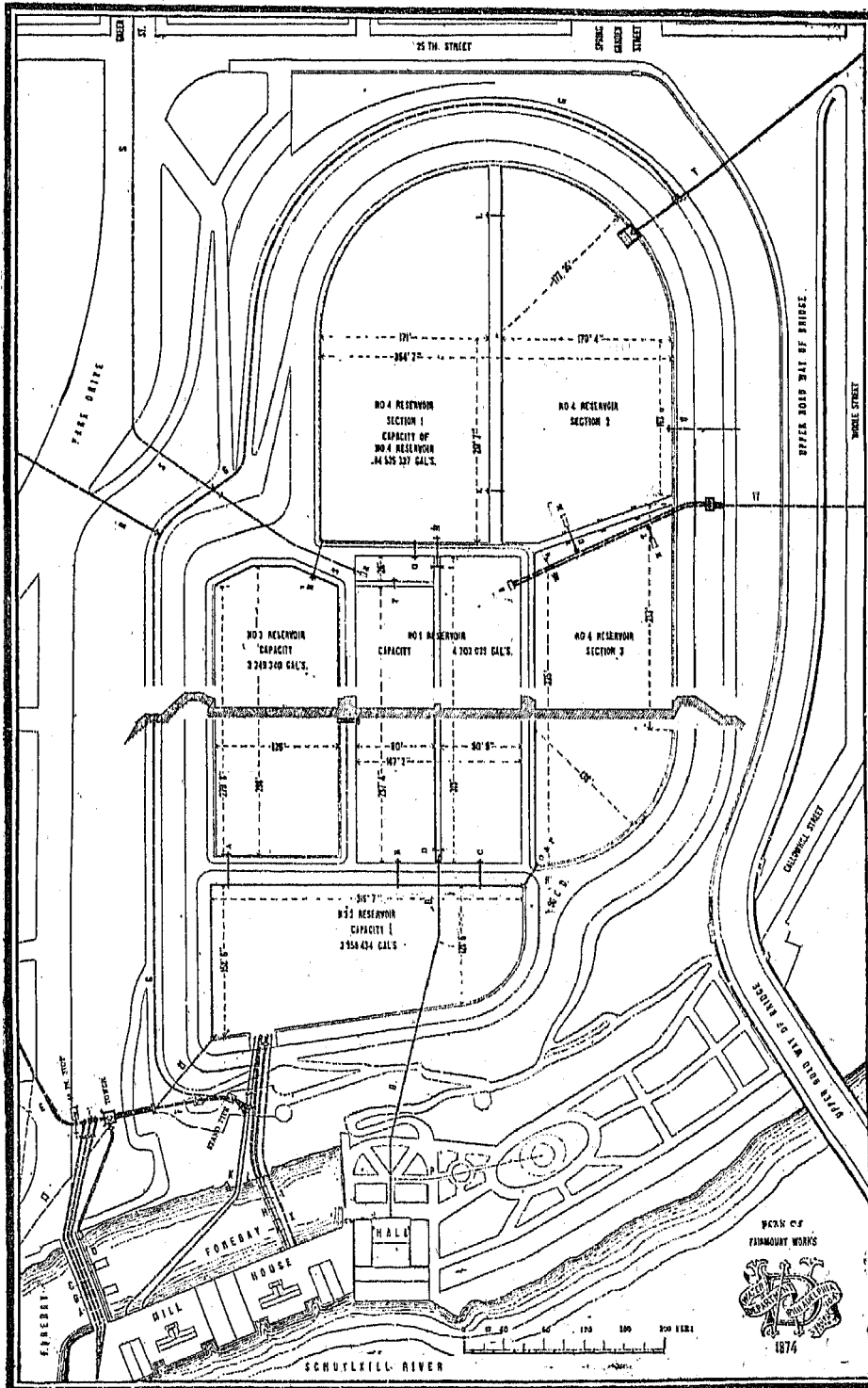
Hours run	4,358
Hours stopped for high or low water or for full reservoir	2,933
Hours stopped for repairs	1,464
Number of revolutions	2,861,458
Gallons pumped	929,973,850
Average gallons per 24 hours	5,121,450
Revolutions per minute	10.9

Wheel No. 9—325 gallons per revolution :

Hours run	4,462
Hours stopped for high or low water or for full reservoir	4,298
Number of revolutions	2,021,842
Gallons pumped	949,698,650
Average gallons per 24 hours	5,107,656
Revolutions per minute	10.9

Summary:

Total number of revolutions	19,800,275
Total number of gallons	7,278,357,488
Average number of gallons per day	37,384,118
Total number of hours	61,320
Total hours run	31,519
Total hours stopped for high or low water or for full reservoir	23,970
Total hours stopped for repairs	5,831
Percentage	0.52, 0.39, 0.09



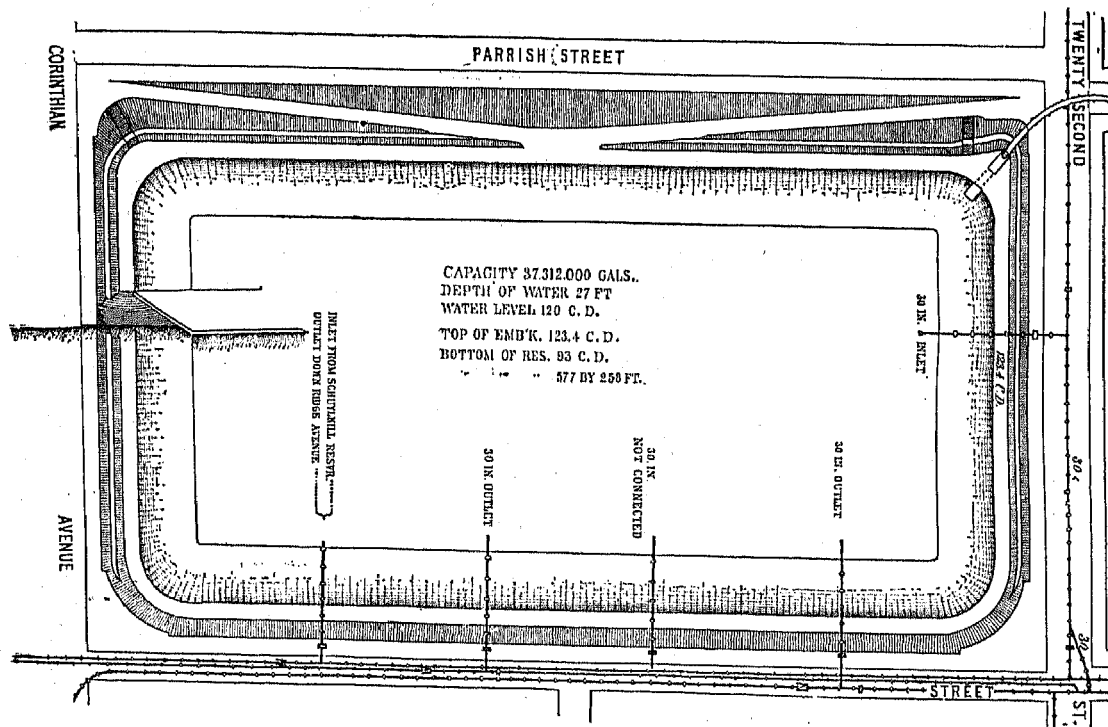
No. 2 can be run only 18 hours per day during high water. From the river the water is pumped through mains of cast iron—the lengths and diameters of which are given below—into two reservoirs. As the quantity of water supplying the turbines was insufficient during a portion of the year, it was found necessary to erect a Worthington engine, which has since been removed to the Frankford works. The details are, however, as follows: It has two double-acting plungers, 16 inches diameter by 24 inches stroke, with an actual capacity of 78.5 gallons per revolution, and running at a velocity of twenty revolutions per minute. Its capacity is 2,500,000 gallons per day. It is operated by one return-flue marine boiler.

A stand-pipe, 71 feet high by 4 feet diameter, is connected with the Fairmount system, the top being 15 feet above high water in the Fairmount reservoir. It has one inlet and two outlets; is of wrought iron, surrounded with brick at base and frame at the top. It is used with the Corinthian Avenue reservoir, and is located about 225 feet from the pumps. A 30-inch main 3,747 feet long connects it with the reservoir.

The Fairmount reservoirs shown in plan on the map on page 129 contain an average of 27,000,000 gallons. The sizes, capacity, and cost may be seen from the annexed statement:

Number.	When finished.	Size in feet.	Depth in feet.	Capacity in ale gallons.	Cost.	
1.....	1815	167 by 317	12½	3,917,659	\$32,508 52	
2.....	1821	140 by 316	12½	3,206,434	9,570 47	
3.....	1827	160 by 317	12½	2,707,205	24,521 75	
4 {	First section...	1835	136 by 350	12½	3,658,016	} 67,214 08
	Second section..	1835	358 by 302	12½	4,381,322	
	Third section...	1836	.....	12½	4,071,250
Total.....				22,031,970	133,824 42	

Capacity in wine gallons, about 27,000,000; water-level, 94.14 feet above city datum.



CORINTHIAN AVENUE RESERVOIR.

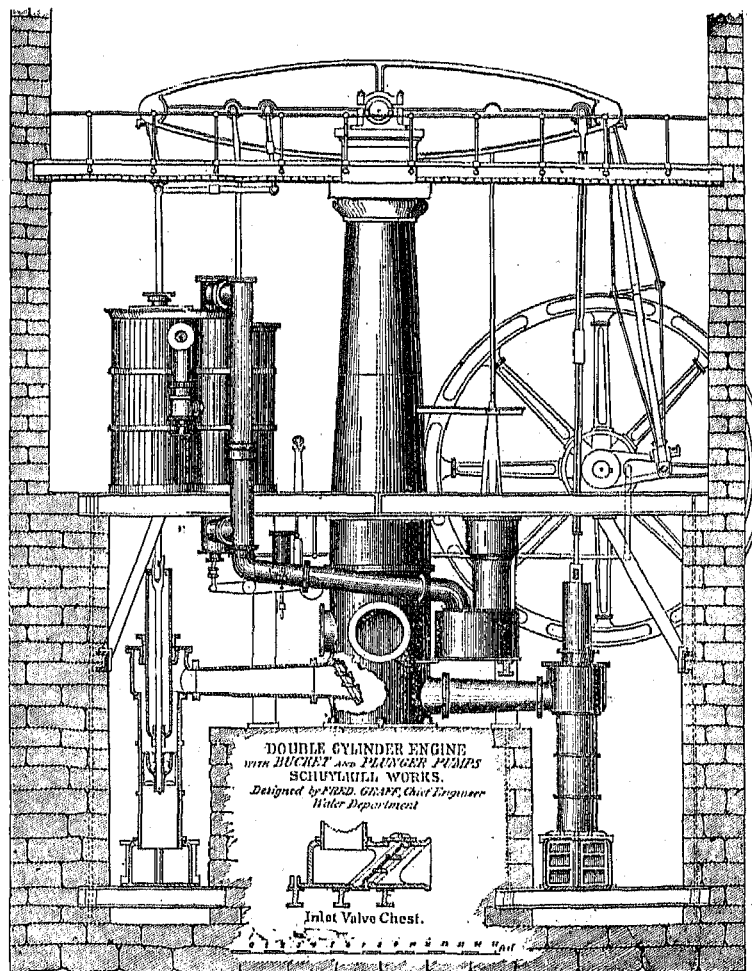
The Corinthian Avenue reservoir was built in 1852. It is 16 feet higher than the Fairmount, and measures 258 by 577 feet on the bottom by 27 feet deep, with a capacity of 37,312,000 gallons; slope of inside face, 1½ to 1; of outer, 1½ to 1; plan, rectangular, with rounded corners; area of water-surface, 4 acres and 50 square rods; width of banks, 12 feet.

The cost of the reservoir was \$46,030. From it a main, 30 inches diameter, passes to Delaware reservoir, a distance of 14,000 feet. There are four 30-inch outlets, one of which is not in use. The following table gives details of the Fairmount wheels at the pumping-station:

Style of wheels and engines.	PUMPING-MAINS.						Reservoir's capacity (gallons).
	Diameter.	Length.	Diameter.	Length.	Diameter.	Length.	
	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	
Worthington engine	12	585	Fairmount, 26,996,636.
No. 1, Jonval wheel	10	433	.....	.....	.....	.....
No. 2, breast-wheel	16	183	.....	.....	.....	.....
No. 3, Jonval wheel	36	240	.....	.....	.....	.....
No. 4, Jonval wheel	36	320	.....	.....	.....	.....
No. 5, Jonval wheel	30	293	Corinthian, 37,312,000.
No. 7, Jonval wheel	20	46	30	273	30	3,747	
No. 8, Jonval wheel	20	46	30	304	48	3,570	
No. 9, Jonval wheel	20	46	30	338	.....	.....

THE SCHUYLKILL WORKS.

These works, the position of which can be seen from the plan on page 126, and formerly known as the Spring Garden works, consist of, (1) pumping-station and engines; (2) force-mains; (3) reservoir.



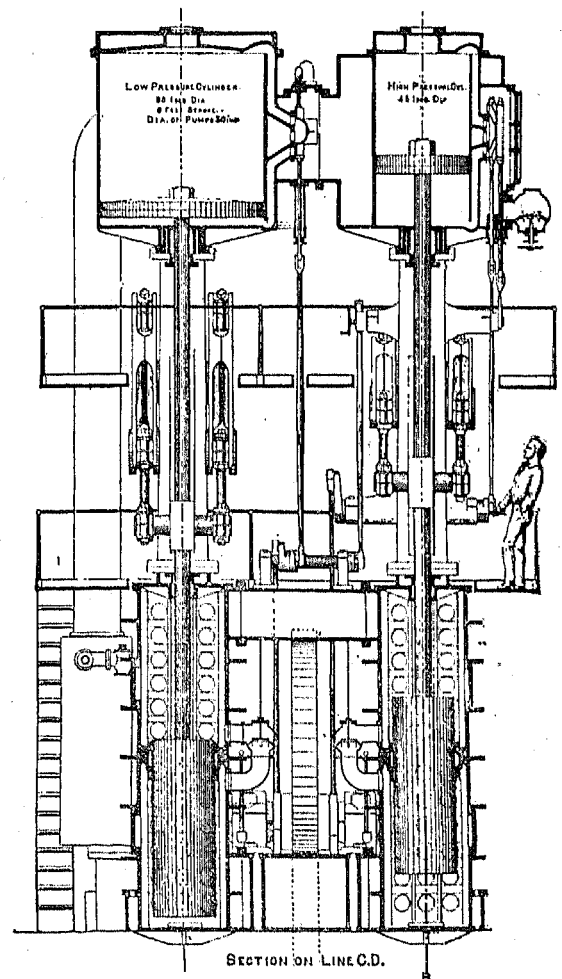
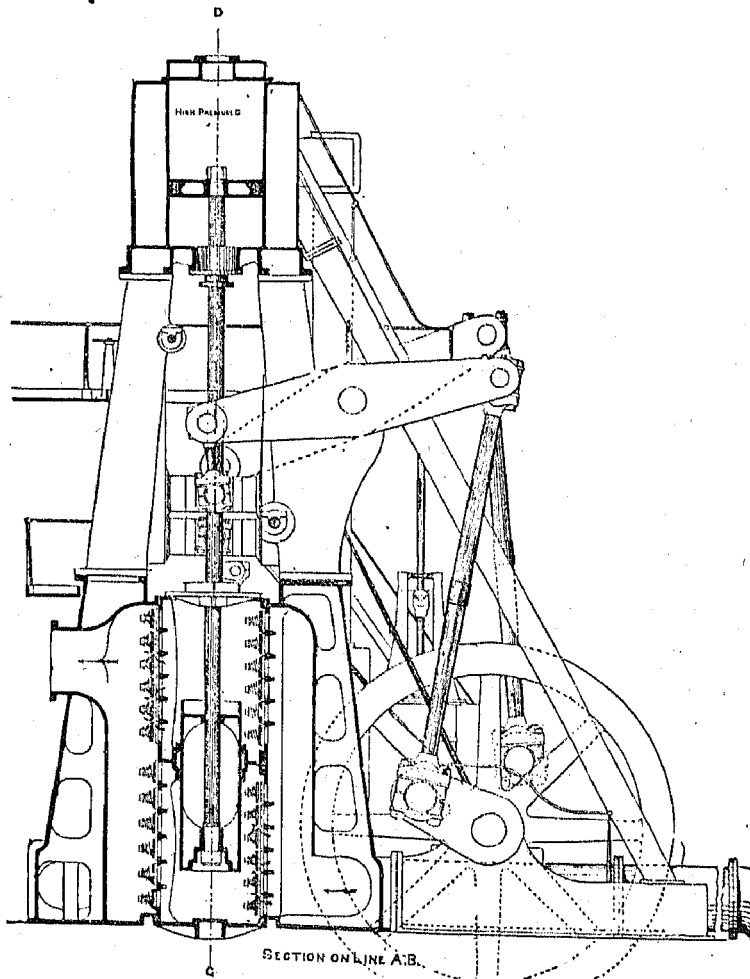
The fore-bay of the engine-house is 450 by 60 feet, and conduits convey the water into the different pump-wells. Of the seven engines which have been used in these works three have been worn out and removed after twenty-five years' service. At present there remain four by the following makers:

Engine No. 4, by I. P. Morris & Co., of Philadelphia, is a Cornish engine with single-acting plunger-pump operated by a beam. The plunger is weighted, and beneath it is a double-beat inlet-valve of cast iron on composition

seats. The discharge-valve is treble-beat. The diameter of steam-cylinder is 60 inches, and stroke 120 inches; pump-cylinder, 30 inches diameter and 120 inches stroke; duty averaged at 50,000,000 foot-pounds, and has reached as high as 58,000,000; air-pump, 22 inches by 5 feet stroke, with a jet-condenser; capacity, about 5,000,000 gallons. Four plain cylinder boilers with two mud-drums, each 4 feet 3 inches diameter of shell by 32 feet long, furnish the requisite steam. The mud-drums are 26 inches diameter by 23 feet long.

Engine No. 5 is a side-lever Cornish, of a capacity of 7,500,000 gallons, operating against a lift of 120 feet, including friction, and of 193 horse-power. It has one single-acting plunger, with pump-cylinder 36 inches diameter; stroke, 120 inches. The diameter of steam-cylinder is 72 inches, and stroke 10 feet. Connected with this is an air-pump 26 inches in diameter by 4 feet stroke. This engine was built in 1869 by Merrick & Sons. During 1879 it pumped 440 hours, at an average of ten revolutions per minute. The theoretical discharge is 528.9 gallons per revolution, forced into the Schuylkill reservoir. It has one inlet- and one outlet-valve in the pump-cylinder.

Steam is supplied by six cylinder boilers, 4 feet 6 inches diameter by 30 feet long, with two mud-drums, each 28 inches diameter by 22 feet long. The duty averaged as high as 50,000,000 foot-pounds in 1879. The pump-valves are of double-beat Cornish pattern.



Engine No. 6 is a compound cylinder rotative of the Simpson type, constructed by Henry G. Morris in 1872. Diameter of low-pressure cylinder, 57 inches; stroke, 96 inches; diameter of high-pressure cylinder, 36 inches, stroke 61 inches; diameter of pump-piston, 28½ inches. The capacity of the engine was guaranteed at 10,000,000 gallons per day at 14 revolutions per minute. Discharge, 500 gallons per revolution. The actual capacity is about 8,000,000 gallons per day, and number of revolutions 11 per minute. It is a bucket-and-plunger pump, with two double-acting plungers and rubber-disk pump-valves, with a lift of 1 inch. The engine is of 294 horse-power, pumping against a height of 170 feet, including friction. It can be made to pump either into the Schuylkill or into the East Park reservoir. It was run 4,900½ hours in 1879. The duty in 1879 averaged about 56,900,000 foot-pounds. It derives steam from a battery of five multitubular boilers, 6 feet in diameter by 15 feet long, containing seventy-five 4-inch tubes each. The air-pump is 22 inches diameter by 4 feet stroke. A jet-condenser used is 4 feet 8 inches by 3 feet 8 inches.

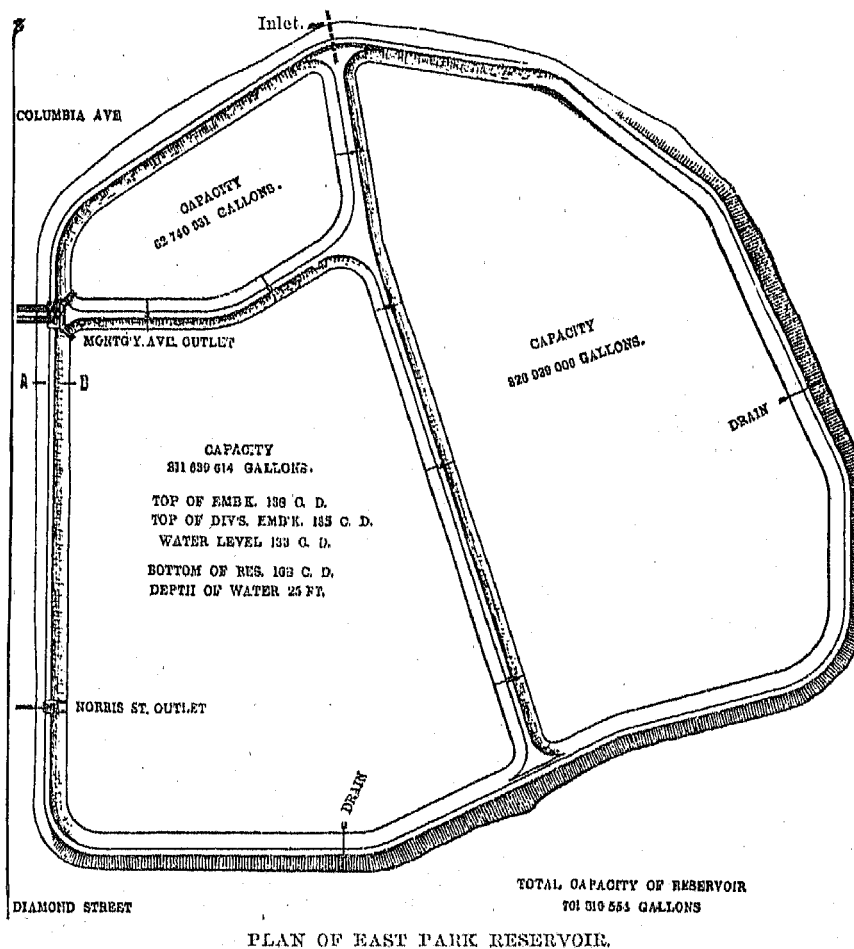
Engine No. 7 is an upright, rotative, independent, compound engine. The cylinders are placed side by side, with a double-acting plunger-pump beneath each. The fly-wheel is at the back, worked by beams obtaining motion from a cross-head between cylinder and pump. The cylinders are 80 inches and 45 inches, respectively, in diameter, by 6 feet stroke. It was constructed to pump into the East Park reservoir, a lift of 130 feet, and the duty was guaranteed at 75,000,000 foot-pounds with the boilers evaporating $9\frac{1}{2}$ pounds of water. The duty-trial showed a capacity of 75,065,689 foot-pounds pumped to a height of 121.96 feet, the boilers having an evaporative power of 8.62 pounds to 1 pound of coal.

The theoretical capacity of the pump is 850 gallons per revolution. The engine in 1879 pumped 2,319,436,660 gallons with a consumption of 1,809 $\frac{1}{2}$ tons of coal, running 3,638 hours, with a lift of 120 feet, including friction. It was built by W. Cramp & Sons, Philadelphia, in 1876. There were no boilers specially provided for the engine, but steam is supplied by those already in use with the other engines at the station. All the engines are seldom run at the same time. In addition to those already mentioned there are two hog-nose tubular boilers, 5 feet diameter by 17 feet 9 inches long, containing eighty-three 3-inch tubes in each, 12 feet long, and one drum, 30 inches by 12 feet, to each boiler.

Another battery of five tubular boilers is now being erected, similar to those described under engine No. 6.

From the Schuylkill station the water is to be pumped through one 48-inch main, 2,100 feet long, into the East Park reservoir, but is at present pumped through two 36-inch, one 20 inch, and two 16-inch mains into the Schuylkill reservoir, a length of 3,300 feet each.

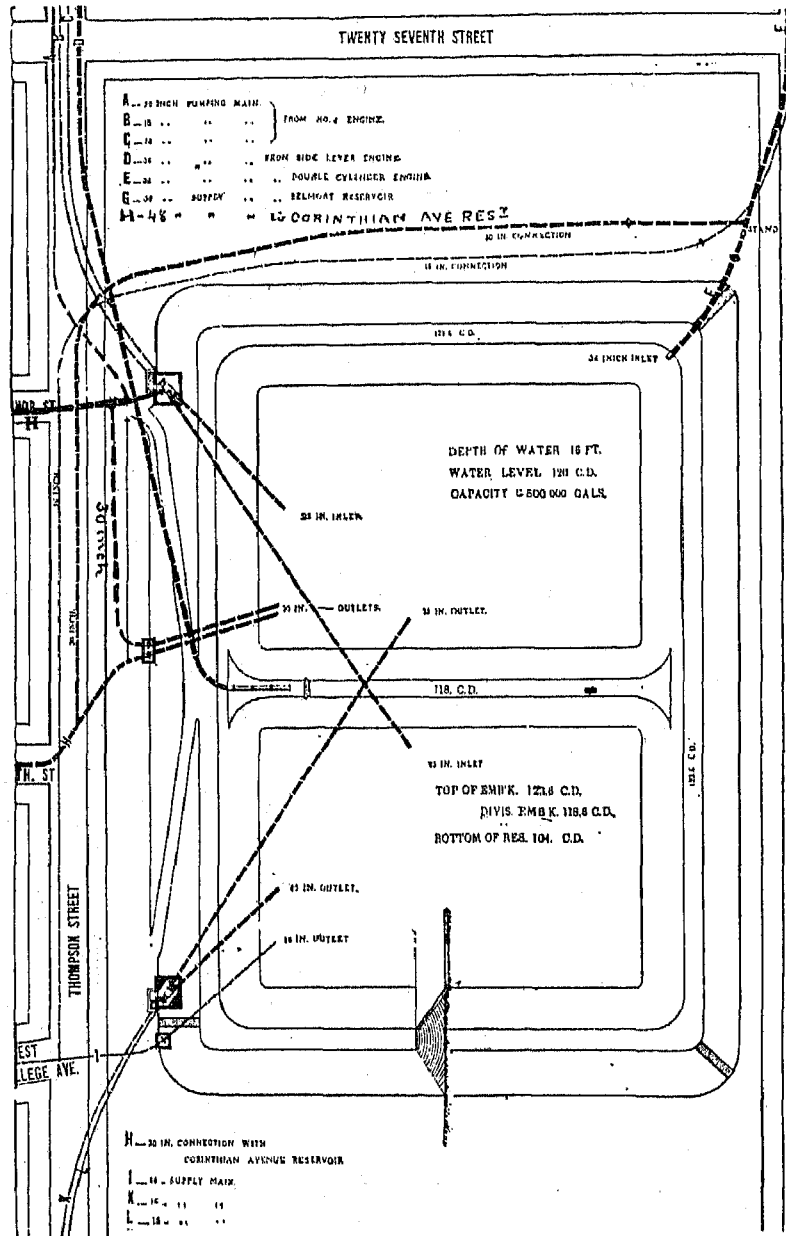
The position of the East Park reservoir is shown on page 126, and its plan in the accompanying drawing. It has never been completed. It is intended to contain 750,000,000 gallons at a depth of 25 feet.



In close proximity to the engine-house is a stand-pipe of wrought-iron, 6 feet in diameter at bottom and tapering to 3 feet 6 inches at top, with an octagonal stone base and ornamental cap and cornice. Height, 137 feet. There are three 30-inch inlets and one 45-inch outlet, the former being directly connected with the engines.

Schuylkill reservoir, sometimes known as Spring Garden reservoir, is located on the corner of Twenty-seventh and Master streets, 3,250 feet on the line of the main from the pumping-station, at a height of 120 feet above city datum, and has a capacity of 9,800,000 gallons, with an area of water-surface of 2 acres and 108 square rods. It is formed of earth embankments, puddle-faced, and riprapped with brick, and contains a division-wall built within 4 feet of the top, which divides it into two basins, one of which is the receiving and the other the distributing

section, the water flowing over it like a weir at high water. It is 16 feet deep when full, and is 510 feet long by 368 feet wide. Width of banks at top, 13 feet; slope, $1\frac{1}{2}$ to 1. There are three supply-mains, each 16 inches in diameter.



PLAN OF SCHUYLKILL RESERVOIR.

THE BELMONT WORKS.

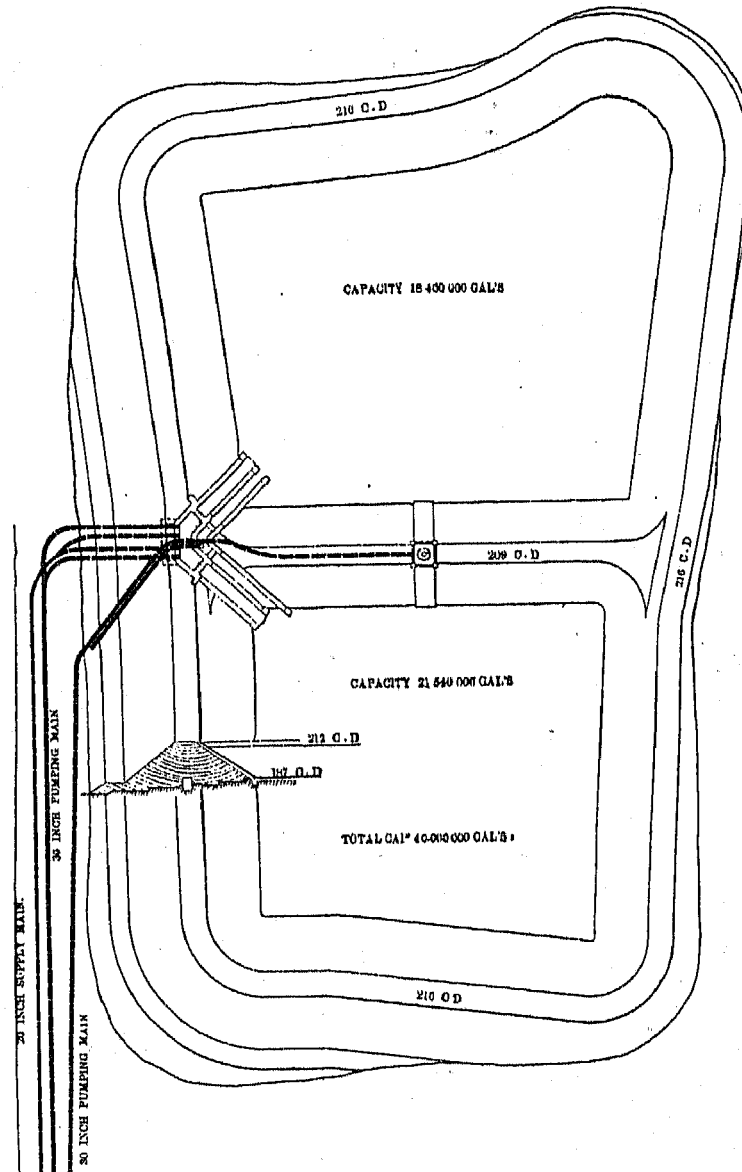
These works are located on the west bank of the Schuylkill at Thirty-ninth street, and on a line with Columbia avenue. They consist of, (1) a pumping-station with three engines; (2) force-mains; (3) distributing reservoirs. The present works, in 1870, replaced the old Twenty-fourth Ward works. The buildings are of stone, the engine-house being circular, and two wings contain the boilers. The original engines were removed in 1870, and three Worthington engines were substituted; two of these are alike, and are of the following dimensions: Low-pressure cylinder, $50\frac{1}{2}$ inches in diameter; high-pressure cylinder, 29 inches in diameter; pump-plunger, $22\frac{1}{2}$ inches in diameter; stroke, 4 feet; stroke of air-pumps, 2 feet. They are each of 5,000,000 gallons capacity, and at a test of engine No. 2 in 1872 a duty of 54,417,000 foot-pounds was obtained.

Engine No. 3, of 8,000,000 capacity, has a low-pressure cylinder $58\frac{1}{2}$ inches in diameter, high-pressure cylinder $33\frac{3}{4}$ inches in diameter, pump-plungers 28 inches in diameter, stroke 4 feet; connected with it are four air-pumps, two of which are each $23\frac{3}{4}$ inches in diameter by 23 inches stroke, and two others each $29\frac{3}{4}$ inches in diameter by 23 inches stroke.

For engines Nos. 1 and 2 there are six cylinder boilers, each 42 inches in diameter; 30 feet long, and having one drum 30 inches by 22 feet. For engine No. 3 there are eight cylinder boilers, each 54 inches in diameter, 30

feet long, with two mud-drums each 28 inches in diameter by $22\frac{1}{2}$ feet long. These engines pump against a head of 207 feet and run at an average of 12 revolutions per minute. No. 1 pumped 1,291,341,900 gallons with a consumption of 3,070.1 tons of coal during 6,022 hours. No. 2 pumped 638,127,672 gallons during 2,957 $\frac{1}{4}$ hours, consuming 1,481 $\frac{3}{4}$ tons. No. 3 pumped 2,025,493,345 gallons during 5,414 $\frac{1}{2}$ hours, consuming 4,067 $\frac{1}{2}$ tons of coal.

No. 1 pumps through a 30-inch main 4,400 feet long, into the Belmont reservoir. The discharge-pipes of Nos. 2 and 3 unite into one 36-inch main, 4,200 feet long, also discharging into the Belmont reservoir.



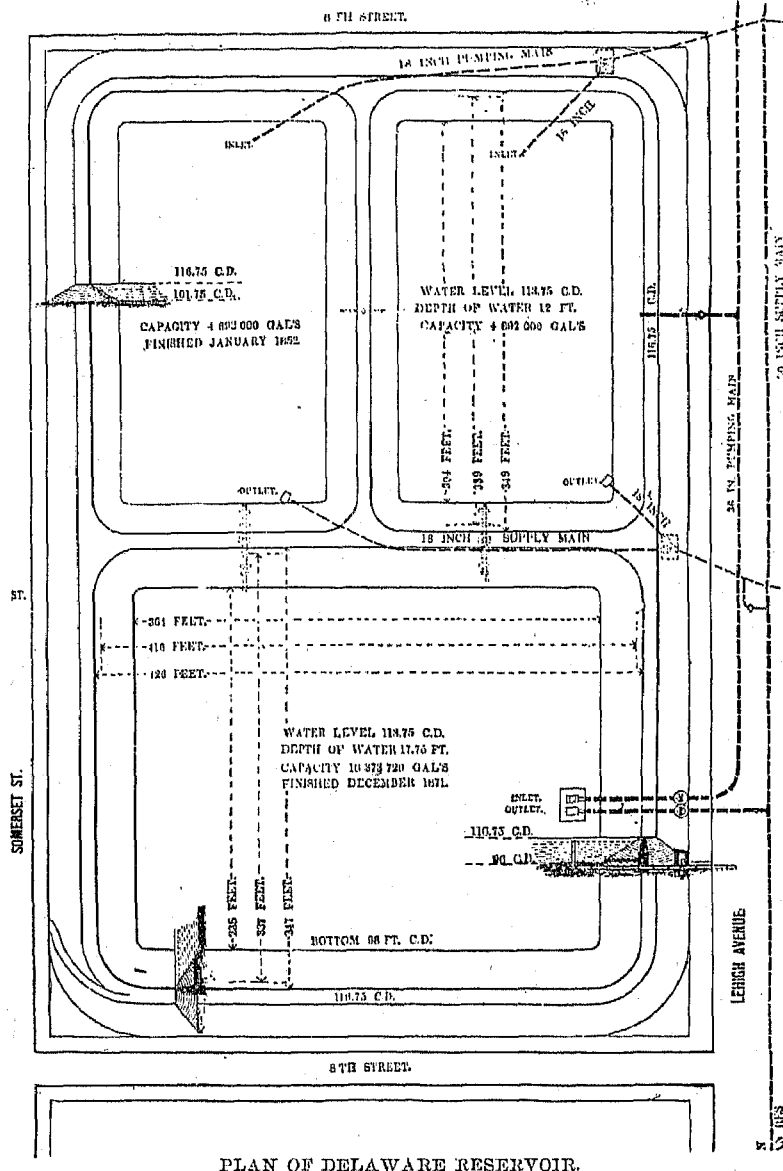
PLAN OF BELMONT RESERVOIR.

Belmont reservoir, 4,000 feet east of the works, is rectangular, with a high-water surface of 6 acres and 46 square rods, a capacity of 40,000,000 United States gallons, and a depth of 25 feet when full. High-water surface is 212 feet above city datum. The reservoir is 675 feet long by 450 feet wide; bottom area 375 feet wide by about 260 feet long in each of its two compartments. There is one 20-inch supply-main from the eastern compartment.

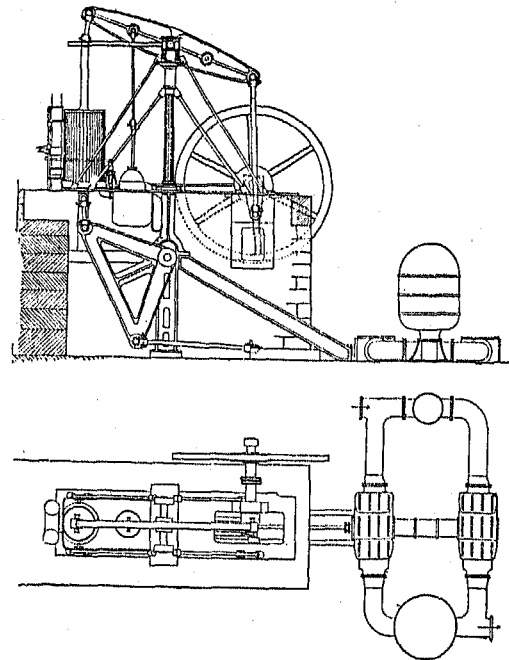
THE DELAWARE WORKS.

These works are located on the right bank of the Delaware at the foot of Otis street. The engine-and-boiler house is a brick building erected in 1851. The original cost of the works was \$200,000. In the pump-house there are three engines. The first, or No. 1, is a double-acting, high-pressure, horizontal engine, operating a double-acting horizontal pump, whose piston is worked by a vertical beam 18 feet long, to the upper end of which are connected both the connecting-rod of the steam-cylinder and the connecting-rod of a fly-wheel. The diameter of the steam-cylinder is 30 inches; diameter of pump-cylinder, 18 inches; stroke, 72 inches; actual discharge, 145 gallons per revolution; capacity, 3,750,000 gallons; average number of revolutions per minute, 18. The pumps contain metallic flap-valves seated in at an angle of 45°. Engine No. 2 is a condensing beam-

engine with a vertical cylinder. One end of the beam is connected with the fly-wheel, and from the other a piston-rod passes through the steam-cylinder and is connected by a short link with a horizontal arm of a right-angled bell-crank lever, from the lower vertical arm of which the pump-rod is operated. The steam-cylinder is 42 inches in diameter; pump-cylinder, 19½ inches in diameter; stroke, 6 feet; pump, double-acting; actual capacity, 172 gallons per revolution; average number of revolutions per minute, 18; daily capacity, 4,500,000 gallons; air-pump 21 inches in diameter, 3 feet stroke. It was built by Reaney & Neafie in 1851. The pumps of engines Nos. 1 and 2, which are several feet below the level of the river, are connected to a single 18-inch main 12,000 feet long, emptying into the Delaware reservoir. Engine No. 2 is shown in the cut. The highest actual duty of engine No. 1 in 1879 was 37,000,000 foot-pounds, the average being about 34,300,000. The average duty of No. 2 during the same period was 33,675,000 foot-pounds. Engine No. 3 is a 6,000,000-gallon Worthington with two double-acting plungers, erected in 1871. The plungers are 24 inches in diameter; steam-cylinders: high-pressure, 21 inches in diameter; low-pressure, 33½ inches in diameter; stroke, 4 feet; average number of revolutions per minute, 12; actual discharge, 357 gallons per revolution. This engine discharges through a cast-iron main 36 inches in diameter and 12,493 feet long into the new section of the Delaware reservoir. The three engines above described, Nos. 1, 2, and 3, during 1879 pumped 2,194,470,977 gallons with a consumption of 2,980½ tons of coal, against a head of 133 feet, including friction, during a total of 9,869 hours.



was 33,675,000 foot-pounds. Engine No. 3 is a 6,000,000-gallon Worthington with two double-acting plungers, erected in 1871. The plungers are 24 inches in diameter; steam-cylinders: high-pressure, 21 inches in diameter; low-pressure, 33½ inches in diameter; stroke, 4 feet; average number of revolutions per minute, 12; actual discharge, 357 gallons per revolution. This engine discharges through a cast-iron main 36 inches in diameter and 12,493 feet long into the new section of the Delaware reservoir. The three engines above described, Nos. 1, 2, and 3, during 1879 pumped 2,194,470,977 gallons with a consumption of 2,980½ tons of coal, against a head of 133 feet, including friction, during a total of 9,869 hours.



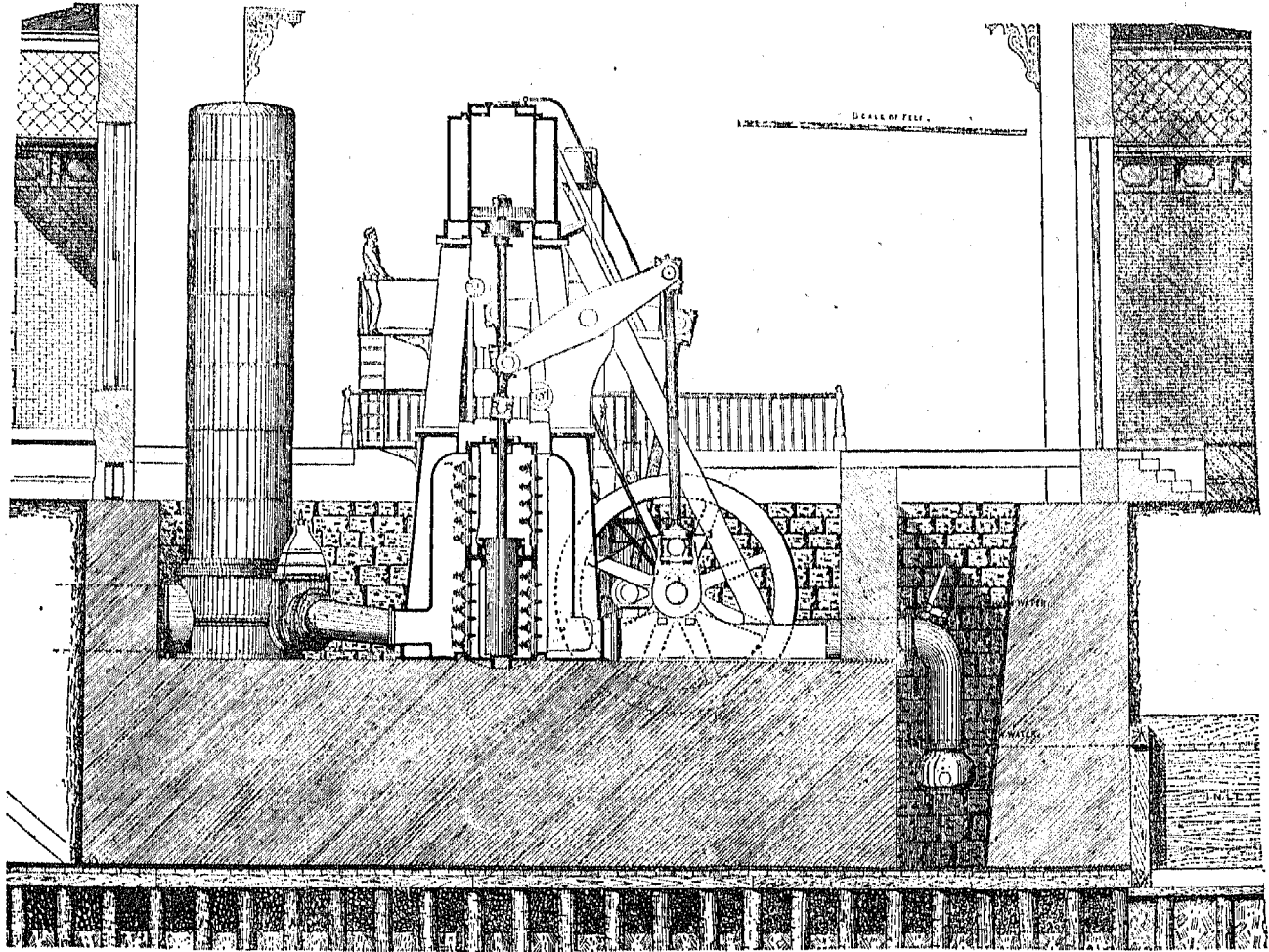
The Delaware works, to furnish steam for the above engines, contain each eight cylinder boilers 42 inches in diameter and 26 feet long, with one drum 30 inches in diameter by 16½ feet long. Another battery has five plain tubular boilers each 6 feet in diameter, 15 feet long, and each containing seventy-five 4-inch tubes. The pumps deliver their supply into a stand-pipe 5 feet in diameter by 157 feet high. It has a stone base and plain shaft. There are one 30-inch and two 18-inch inlets, one 18-inch and one 30-inch outlet extending to the Delaware reservoir.

Delaware reservoir, located at Seventh and Somerset streets, is in three divisions, the largest one of which was built in 1871 as an addition to the small ones. It covers an area of 3.29 acres, with a depth of water of 17 feet 9 inches, and contains 16,373,718 United States gallons. It is 500 feet long by 400 feet wide at high-water surface; slope of banks 1½ to 1; each of the smaller sections is 425 feet long by 240 feet wide. The depth of water in the old sections is only 12 feet, and the combined capacity 9,800,000 gallons, making the total capacity of the Delaware reservoirs 26,173,718 gallons. The water-surface is 114 feet above city datum. The old sections are formed by

embankments puddled with clay and lined with bricks laid in cement; slope $1\frac{1}{2}$ to 1. There are two 18-inch supply-mains leading from this reservoir to the distribution mains, and a 30-inch main, previously mentioned, connects it with the Corinthian Avenue reservoir.

THE FRANKFORD WORKS.

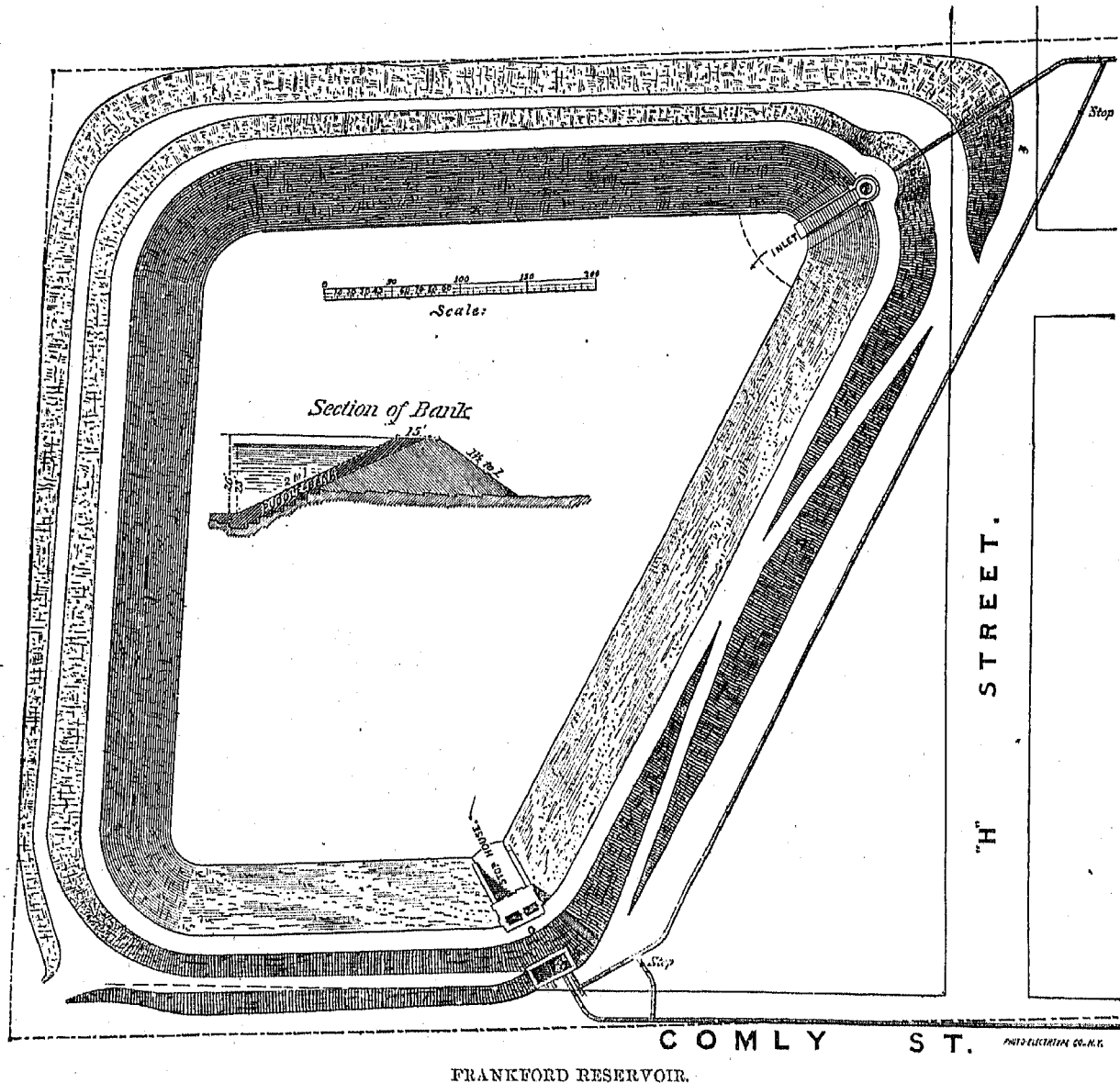
These works are located at Eugene and Robbins streets, on the right bank of the Delaware river, about $5\frac{1}{2}$ miles above the Delaware works. They consist of a pumping-station, a force-main, and a reservoir. The main engine-house is 60 feet long by 47 feet wide, with the boiler-house 72 feet long by 40 feet wide. It contains one Cramp engine and a Worthington donkey-engine of a capacity of 2,500,000 gallons. The former, built by W. Cramp & Sons, in 1877, is a compound rotative with a high-pressure cylinder 40 inches in diameter, low-pressure 69 inches



CRAMP ENGINE—FRANKFORD WORKS.

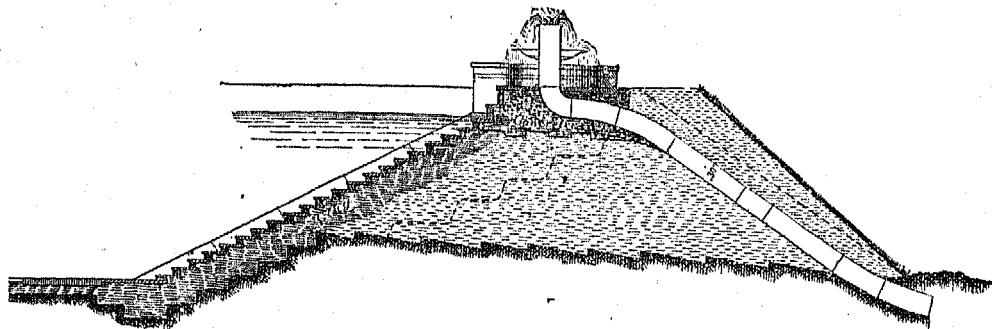
in diameter, each 5 feet stroke, operating two double-acting plunger-pumps, each 21 inches in diameter by 5 feet stroke, placed vertically beneath the steam-cylinders. The piston-rod is connected, by means of a short link, at a point midway between the steam- and the pump-cylinder, to a horizontal working-beam, the other end of which operates a fly-wheel. The capacity of this engine is 9,500,000 gallons. Each pump-cylinder contains 40 puppet-valves, each 8 inches in diameter. The average quantity pumped at present by these engines amounts to 3,500,000 gallons per day. For this and the Worthington engine four marine-boilers are used, each 9 feet 10 inches long, 9 feet 6 inches wide, and 11 feet 6 inches high, containing 130 4-inch tubes in each, and evaporating $10\frac{1}{2}$ pounds of water per pound of coal. Their furnaces are two to each boiler, and 3 feet $1\frac{1}{2}$ inch by 3 feet 7 inches in section. The Cramp engine during 1879 pumped 583,081,803 gallons with a consumption of $807\frac{3}{4}$ tons of coal, against a lift of 203 feet, including friction, running 1,764 hours, the number of revolutions per minute averaging 16. Actual duty varies from 50,000,000 to 60,000,000 foot-pounds. The Worthington engine in the same year pumped 182,469,990 gallons, consuming $470\frac{1}{2}$ tons of coal while running 1,874 $\frac{1}{4}$ hours. Duty varies from 20,000,000 to 30,000,000 foot-pounds. A view of the Cramp engine and a sectional view of the pumping-station are given in the above cut.

Frankford reservoir.—From the pumping-station the water is forced through a main 20,250 feet long and 30 inches diameter into the Frankford reservoir, 167 feet above city datum. It is trapezoidal in plan, as shown in the



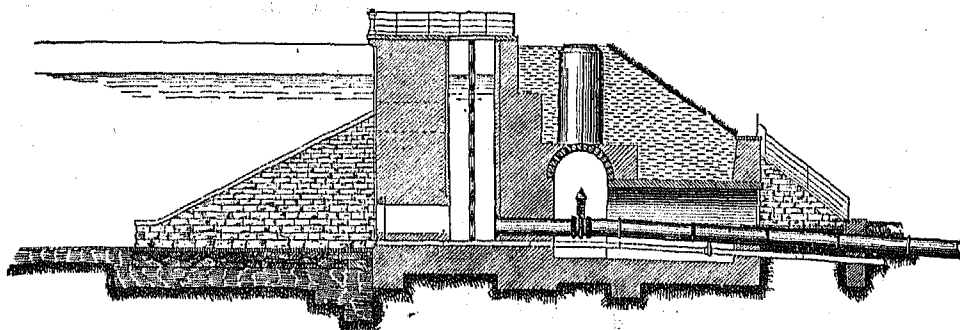
FRANKFORD RESERVOIR.

cut, with a bottom area of 166,250 square feet; water-level area, 248,250 square feet; capacity, 35,750,000 gallons; depth, 23 feet; height of banks, 3 feet above high-water level; width of banks at top, 15 feet. The force-main discharges over the eastern corner of the bank, falling over a flight of stone steps, as shown, into the reservoir.

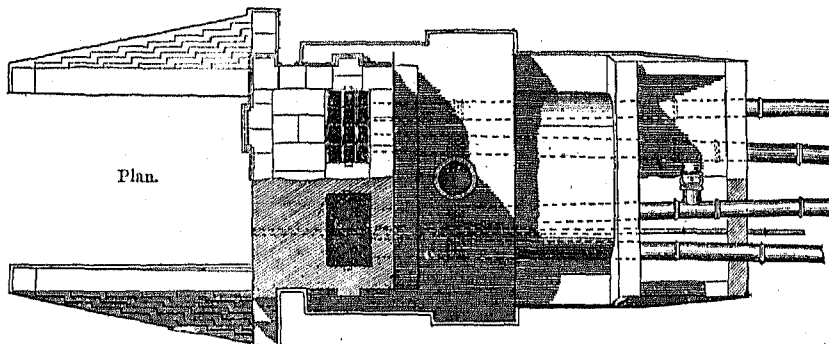


SECTION OF EMBANKMENT AT INLET.

The slope of the interior face is 2 to 1; exterior, $1\frac{1}{2}$ to 1. The interior is puddled 4 feet thick. Details of the gate-house are shown in the cuts on page 139. From the reservoir a single 20-inch main supplies the Frankford reservoir.

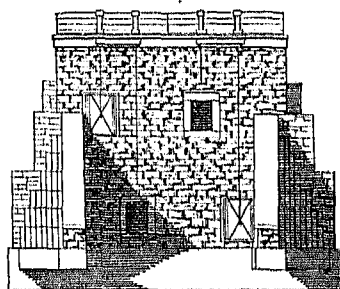


LONGITUDINAL SECTION THROUGH STOP-HOUSE.



Plan.

Front elevation.



Rear elevation.

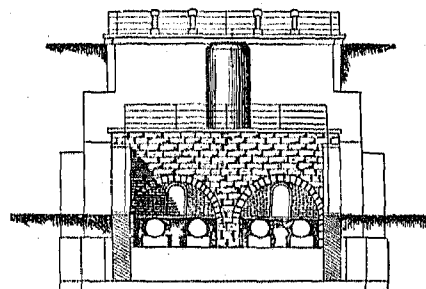


PHOTO-ELECTROTYPE CO. N. Y.

DETAILS OF GATE-HOUSE, FRANKFORD RESERVOIR.

THE ROXBOROUGH WORKS.

These works are located on the left bank of the Schuylkill river about 5.7 miles above the Belmont pumping-station, and consist of the main pumping-station, a force-main, and the Roxborough reservoir. By means of a line of connecting main and an inverted siphon and a pipe-bridge shown in the cut on page 140, a second reservoir, known as Mount Airy reservoir, is supplied by gravity from the Roxborough basin. The pumping-station contains two engines, a Cornish and a Worthington, the former of a capacity of 2,289,000 gallons, the latter of a capacity of 4,248,000 gallons. The Cornish engine was erected in 1869 and the Worthington in 1872. The former has one single-acting plunger $20\frac{1}{2}$ inches in diameter by 10 feet stroke. The diameter of the steam-cylinder is 72 inches, stroke 10 feet, to which an air-pump is connected 36 inches in diameter by 5 feet stroke. The average number of revolutions per minute is 10, and the actual capacity 159 gallons per revolution. During 1879 it pumped 161,442,240 gallons, with a consumption of $78\frac{1}{2}$ tons of coal, and running a total of 720 hours. The lift, friction included, was 378 feet. The duty performed in 1879 varied from 34,800,000 to 40,000,000 foot-pounds.

The Worthington engine has two double-acting plungers each 22 inches diameter, with high-pressure cylinder 36 inches in diameter, low-pressure cylinder 58 inches diameter, by 4 feet stroke. The capacity at 10 revolutions per minute is 295 gallons per revolution. During 1879 it pumped 979,914,480 gallons with a consumption of $3,287\frac{1}{4}$ tons of coal against a head of 345 feet, including friction, running in all 4,863 hours, developing a duty varying from 31,000,000 to 46,000,000 foot-pounds. To operate the Roxborough pumping-engines there are eight cylinder boilers, each 36 inches in diameter by 36 feet long, and two patent boilers of 100 horse-power each, with an evaporative power of 8 pounds of water to 1 pound of coal. The discharge-pipes from both engines combine into one of 20 inches diameter and 3,824 feet long, through which the water is forced into the Roxborough reservoir.

This has a capacity of 11,771,700 gallons, is 18 feet 6 inches deep, situated northeast of the pumping-works, and having a high-water area of 2 acres and 47 square rods, at an elevation of 365 feet above city datum. It is 410 feet long by 240 feet wide. The embankments are of earth faced with puddle 1 foot thick at top and 2 feet at bottom. Slope $1\frac{1}{2}$ to 1. It is lined with brick laid on edge in cement.

Mount Airy reservoir, supplied by gravity from Roxborough, is 15 feet deep, high-water surface 49,553.5 square feet, 363 feet above city datum, with a capacity of 4,390,000 gallons. The connecting main is 20 inches in diameter and 3.8 miles long, crossing the Wissahickon river by an inverted siphon, the difference in elevation between the two reservoirs being $2\frac{3}{4}$ feet, and the pipes at the bottom of the valley being under a head of 295 feet.

THE CHESTNUT HILL WORKS.

For the supply of Chestnut hill the city government in 1873 purchased for \$65,000 the Chestnut Hill water-works. The water is taken from a well and a spring by two horizontal high-pressure engines, working one double-acting pump 7 inches in diameter by 4 feet stroke, and raising the water 125 feet into a tank with a capacity of 40,000 gallons, through an 8-inch main 480 feet long. In 1876 an Olds pump was added. During 1879 the number of gallons pumped was 87,532,350, consuming 465 tons of coal in a total of 4,106 hours. At these works there are used two cylinder boilers, each 30 inches in diameter by 30 feet long, each having one drum 30 inches by $7\frac{1}{2}$ feet.

On Roxborough ridge a pumping-station has been erected, the plan and elevation of which is shown in the figure, containing one Worthington engine with a pumping capacity of 400,000 gallons per day, and pumping into two tanks, each 30 feet in diameter by 6 feet deep, with a total capacity of 100,000 gallons, the water-surface of which is 440 feet above city datum. They are erected on trestle-work. These works are known as the Roxborough auxiliary, and in 1879, pumping one day in six, elevated 3,389,250 gallons 80 feet high, including friction, with a consumption of 61 tons of coals during 1,735 hours.

A stand-pipe formerly used in the West Philadelphia system, and shown on page 142, is to be removed to the Schuylkill works. It is 5 feet in diameter and 130 feet high, to be increased to 153 feet. The stone base is 37 feet high and 15 feet in diameter. One $38\frac{1}{2}$ -inch outlet and one 20-inch inlet.

The distribution is carried out through 730 miles and 1,171 feet of cast-iron main of the dimensions 48, 36, 30, 20, 18, 16, 12, 10, 8, and 6 inches, respectively, in diameter, in which there are 5,819 fire-hydrants known as the Philadelphia pattern.

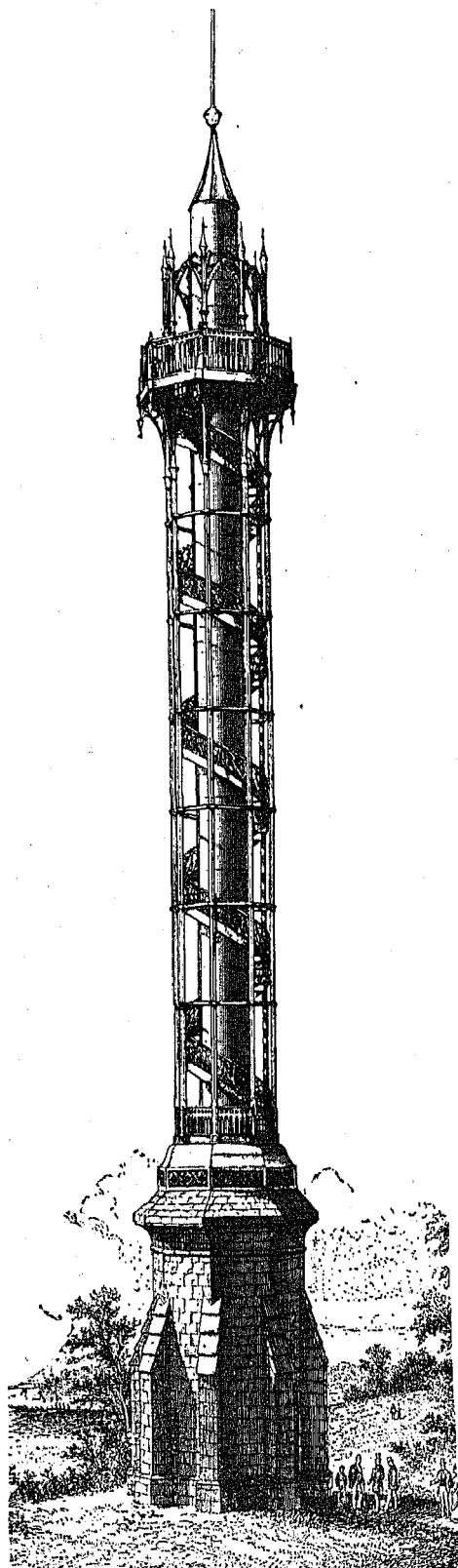
In 1880 the consumption averaged 57,707,082 gallons per day. The original cost of the old Schuylkill and Center Square works to the time of introduction of steam at Fairmount was \$657,398. The cost of the Fairmount works to 1855 was \$3,356,627, and the total cost of all works to January 1, 1880, is \$15,828,331. The annual cost of maintenance for 1879, exclusive of extension and interest, was \$295,278. The number of water-takers in 1879 was 150,000.

The annexed table gives analyses of the Schuylkill and the Delaware rivers at intervals since 1842. The figures represent number of grains in 1,000 gallons :

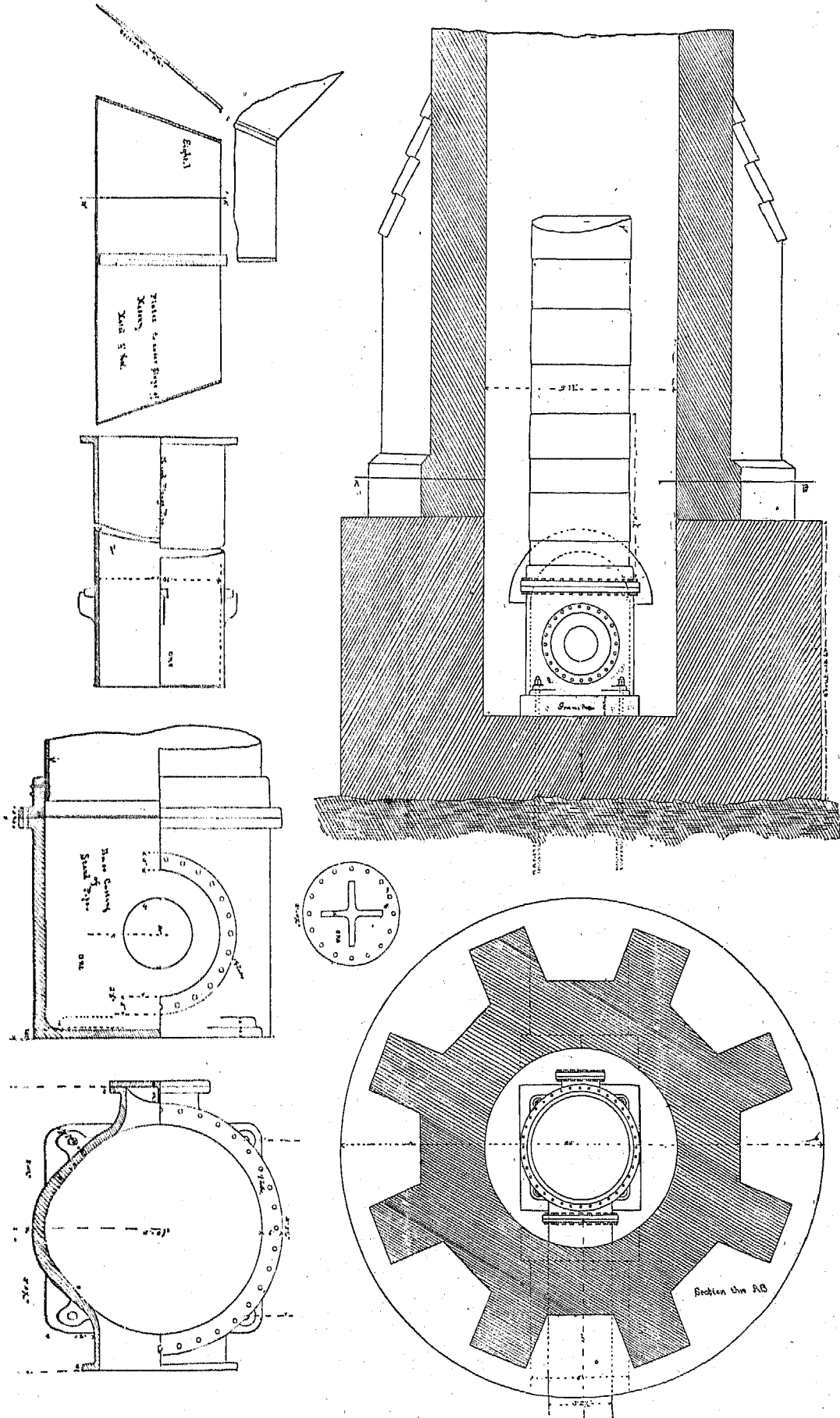
Constituents.	DATE OF ANALYSIS.			
	1842.	1854.	1862.	1875.
Lime	1,226	1,404	1,457	1,821
Magnesia	240	606	835	802
Soda	455	348	131	568
Sulphuric acid	302	1,417	1,508	2,445
Alumina and oxide of iron	77	08	75	Trace.
Chlorine	80	168	130	155
Silica and insoluble matter	385	(a)	330	348
Organic matter, carbonic acid, water of hydration, etc	1,650	2,008	2,556	1,900
Total solid matter per 1,000 gallons determined direct...	4,421	6,100	7,040	8,138

a Undetermined.

There is a striking increase in the solid matter in the water from (4,421 grains) 10 ounces in 1842 to (8,138 grains) 18 ounces in 1875, gradually rising, as shown in the totals of 1854 and 1862.



WEST PHILADELPHIA STAND-PIPE.



DETAILS OF STAND-PIPE FOR SPRING GARDEN WORKS.

WATER-SUPPLY OF CITIES—SAINT LOUIS, MO.

Below is given a statement of the running expenses in 1879 for pumping only:

Running expenses for all the works for the year 1879.

	WORKS.								Total.
	Schuylkill.	Delaware.	Belmont.	Roxborough auxiliary.	Roxborough.	Chestnut Hill.	Frankford.	Fairmount.	
Salaries of engineers and firemen	\$11,818 00	\$10,575 00	\$12,000 00	\$300 00	\$6,345 00	\$777 00	\$6,525 00	\$10,575 00	\$59,515 00
Coal (tons).....	4,735½	2,081	8,019	61	3,885½	465	1,278	174	22,179
Price per ton.....	\$3 13	\$3 02	\$2 70	\$3 10	\$3 00	\$3 00	\$3 20	\$3 20	.....
Amount.....	\$14,822 11	\$9,002 62	\$29,271 80	\$189 10	\$11,983 05	\$1,674 00	\$4,030 60	\$560 80	\$65,588 58
Lubricating, cylinder, and castor oil (gallons).	600½	354½	873	3	334½	93½	93½	200½	2,770
Price per gallon.....	c \$0 30	.....	.....	d \$1 10	.....	.....	.....	.....	.....
Amount.....	\$207 07	\$106 27	\$201 00	\$0 00	\$100 42	\$28 12	\$28 05	\$78 22	\$883 38
Tallow (pounds).....	7,430	562	5,297	0	533	616½	386½	117	14,948
Price per pound.....	\$0 09½	\$0 09½	\$0 09½	\$0 09½	\$0 09½	\$0 09½	\$0 09½	\$0 09½	.....
Amount.....	\$705 85	\$53 80	\$503 21	\$0 57	\$50 63	\$58 50	\$36 72	\$11 12	\$1,420 05
Lighting works, gas.....	\$1,725 27	\$990 00	.....	.....	.....	.....	.....	\$2,254 51	\$4,070 74
Lighting works, oil.....	.....	.....	\$122 78	\$0 70	\$48 20	\$5 98	\$45 00	\$0 03	\$288 81
All repairs.....	\$2,881 71	\$811 18	\$1,306 04	.....	\$1,203 54	.....	\$930 33	c \$3,233 40	\$15,960 80
Packing and small stores.....	\$770 87	\$130 05	\$780 00	.....	\$62 10	\$47 83	\$90 00	\$1,000 83	\$2,909 58
Total expenses.....	\$22,039 88	\$21,070 37	\$38,005 83	\$401 33	\$10,793 00	\$2,502 00	\$11,744 70	\$22,847 40	\$151,033 00
Cost of raising 1,000,000 gallons into reservoir.	\$7 37	\$0 88	\$0 84	\$144 57	\$17 34	\$29 02	\$15 34	\$3 14	.....
Total gallons pumped.....	4,408,480,020	2,104,470,077	3,054,002,017	3,380,250	1,141,350,720	87,532,350	763,551,793	7,278,357,488	10,801,101,515
Lift, in feet, including friction.....	120 150 170	133	210 207	80	358 345	125	203	100	.....
Number of gallons pumped 100 feet high, friction included.	5,062,060,662	2,018,046,399	8,802,004,000	2,711,400	3,058,008,175	100,415,437	1,554,070,130	7,278,357,488	29,767,820,000
Cost of raising water 100 feet high per 1,000,000 gallons, friction included.	\$5 82	\$7 42	\$1 00	\$181 97	\$5 00	\$23 70	\$7 55	\$3 14	.....
Days run.....	293	353	305	364	365	365	247	304	.....

a \$2,098, extra firemen, paid from item "Buildings and grounds".
 b Including 523½ tons, banking, starting fires, and heating building.
 c Lubricating oil.

d Castor oil.
 e Rebuilding turbines No. 4, \$4,622 05, not included.

Total expense of water pumpage alone, without interest on plant, \$3 14.
 Total expense of steam pumpage alone, without interest on plant, \$5 69.
 Total expense of water and steam pumpage together, without interest on plant, \$5 07.

The department of water-works is under the supervision of William H. McFadden, C. E., with Mr. J. T. Hickman as chief clerk.

The cost of pumping is increased to an enormous extent in this city, owing to the poor quality of the boilers and their very low evaporative power. Of the sixty and more in use the great majority are of the plain cylinder type, with an evaporation of 5½ pounds of water to a pound of coal. A few of the remaining have as high an evaporative power as 8½ to 1. The better class of boilers as found in other works evaporate as high as 10 to 12 pounds of water to a pound of coal, the difference between the two representing the loss to the city every year. See *Report of Water Department of Philadelphia, 1876.*

A number of the older engines are of low duty and expensive character both in maintenance and in first cost.

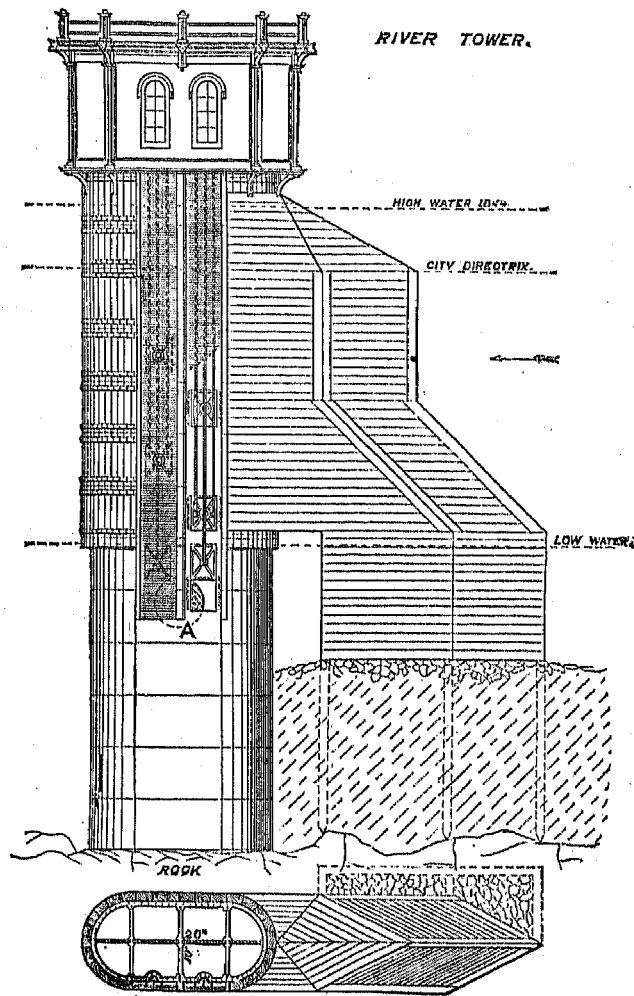
There has for several years been a project under consideration for increasing the supply by a gravity system from Perkiomen creek.

SAINT LOUIS, MISSOURI.

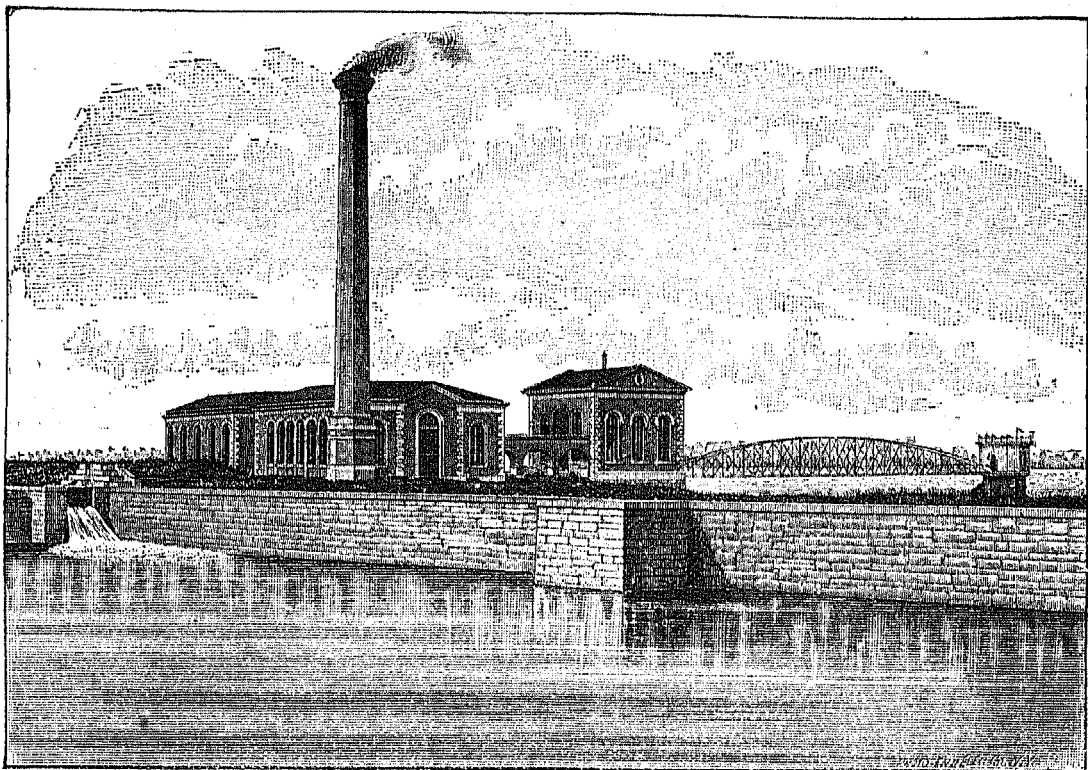
Saint Louis is situated on the west bank of the Mississippi river 16 miles below the mouth of the Missouri, and 1,294 miles from the Gulf. It is located on ground rising in three terraces from the river, and on a foundation of limestone. The population, 350,518, is spread over an area extending 14 miles along the river and 9 miles inland. The streets generally intersect each other at right angles. Its interests are principally mercantile and manufacturing.

Water from the river was first introduced in 1830, but a set of new works, designed and constructed under the direction of Mr. James P. Kirkwood, civil engineer, in 1867-72, has almost entirely superseded the original plant.

The water is drawn from the river at a point opposite the northern limit of the city, known as Bissell's point. For this purpose a cast-iron tower, shown on page 145, was built in the river upon bed-rock, and 20 by 10 feet by 38 feet high above foundations. From the 36-foot mark, which represents low water, as shown, it extends 45 feet higher to a point just above highest known level, and is surmounted by a gate-house. On one side of this inlet-tower, as



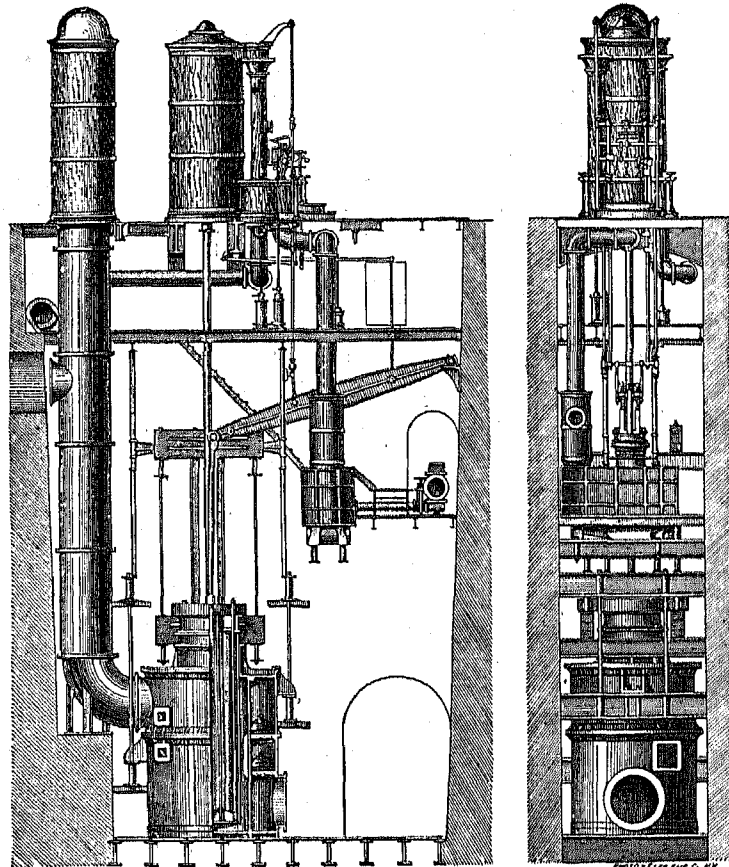
SAINT LOUIS WATER-WORKS, PLAN AND SECTION.



PUMPING STATION OF SAINT LOUIS WATER-WORKS.

shown, there are six gates of cast iron at different depths, each protected by screens. The one usually used is at 5 feet below the level of the water. The end of the river conduit enters the tower 10 feet below low-water mark at A, and consists of an iron pipe 5 feet 6 inches diameter, and 200 feet long, extending to the pumping station.

The latter is shown in the cut on page 145, and is connected with the gate-house of the inlet-pier by the iron bridge there shown. The buildings shown consist of an engine-house at the end of the bridge, 50 feet wide by 42 feet deep by 35 feet 8 inches high, of brick and stone; a boiler-house 86 feet wide, 57 feet deep, and 26 feet high, and a coal-shed of the same size. Between the boiler- and engine-house extends a pipe bridge.



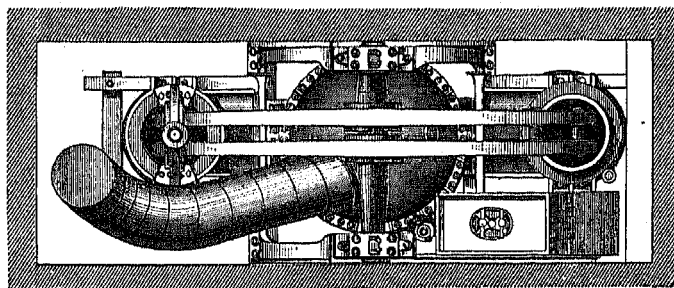
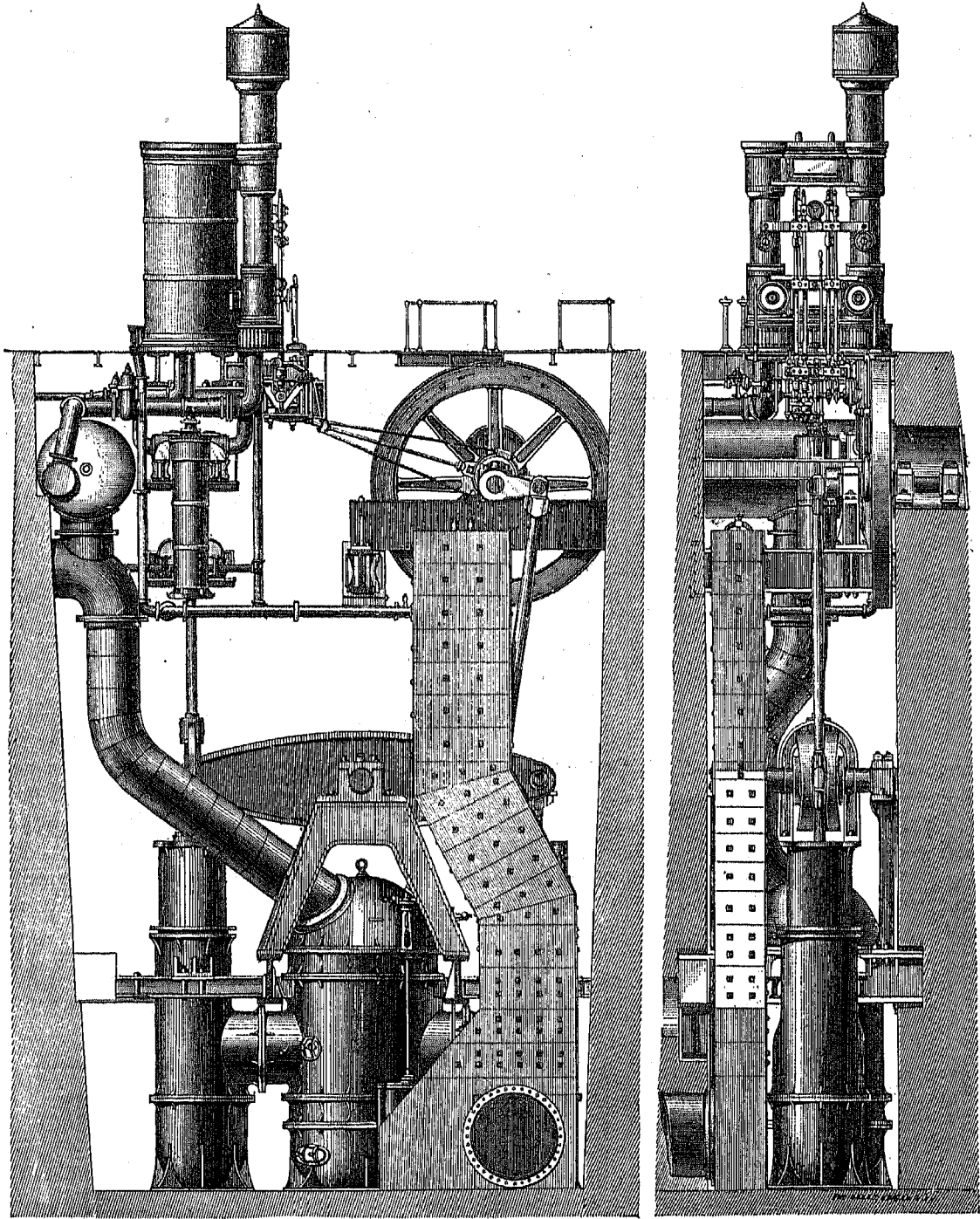
In the engine-house are three engines—two Bull Cornish engines and one rotative beam-engine. The former are shown in the cut, and are of the following dimensions :

Diameter of steam-cylinder.....	inches..	56
Stroke.....	feet..	12
Diameter of pump-plunger.....	inches..	56
Diameter of water-cylinders.....	do.....	72

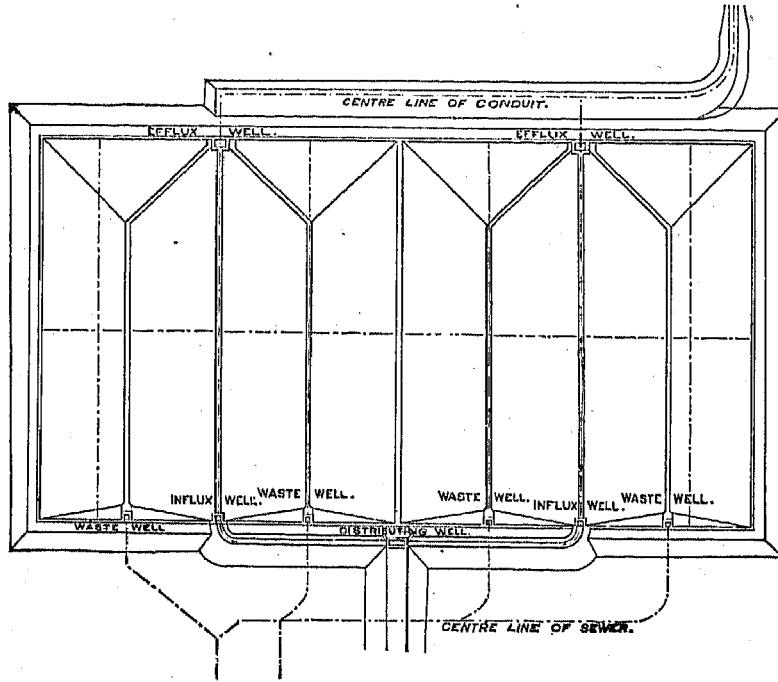
The combined capacity of the two pumps amounts to 17,500,000 gallons per day. The steam-valves are of double-beat Cornish pattern, operated by cams and plug-rods. The cataract is single, and supported on a bracket attached to the pit-wall, and controls the exhaust, steam-, and injection-valves. A double beam, working on a pin supported from the pit-wall, operates the air-pump, one end being connected to the pump-plunger, and the air-pump rod being connected at the center of the beam. The air-pump is of the single-acting pattern, 28 inches diameter by 72 inches stroke. The pipe-condenser consists of two vertical pipes joined by a flange, one being 5 feet long by 21 inches diameter, and the other 5 feet long by 30 inches diameter. The pump-cylinders contain 24 Harvey & West double-beat Cornish valves, with seats 16 and 14 inches, respectively, in diameter, with 12 in the suction and 12 in discharge, lifting 1½ inch each. The induction- and eduction-mains and the stand-pipe are 48 inches in diameter, and the rising-main is 36 inches, with valves in the latter and in the induction-main. The record of work done by these two and No. 3—April, 1879, to April, 1880—is given below:

Hours of pumping.....	13,462½
Bushels of coal.....	268,636
Number of United States gallons of water pumped.....	8,871,583,000

Nos. 1 and 2 cost \$47,500 each, including boilers, and No. 3 cost \$132,000 without them.

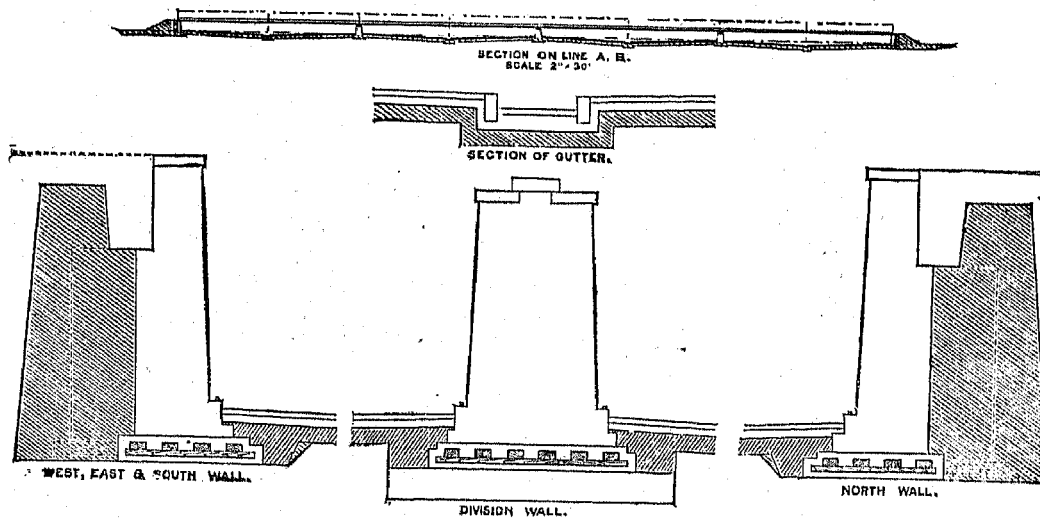


Engine No. 3 is a double-acting condensing beam-engine, as shown in the cut, with crank and fly-wheel and one cylinder, the latter being above the engine-house floor, while the pumps, beam, condenser, etc., are below in the pump-pit. The pumps are two single-acting plunger-pumps, one attached directly to the steam-piston rod and then by a linked connection with the beam, driving the other pump at its opposite extremity, between which and the center is attached the crank-connection.



PLAN OF SETTLING RESERVOIRS.

The steam-cylinder is 60 inches diameter by 7 feet stroke, and bolted to two girders across the pump-pit. The piston-rod extends through the bottom head and connects directly with a yoke bolted to the top of the plunger of the pump. The beam is double, and the centers of the plunger connections are 21 feet 7½ inches apart. From the cylinder the exhaust-pipe extends above the upper steam-chest, with a bell-cap for river-water injection and condensation. A 5-inch pipe, connected with the dome of the pump-valve chamber, passes up through the exhaust-



CROSS SECTIONS THROUGH WALLS OF SETTLING RESERVOIRS.

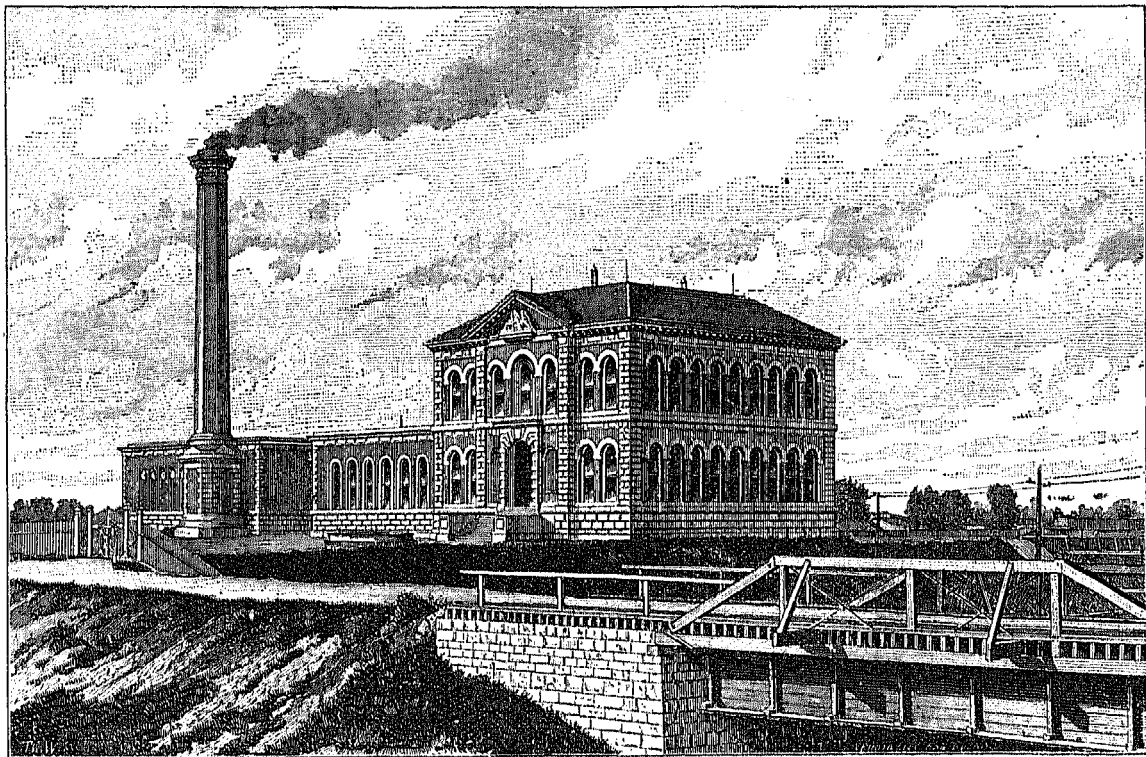
side pipe and discharges water into a shower-tank in the bell-cap condenser. The shower falling condenses the steam, which is caught with it in the funnel beneath, and a 6-inch pipe is led to the inlet-chamber of the air-pump. The air-pump is single-acting, 26 inches diameter, with its piston on the piston-rod of the steam-cylinder, and forming a coupling with it. It is open at the bottom to enable the follower to be set up without removing the head. The stroke is the same as that of the pump, and the valves are 1-inch rubber, 2½ by 16 inches, on inclined seats. The hot-well is a small tank resting on girders supporting the steam-cylinder.

The valve-chamber to the two pumps is placed between them, circular in plan, 9 feet in diameter. The water from the river is received in an open tank of boiler-iron on the south side of the outer pump, resting on the bottom of the pump-pit, and extending to within 1 foot of the engine-room floor. The induction-pipe from the well to the valve-chamber is a rectangular pipe, with a cast-iron slide-gate 5 feet 8 inches by 3 feet. The force-main is 40 inches diameter, and curved as shown. The air-chamber, 6 feet diameter by 13 feet long, is placed horizontally and transversely over the force-main. The steam-valves are of the double-beat pattern, 11½ and 12 inches diameter; exhaust-valves, 15½ and 16 inches diameter, Wright's patent cut-off.

To supply steam, there are eight 2-flue Cornish boilers, each 7 feet diameter, 30 feet long, and containing 33-inch tubes. The settling-drum, 15 inches diameter and 15 inches deep, is placed on the under side of each, 5 feet from the back end. The 33-inch flues are 19 feet and 10 inches long. The two furnaces in each boiler at the front end of the flues are each 2 feet 9 inches wide by 5 feet 6 inches long and 2 feet high. Their evaporation is said to amount to 7½ pounds of water per pound of coal.

From this pumping-station, known as the low service, the water is forced through three 36-inch cast-iron mains a distance of 365 feet, with a lift of from 15 to 50 feet, according to the stage of the river, into four settling basins, shown in the cut, and used alternately—two as settling, one as supply-basin, and the other one being filled. They are each 600 feet long by 270 feet wide and 19 feet deep. The construction may be seen from the cross-sections.

The sides are faced with masonry 4 feet 7 inches thick at the bottom by 3 feet thick at the top. They are backed with puddling. The division-walls between the basins are 8 feet thick at the top by 13 feet thick at the foundation. The method of filling can be understood from the position of the influx-wells. The bottoms are formed of brick laid on edge with cement. Owing to the immense amount of suspended impurity always found in Mississippi River water below the Missouri, a sediment of about 16 inches in depth has to be removed from the bottom of the basins about once in four months by a system of hydraulic mining. The water is drawn from the basins by a brick conduit 1,100 feet long, 6 by 5½ feet in diameter, extending to the clear-water well. The latter is 150 feet long by 100 feet wide by 17 feet deep, and a brick conduit 13 by 8 feet and 120 feet long conducts the water to a chamber 50 by 9 feet containing the screens. Three 60-inch iron pipes pass from here to the well of the high-service pumps 12 by 87 feet and 39 feet below the level of the floor.



SAINT LOUIS WATER-WORKS, HIGH-SERVICE PUMPING-STATION.

The high-service pumping-station comprises an engine-house, boiler-house, coal-shed, machine-shop, and chimney, which may be seen in the cut. The engine-house is 86 feet wide, 92 feet deep, and 63 feet high. The boiler-house is 73 feet wide, 88 feet deep, and 37 feet high. The coal-house is 103 feet wide, 63 feet deep, and 37 feet high. Chimney, 134 feet high. They are all of brick trimmed with stone.

Two engines, known as the high-service pumps, receive the water from the well above mentioned, and force it into a distributing reservoir on Compton hill. These engines are double-acting condensing beam-engines, with crank and fly-wheel, and are shown in the cuts on page 150. The cylinders are 85 inches in diameter and 10 feet stroke,

operating a bucket-and-plunger pump, 51 inches diameter of plunger and 10 feet stroke. The capacity of each is 16,500,000 gallons. The pump is placed beneath the steam-cylinder in a dry well of masonry, the pump-rod being coupled to the steam-piston rod extended down through the bottom of the cylinder. A nozzle is cast upon the lower

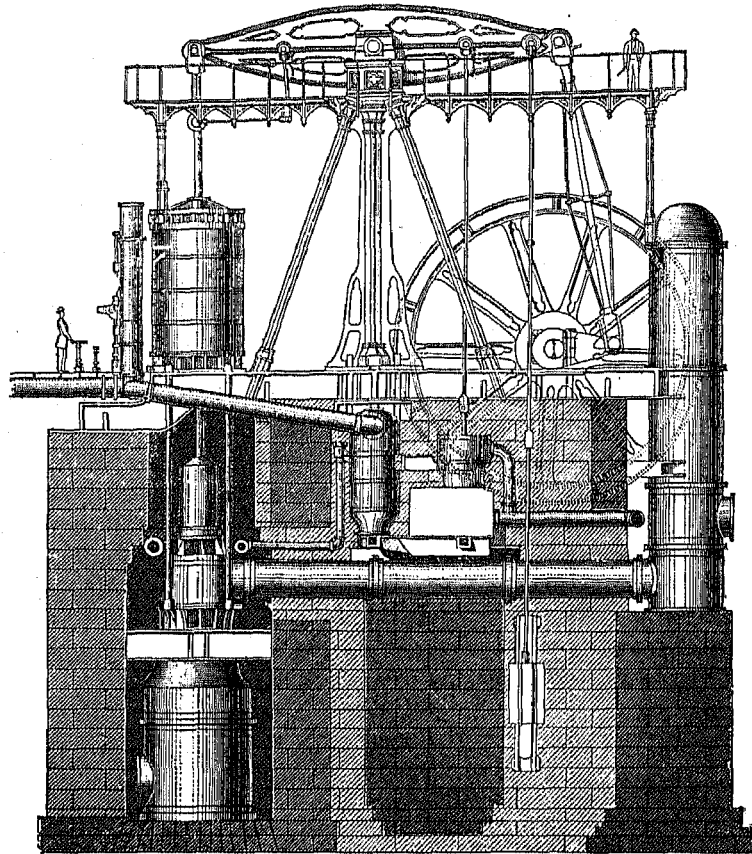
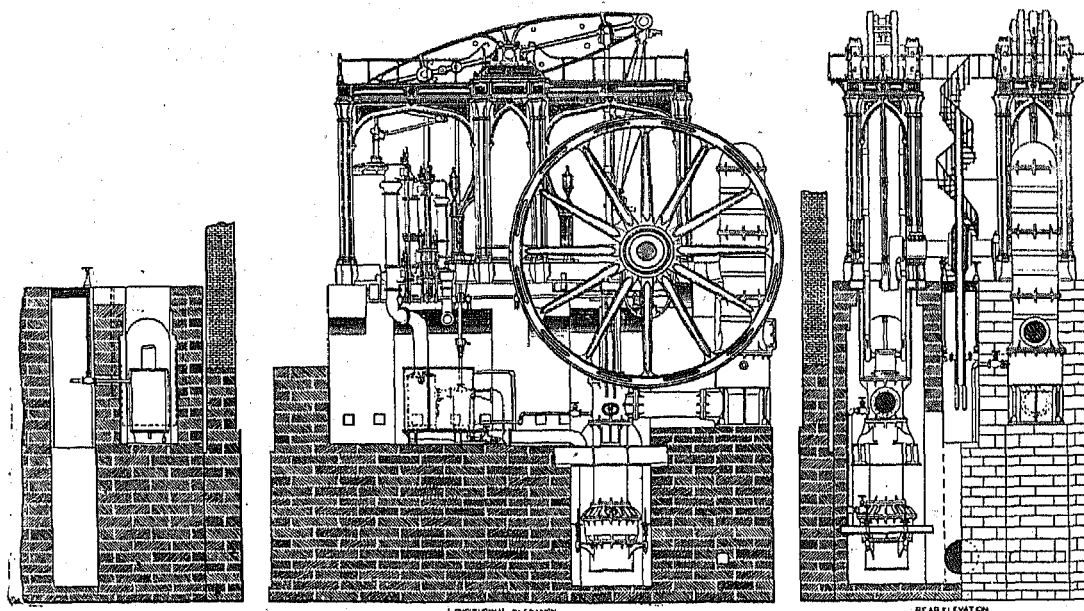


PHOTO-ELECTROTYPE CO. N. Y.

HIGH SERVICE PUMP.

chamber of the pump, and connects with the suction-pipe from the well. There are 11 induction- and 10 eduction-valves, each 16 inches and 13 $\frac{1}{2}$ inches diameter of seat; lift, 1 $\frac{1}{2}$ inch. The lower chamber contains a foot-valve for suction, consisting of 22 composition valves, faced with rubber. The air-chamber also contains a check-valve.



HIGH SERVICE ENGINE NO. 8.

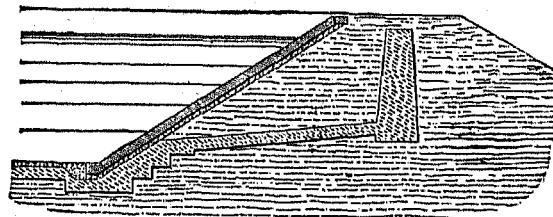
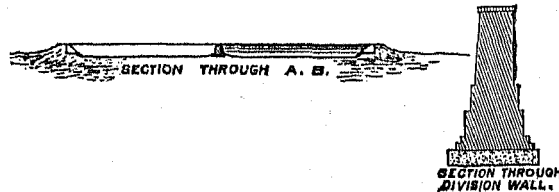
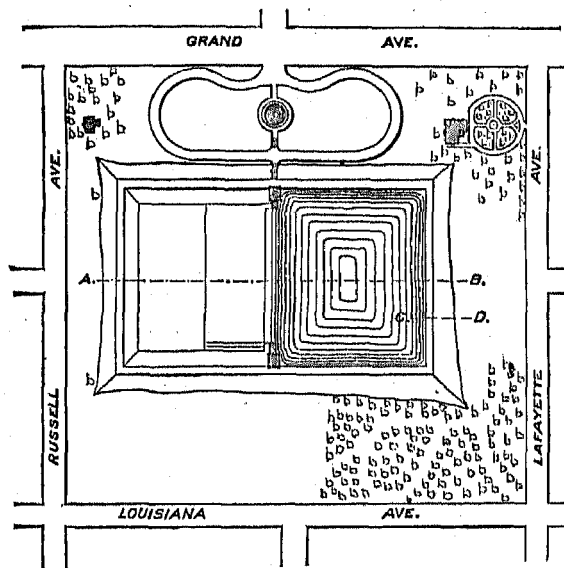
These engines were guaranteed to pump 16,500,000 gallons each to a height of 181 feet, through two mains, one 36 inches diameter and 18,500 feet long, and the other 30 inches diameter and 8,700 feet long, with a duty of

60,000,000 foot-pounds. The annexed table will show the work performed by all three of the high-service engines during 1879-'80. The pump-bucket contains a double-beat Harvey & West valve. Cost of engines, \$121,000 each, including boilers.

The record of work done by high-service engines from April, 1879, to April, 1880, is as follows:

Hours of pumping.....	13,148 $\frac{3}{4}$
Number of revolutions.....	8,782,700
Bushels of coal.....	688,638
Number of United States gallons of water pumped.....	8,692,473,000
<hr/>	
Hours of pumping, engine No. 1.....	3,913 $\frac{1}{4}$
Hours of pumping, engine No. 2.....	4,509 $\frac{1}{4}$
Hours of pumping, engine No. 3.....	4,726
<hr/>	
Total.....	13,148 $\frac{3}{4}$

There are two batteries of eight return drop-flue boilers to operate the three engines, each 6 feet diameter and 24 feet long, containing 6 flues. The products of combustion pass from the furnaces (with grates 5 feet 2 inches by 5 feet 6 inches) through the four upper flues, each 13 inches diameter by 16 feet long, and return through the two lower ones, 19 inches diameter and 13 feet 10 inches long.



SECTION THROUGH C. D.
RESERVOIR AT COMPTON HILL.

Engine No. 3, built by the Hartford Machine Company, in 1875, and shown in the cut, is double, consisting of two separate engines coupled to the same shaft and fly-wheel. Each is a double-cylinder or compound condensing engine, with low-pressure cylinder 80 inches diameter, and high-pressure 50 inches diameter, with a stroke of 11 feet for the low-pressure and 87 inches for the high-pressure, and daily capacity of 24,000,000 gallons. The pumps are bucket-and-plunger and the air-pumps and condenser are located in the pit beneath the cylinder. The former is double-acting, 23 inches diameter by 54 inches stroke, and the latter is 40 inches diameter by 7 feet stroke. The pumps have 45 $\frac{1}{4}$ -inch buckets, and plunger 32 inches in diameter and 100 inches stroke. The pump-valves are

similar to those in high service engines Nos. 1 and 2, and are 15 by 12 inches diameter of seat; lift, 1½ inch. From the high-service pump-well the water is forced into the storage-reservoir on Compton hill, a lift of 181 feet; midway of this distance the stand pipe (a Corinthian column) is erected at a height of 100 feet above the pump-well. This stand-pipe is 160 feet high by 48 inches in diameter. It has one inlet and two outlets. One of the latter extends to the reservoir direct and the other to the city. Each is 36 inches in diameter. The plan and details of construction of the reservoir can be seen in the cut. It is 22 feet deep, 870 feet long by 540 feet wide at high-water mark, with a slope inside and out of 1½ to 1. The banks are 18 feet wide at the top, with a puddled wall 4 feet wide at the top, which is 2 feet above high-water level and 7 feet thick at the base and 18 feet high. The offset of puddle shown in the figure is 2 feet thick, and a like thickness extends under the whole bottom of the reservoir. The riprap facing is about 16 inches thick, resting on an 8 inch layer of gravel, and consists of rubble laid dry. The division-wall of masonry divides the reservoir into two compartments. The capacity is about 60,000,000 gallons. The bottom is protected by a layer of 6-inch concrete. High-water surface is about 176 feet above city datum. From here a cast-iron supply-main connects with the distribution system. The force-main enters the reservoir at the bottom, and is connected with the distribution system so that only the surplus above consumption passes into it, amounting to about 10,000,000 gallons daily. The daily consumption amounts to about 25,000,000 gallons, supplied through about 200 miles of cast-iron main, the sizes and lengths of which can be seen in the annexed table:

Date of laying mains.	30-inch.	30-inch.	20-inch.	15-inch.	12-inch.	10-inch.	8-inch.	6-inch.	4-inch.	3-inch.	Miles.
Previous to October 6, 1877.....	Feet. 33,213	Feet. 16,670	Feet. 70,024	Feet. 41,909	Feet. 35,591	Feet. 45,130	.....	Feet. 608,626	Feet. 9,329	Feet. 68,414	Total. 177.077
From October 6, 1877, to April 8, 1879.....	.....	.....	.....	.....	1,070	.....	.....	75,017	.....	.....	14.410
From April 8, 1879, to April 8, 1880.....	.....	.....	.....	.....	1,077	1,213	3,570	36,375	.....	.....	8.113
Total.....	33,213	16,670	70,024	41,909	38,338	46,343	3,570	720,018	9,329	68,414	199.600

	Miles.
Total laid previous to October 6, 1877.....	177.077
Total laid since October 6, 1877.....	22.523
Total.....	199.600

About 573 meters are in use, mostly of the Worthington patent, but many of the Crown and Union patents. On this system there are 1,696 fire-hydrants and 1,606 gates. The total cost of the old works up to the time of the completion of the new was about \$3,000,000, and the total cost of all works is now between \$12,000,000 and \$13,000,000. The cost of maintenance in 1879 was about \$195,000. The works are now controlled by Mr. Thomas J. Whitman, water commissioner.

The annexed table gives the results of analyses, made during different years, of samples taken at different points of the works:

Location from which samples were taken.	Date.	Analyst.	GRAINS PER GALLON.			Hardness, degrees.
			Solid matter.	Organic matter.	Solid matter separated by filter.	
River, opposite works.....	June, 1871	Dr. Theo. Fay	.....	0.504	232.00	7.050
Hydrant, Walnut and Sixth streets.....	Aug., 1872	do	.....	0.420	None.	4.900
River, 2,500 feet above works.....	Aug., 1873	Dr. D. V. Dean	161	2.380	134.00	8.333
River, 2,500 feet above works.....	Dec., 1873	do	94	3.360	70.00	6.095
Influx-chamber.....	Aug., 1873	do	171	2.940	138.00	8.031
Influx-chamber.....	Dec., 1873	do	91	3.500	72.00	5.342
Influx-chamber.....	May, 1874	do	134	1.500	107.00	7.894
Clear well.....	Aug., 1873	do	36	0.840	12.00	6.740
Clear well.....	Dec., 1873	do	51	2.600	40.00	5.000
Clear well.....	May, 1874	do	31	0.800	6.00	6.992
After remaining in settling basin 8 hours..	Feb., 1874	Dr. Theo. Fay	.....	1.570	2.64	6.653

The influx-chamber receives the water from the river-engines and distributes it to the various settling basins. The water taken from this chamber would be the same as if taken from the river opposite the works at the same time. The clear well receives the settled water after it has passed through the basins. Samples taken from this well would indicate the quality of the water that was being pumped into the city at that time.

The quantity of sediment deposited from the water in the basins may be taken to average for nine months of the year from 7 to 9 parts (by measure) in 1,000, and for the remaining three months it will average about 3 parts in 1,000.

No regular system of duty-trials of engines in the Saint Louis system has ever been made, so that a comparison of their values can not be instituted.

NEW ORLEANS, LOUISIANA.

New Orleans, with a population of 216,090 inhabitants, is situated on the east bank of the Mississippi river, 120 miles from its mouth. Its interests are almost exclusively commercial. Its site is level, and lies from 4 to 12 feet below high-water level in the river, the water being excluded by dikes or levees. The city extends its limits eastward to lake Pontchartrain, and the soil upon which it is built is a black alluvium of sand and clay. The plan of the city is rather irregular. In 1837 a company introduced a supply of water from the river for fire-protection and all domestic uses save drinking, the water being too impure for the latter purpose. Drinking-water is largely derived from large elevated wooden cisterns at the rear of every house, into which the rain-water falling upon the roofs is collected. In many of the cisterns an arrangement of stop-cocks permits the exclusion of the first washings of the roof during a storm and the collection of the subsequent fall. As a matter of fact this apparatus is seldom attended to, and as a result the drinking-water is any thing but pure. Some people filter the river-water for drinking. Water is taken from the river by means of an iron pipe the outer end of which is sunk in a crib. From this point, which is within the city limits, the water enters the pump-well within the engine-house. The latter consists of two square brick buildings, the one containing the old engines and the other the new; while a small building behind them contains a compound Knowles pump. The old engine, built by the Allaire Works, of New York, after designs by Erastus W. Smith, in 1837, with a capacity of 7,000,000 gallons, is a condensing beam-engine, two of them being coupled to the same fly-wheel. They are of the following dimensions: Steam-cylinder, 30 inches diameter; pump-cylinder, 21 inches diameter; stroke, 6 feet. Jet-condenser, 30 inches diameter; depth, 30 inches. Air-pump, 20 inches diameter; stroke, 40 inches.

The condenser is placed immediately beneath the steam-cylinder. The average speed of the engine is 16 revolutions per minute. There is one piston-plunger to each engine, and the pump-cylinders contain two double-beat suction- and two delivery-valves about 12 inches diameter by 3 inches lift, and mechanically operated by cams and plug-rods. The steam-valves are double-beat puppet, operated by plug-rods, bent lever, and eccentrics. There seems to have been no duty-trial.

The new engines, also designed by E. W. Smith, but built in 1868 by the New York Novelty Works, at a cost of \$48,000, are very similar to the old ones. There are two coupled to the same fly-wheel and of 14,000,000 gallons capacity. They are condensing beam-engines with steam-cylinders 57 inches in diameter and 8 feet stroke; pump-cylinders, 28 inches in diameter, 8 feet stroke. The construction is essentially the same as in the old engines. The water-valves are also double-beat, 2 suction and 2 delivery, each 20 inches diameter by 7 inches lift. All the pumping-engines have double-acting pumps. The jet-condenser, located as before, is 5 feet 8 inches diameter by 3 feet 6 inches high, with an air-pump 32 inches diameter by 4 feet stroke. The speed of the engine averages 10 revolutions per minute.

There are 8 boilers in use for the two sets of engines—4 being used with the new, 2 with the old, and 2 idle. They were made by John Armstrong, of New Orleans, are 42 inches diameter by 30 feet length of shell, with two 15-inch flues in each, and burn Pittsburgh coal, with a pressure of 20 pounds. Their evaporation is unknown.

The Knowles pump, of 5,000,000 gallons capacity, was built in 1880. It is compound condensing, with high-pressure cylinder 38 inches diameter, 3 feet stroke; and two low-pressure, 20 inches diameter, 3 feet stroke, one on each side of the high-pressure cylinder. These operate directly a double-acting piston plunger 26 inches in diameter. The duty of the engine is given at 50,000,000 foot-pounds, and the average speed 22 revolutions per minute. It is used as an auxiliary in case of failure or repair in the large engines. In the pump-valve chambers there are a large number of 3-inch suction- and discharge-valves of disk-shaped rubber, confined by a spiral spring. The air-pump is a small Knowles pump, seen in the rear of the floor of the engine-room. It is 16 inches diameter by 21 inches stroke. The jet-condenser is 24 inches diameter by 26 inches high, and is located just above the air-pump. There is a battery of two multitubular boilers, made by Ed. P. Hampson, of New York; they are 54 inches diameter by 16 feet long, with 46 tubes $3\frac{1}{2}$ inches diameter in each. The pressure averages 50 pounds. The total cost of this pump, including boilers erected, was \$12,000.

From the engine-house the water is forced partly into the stand-pipe for high buildings, and partly into the reservoir. The former is 200 feet from the pumps, and in the yard a 30-inch main connects them. It is of wrought iron, 150 feet high, 6 feet diameter at bottom by 4 feet at top, with a small and low base of brick-work. There are two 36-inch inlets and two outlets, one of 30 and the other of 36 inches. It is an economical but handsome structure.

The reservoir was originally a large brick basin or tank, 250 feet square, with perpendicular brick-masonry walls, backed on the outside by earth embankments, and divided by 5-foot brick walls into four compartments, each 120 feet square. A few years ago two of the compartments gave way, and only two are at present in use, of about 1,000,000 gallons capacity each. The depth is 10 feet. The sides and bottom are of brick in cement, $2\frac{1}{2}$ feet thick. The reservoir is situated within the city limits, and about 1,100 feet from the engine-house. It has a head of only 28 feet, and is used to supply the low-lying districts. Without the stand-pipe the maximum pressure is 30 pounds at the pumps.

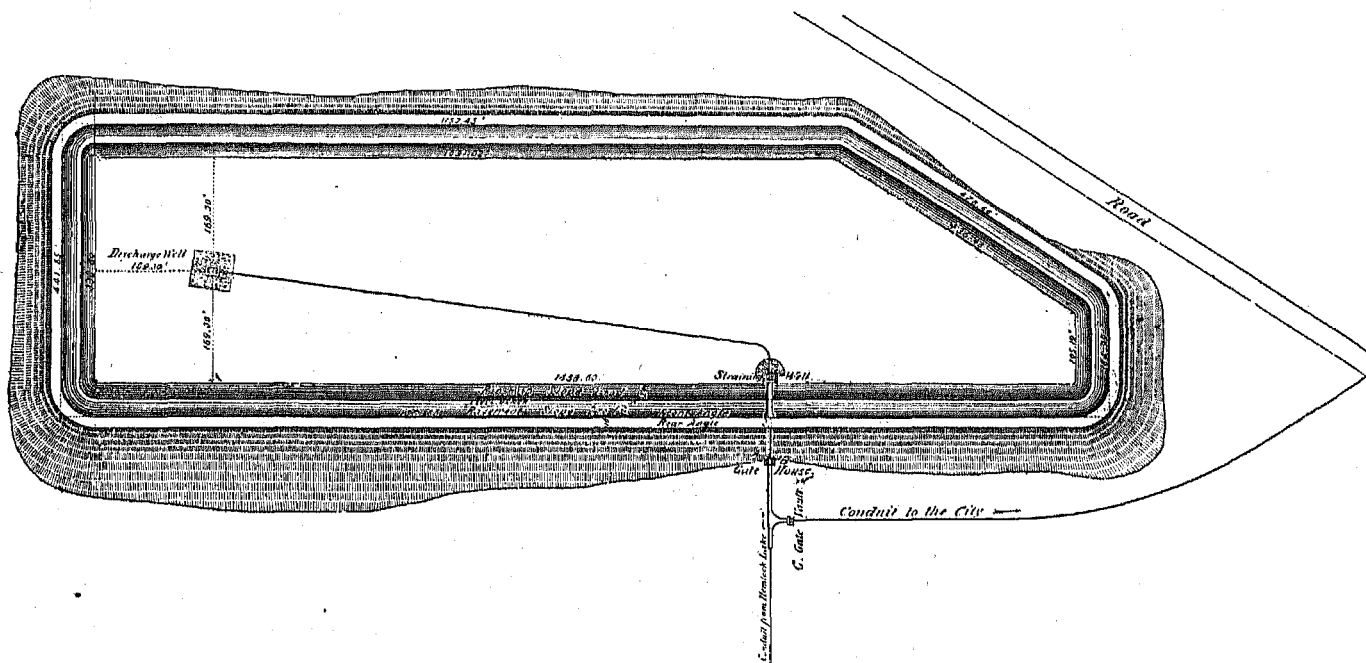
In December, 1880, there were 81 miles of mains, 3, 4, 6, 8, 10, 12, 16, and 18 inches in diameter, with main supply-pipes of 36, 30, and 20 inches. The distribution pipes are mainly cement-lined wrought iron, with about 8 or 9 miles of cast iron. Much of the former is being replaced by the latter.

There are 1,200 hydrants in the city, of different patents. The most recent ones, however, are Matthews' patent. The number of takers being 6,000, the consumption averages about 9,000,000 gallons per day.

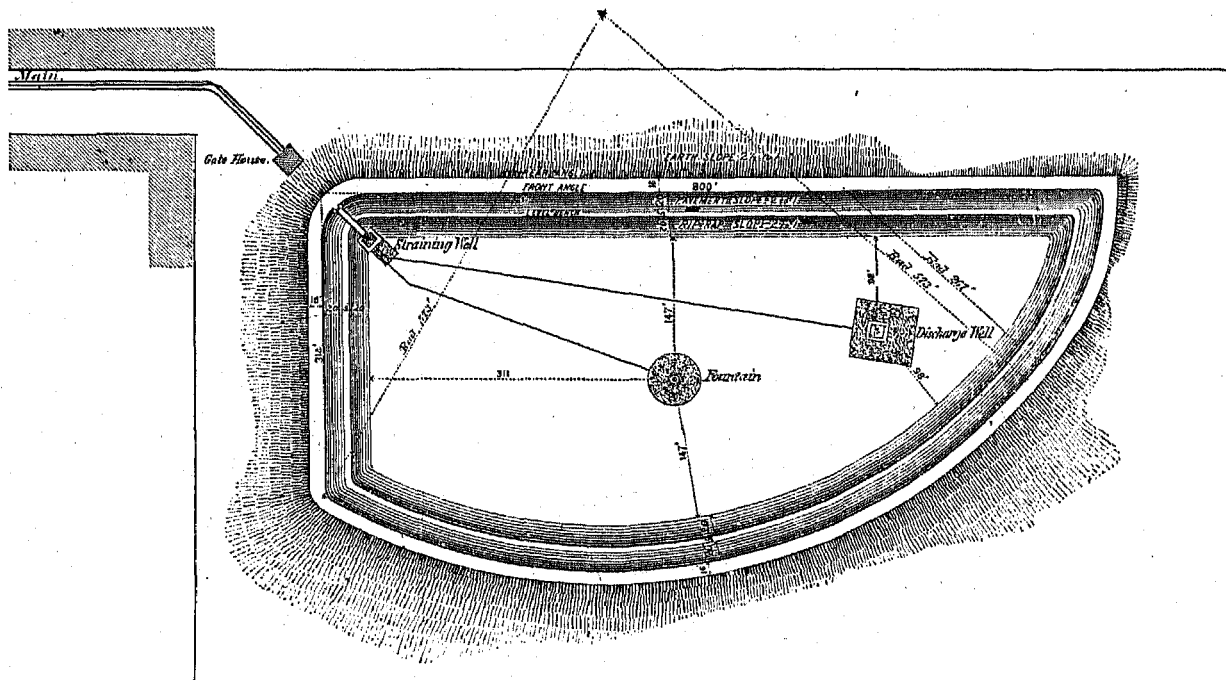
The original cost of the works was \$2,000,000, increased to \$2,300,000 to date. The annual cost of maintenance is about \$45,000, and revenues for 1879 were \$91,371. Improvements are at present under way, in charge of Mr. Moses Lane, civil engineer. The present chief officer of the company is Mr. Edward Toby, president and superintendent.

ROCHESTER, NEW YORK.

Rochester has a population of 89,366 inhabitants, and is situated upon both sides of the Genesee river, 7 miles from its mouth. Its site is level, resting upon strata of shale and limestone, and its streets are regular. Its interests are commercial and manufacturing.



ROCHESTER WATER-WORKS—PLAN OF THE STORAGE RESERVOIR AT RUSH.



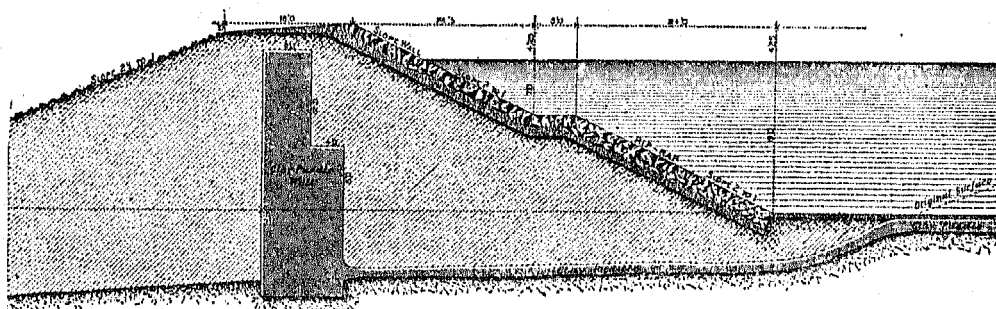
MOUNT HOPE RESERVOIR

In 1874, under the direction of the present engineer, water-works were built, deriving the supply, first, by gravity, from Hemlock lake, 30 miles south of the city, and, second, by pumping from the Genesee river.

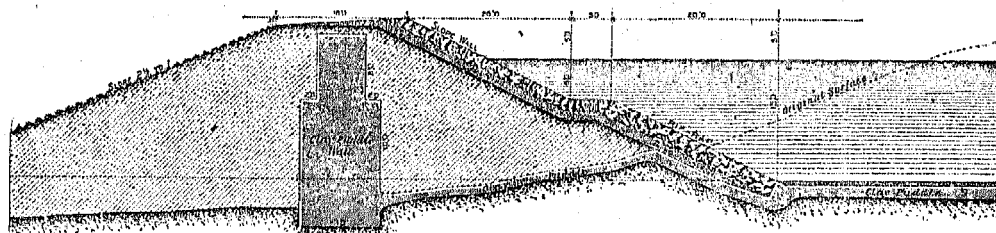
The water is taken from the lake by a wrought-iron pipe, 36 inches diameter, extending 1,000 feet into the lake, its extremity being supported in a timber crib. The latter is 12 feet square and 9 feet high, the sides formed of oak and pine timber 9 by 12 inches, bolted together, and the flooring of oak plank 3 inches thick. A couple of transverse partitions form two compartments, filled with stone to sink the crib. The top of the structure is covered with timbers laid 4 inches apart, to protect the mouth of the pipe from influx of floating materials. The pipe, beginning at one of the compartments in a funnel-shaped mouth-piece, consists of 300 feet of $\frac{3}{8}$ -inch wrought iron pipe laid in lengths of 75, 97, and 100 feet, with ball-and-socket joints. The remaining 700 feet, 36 inches diameter, was laid in a trench in the lake-bottom, wooden platforms being placed beneath the joints in certain soft places to prevent them from sinking too deeply. The inlet-pipe in the crib takes water at a depth of 30 feet below the surface of the lake. The lake itself is a sheet of very soft water 6.7 miles long, $\frac{1}{6}$ of a mile wide, and from 40 to 90 feet deep. Its water-surface is 1,828 acres, and its bed is of Genesee shale. Its drainage area is 42.39 square miles, and its banks are bold bluffs of uncultivated land. Canadice lake, which is also tapped, lying to the east of the Hemlock valley and adjacent to it, is 3.1 miles by $\frac{1}{2}$ mile, and 648 acres in area. It discharges into Hemlock outlet $\frac{1}{4}$ mile from the latter lake. The minimum flow of Canadice lake is estimated at 2,000,000 and that of Hemlock lake at 12,000,000 gallons per day. The head of water between the lake and the distributing reservoir is 261 feet. The main, which follows the profile of the country, is of the following dimensions:

	Linear feet.
36- by $\frac{3}{8}$ -inch wrought-iron pipe, to face of gate-house at Hemlock lake.....	50, 776. 00
24- by $\frac{3}{8}$ -inch wrought-iron pipe.....	1, 913. 65
24-inch cast-iron pipe.....	30, 549. 75
24- by $\frac{1}{2}$ -inch wrought-iron pipe.....	13, 809. 38
From face of well-house, 24-inch cast-iron pipe.....	4, 212. 27
From inlet-opening in bottom of Rush reservoir to outside face of well-house, 24-inch cast-iron pipe....	1, 010. 00
Total from face of gate-house to inlet-well, linear feet.....	102, 271. 05

The storage basin known as Rush reservoir is situated about 10 miles from the center of the city, and is connected by 46,064 feet of 24-inch cast-iron main with the Mount Hope or distributing reservoir, $1\frac{1}{2}$ mile from the city hall. It is in plan a rectangle with one corner cut off, having a bottom area of 10.354 acres, a total depth of 24 feet, and a depth of water of 18 feet. Area of water-surface at 18 feet, 13,702 acres. The embankments are of earth, with a puddle-wall through the center 10 feet thick from the bottom up to a height of 8 feet, and 6 feet thick for the remaining height of 12 feet. It is started at a depth of 10 feet below the bottom of the reservoir. The inner slope of 2 to 1 is faced with 18 inches of riprap laid on a 12-inch bed of gravel. This face has a level offset 5 feet wide at a distance of 11.25 feet below the top, the high-water line being also $4\frac{1}{2}$ feet below the same. The banks are 16 feet wide at top, and the exterior slope is $2\frac{1}{2}$ to 1. The bottom is gravel, 8 inches thick, underlaid by 18 inches of puddle. The capacity at 18 feet is 70,033,589 gallons, and its high-water elevation 242 feet above city datum.



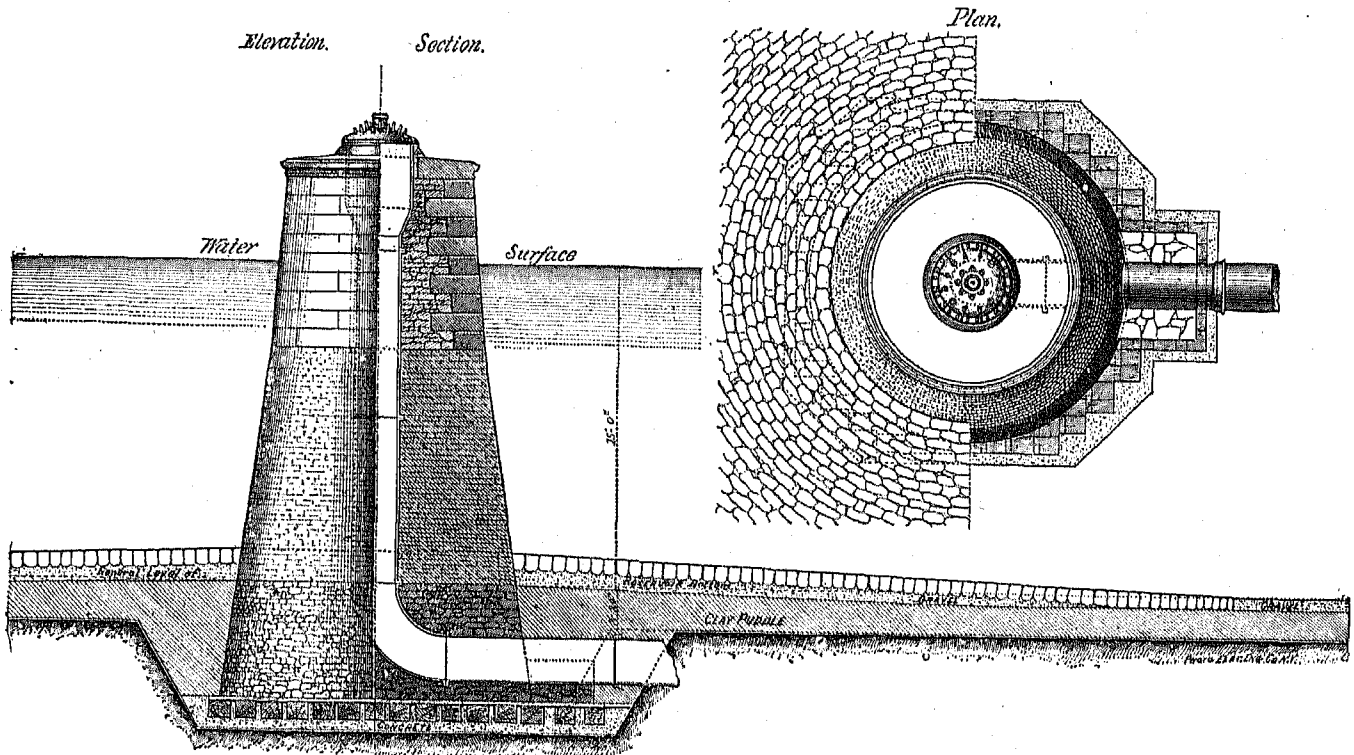
CROSS SECTION OF BANK OF DISTRIBUTING RESERVOIR, ROCHESTER.



CROSS SECTION OF BANK OF STORAGE RESERVOIR, RUSH.

Mount Hope reservoir, $1\frac{1}{4}$ mile from the city hall, in plan is a segment of a circle with one extremity cut off. Its construction is very similar to that of the Rush reservoir. The bottom area is 3.887 acres, and area of high-water surface 5.517 acres, the depth of the water being 16 feet, and total depth to top of banks 20 feet. Width of banks, 16 feet. Capacity at 16 feet depth, 24,278,101 gallons. Slopes and puddle-wall as before.

The 24-inch main from Rush enters the Mount Hope basin at the center, and rises through a masonry pier to a few feet above high-water surface, where it discharges through a fountain-jet to a considerable height. It is a



PLAN OF FOUNTAIN FOR DISTRIBUTING RESERVOIR.

noteworthy fact in this connection that at a time when the whole city was annoyed by the old familiar "fish-lake odor" in the water-supply the water in this reservoir was entirely free from the taint. This would seem to show that aeration through fountain-jets is an effective cure for this almost universal difficulty, although in many cases it would be a difficult matter to obtain the necessary head.

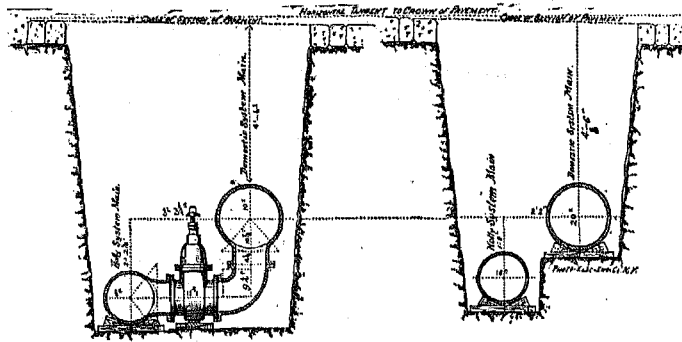
By an arrangement of valves in the supply-mains and pipes, the water from the Rush reservoir may be directly connected with the distribution pipes of the city, and produce a much greater pressure. This operation, which consumes but a few moments, is used to a considerable extent in the suppression of fires, the office and different parts of the works being connected by telephone. The use of this instrument in water-works is very general throughout the country, and has worked remarkable changes in their management. The level of water in the reservoirs is measured from the Erie Canal aqueduct. Water-surface of Hemlock lake is accordingly 388 feet, flow-line of Rush, 241.84 feet, and of Mount Hope, 124.4 feet above this datum.

The effluent-chambers or straining-wells of Rush and Mount Hope basins are in masonry towers rising above water-level at the foot of the slopes and connected with banks by iron foot-bridges. There are two openings from the reservoirs into them, one at bottom for draining and one 8 feet below high water. They are each 3 feet square, closed by a sliding gate from above. Screens of wire, $\frac{1}{4}$ -inch mesh, protect the entrance of the effluent-pipes. The effluent-wells are 6 by 13 feet at bottom by $9\frac{1}{2}$ by 13 feet at top.

For the purpose of utilizing the waters of Canadice lake a bulkhead was constructed at the northern end of the lake, extending across the natural outlet creek, which delivers the water from it into Hemlock lake. It consists of two stone abutments, with an intermediate pier of masonry, forming two channels. Across these are placed stop-planks, provided with sliding gates. The foundation of the water-ways, abutments, and pier are of timber, the upper surface of which is 8 feet below high-water level. Sheet-piling was driven in front and behind its edges. The abutments and pier are of rubble masonry 10 feet high, $22\frac{1}{2}$ feet long, and $4\frac{1}{2}$ feet thick; width of water-ways, 15 feet.

There are twelve openings in each gate, arranged in three tiers of four each. The upper ones are 22 inches wide and 24 inches high, the bottoms being on the highwater line. The remaining tiers contain gates or openings 22 inches wide and 36 inches high, and are all below high-water line, with rack and pinion appliances for raising and lowering them. There are no slides to the upper tier, which therefore act simply as sluices.

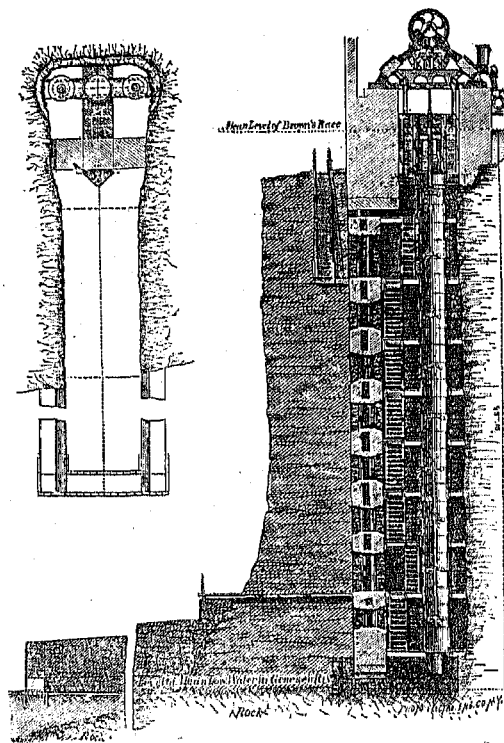
A connection is arranged at different points between the gravity and Holly systems.



Section showing a connection between the mains of the Domestic and Holly systems.

Section showing the relative positions in the trench of the mains of the Domestic and Holly systems.

The Holly system, used to supply certain parts of the city and for use in case of fire, consists of an engine-house located upon the Genesee river, between it and a race which supplies many of the city mills. The building is of brick and sandstone, and contains a set of rotary pumps, a new Holly engine, and a gang of eight double-

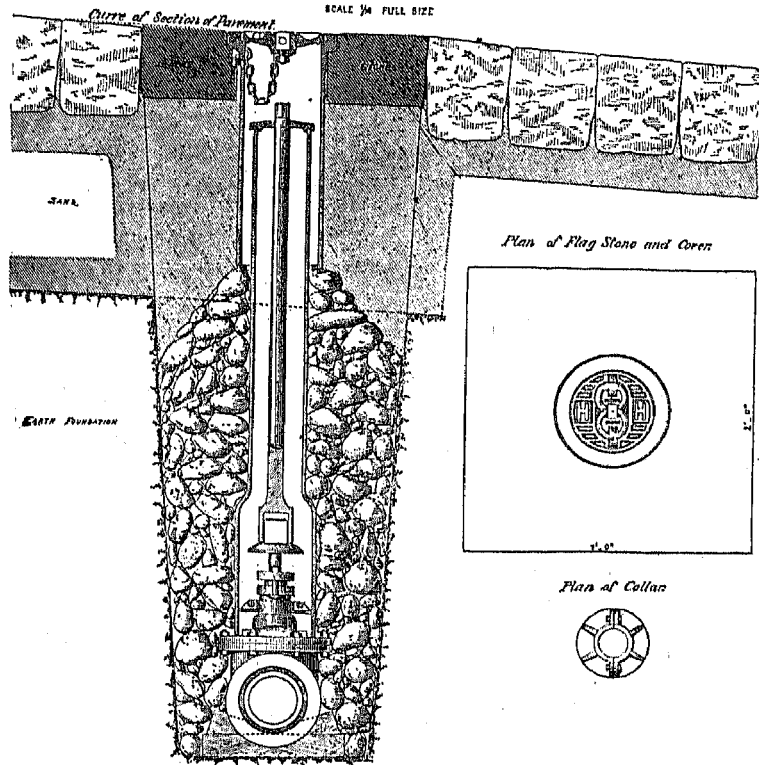


acting pumps. The latter are operated by a pair of Centennial or Tate turbines. The water running them is derived from near the head of the race, and the supply to all the pumps is taken either from a 20-inch main from Hemlock lake or by a 24-inch wrought-iron pipe from the river above the works.

The new engine is at present used only as auxiliary to the others at times. It has four steam-cylinders, 16 inches diameter, 27 inches stroke, operated at high pressure, four double-acting piston-pumps aligned with them, 10 inches in diameter by 27 inches stroke. The speed averages 35 revolutions per minute. It may be used as a condensing-engine.

The rotary pumps, two in number, are so arranged as to be run either by two steam rotary engines or by the engine last described. They run at 200 revolutions per minute, discharging 16 gallons per revolution. The remaining machinery, consisting of two sets of four pumps each, is operated by water-power, with two Centennial or Tate wheels. The latter are 25 inches in diameter, and run, under a head of 90 feet, at from 220 to 600 revolutions per minute. Each set consists of four double-acting pumps, two fastened at an inclination upward on each side of a cast-iron frame, and by means of connecting-rods driven by gear-wheels above. These cylinders are 9 inches diameter and 24 inches stroke. The maximum speed is 40 revolutions per minute. The plungers are of the plain piston type. The capacity of the new engine is 3,000,000, and of the rotary engines and of the water-set 4,000,000 gallons per 24 hours. Water is conveyed to the turbines through a wrought-iron flume $4\frac{1}{2}$ feet in diameter, $\frac{1}{4}$ inch thick.

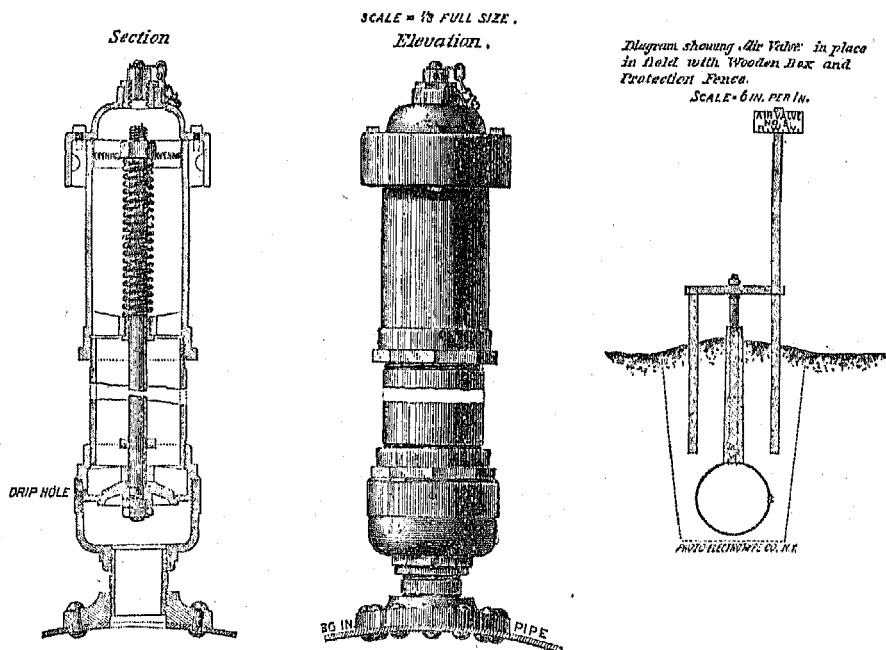
There are three multitubular boilers to supply the large engine with steam. They are 16 feet long by 52 inches diameter of shell, and contain fifty-nine 3½-inch tubes in each. They use anthracite coal, and, with a pressure of 90 or 100 pounds, give a very high evaporation.



PLAN OF CAST-IRON STOP-GATE BOX.

The cost of the wheels, boilers, machinery, penstocks, etc., set up, amounted to \$78,000. The average daily pressure maintained by this Holly system is 65 pounds.

The extent of the Holly system mains is about 8 miles in the heart of the city. Details of stop-gates and air-valves are given in the cuts.



PLAN OF AIR-AND-VACUUM VALVE FOR CONDUIT.

The discharging capacity of the conduit from Hemlock lake to Rush reservoir proved by experiment to be 9,293,000 gallons per day. In this section are two grade lines, the first falling 27 feet below lake-level in 51,000 feet, and the succeeding one falling 143 feet in 52,000 feet.

WATER-SUPPLY OF CITIES—TROY, N. Y.

The annexed table contains a general summary of extent of all water-pipes regarded as distributing mains laid in the city:

By whom laid.	Date.	NUMBER OF LINEAR FEET OF CAST-IRON MAINS LAID.							
		24-inch.	20-inch.	16-inch.	12-inch.	10-inch.	8-inch.	6-inch.	4-inch.
Water commissioners and executive board.	Up to May 1, 1879.....	8,601.10	8,293.30	45,437.83	33,975.20	10,065.31	63,119.23	153,012.08	171,355.00
Water-works and fire board.....	From May 1, 1879, to April 1, 1880.	.....	.....	668.38	301.14	851.05	2,573.02	17,208.54	23,550.32
Total.....	.....	8,601.10	8,293.30	46,106.21	34,276.34	10,856.96	65,693.20	171,120.62	194,905.02

By whom laid.	Date.	NUMBER OF LINEAR FEET WROUGHT-IRON AND LEAD PIPE FOR MAINS LAID.							TOTAL NUMBER LINEAR FEET LAID IN EACH SYSTEM.		Total.
		3-inch.	2½-inch.	2-inch.	1½-inch.	1¼-inch.	1-inch.	¾-inch.	Domestic.	Holly.	
Water commissioners and executive board.	Up to May 1, 1879.....	2,804.00	708.80	1,084.20	5,213.51	664.80	2,504.21	341.02	400,148.34	43,021.90	504,070.24
Water-works and fire board.....	From May 1, 1879, to April 1, 1880.	.....	.....	172.31	561.70	650.05	298.09	67.00	40,704.06	207.74	40,912.70
Total.....	.....	2,804.00	708.80	2,156.51	5,775.21	1,323.85	2,802.90	408.02	506,853.80	44,129.64	550,983.04

Total number of miles in Holly system, 8.326.

Up to April 1, 1881, there were 980 fire-hydrants, mostly of the Matthews patent, with a few Ludlow.

The consumption averages 4,500,000 gallons per day from Hemlock and 1,000,000 from the Holly system, the latter being used mostly for running elevators, etc. This amount is consumed by about 7,800 takers.

The first cost of the works amounted to \$3,182,000, and the cost of maintenance and repairs for 1879 was \$33,184. In the same period the total disbursements were \$74,846, and receipts \$67,000. About 125 meters are in use at the present time.

The results of an analytical investigation of Hemlock Lake water, as taken from the mains of the city, made by Professor S. A. Lattimore, of Rochester university, are given below in parts per 100,000 of water by weight, and grains per United States gallon:

Date.	SOLID RESIDUE.			"Albuminoid ammonia."
	Inorganic.	Organic and volatile.	Total at 212° Fahr.	
March, 1877.....	7.25	4.00	11.25	0.0005
April, 1877.....	7.25	3.95	11.20	0.0005
May, 1877.....	7.22	3.98	11.20	0.0005
June, 1877.....	7.22	4.03	11.25	0.0004
July, 1877.....	7.23	3.92	11.15	0.0005
August, 1877.....	7.20	3.80	11.00	0.0002
September, 1877.....	7.25	3.65	10.90	0.0004
October, 1877.....	7.20	3.75	10.95	0.0002
November, 1877.....	7.15	3.85	11.00	0.0005
December, 1877.....	7.20	3.80	11.00	0.0002
January, 1878.....	7.22	3.73	11.05	0.0005
February, 1878.....	7.20	3.85	11.05	0.0005

Total solids, residue, 6.40 grains; chloride of sodium, trace; "albuminoid ammonia," 0.001 grain.

The works are at present in charge of J. Nelson Tubbs, C. E., chief engineer. The records, including drawings, are unusually full and complete at the Rochester water-works.

TROY, NEW YORK.

Troy is situated on the east bank of the Hudson river, 6 miles north of Albany. It contains 56,747 inhabitants, and has very extensive manufacturing establishments. The surface of the city is very irregular, with sections of it elevated to a height of from 100 to 200 feet above the rest. The larger portion of the city, however, is but little elevated above high water in the river. The streets are laid out rectangularly with considerable regularity.

Water was first introduced into the city by gravity in 1833 by a private corporation, but the works, since 1855, have been controlled by the city. As at present existing, the system is a combination of direct pumping and gravity. The former is accomplished by a system of Holly pumping machinery, and the latter is derived from three reservoirs on Piscawen creek, 1 mile east of the Hudson river, numbered 8, 9, and 10 on the accompanying map. The total drainage area of these ponds is 1,900 acres, with an average annual rainfall of 39 inches, the range being from 30 to 42 inches.

The first storage or impounding reservoir (No. 9) is located about 50 rods east of Oakwood avenue, in the bed of the Piscawen creek, and is formed by backing up the water behind an earth dam 35 feet long by 165 feet wide at the bottom in the lowest part of the ravine, 20 feet wide by 270 feet long on the top; 35 feet deep at its deepest part near the outlet-pipe, with an average depth of from 15 to 18 feet, and a capacity of 40,000,000 gallons; slope of the embankments, 2 to 1 on the face and $1\frac{1}{2}$ to 1 on the back; water-line 5 feet below the top of the banks. The greatest height of the bank is 49 feet. A puddle-wall extends through the center of the bank 15 feet thick from the base to a height of 12 feet, 13 feet thick for the next 10 feet, 11 feet thick for 10 feet above, and finished to within 2 feet of the top at a thickness of 8 feet. The base of the dam rests upon a foundation of slate-rock, which underlies this whole section of country. It was started in a trench 15 feet wide by 6 feet deep.

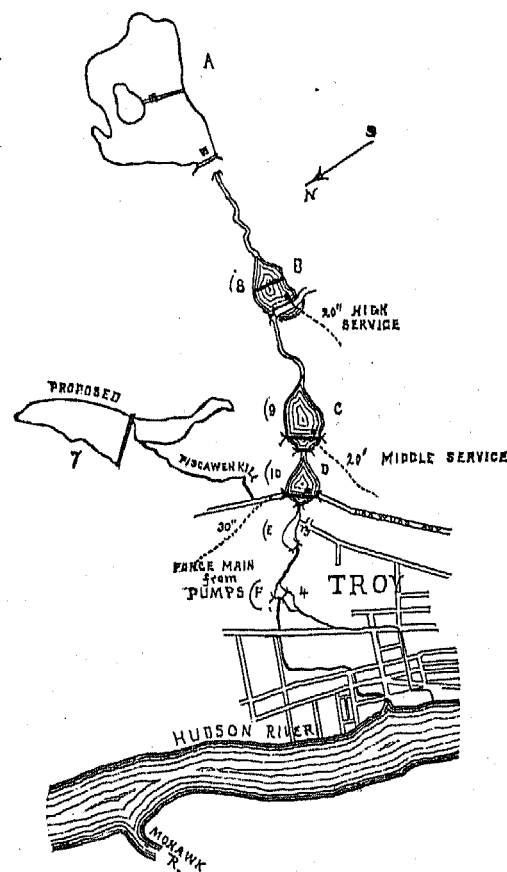
Three cast-iron pipes—two 12-inch and one 8-inch—extend from the foot of the inner slope through the embankment, a distance of 140 feet, to the pipe-chamber under the outer slope. It is a stone chamber arched with brick, 16 feet long, 9 feet high, and 8 feet wide. The bottom is 2 feet below the outlet. Gates are fitted in the effluent-pipes mentioned, and controlled on the inner side of the chamber at one end. The foot of the outer slope is shortened and backed with a retaining-wall 11 feet high, 36 feet long, and $4\frac{1}{2}$ feet thick, in which doors and a passage-way lead to the pipe-chamber. The face of the dam is covered with gravel 2 feet thick and riprapped $1\frac{1}{2}$ feet thick. The area of high-water surface is about 8 acres. A waste-weir cut in the rock about 50 feet south of the dam extends around and is entirely disconnected from it, discharging into the creek 200 feet below the dam. The flow of the creek at the dam is about 1,500,000 gallons per day. Cost of reservoir, \$16,571.

In 1860-'61 a second reservoir was constructed at (10) (see map) by the erection of a second dam, the back-filling of which forms the embankment of Oakwood avenue, and serves to collect the overflow from the upper dam, No. 9. The dam extends across the ravine a distance of 300 feet. It consists of an earth embankment with a puddle core, started 6 feet below the bed of the stream, with a thickness of 20 feet, gradually diminishing to 6 feet thick at top of the embankment, increasing 2 feet in thickness for every 6 feet in depth from the top by steps. The total height of the dam is 43 feet; slope of inner face 2 to 1, and of outer $1\frac{1}{2}$ to 1; capacity of reservoir, about 40,000,000 gallons. A culvert, $6\frac{1}{2}$ by 6 feet, extending under the avenue, conducts the water from a well on the upper side of the embankment through the dam to the supply-mains. The well is of brick, 4 feet thick at bottom, $2\frac{1}{2}$ feet at top, and 22 by 20 feet, with a partition-wall 2 feet thick. The top is covered by a gate-house 10 by 12 feet. The gates, four in number, on the front side of the well, are of iron, operated by hand-wheels above, except the lower one, which is of heavy timber, and removed only when cleaning the bottom of the well. The iron gates are each 2 by $2\frac{1}{2}$ feet. The top of the well serves as a waste-weir. One of the compartments is 12 by 8 feet, and the other 12 by 4 feet. Total cost of reservoir, \$29,312.

There are two lakes, known as the Brunswick lakes, situated 3 miles back of the reservoir described, and having dams for controlling the flow. The area of the upper of the two is about 20 acres water-surface, and of the lower 7 acres, the capacity of the former being about 180,000,000 gallons. They are separated by a dam across the middle. The water from them flows into the Oakwood reservoir through the creek. A storage reservoir, holding 76,000,000 gallons, is proposed as shown on the map at (7).

The dam at the lower end of the Brunswick lakes is very similar to that described as adjoining Oakwood avenue in the lower Oakwood reservoir. It is of earth, puddled, 125 feet thick at bottom by 16 feet at top.

A brick culvert, 125 feet long by 4 feet diameter, passes through the foot of the dam into the stream below. A well, rising on the inside of the dam, forms the only outlet. It is 18 by 20 feet, with 4-foot walls, and divided by



MAP OF WATER-SUPPLY OF TROY, N. Y.

a 2-foot division-wall. On the front of the well are four gates, as before described, each 20 inches square. The dam is 30 feet high, and the reservoir averages 20 feet deep.

The distributing reservoir is shown at (4), and is constructed in a manner very similar to the others, by damming the lower end of a small pond in the bed of the outlet from the Oakwood reservoirs. The bottom and sides are of slate-rock, and a small stone dam, a short distance above the reservoir, is built, 7 feet thick at bottom by 5 feet 7 inches at top; 17 feet high and $67\frac{1}{2}$ feet long. A length of 9 feet in the center is 7 feet thick, and through this part pass two 20-inch pipes, one above the other, and controlled by gates. This dam makes a pond above it, 141 by 25 feet by 5 feet deep, and holding 123,700 gallons. From here the water passes into an excavated reservoir 116 by 67 feet by 8 feet 3 inches deep, containing 450,000 gallons. Another dam below the last carries the water from here through it to a third division, 51 by 41 feet by 8 feet 3 inches deep, containing 115,300 gallons. From here it passes into a covered gallery 304 feet long by 18 feet 4 inches broad by 8 feet 3 inches deep, containing 322,000 gallons. It is of brick, and contains wire screens at its lower end, from which the supply-mains extend to the city. Two supply-mains are in use, one 20 inches in diameter and the other 12 inches, of cast iron, 1 mile in length. The head from the lower service is 105 feet; from the middle, 292 feet; and from the upper service, 382 feet.

The supply from the lakes and Piscawen creek having proved insufficient, it was determined to supplement it, in 1879, by the erection of a set of pumping-machinery. The result was the introduction of two Holly pumping-engines, built after designs by Chief Engineer D. M. Greene, of the Rensselaer Polytechnic Institute.

The pumping-station is located at the northern end of Lansingburg, and below the Waterford bridge. The pump-house is 70 by 70 feet, with boiler-house 40 by 60 feet and coal-shed 60 by 50 feet attached, and situated about 100 feet from the river-bank.

The two engines are alike, and of 6,000,000 gallons capacity. The description of one serves for both. There are four pump-cylinders 17 inches diameter, with plain piston-plungers, and a stroke of 36 inches, making 30 single strokes per minute. The total length of the cylinders is 48 inches, leaving 6 inches clearance at each end. There are 208 brass valves in each cylinder, half in the inlet and half in the outlet. They are circular, $1\frac{3}{4}$ inch diameter, with a lift of $\frac{3}{8}$ inch, guided by a brass stem or spindle, and seating themselves by gravity. The steam-cylinders are 27 inches diameter and 36 inches stroke, with balanced double-beat puppet-valves, operated by an eccentric cam and rod, bevel-gear to the main shaft. The steam is condensed by a jet-condenser 48 inches diameter and 30 inches long, with an air-pump 30 inches diameter and 30 inches stroke. Six multitubular boilers, containing 58 tubes of $3\frac{1}{2}$ inches diameter in each, and 5 feet diameter by 17 feet 4 inches length of shell, supply steam at a pressure of from 67 to 70 pounds. By a peculiar arrangement of dampers the heat beneath all the boilers can be thrown in an instant directly into the chimney, so as to stop the production of steam. The evaporative power is given at 12 pounds of water to 1 pound of anthracite coal used. The pumping-engines are run alternately and during only 12 hours per day, pumping, at 15 revolutions per minute, 3,000,000 gallons into the reservoir, with a duty given at 85,000,000 foot-pounds, and guaranteed by the Holly company at 80,000,000 foot-pounds.

From the pumping-station the water is forced through $3\frac{1}{2}$ miles of 30-inch cast-iron main into the lower Oakwood reservoir, which therefore serves as a distributing basin. The water is drawn from the Hudson river through an inlet-pier, 50 by 20 feet, in the river, with well 6 by 6 feet, and a $7\frac{1}{2}$ - by $4\frac{1}{2}$ -foot tunnel leading from it to the pump-well. The contract price for the complete construction of this branch of the Troy works was \$235,000. This includes the costs of the pump-house, boiler-house, and chimney, complete, inlet-chamber and tunnel, two engines, and all appendages, a high-service reservoir, and $3\frac{1}{2}$ miles of 30-inch force-main. In addition, there was a stone dock or front at the pumping-station, 300 feet long, at an additional cost of \$8,000.

The additional reservoir is built upon the Piscawen creek, in Brunswick, a short distance to the east of the upper Oakwood reservoir, at a cost of \$10,000, with a capacity at 6 feet below high water of 2,000,000 gallons. Length of earth dam, 300 feet; maximum height, 20 feet, with a dam forming two compartments, and 100 feet long by 10 feet high, with spill-way 64 feet long. The gate-house is about 16 feet square.

From this reservoir a 20-inch cast-iron main supplies the highest portions of the city, with a maximum head of water equal to 382 feet. The upper Oakwood supplies the districts lying midway between the lowest and highest by a 20-inch main, as before, with a head of 292 feet, while the lower Oakwood allows all its water to pass into the distributing gallery before described (No. 4, see map), and from thence flows with a head of 105 feet through a 12-inch main to supply the lower portions of the town. The total length of distributing mains, with which the above three supply-mains connect, is $38\frac{3}{4}\frac{1}{2}\frac{3}{8}$ miles (1880), of 20, 16, 12, 10, 8, 6, and 4 inches diameter, all cast iron. Upon this system of pipes there are 392 Knickerbocker hydrants, made by the Mohawk & Hudson Manufacturing Company, and 563 gates. The consumption averages 4,500,000 gallons, and is supplied to everybody who requests a service, the cost of maintenance and repairs being defrayed by a general tax. Nearly 2,000,000 gallons per day are supplied by the gravity works, the remainder, about 3,000,000 gallons, being pumped.

The first cost of construction of the works was about \$216,000, which has been increased to a total in 1880 of \$840,000. The annual cost of pumping for 1880 is about \$13,000, while the total cost of maintenance and ordinary expenses of the whole works will average \$39,000.

The purity of the water from the different sources can be judged from the following analyses made in the analytical laboratory of the Rensselaer Polytechnic Institute in 1872:

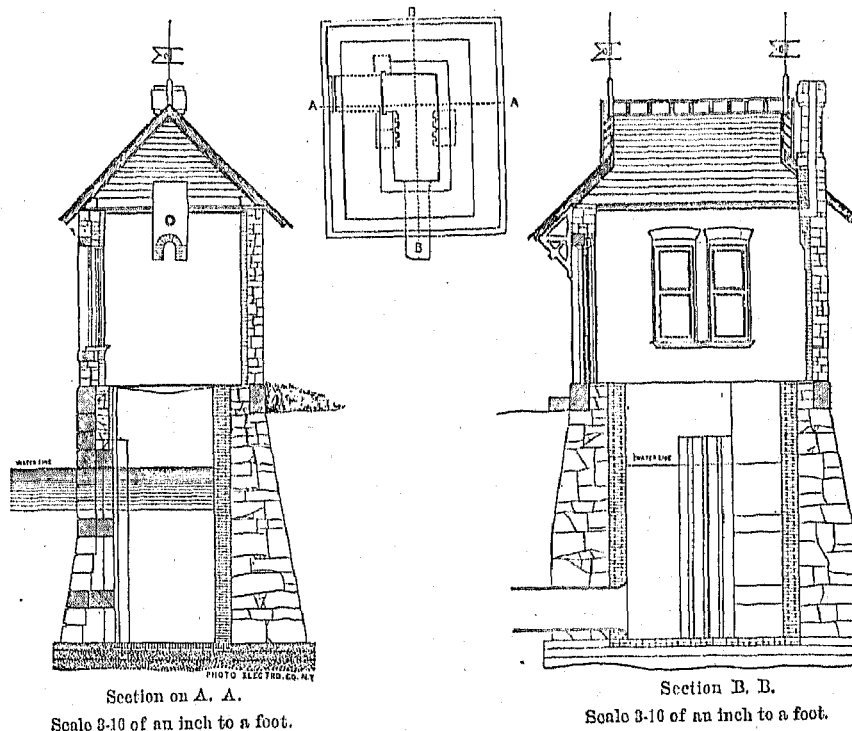
	Reser- voir.	Hudson river.		
Color in one-foot tube.....	Slight yellow.	Greenish- yellow.		
Taste at 30° C. (86° F.)			None.	Illeggy.
Hardness on Clark's scale			7.4°	3.16°
	<i>Grains.</i>	<i>Grains.</i>		
Oxygen absorbed by organic matter from per- manganate of potash.....	0.0784	0.2884		
Inorganic matter	0.6080	3.7128		
Organic matter	1.8480	1.4840		
Total solids	8.4560	5.1968		
The inorganic matter contains the following:				
Chlorine	0.0400	0.0740		
Sulphuric acid, SO ₂	0.2680	0.2308		
Silica	0.5278	0.5684		
Lime	2.0801	1.1409		
Magnesia	0.1551	3.5040		
Oxide of iron, alumina, and phosphates.....	0.0210	0.0260		
Potassa	0.1414	0.0546		
Soda	0.2079	0.1264		

The water from the river proves softer than that in the creek. The latter was taken from the lower Oakwood reservoir, and that from the river was obtained from near the pumping-station.

The works are under the charge of Professor D. M. Greene, of the Rensselaer Polytechnic Institute, as chief engineer.

PAWTUCKET, RHODE ISLAND.

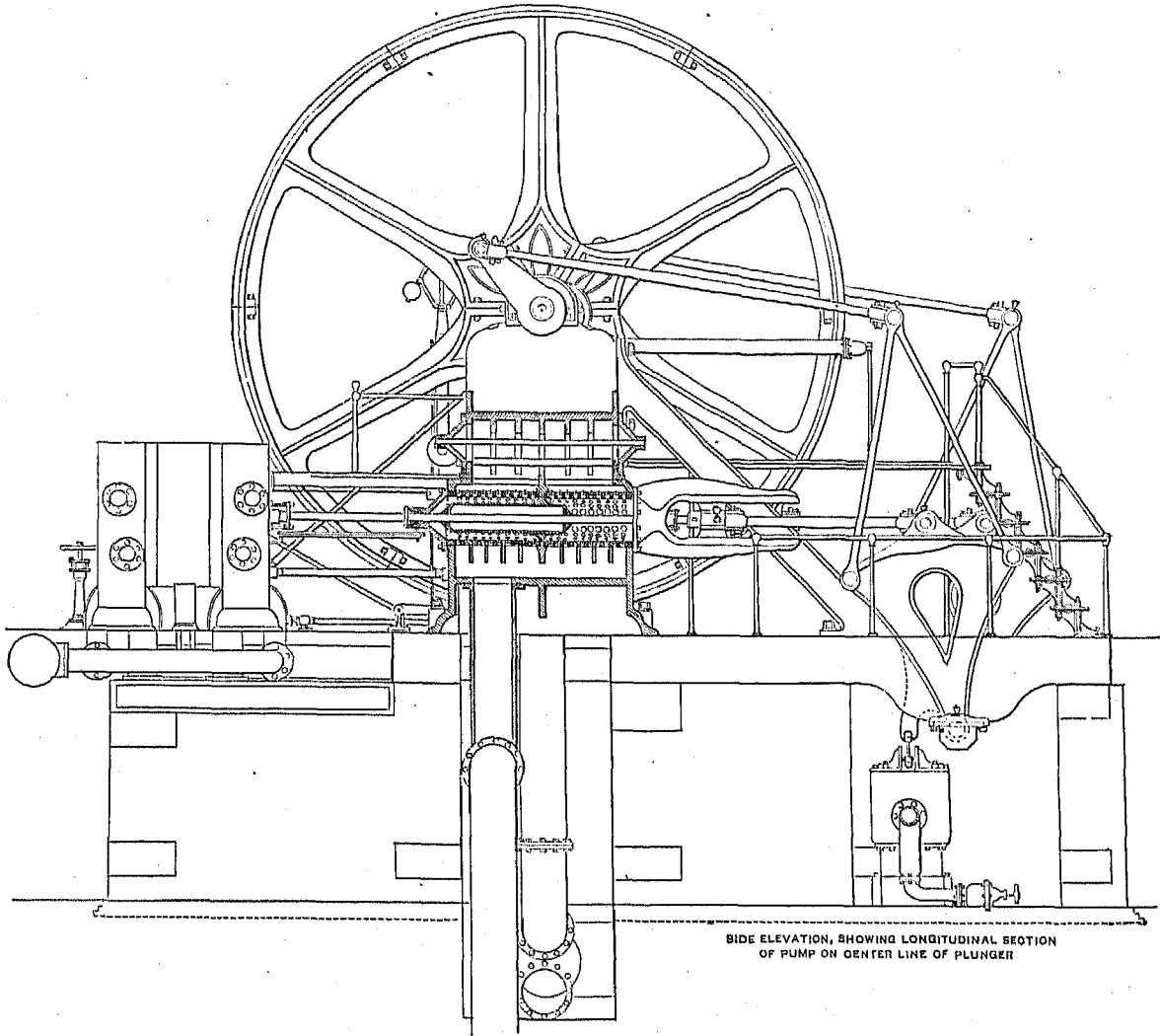
Pawtucket, situated on both sides of the Pawtucket river, 4 miles northeast of Providence, contains a population of 19,030, chiefly engaged in manufactures. It is irregular in topography, and obtains its supply of water from Abbott Run, a stream draining an area of 26 square miles. The streets have little regularity. The supply was introduced in 1878, under municipal control, and is pumped either into a distributing reservoir or directly into the mains.



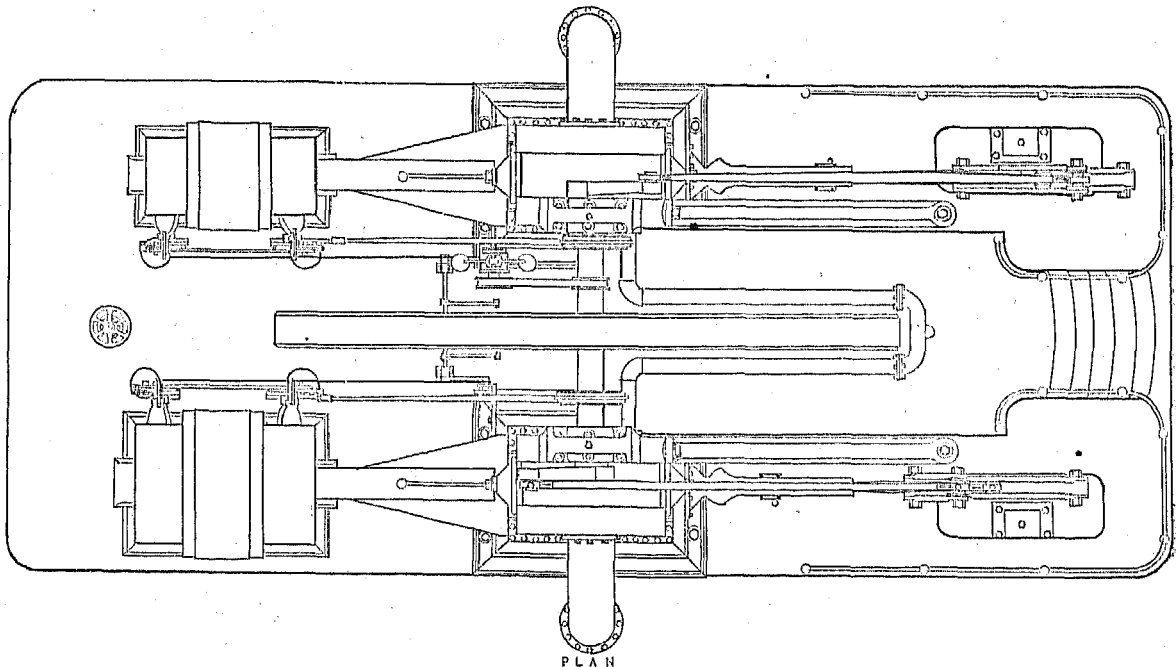
Section on A. A.
Scale 3-10 of an inch to a foot.

Section B. B.
Scale 3-10 of an inch to a foot.

The dam on Abbott Run is a plain wooden structure, 75 feet long and 9 feet high, formerly part of an old water-privilege, upon which a gate-house was constructed at a cost of \$5,000. This backs the water into what is known as Happy Hollow pond, having an area of 23 acres and a capacity of 72,000,000 gallons. The water, passing through three sets of screens in the gate-house, shown in the cut, enters a 30-inch cast-iron conduit 3,696 feet long,



SIDE ELEVATION, SHOWING LONGITUDINAL SECTION OF PUMP ON CENTER LINE OF PLUNGER



PLAN

to the engine-house. The pump-well is 10 feet in diameter and 17 feet deep, containing about 14 feet of water. The pumping-station is of brick and stone, 40 by 45 feet, with a wing 25 by 30 feet, and one of the handsomest in the country. The pumping-engines, built by George H. Corliss in 1878, are compound condensing-engines, two being coupled to the same fly-wheel, the principal dimensions of which may be seen from the appended description:

Diameter of high-pressure cylinder.....	inches..	15
Diameter of low-pressure cylinder.....	do.....	30
Diameter of piston-rods.....	do.....	2½
Length of stroke.....	do.....	30
Diameter of pump-barrel.....	do.....	15
Diameter of plunger.....	do.....	10.52
Diameter of plunger-rod.....	do.....	2½
Diameter of suction- and discharge-pipes.....	do.....	15
Diameter of fly-wheel.....	feet.....	18

Each pump is a double-acting plunger-pump, and contains 280 Corliss copper disk-valves, 2 inches in diameter each, with a free lift. These valves consist of a single disk of sheet copper, the top of which is attached to a flat spiral spring, the upper end of which is fixed. They rest upon their seats with the elasticity of rubber, the only effect of time appearing to be that they fit, if possible, more perfectly to their seats.

Steam is supplied by three vertical multitubular boilers, the dimensions and particulars of which are given below:

Number of boilers.....		3
Length of shell.....	feet.....	14
Diameter of shell.....	do.....	4
Height of fire-chamber.....	do.....	3½
Number of tubes.....		48
Diameter of tubes.....	inches..	3
Grate-surface.....	square feet.	19.63
Fire-surface.....	do.....	560
Average steam-space.....	feet.....	3½ to 4
Average steam-pressure.....	pounds..	125
Average water-pressure.....	do.....	110

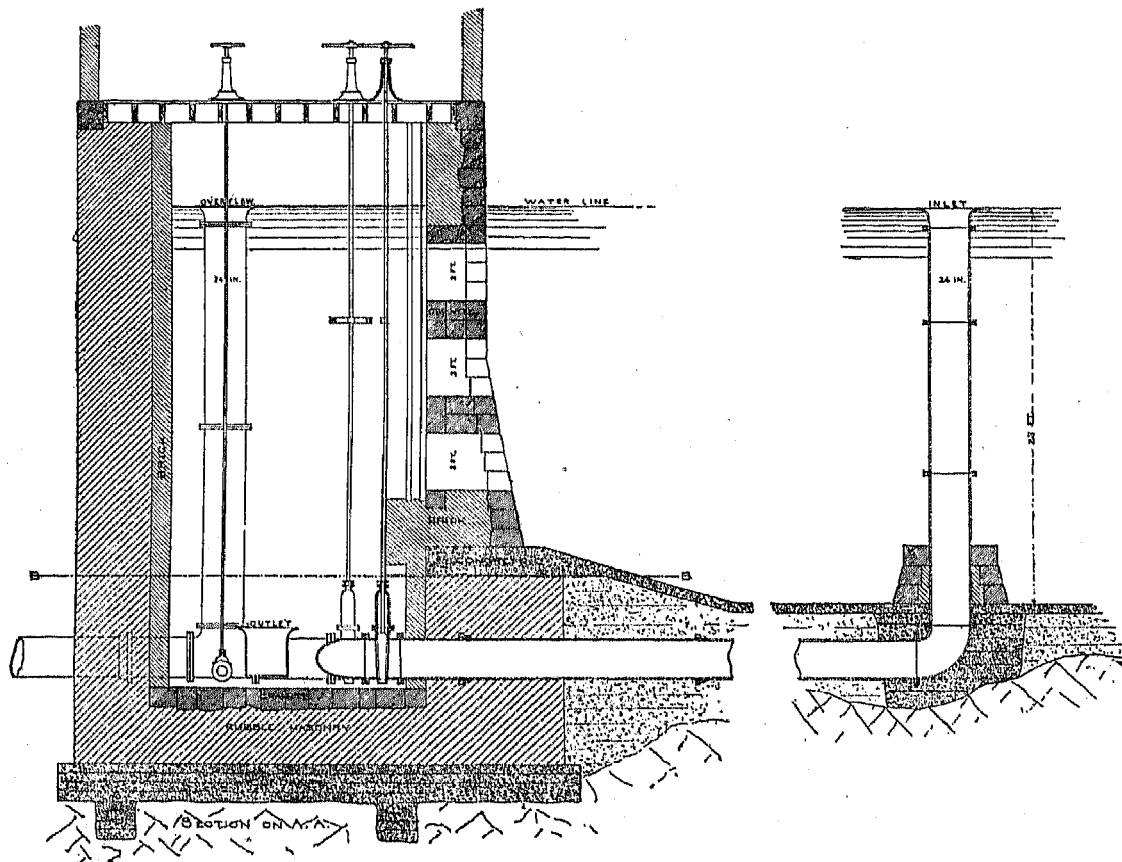
The pumps average 44.6 revolutions per minute during 11½ hours per day. The work performed during 1879 is given in the accompanying summary:

Number of days' pumping.....		252
Total pumping time per month, in hours and minutes.....		247 29
Average pumping time per day, in hours and minutes.....		11 59
Total revolutions per month.....		7, 956, 727
Average revolutions per minute.....		44.61
Coal consumed starting fires.....	pounds..	178, 375
Coal consumed pumping.....	do.....	471, 441
Coal consumed banking.....	do.....	57, 800
Coal consumed heating building.....	do.....	29, 133
Total coal consumed.....	do.....	736, 749
Total number of gallons pumped per month.....		325, 408, 303
Average number of gallons pumped per pound of coal consumed, excluding heating when not pumping.....		458.42
Average number of gallons raised 100 feet per pound of coal consumed.....		1, 200.50
Average head against pump, in feet (no allowance for friction in suction).....		262.30
Average duty in pounds of water raised 1 foot high per 100 pounds of coal (calculated on total coal used for all purposes; no deduction for ashes and cinders).....		96, 046, 816
Average duty in pounds of water raised 1 foot high per 100 pounds of coal (calculated on amount of coal used for starting, pumping, and banking; no deduction for ashes and cinders).....		105, 014, 399

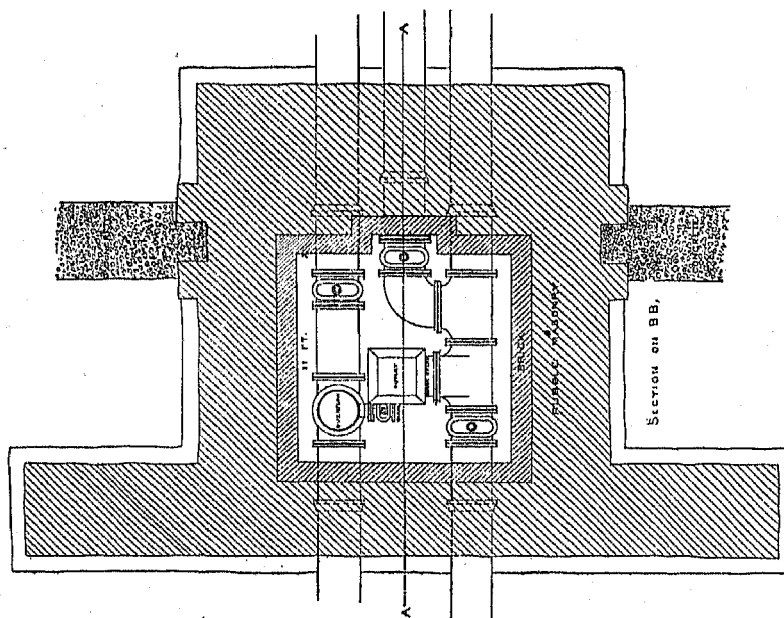
Condensation takes place in a pipe-condenser 6 feet long and 10 inches in diameter, the water being injected at one end and producing a vacuum of 26½ or 27 inches. The air-pump is 20 inches in diameter and 7½ inches stroke. The test trial made in 1878 showed a duty, during a run of 120 hours, of 104,357,654 foot-pounds, with a capacity of 3,060,000 gallons per day. A 24-hour test showed a duty in excess of any other encountered among the water-works of the country, viz, 133,522,060 foot-pounds. The engines cost \$30,000, erected. The rate of speed is so high as to produce a slight pounding when pumping directly into the mains. The pumping expenses for 1880 amounted to \$4,419, divided as follows: 736,749 pounds of coal, \$1,790 59; salaries of engineers, firemen, watchmen, etc., \$2,460; oil, waste, etc., \$118 50; lighting with gas, \$50. Therefore the cost of raising 1,000,000 gallons 1 foot high is 5½ cents. From the engine-house the water is forced through a main 24 inches in diameter and 11,000 feet long, into the distributing reservoir, under a total head of 269 feet.

This reservoir is 300 feet above tide-water, with an area of 3 acres, circular in plan, and a capacity of 20,000,000 gallons. Its depth is 21 feet. The embankments are of earth, resting on a natural ledge of rock, faced with masonry on the inner side, behind which are 2 feet of concrete; this masonry facing rests on 6 feet of concrete, and

a layer of 12 inches of the same material extends over the whole reservoir bottom. The top of the embankment is 35 feet wide with an outer slope of $1\frac{1}{2}$ to 1. Further details can be seen from the figure. A section of the gate-house is also given.



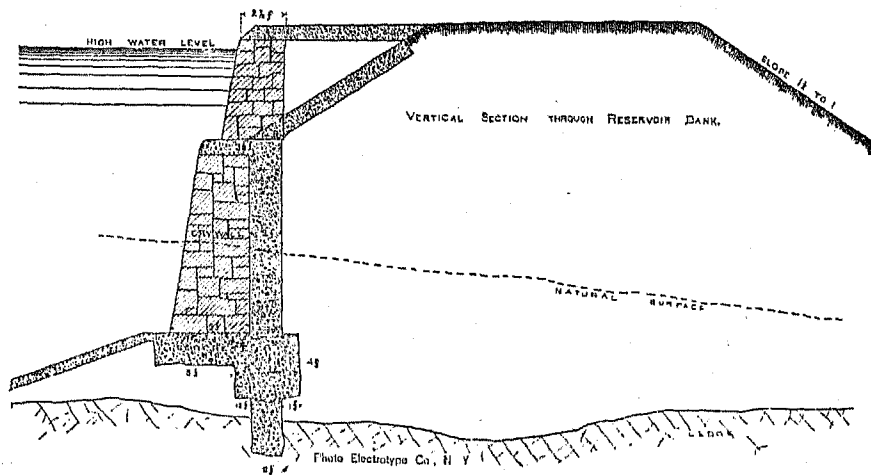
When the engine begins pumping, a check-valve in the gate-house closes and the water flows into the reservoir through the stand-pipe near the center; when it ceases, the same valve opens and the water flows back to the town through the gate-house. It will thus be seen that any surplus above the consumption flows into the reservoir for storage.



There are three gates, each 3 feet square, entering the inlet-chamber for the purpose of drawing the water from different depths.

A receiving basin was partly completed to hold about 7,000,000 gallons, and located in the immediate vicinity of the pumping-station. It was designed to be used as a reserve in case of accident to the conduit or a turbid state

of the water, or to receive the overflow of the conduit in case of a freshet at the dam. It might be well here to state that the engine is situated at one end of the town and the reservoir at the other.



The total amount of pipe laid is 30.59 miles, as follows: 30-inch, 3,696 feet; 24-inch, 10,994 feet; 20-inch, 8,928 feet; 12-inch, 13,327 feet; 10-inch, 13,787 feet; 8-inch, 36,098 feet; 6-inch, 44,248 feet; 4-inch, 30,449 feet. They are of cast iron, coated inside and out with cold-tar varnish; 472 fire-hydrants are in use (of the Fales & Jenks pattern), placed from 250 to 500 feet apart. Of service-pipe there is about 66,500 feet of 2 inches, 1½ inch, 1¼ inch, 1 inch, and ¾ inch in diameter, of wrought iron dipped in coal tar; 1,065 Union rotary meters are in use, giving great satisfaction.

The consumption averaged 891,529 gallons per day during 1880, supplied, by the pumps working a little over 11 hours per day, to 2,043 consumers.

There is probably less waste of water in Pawtucket, in proportion to its size, than in most cities in the country.

The total cost of the works to April, 1880, amounts to \$608,071, although not then quite completed. The annual cost of maintenance for the year ending April 1, 1881, amounted to about \$8,497. The receipts from April 1, 1880, to February 1, 1881, amounted to \$23,000. No analysis of the water seems to have been made. The present superintendent is Mr. Edwin Darling, and the management is by a board of three commissioners.

POUGHKEEPSIE, NEW YORK.

Poughkeepsie, containing a population of 20,207, is situated on the east bank of the Hudson river 75 miles from its mouth. From the river-bank the site of the city slopes abruptly for about 1 mile eastward. Back of this is a comparatively level plateau at an elevation of about 250 feet above the river-level, at which point the streets are regular. Its business interests are chiefly commercial and manufacturing. On account of the failure of the old gravity works, a new supply of water was introduced in 1872 from the Hudson river at a point about 1½ mile above the city, and under the auspices of the city authorities and the direction of Mr. James P. Kirkwood, civil engineer.

At this point a wharf has been built 85 feet long on the river by 133 feet outward, for the purpose of landing coal, sand, etc., for the use of the works. At the northern end of this and at the pier-line a wooden crib is sunk, into the end of which a 24-inch pipe 130 feet long is joined, and conveys the water to the engine-house well. The crib is 3 feet 8 inches by 7 feet 3 inches, divided into two compartments, the outer 2 feet 8 inches by 3 feet 3 inches, and the inner 2 feet 8 inches by 2 feet. The walls and floors have a 4-inch space back of each, filled with concrete. The floor of the inner compartment is 4 feet 8 inches above the level of the outer. In the place of the river-end of the outer compartment a copper-wire screen is fitted in grooves, and another is placed in the division-wall between the compartments, and is 2 feet wide by 3 feet high. To lay the remainder of the pipe, coffer-dams had to be resorted to as far as the engine-house wall. The pipe has a valve-gate operated in the engine-room to shut off the inflow to the well if desirable. The river at the end of the pier is 24 feet deep, and water is drawn at a point 4 feet below low-water level.

The engine-house, located at the head of the pier, is of brick, stone-trimmed, 40 by 50 feet by 30 feet high, with boiler-house from one corner 30 by 40 feet by 20 feet high, and a stack 106 feet high by 11 feet square at base, and an internal section of 3 feet. A two-story house of the same material serves for the engineer's residence, and the effect of the whole station is exceedingly pleasing.

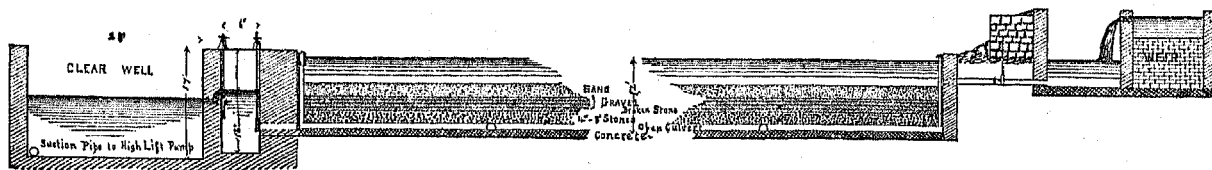
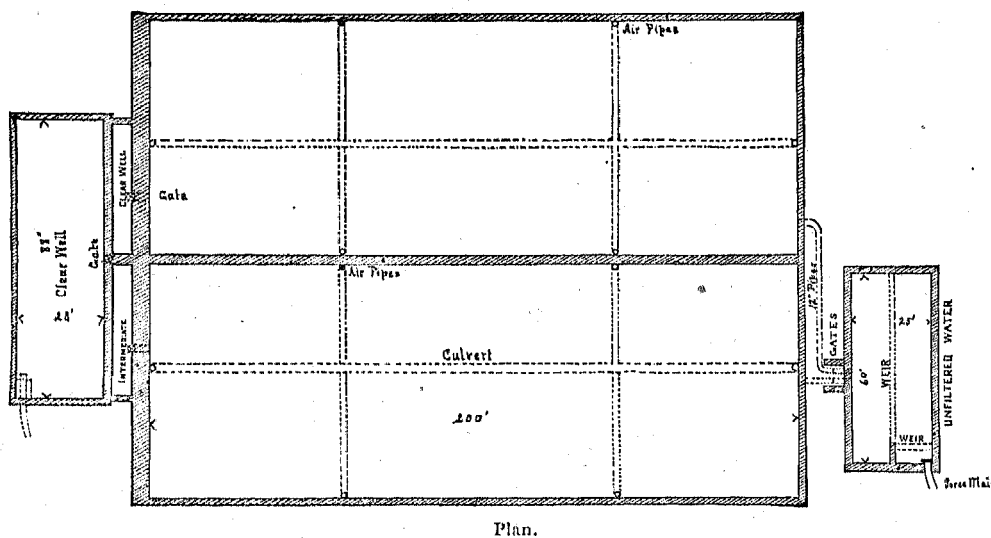
The pump-well, rectangular in plan, is 30 by 10 feet by 20 feet deep below low-water mark (the floor of the engine-house being 8 feet above high, or 12 feet above low water), and divided midway by a weir fitted with an iron gate, now always kept open. One of the compartments was originally intended as the suction-well of the engine pumping into the filter-bed, and the water from the clear well of the latter flowed back into the other compartment

and was drawn up into the suction-pipe of the reservoir pumping-engine—a useless waste of power, considering the high lift into the reservoir. It has now been changed so that the pipe from the clear well is directly connected with the suction-pipe of the engine, thus converting the lift of 9 feet into a head of 17 feet, an effective diminution of the height to be overcome, amounting to 26 feet.

From the pump-well a non-condensing Worthington duplex engine lifts the water 10 feet and forces it through 273 feet of pipe into the unfiltered-water basin, 20 feet above the level of the discharge-valves. This engine has steam-cylinders of 22 inches diameter; pump-plungers, 20 inches in diameter; stroke, 25 inches; daily capacity, 3,000,000 gallons; both pistons, average double strokes per minute, 39. It contains 16 suction- and 16 discharge-valves in each pump-cylinder 7 inches in diameter, consisting of rubber disks 1 inch thick, with iron weights and spiral steel springs around the spindles. Its cost was \$5,500, erected in 1872.

The engine for pumping into the reservoir is a Worthington compound duplex, also built in 1872, and of nearly the same size as the above, with low-pressure cylinders of 43 inches diameter; high-pressure cylinders, 24 inches diameter; pump-plungers, 17½ inches diameter; stroke, 30 inches; jet-condenser, 3 feet diameter and 7 feet high; four air-pumps, 14 inches stroke, 3 feet diameter; head on pump, 300 feet of water; daily capacity, 3,000,000 gallons; cost, \$28,135, with boilers. The number and arrangement of pump-valves is the same as in the other pumps, and the summary of the engine record for the year 1880 is given below, showing the operation of both:

Hours run :	
• Small engine	4,502
Large engine	4,186
Tons (2,240 pounds) coal consumed :	
Small engine	573.08
Large engine	828.40
Banking and starting	124.58
Total.....	<u>1,526.06</u>
Tons of ash from furnaces	188.18
Percentage of ash	12.24
Gallons of water pumped each month	512,774,130
Tons of coal per 1,000,000 gallons :	
Large engine	1.56
Total	2.84
Average hours run each day :	
Small engine	12.26
Large engine	11.43
Average gallons pumped each day	1,403,292
Average tons of coal each day	4.19



Longitudinal section.

FILTER BASIN OF POUGHKEEPSIE WATER-WORKS.

The filtering basin, into which the water is first pumped by the non-condensing engine, is constructed as follows: The water first enters the unfiltered-water basin 25 by 60 feet by 12 feet deep, which is divided into three compartments by walls of masonry. The first and smallest is 11 by 6 feet, whence the water flows over a weir into the second compartment, 11 by 53 feet, and partly settles, thence over a second weir into the third division. From here it passes through 12-inch pipes controlled by gates upon the top of the sand in the basins proper. Of the latter there are two side by side, separated by a 30-inch wall of masonry, and each 200 feet long, $73\frac{1}{2}$ feet wide, and 12 feet deep. On the concrete floor, which is 12 inches thick, is a layer of 24 inches of stones 4 to 8 inches in diameter. Through this layer a main open culvert passes from end to end in the center of the basin with two laterals on each side of it, and is used the more easily to collect the filtered water and convey it into the clear well. At each end of the main and the extremities of the lateral culverts a 6-inch cast-iron pipe passes up above the level of the basin and serves as an exit for air when filling the filter. Above the stones there is another layer of 2-inch broken stone 6 inches deep. Above this is 18 inches of gravel, varying in size from $\frac{1}{4}$ to 1 inch diameter, and the whole is covered with 24 inches of fine sand. The water above this rises to within about 12 inches of the top of the basin.

The filtered water is led through a gate in an outlet-pipe at the end of each basin into the intermediate clear well, built of masonry, 6 feet wide, 85 feet long, and 16 feet deep. In this the depth of water is kept about 11 inches above the level of the top of the sand in the basin. A square iron gate, 4 by $4\frac{1}{2}$ feet, and operated by a wheel, is located in the middle of the wall separating the intermediate from the clear well. Over the top of this the water flows into the latter. When depressed to its fullest extent the top of this gate is 9 inches below the level of the top of the sand in the basins. The clear-well is 88 feet long, 28 feet wide, and 17 feet deep, the walls being built of masonry, about 18 to 24 inches thick. From one corner of this well the outlet-pipe, 18 inches diameter and 408 feet long, extends to the suction-pipe of the compound or reservoir pumping-engine, giving a head upon the pumps of about 17 feet. The cost of the beds can be seen from the table of cost of construction. They require cleaning once a month, when about half an inch of silt and material is removed from the surface. Once a year the sand is entirely replaced with fresh. The maximum yield of the filtering basins has not yet been accurately ascertained, but it is estimated at about 3,500,000 gallons per day. For its management it requires the services of the mechanical engineer at the pumps and three sand-washers. When cleaned once per month a force of 20 laborers is obtained by advertisement, and they are occupied one day in cleaning it.

The force-main from the pumping-house to the reservoir is 18 inches in diameter and 7,590 feet long. The reservoir inlet is of iron, 3 feet in diameter by 10 feet deep, closing air-tight at top, and entered by the force-main from the west about 4 feet below the ground. The 24-inch supply-pipe line is at the same level.

The reservoir is situated on College hill, to the north of the city, and is irregular in plan to conform to the nature of the locality, about 540 feet long by 210 feet wide and 16 feet depth of water. Height above water-line, $4\frac{1}{2}$ feet, with bottom area of 1.6 acre and at water-line 2.3 acres; its capacity is 12,000,000 gallons. A puddle wall extends through the whole length of the banks, and a thickness of 2 feet from the foot of said wall to the toe of the inner slope. The bottom of the reservoir is not puddled, owing to the fact that it was found to be impervious in itself, but is covered with 3 inches of coarse gravel. The riprap facing extends from 2 to 4 feet below the bottom. The force-main enters the reservoir on the bottom and at the eastern end. The masonry about the pipe rises to a height of $3\frac{1}{2}$ feet above the bottom, and is $2\frac{1}{2}$ by 5 feet in plan. Into this an inlet-main discharges, and immediately around the well the bottom of the reservoir is paved. The inlet-well of cast iron in the eastern bank, and before described, is connected with the masonry well just mentioned by an inlet-main, 24 inches in diameter, passing 4 feet beneath the slope-wall.

About 460 feet to the west of the inlet the effluent gate-house is situated. The supply-pipe leaving it is 24 inches diameter, belled to 26 inches at the outlet-well, where it fits into a cast-iron frame provided with a gate operated from the gate-house above by a screw and wheel. Two screens of copper wire with $\frac{3}{8}$ -inch mesh are fastened in front of the outlet by grooves in the masonry, and extend above high-water mark. The 24-inch outlet-main branches into mains, one of 12 inches and one of 16 inches diameter, at a point 88 feet from the gate-house, and each is provided with a gate.

A check-valve in the force-main is outside of the engine-house wall, and is accessible through a chamber built for the purpose.

The distribution system comprises about 15.83 miles of cast-iron mains, the great majority of which is of 6 inches diameter. The sizes in use are 24, 18, 16, 12, 8, 6, and 4 inches. Of hydrants there are 292, mostly of Matthews' patent.

Worthington meters are used to a small extent, 130 being the total of all patterns. They are chiefly for attachment to small service-mains.

The number of takers in 1880 was 1,363, and the consumption in 1881 amounted to about 1,500,000 gallons per day.

WATER-SUPPLY OF CITIES—POUGHKEEPSIE, N. Y.

The first cost of the works is given in an itemized statement below :

Pumping-works :	
Paid for land	\$2,000 00
Paid contractors for wharf, conduit, well, foundations	13,204 76
Paid for engine-house	14,748 97
Paid for engineer's house	4,470 78
Paid for large engine	28,135 80
Paid for roadway	903 00
General account, including office, engineering, legal, inspection, superintendence, materials, labor	14,223 46
	\$77,686 77
Filtering-works :	
Paid for land	2,000 00
Paid contractors	56,701 76
Paid for small engine	5,500 00
Paid for well	2,000 00
Paid for pipe	3,665 01
Paid for gates	1,084 18
Paid on general account, including office, engineering, legal, inspection, superintendence, materials, labor	4,743 87
	75,694 82
Total	153,381 59
Force-main, or pipe from the engine to the reservoir on College hill :	
Paid for right of way	497 00
Paid contractors for pipe	42,389 42
Paid contractors for laying pipe	18,381 45
Paid on general account, including office, engineering, legal, inspection	2,068 33
	63,336 20
Reservoir :	
Paid for land	7,557 21
Paid contractors	69,823 58
Paid for pipe	1,267 24
Paid for gates	200 00
Paid for drive	4,391 76
Paid for walk	475 50
Paid for grounds	2,074 49
Paid for fence	562 40
Paid on general account, including office, engineering, legal, inspection, superintendence, materials, labor	7,850 10
	94,202 28
Total	310,920 07

At the pumping-station, filter-beds, and reservoir sufficient ground was purchased for additional works when required. The cost of improving these grounds is included in the general accounts.

Distribution :	
Paid contractors for pipe	\$55,392 23
Paid contractors for gates	5,135 50
Paid contractors for hydrants	6,840 00
Paid contractors for laying pipe	36,933 69
Paid on general account, including office, engineering, legal, inspection, superintendence, materials, labor	12,476 96
	116,778 38
Due contractors on distribution pipe	23,223 93
Due on laying pipe	1,092 00
Total	24,315 93

SUMMARY.

Water-works	\$310,920 07
Distribution	116,778 38
Indebtedness January 1, 1873, on construction account	24,315 93
Total	452,014 38

In the next year (1873) 31,600 feet of pipe were laid, and various additions and enlargements have brought the total cost to date (January, 1881) to a grand total of \$842,614.

The annual cost of maintenance and repairs for 1880 was \$18,626. The character of the water supplied can be seen from the appended analysis by Professor William Ripley Nichols, of the Massachusetts Institute of Technology. Results stated in parts in 100,000:

No. of samples.	Date received.	Locality.	UNFILTERED.		FILTERED.		Inorganic.	Organic volatile.	Total at 212° Fahr.	Total solids after filtration through paper.
			Ammonia.	"Albuminoid ammonia."	Ammonia.	"Albuminoid ammonia."				
408	Nov. 13	River	0.0109	0.0197	0.0109	0.0184	10.4	1.7	12.1	10.1
409	Nov. 13	Clear-water basin	0.0077	0.0139	0.0077	0.0139	8.9	1.1	10.0	9.0
423	Nov. 10	River	0.0104	0.0157	0.0104	0.0157	9.0	1.5	10.5	8.6
427	Nov. 19	Clear-water basin	0.0112	0.0155	0.0112	0.0149	8.1	1.3	9.4	9.0

The specimen numbered 409 was taken just previous to the cleansing of the filter-beds, and was filtered at the rate of $6\frac{1}{2}$ inches per square foot per hour.

The specimen numbered 427 was a portion of the first water pumped after the cleansing of the beds, and was slightly turbid. Both specimens of river-water were very turbid.

The works are under the control of a board of commissioners, with Mr. Charles E. Fowler as superintendent.

WATER-WORKS EMPLOYING THE GRAVITY SYSTEM.

CALIFORNIA.

DUTCH FLAT:

Population: 939 inhabitants.
 Name of corporation: Dutch Flat Water-Works (private).
 Water obtained from: Springs and miners' ditches.
 Cost of dam: About \$6,000.
 Water first introduced: In 1859.
 Description of main conduit: Length, 2,000 feet; diameter, 13 inches; material, sheet iron.
 Description of distributing reservoir: 60 by 80 feet; 8 feet deep; plank, stone wall banked and roofed.
 Sizes of distributing mains: 6-inch cast iron; 2½- to 4-inch gas-pipe.
 Available head: 0 to 200 feet.
 Total length of distributing mains: 1½ mile.
 Number of water-takers: 50 to 100.*
 First cost of water-works: About \$6,000.
 Average annual cost of maintenance and repairs: \$200.
 Number of fire-plugs: 10.

GRASS VALLEY:

Population: 6,688 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: South Yuba canal.
 Capacity of receiving reservoir: 9,000,000 gallons.
 Cost of dam: \$75,000.
 Water first introduced: In 1858.
 Description of main conduit: 6 inches diameter; cast iron.
 Description of distributing reservoirs: Three large reservoirs on top of Alta hill.
 Sizes of distributing mains: 6 to 4 inches.
 Available head: 210 feet (average).
 Total length of distributing mains: 6 miles.
 Number of water-takers: 550.
 First cost of water-works: \$30,000.
 Average annual cost of maintenance and repairs: \$800.

LOS ANGELES:

Population: 11,183 inhabitants.
 Name of corporation: Los Angeles City Water Company (private).
 Water obtained from: Los Angeles river.
 Total area of water-shed available: 182 square miles.
 Character and dimensions of dams: No. 1—150 feet long; 8 feet wide on top; 40 feet deep; slope 1½ to 1; earth. No. 2—200 feet long; 6 feet wide on top; 22 feet deep; slope 1½ to 1; puddle wall in center, 6 feet wide; puddle 16 inches on face; clay and sand.
 Cost of dams: No. 1—\$5,000, in a cañon; No. 2—\$2,650.
 Water first introduced: In 1868.
 Description of main conduit: Open ditch; length, 35,000 feet; cross-section, 4 feet (average); sides slope 1 to 1; average depth, 1 foot.
 Discharging capacity: 4 cubic feet per second.
 Description of distributing reservoirs: Capacity of No. 1, 5,600,000 gallons; of No. 2, 800,000 gallons; No. 1, drawn 16 feet below surface, pipe passes under embankment laid in a trench; No. 2, drawn 15 feet deep.
 Sizes of distributing mains: 22 inches and 13 inches to 1 inch.

LOS ANGELES—Continued.

Available head: 20 to 120 feet; water-supply sometimes deficient in summer.
 Total length of distributing mains: 23 miles.
 Number of water-takers: About 1,500.
 Consumption of water: 125 gallons per head daily (estimated).
 First cost of water-works: \$375,000.
 Average annual cost of maintenance and repairs: \$6,000.
 Number of fire-plugs: 60.

MISSION SAN JOSÉ:

Population: 246 inhabitants.
 Name of corporation: Mission Water-Works (private).
 Water obtained from: Spring.
 Cost of dam: \$1,500.
 Water first introduced: In 1871.
 Description of distributing reservoir: Circular; 30 feet diameter, 11 feet deep; concrete.
 Size of distributing mains: 3 inches.
 Available head: 50 feet (average).
 Total length of distributing mains: 2,200 feet.
 Number of water-takers: 30.
 Consumption of water: 6,000 gallons per day (estimated).
 First cost of water-works: About \$5,000.

OAKLAND:

Population: 34,555 inhabitants.
 Name of corporation: Contra Costa Water Company (private).
 Water obtained from: Artificial lake.
 Total area of water-shed available: 50 square miles.
 Capacity of lake: 20,000,000,000 gallons.
 Character and dimensions of dam: 300 feet long; 75 feet high; built on solid bed-rock; packed in layers 12 inches thick; slope 1 to 3; can be made 100 feet higher if necessary; no leakage.
 Cost of dam: \$3,000,000.
 Water first introduced: In 1876.
 Description of main conduit: Length, 8 miles; diameter, 24 inches; plate iron, riveted and caulked, tar-coated.
 Discharging capacity: 5,000,000 to 7,000,000 gallons per 24 hours, under 216 feet head (average).
 Sizes of distributing mains: From 24 to 3 inches.
 Available head: 40 to 75 pounds; water-supply deficient at lowest head.
 Total length of distributing mains: About 100 miles.
 Consumption of water: 300 gallons per head per day (estimated).
 First cost of water-works: \$3,000,000.
 Average annual cost of maintenance and repairs: About \$60,000.
 Description of filtering apparatus: Through cotton cloths set in frames in summer; cleaned every 24 hours.
 Number of fire-plugs: 200, made in Oakland.

PETALUMA:

Population: 3,326 inhabitants.
 Name of corporation: The Sonoma County Water Company (private).
 Water obtained from: Adobe creek.
 Total area of water-shed available: 36 square miles.

PETALUMA—Continued.

Water first introduced: In 1872.

Description of main conduit: Length, 5½ miles; diameter, 7 inches; wrought iron, riveted.

Discharging capacity: 300,000 gallons per day; head, 50 feet (average).

Description of distributing reservoir: Excavation in hard pan, 100 by 100 feet; capacity, 500,000 gallons.

Sizes of distributing mains: 7, 6, 5, 2½, and 1½ inches.

Available head: 50 to 170 feet.

Total length of distributing mains: About 12 miles.

Number of water-takers: 620.

Consumption of water: 75 gallons per head per day (estimated).

First cost of water-works: \$100,466 37.

Average annual cost of maintenance and repairs: \$1,000.

Number of fire-plugs: 15, various designs.

PLACERVILLE:

Population: 1,951 inhabitants.

Name of corporation: Placerville Water Company (private).

Water obtained from: American river (South fork).

Total area of water-shed available: About 250 square miles.

Water first introduced: In 1852.

Description of main conduit: Wood, 3,360 feet long, 6 by 6 inches; and plate iron, 1,000 feet long, diameter, 7 inches.

Description of distributing reservoir: Simply earth embankment; receiving reservoir capacity, 2,500,000 gallons.

Sizes of distributing mains: 7, 3, 2½, and 2 inches.

Available head: 125 feet (average); water-supply sometimes deficient.

Total length of distributing mains: 8,700 feet.

Number of water-takers: 100.

Consumption of water: 175 gallons per head per day.

First cost of water-works: \$30,000.

Number of fire-plugs: 4.

SAN JOSÉ:

Population: 12,567 inhabitants.

Name of corporation: San José Water Company (private).

Water obtained from: River and reservoir.

Total area of water-shed available: 50 square miles.

Capacity of receiving reservoir: 500,000,000 gallons.

Material of dam: Earth.

Cost of dam: \$80,000.

Water first introduced: In 1870.

Description of main conduit: Flume, 24 by 24 inches, wood; pipe, 18 inches, No. 14 iron.

Discharging capacity: 5,000,000 gallons per day, 40 pounds head (average).

Description of distributing reservoir: Capacity, 5,000,000 gallons; dam of earth.

Size of distributing mains: 11 inches.

Available head: 40 pounds (average).

Total length of distributing mains: 56 miles.

Number of water-takers: 2,000.

Consumption of water: 3,000,000 gallons daily in summer and 1,000,000 gallons daily in winter (estimated).

First cost of water-works: \$413,500.

Average annual cost of maintenance and repairs: About \$20,000.

SAN RAFAEL:

Population: 2,276 inhabitants.

Name of corporation: Marin County Water Company (private).

Water obtained from: Springs and surface-water.

Capacity of receiving reservoir: 175,000,000 gallons.

Character and dimensions of dam: 400 feet long, earth and clay.

Cost of dam: About \$400,000 by old company; present company bought property.

Water first introduced: In 1872.

Description of main conduit: Diameter, 8 inches; No. 14 iron, riveted joints.

SAN RAFAEL—Continued.

Description of distributing reservoirs: Capacity of No. 1, 1,000,000 gallons; of No. 2, 250,000 gallons; brick, cement-lined.

Sizes of distributing mains: 8 to 6 inches.

Available head: 90 pounds pressure (average).

Total length of distributing mains: 23 miles.

Number of water-takers: 400.

Consumption of water: 200 gallons per head per day (estimated very closely).

First cost of water-works: \$350,000 to present company.

Average annual cost of maintenance and repairs: \$14,000.

Number of fire-plugs: 25.

SANTA BARBARA:

Population: 3,460 inhabitants.

Name of corporation: Mission Water Company (private).

Water obtained from: Mountain streams.

Capacity of receiving reservoir: 100,000 gallons.

Character and dimensions of dam: Length, 125 feet; width at top, 14 feet; at base, 20 feet; stone and brick; built by Indians.

Cost of dam: \$30,000.

Water first introduced: In 1872.

Description of main conduit: Sheet-iron pipes—length, 1,000 feet, diameter, 6 inches; and wrought-iron pipes—length, 5,000 feet, diameter, 5 inches by 4 inches.

Description of distributing reservoir: 105 by 104 feet, 7 to 10 feet deep; sloping to discharge-pipe; stone side-walls, with concrete bottom.

Sizes of distributing mains: 6, 5, 4, 3, and 2 inches.

Available head: 75 pounds to square inch (average).

Total length of distributing mains: 5 miles.

Number of water-takers: 225.

Consumption of water: 15,000 gallons daily.

First cost of water-works: 25,000.

Average annual cost of maintenance and repairs: \$600.

Description of filtering apparatus: Redwood and brass-wire screens, 6 by 10, 6 feet high; cleaned in summer every 15 days, in winter every 30 days.

Number of fire-plugs: 13; globe-valves and nipples.

SANTA CLARA:

Population: 2,416 inhabitants.

Name of corporation: San José Water Company (private).

Water first introduced: In 1870.

Description of main conduit: Length, 2 miles; diameter, 7 inches; sheet iron.

Number of water-takers: 250.

Number of fire-plugs: 25.

TRUCKEE:

Population: 1,147 inhabitants.

Style of corporation: Private.

Water obtained from: Springs.

Dimensions of receiving reservoir: 28 by 60 feet; 6 feet deep.

Cost of dams: \$9,000.

Water first introduced: In 1868.

Description of main conduit: Length, 2,000 feet; diameter, 11 inches; iron.

Description of distributing reservoir: Length, 60 feet; width, 28 feet; depth, 6 feet; wood.

Sizes of distributing mains: 8, 4, and 3 inches.

Available head: 100 feet (average).

Total length of distributing mains: 3,000 feet.

Number of water-takers: 80.

Average annual cost of maintenance and repairs: About \$200.

Number of fire-plugs: 10.

WASHINGTON:

Population: 195 inhabitants.

Style of corporation: Municipal.

Water obtained from: Spring.

Water first introduced: In 1856.

WASHINGTON—Continued.

Description of main conduit: Length, 600 feet; diameter, 1½ inch; galvanized iron.

Discharging capacity: 5 gallons per minute; head, 15 feet (average).

Consumption of water: 200 gallons per head per day (estimated.)

First cost of water-works: \$300.

Average annual cost of maintenance and repairs: \$25.

WATSONVILLE:

Population: 1,799 inhabitants.

Names of corporations: Watsonville Water Company and Corralitos Water Company.

Water obtained from: Corralitos creek.

Cost of dam: \$1,500.

Water first introduced: July, 1868.

Description of main conduit: Boiler iron—length, 1½ mile; diameter, 8 inches. Wooden flume—length, 7 miles.

Description of distributing reservoir: Excavation and embankment; capacity, 3,000,000 gallons.

Sizes of distributing mains: 8, 4, and 3 inches.

Available head: 93 feet (average).

Total length of distributing mains: About 9 miles.

Number of water-takers: 200.

Consumption of water: 200,000 gallons per day (estimated).

First cost of water-works: About \$40,000.

Average annual cost of maintenance and repairs: \$1,200.

Number of fire-plugs: 18.

YREKA:

Population: 1,059 inhabitants.

Name of corporation: Yreka Water-Works (private).

Water obtained from: Culverts in bottom of mining gulches.

Total area of water-shed available: About 8 square miles.

Capacity of receiving reservoir: 60,000 gallons.

Cost of dam: \$10,000 or \$11,000.

Water first introduced: June, 1862.

Description of main conduit: Bored logs—length, ½ mile, diameter, 4½ inches; iron—length, ¼ mile, diameter, 3 inches.

Discharging capacity: 75,000 gallons per 24 hours (average).

Size of distributing mains: 2 inches.

Available head: 50 feet (average); water-supply very seldom deficient.

Total length of distributing mains: About 1 mile.

Number of water-takers: 90.

Consumption of water: 75,000 gallons per day (estimated).

First cost of water-works: \$15,000.

Filtering apparatus: Cleaned once a year.

COLORADO.

CARIBOU:

Population: 549 inhabitants.

Style of corporation: Municipal.

Water obtained from: Ditch 1½ mile long, fed by melting snow in summer and by springs in winter.

Cost of dam: \$2,000.

Water first introduced: October, 1878.

Description of main conduit: Length, 400 feet; diameter, 4 inches; iron.

Description of distributing reservoir: 20 by 20 feet by 12 feet deep; supplied from ditch.

Sizes of distributing mains: 4 and 2 inches.

Total length of distributing mains: 1,400 feet.

Number of water-takers: About 15.

First cost of water-works: \$2,000.

Average annual cost of maintenance and repairs: \$300.

Number of fire-plugs: 5.

COLORADO SPRINGS:

Population: 4,226 inhabitants.

Style of corporation: Municipal.

Water obtained from: Mountain streams.

Area of receiving reservoir: ½ acre.

Cost of dam: \$7,000.

COLORADO SPRINGS—Continued.

Water first introduced: December, 1878.

Description of main conduit: Length, 6 miles; diameter, 12, 10, and 8 inches.

Description of distributing reservoir: Built in a basin; capacity about 1,000,000 gallons; inflow, 500,000 gallons per day.

Sizes of distributing mains: 6, 4, 3, and 2 inches.

Available head: 120 pounds (average).

Total length of distributing mains: About 9 miles.

Consumption of water: 100 gallons per head (estimated).

First cost of water-works: \$80,000.

Average annual cost of maintenance and repairs: \$2,000.

Number of fire-plugs: 30; Holly patent.

CONNECTICUT.

ANSONIA:

Population: 3,855 inhabitants.

Names of corporations: Fountain Water Company and Ansonia Water Company (private).

Water obtained from: Brooks and springs.

Total area of water-shed available: About 50 acres.

Capacity of receiving reservoir: About 630,000 cubic feet.

Character and dimensions of dam: Built of stone; 175 feet long, 18 feet high; curves 10 feet toward water; 8 feet thick at bottom, 3 feet 6 inches thick on top; lapped with stone 9 inches thick across dam; inside filled with earth, leaning at an angle of 45 degrees.

Cost of dam: About \$3,500.

Water first introduced: December, 1872.

Description of main conduit: Length, 4 miles; diameter, 8, 6, 4, and 3 inches; sheet iron, cement-lined.

Description of distributing reservoir: Main pipe enters penstock in center of reservoir, near bottom; the penstock is 20 feet high, 32 inches in diameter, and constructed with sliding gates.

Sizes of distributing mains: 6, 4, and 3 inches.

Available head: 90 feet (average).

Number of water-takers: 220.

First cost of water-works: \$16,000.

Number of fire-plugs: 23; Holyoke patent.

BETHLEH:

Population: 1,767 inhabitants.

Style of corporation: Municipal.

Water obtained from: Springs and surface-water.

Total area of water-shed available: About 150 to 200 acres.

Area and capacity of receiving reservoir: 35 acres; 84,000,000 gallons (estimated).

Character and dimensions of dam: 200 feet long, 80 feet wide, 20 feet high, 12 feet top; earthwork; center wall of stone, 3 feet thick; flume in center, of stone, 20 feet long, 4 feet wide, for gates and filters.

Cost of gate-house: \$125.

Water first introduced: September, 1878.

Description of distributing reservoir: A natural basin, between hills, containing 35 acres.

Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.

Available head: 60 to 80 pounds per square inch.

Total length of distributing mains: 25,816 feet.

Number of water-takers: 145.

First cost of water-works: \$26,100 21.

Average annual cost of maintenance and repairs: Not over \$100.

Description of filtering apparatus: First compartment, 4 by 6 feet by 14 feet deep; second compartment, 2 by 4 feet; third compartment, full of clear water; material, charcoal and sponges.

Number of fire-plugs: 26; Matthews patent.

BIRMINGHAM:

Population: 3,026 inhabitants.

Name of corporation: Birmingham Water Company (private).

Water obtained from: Springs and brook.

Area of receiving reservoirs: 8,160,000 feet in two reservoirs.

BIRMINGHAM—Continued.

Character and dimensions of dams: No. 1, stone, overflow 20 feet wide, 12 feet high; wing-wall run back 4 feet; earth filling 500 feet long; 10 feet high on each side of overflows; No. 2, stone, overflow 15 feet wide, 10 feet high; wing-wall and earth filling 12 feet high, 200 feet long.

Cost of dams: No. 1, \$11,700; No. 2, \$13,300.

Water first introduced: In 1860.

Description of main conduit: Length, 2,054 feet; diameter, 12 and 8 inches; cast iron.

Sizes of distributing mains: 12, 8, 6, and 4 inches.

Available head: 120 feet (average).

Total length of distributing mains: About 5 miles.

Number of water-takers: 250.

Consumption of water: 2,500 gallons (estimated).

First cost of water-works: \$28,000.

Average annual cost of maintenance and repairs: \$250.

Number of fire-plugs: 47.

DANBURY:

Population: 11,666 inhabitants.

Style of corporation: Municipal.

Water obtained from: Springs and small brooks.

Total area of water-shed available: About 1,000 acres.

Capacity of receiving reservoirs: 300,000,000 gallons; 2 reservoirs.

Character and dimensions of dams: Length of each, 300 to 400 feet; height, 25 to 30 feet; slope, 2 to 1 inside, 1½ to 1 outside; built 5 feet above water-level; earth; puddle walls in center.

Cost of dams: About \$30,000.

Water first introduced: December, 1860.

Description of main conduit: Length, 1½ mile; diameter, 10 inches; sheet iron, lined and covered with cement.

Sizes of distributing mains: 8, 6, 4, 3, and 1 inches.

Available head: 40 to 190 feet; water-supply sometimes deficient.

Total length of distributing mains: About 15 miles.

Number of water-takers: About 1,000.

First cost of water-works: \$37,500.

Average annual cost of maintenance and repairs: \$800 to \$1,000.

GREENWICH:

Population: 7,892 inhabitants.

Name of corporation: Greenwich Water Company (private).

Water obtained from: Artificial lake, fed by springs and river.

Total area of water-shed available: About 1 square mile.

Capacity of receiving reservoir: 234,297,536 gallons.

Character and dimensions of dam: 485 feet long, 20 feet wide; puddle earth; stone wall in cement through length from top to bottom; escape, 54 feet wide; stone and cement with filtering chamber.

Cost of dam: About \$35,000.

Water first introduced: September, 1880.

Description of main conduit: Length, 1 mile, diameter 16 inches; and 3 miles, diameter 12 inches; cast iron.

Sizes of distributing mains: 10, 8, 6, and 4 inches.

Available head: 50 to 125 pounds.

Total length of distributing mains: About 2½ miles.

Number of water-takers: 15.

First cost of water-works: \$70,000.

Description of filtering apparatus: 6 feet wide through dam; 3 chambers—1st, charcoal; 2d, sponges; water enters main from 3d; sponges cleaned four times a year.

Number of fire-plugs: 24.

MERIDEN:

Population: 15,546 inhabitants.

Name of corporation: Meriden Water-Works (municipal).

Water obtained from: Water-shed.

Total area of water-shed available: 800 acres.

Area and capacity of receiving reservoir: Length, 1 mile, width, ¾ mile; capacity, 300,000,000 gallons.

Character and dimensions of dam: Earthwork.

MERIDEN—Continued.

Cost of dam: \$350,000.

Water first introduced: In 1869.

Description of main conduit: Length 3 miles, diameter 12 inches, cast iron, cement-lined; and length 2¼ miles, diameter 16 inches, cast iron.

Sizes of distributing mains: From 8 to 1 inches.

Available head: Water-supply failed on one occasion.

Total length of distributing mains: 22 miles.

Number of water-takers: 1,500.

Consumption of water: 90 gallons per head daily (estimated).

First cost of water-works: \$275,000.

Average annual cost of maintenance and repairs: About \$6,000.

Number of fire-plugs: 190.

NEW BRITAIN:

Population: 11,800 inhabitants.

Name of corporation: City of New Britain Water-Works (municipal).

Water obtained from: Shuttle Meadow lake.

Total area of water-shed available: About 2 square miles.

Area and capacity of receiving reservoir: 175 acres; 650,000,000 gallons.

Character and dimensions of dam: 600 feet long, 30 feet high, 30 feet wide on top; bank, with waste-weir in center of substantial masonry, 30 feet wide.

Cost of dam: Original cost, \$50,000; present cost, \$171,000.

Water first introduced: October, 1857.

Description of main conduit: Length, 2¼ miles; diameters, 16 and 12 inches; wrought iron and cement.

Description of distributing reservoir: ¼ mile from city; 146 feet above level of business part; used as a reserve and protection if mains should fail.

Sizes of distributing mains: From 8 to 2 inches.

Available head: 70 to 80 pounds.

Total length of distributing mains: About 30 miles.

Number of water-takers: 1,350.

First cost of water-works: \$50,000.

Average annual cost of maintenance and repairs: \$2,800.

Number of fire-plugs: 152.

NEW MILFORD:

Population: 1,416 inhabitants.

Name of corporation: New Milford Water Company (private).

Water obtained from: Springs and running streams.

Total area of water-shed available: About 1,000 acres.

Capacity of receiving reservoir: About 2,000,000 gallons.

Character and dimensions of dam: 148 feet long, 16 feet 6 inches base, 4 feet 10 inches top, 22 feet high; overflow 20 feet long, 2 feet deep, flooding ¼ acre; stone masonry.

Cost of dam: \$9,203 08.

Water first introduced: In 1874.

Description of main conduit: 1—length 60 feet, diameter 10 inches. 2—length 9,108 feet, diameter 6 inches. 3—length 12,774 feet, diameter 4 inches; iron.

Sizes of distributing mains: 6 and 4 inches.

Number of water-takers: 134.

First cost of water-works: \$29,891 99.

Average annual cost of maintenance and repairs: \$541 40.

Description of filtering apparatus: Size, 12 by 12 feet; brick; charcoal and gravel; cleaned once a year.

Number of fire-plugs: 32.

ROCKVILLE:

Population: 5,902 inhabitants.

Name of corporation: Rockville Aqueduct Company (private).

Water obtained from: Shenipsit lake.

Area of receiving reservoir: 524 acres.

Character and dimension of dam: Length 50 feet, width 18 feet; granite, laid in water cement.

Water first introduced: In 1846.

Sizes of distributing mains: 15 to 2 inches.

Available head: 75 to 279 feet.

Total length of distributing mains: About 8 miles.

Number of water-takers: 350 to 375.

ROCKVILLE—Continued.

First cost of water-works: \$22,000.
Average annual cost of maintenance and repairs: \$1,000.
Number of fire-plugs: 50.

SHELTON:

Population: 1,362 inhabitants.
Name of corporation: The Shelton Water-Works (private).
Water obtained from: Brook.
Capacity of receiving reservoir: 2,750,000 gallons.
Character and dimensions of dam: Length 110 feet, height 25 feet; side-wall, on one side 60 feet long, 18 feet thick on bottom, 4 feet on top; overflow, 40 feet wide; walls on sides rise 4 feet above overflow; stone; stone-work grouted.
Cost of dam: \$5,435 20.
Water first introduced: October, 1879.
Description of main conduit: Length 2,494 feet, diameter 12 inches; cast iron.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 200 feet (average).
Total length of distributing mains: 2.345 miles.
Number of water-takers: 45.
Consumption of water: 30,000 gallons daily (estimated).
First cost of water-works: \$16,306 37.
Average annual cost of maintenance and repairs: Less than \$100.
Number of fire-plugs: 15.

SIMSBURY:

Population: 1,830 inhabitants.
Name of corporation: Simsbury Water Company (private).
Water obtained from: Small streams.
Area of receiving reservoir: 1 acre.
Character and dimensions of dam: 5 feet high, 8 feet wide; wings into high ground on either side.
Description of main conduit: Length $1\frac{1}{2}$ mile, diameter 6 inches; iron.
Available head: 75 feet (average).
Total length of distributing mains: About $\frac{1}{2}$ mile.
Number of water-takers: 19.
First cost of water-works: \$13,000.
Average annual cost of maintenance and repairs: \$25.
Number of fire-plugs: 10.

SOUTH NORWALK:

Population: 3,726 inhabitants.
Style of corporation: Municipal.
Water obtained from: Streams.
Total area of water-shed available: 9 square miles.
Area of receiving reservoirs: 1st, 17 acres; 2d, 4 acres.
Character and dimensions of dams: No. 1—207 feet long, 31 feet high; No. 2—205 feet long, 15 feet high; gravel and clay, with core of cemented masonry; width on top, 20 feet; lower slope, $1\frac{1}{2}$ to 1; pond slope, 2 to 1.
Cost of dams: No. 1, \$6,086; No. 2, \$7,536.
Water first introduced: December, 1875.
Description of main conduit: Length $4\frac{1}{2}$ miles, diameter 12 inches; cast iron.
Description of distributing reservoir: Natural basin, with dam 13 feet high.
Sizes of distributing mains: 12 to 4 inches.
Available head: 80 pounds per square inch (average).
Total length of distributing mains: 7 miles.
Number of water-takers: About 300.
Consumption of water: 250,000 gallons per day (estimated).
First cost of water-works: \$100,724 62.
Average annual cost of maintenance and repairs: About \$500.
Description of filtering system: Charcoal, 4 by 4 by 8 feet; sponge, 4 by 4 by 8 feet; cleaned twice a year.
Number of fire-plugs: 53.

STAMFORD:

Population: 11,297 inhabitants.
Name of corporation: Stamford Water Company (private).
Water obtained from: Mill river and Trinity lake.
Water first introduced: July, 1871.

STAMFORD—Continued.

Sizes of distributing mains: 10, 8, 6, and 4 inches.
Total length of distributing mains: About 10 miles.
Number of water-takers: 536.
Consumption of water: 300,000 gallons daily (estimated).
Number of fire-plugs: 53.

WATERBURY:

Population: 17,806 inhabitants.
Name of corporation: Waterbury City Water-Works (municipal).
Water obtained from: Springs.
Total area of water-shed available: 1 square mile.
Capacity of receiving reservoirs: 1st, 100,000,000 gallons; 2d, 8,000,000 gallons; 3d, 10,000,000 gallons.
Character and dimensions of dam: 18 to 30 feet high, 200 to 800 feet long; earth, with puddle center; pond-slope faced with stone paving; lower slope, sod.
Cost of dam: \$50,000.
Water first introduced: January, 1868.
Description of main conduit: Length 12,700 feet, diameter 12 inches; wrought iron, lined, and covered with cement.
Discharging capacity: Over 3,000,000 gallons per day; head, 230 feet (average).
Description of distributing reservoir: 3 acres; 8,000,000 gallons.
Sizes of distributing mains: 12 to 1 inches.
Available head: 100 pounds (average); head impaired on high ground.
Total length of distributing mains: About 29 miles.
Number of water-takers: 63.
Consumption of water: 1,000,000 gallons per day (estimated).
First cost of water-works: \$325,000.
Average annual cost of maintenance and repairs: \$3,000.

WEST WINSTED:

Population: 3,000 inhabitants.
Name of corporation: Winsted Water-Works (municipal).
Water obtained from: Lake.
Water first introduced: In 1862.
Description of main conduit: Length 3 miles, diameters 12, 8, and 6 inches; cast iron, cement-lined.
Discharging capacity: 180 gallons per hour.
Sizes of distributing mains: 12, 8, and 4 inches.
Available head: 160 feet (average).
Number of water-takers: About 500.
First cost of water-works: \$25,000.

WINDSOR:

Population: 3,058 inhabitants.
Name of corporation: Windsor Water-Works (private).
Water obtained from: Springs and surface-water.
Total area of water-shed available: About 50 acres.
Dimensions of receiving reservoir: 300 by 500 feet; 10 feet deep.
Character and dimensions of dam: Earth embankment, with canal on one side lined with stone, about 2 feet on top; has gates for outlet.
Cost of dam: \$6,000.
Water first introduced: In 1877.
Description of main conduit: Part length, 600 feet, diameter 8 inches, iron; part length, 1 mile, diameter 6 inches, iron.
Size of distributing mains: 6 inches.
Available head: 60 feet (average).
Total length of distributing mains: 2 miles.
Number of water-takers: 30.
First cost of water-works: \$6,000.
Average annual cost of maintenance and repairs: Not over \$25.
Description of filtering apparatus: Only brick, with plaster joints at well-house.
Number of fire-plugs: 8.

WOLCOTTVILLE:

Population: 2,245 inhabitants.
Name of corporation: Wolcottville Water Company (private).
Water obtained from: Running stream.
Total area of water-shed available: 6 square miles.

WOLCOTTVILLE—Continued.

Area and capacity of receiving reservoir: $5\frac{1}{2}$ acres; 16,000,000 gallons.

Character and dimensions of dam: 234 feet long, 20 feet high; wall of grouted masonry, 8 feet thick at base and 2 feet 6 inches on top; earth embankment; slope, $1\frac{1}{2}$ to 1.

Cost of dam: \$5,944 52.

Water first introduced: August, 1878.

Description of main conduit: Length 11,468 feet, diameter 10 inches; iron.

Sizes of distributing mains: 6 and 4 inches.

Available head: 170 feet (average).

Total length of distributing mains: 18,187 feet.

Number of water-takers: 107.

First cost of water-works: \$30,000.

Average annual cost of maintenance and repairs: About \$500.

Description of filtering apparatus: Two chambers, one charcoal and the other sponges; cleaned twice a year.

Number of fire-plugs: 37.

DAKOTA.

DEADWOOD:

Population: 3,777 inhabitants.

Name of corporation: Deadwood Water Company (private).

Water obtained from: City and Whitewood creeks.

Total area of water-shed available: 14 square miles.

Capacity of receiving reservoir: 300,000 gallons.

Cost of dam: \$15,000.

Water first introduced: September, 1870.

Sizes of distributing mains: 6, 4, and 3 inches.

Available head: 95 pounds (average).

Total length of distributing mains: About 3 miles.

Number of water-takers: 250.

Consumption of water: 125,000 gallons per day (estimated).

First cost of water-works: \$40,000.

Average annual cost of maintenance and repairs: \$5,000.

Number of fire-plugs: 15.

GEORGIA.

MACON:

Population: 12,740 inhabitants.

Name of corporation: Macon Gas-Light and Water Company.

Water obtained from: Springs.

Capacity of receiving reservoir: 140,000 gallons.

Water first introduced: In 1867.

Description of main conduit: Length 3,000 feet, diameter 4 inches; cast iron.

Discharging capacity: 26,928 gallons per minute; head, 73 feet (average).

Description of distributing reservoir: 4 circular cisterns; capacity, 150,000 gallons.

Sizes of distributing mains: 4, 3, and 2 inches.

Available head: 70 feet (average); water-supply deficient in summer.

Total length of distributing mains: 7,424 feet.

Number of water-takers: 84.

Consumption of water: In winter, 30,000 gallons per day; in summer 19,000 gallons per day.

First cost of water-works: \$14,000.

MAINE.

AUBURN:

Population: 9,555 inhabitants.

Name of corporation: Auburn Aqueduct Company (private).

Water obtained from: Wilson pond.

Total area of water-shed available: 10,000 acres.

Water first introduced: In 1869.

Description of main conduit: First part, length 3,000 feet, diameter 12 inches; second part, length $2\frac{1}{2}$ miles, diameter 10 inches; cast-iron.

Discharging capacity: 1,500,000 gallons in 24 hours; head, 118 feet (average).

AUBURN—Continued.

Description of distributing reservoir: Main distribution direct from pond; iron reservoir; capacity, 500,000 gallons.

Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.

Available head: 70 to 118 feet.

Total length of distributing mains: 10 miles.

Number of water-takers: 800.

Consumption of water: 45 gallons per head daily (estimated).

First cost of water-works: \$125,000.

Average annual cost of maintenance and repairs: \$2,000.

Number of fire-plugs: 24.

SKOWHEGAN:

Population: 2,609 inhabitants.

Style of corporation: Three principal companies—private.

Water obtained from: Springs.

Description of main conduit: Length 2 miles, diameters 4 and 3 inches.

Discharging capacity: 200,000 gallons per day; head, 10 to 25 feet.

Sizes of distributing mains: 4, 3, 2, 1, $\frac{1}{2}$, and $\frac{1}{4}$ inches.

Available head: 10 to 25 feet.

Total length of distributing mains: Between 2 and 3 miles.

Number of water-takers: Between 300 and 400.

First cost of water-works: \$15,000.

Average annual cost of maintenance and repair: Between \$300 and \$400.

SPRINGVALE:

Population: 1,116 inhabitants.

Name of corporation: Springvale Aqueduct Company (private).

Water obtained from: Pond.

Area of receiving reservoir: 40 acres.

Water first introduced: In 1876.

Description of main conduit: Diameter, $4\frac{1}{2}$ inches; iron.

First cost of water-works: \$7,000.

Average annual cost of maintenance and repairs: About 2 per cent. on first cost.

Number of fire-plugs: 1 hydrant and many plugs.

MARYLAND.

FROSTBURG:

Population: 4,057 inhabitants.

Name of corporation: Frostburg Water-Works (private).

Water obtained from: Springs.

Total area of water-shed available: About 2 square miles.

Character and dimensions of dam: 100 feet long; built of wood.

Cost of dam: \$4,500.

Water first introduced: In 1854.

Description of main conduit: Part length 100 feet, shape, square, 2 by 2 feet, wood; part length 1 mile, diameter 6 inches, cast iron.

Discharging capacity: 10 to 400 gallons per minute; head, 70 feet (average).

Description of distributing reservoir: Area, 50 feet square, 15 feet deep; stone laid in cement.

Sizes of distributing mains: 8 to 6 inches.

Available head: 10 to 100 feet; water-supply deficient in dry weather.

Total length of distributing mains: About 11,000 feet.

Number of water-takers: About 160.

Consumption of water: 10 gallons per head per day (estimated).

First cost of water-works: \$10,000.

Average annual cost of maintenance and repairs: About \$300.

Number of fire-plugs: 15.

MASSACHUSETTS.

AGAWAM:

Population: 2,216 inhabitants.

Name of corporation: Agawam Water-Works (private).

Water obtained from: Springs.

Character of dam: All puddle-clay.

AGAWAM—Continued.

Water first introduced: January, 1877.
 Description of main conduit: Diameter, 6 inches; wrought iron; cement-lined.
 Available head: 30 to 40 feet.
 Total length of distributing mains: 2 miles.
 Number of water-takers: 33.
 First cost of water-works: \$6,000.

ARLINGTON:

Population: 4,100 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Great meadows and water-shed.
 Area of receiving reservoir: 27 acres.
 Character and dimensions of dam: 850 feet long, 13 feet high; blue gravel and earth; built across valley to form storage reservoir.
 Water first introduced: In 1873.
 Description of main conduit: Diameters, 12, 6, and 4 inches; sheet iron, covered and lined with cement.
 Discharging capacity: 2,000,000 gallons in 24 hours; head, 117 feet (average).
 Description of distributing reservoir: Formed by building a dam across valley; capacity, 73,500,000 gallons.
 Sizes of distributing mains: 12, 6, and 4 inches.
 Available head: 117 feet (average).
 Total length of distributing mains: 73,342 feet.
 Number of water-takers: 438.
 First cost of water-works: \$300,000.
 Average annual cost of maintenance and repairs: About \$1,500.
 Description of filtering apparatus: Excavation in natural bank of coarse gravel at side of reservoir, 230 feet long, 12 feet wide, 12 feet deep; covered with semicircular arch of brick, 8 inches thick, sprung from stone; side walls 4 feet high; no cleaning.
 Number of fire-plugs: 98.

ATHOL:

Population: 4,307 inhabitants.
 Name of corporation: Athol Water Company (private).
 Water obtained from: Mountain streams.
 Total area of water-shed available: About 4 square miles.
 Area and capacity of receiving reservoir: 27 acres; 15 feet deep.
 Character and dimensions of dam: 450 feet long, 18 feet high; puddle dam, with stone center.
 Cost of dam: About \$16,000.
 Water first introduced: In 1876.
 Description of main conduit: Length 10 miles, diameter 10 inches; cast iron.
 Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
 Available head: 300 feet (average).
 Total length of distributing mains: About 8 miles.
 Number of water-takers: 250.
 First cost of water-works: \$80,000.
 Average annual cost of maintenance and repairs: \$500.
 Filtering apparatus: Size, 4 feet square; sand.
 Number of fire-plugs: 50.

CHICOPEE:

Population: 11,286 inhabitants.
 Name of corporation: Chicopee Water Company (private).
 Water obtained from: Brooks and springs.
 Character and dimensions of dam: 250 feet long, 14 feet high, 12 feet wide on top; each embankment 6-inch piles in center; batter, 1½ to 1.
 Cost of dam: About \$5,000.
 Water first introduced: In 1877.
 Description of main conduit: Length 5,000 feet, diameter 8 inches; iron, cement-lined.
 Sizes of distributing mains: 4, 3, and 2 inches.
 Available head: About 72 feet (average).
 Total length of distributing mains: About 6 miles.
 First cost of water-works: \$55,000.
 Average annual cost of maintenance and repairs: \$400.

FITCHBURG:

Population: 12,429 inhabitants.

FITCHBURG—Continued.

Name of corporation: Fitchburg Water-Works (municipal).
 Water obtained from: Water-shed.
 Total area of water-shed available: 1,800 acres.
 Area and capacity of receiving reservoirs: 1st, 13 acres; 60,000,000 gallons; 2d, 35 acres; 200,000,000 gallons.
 Character and dimensions of dams: 1st, 43 feet high; 151 feet base; 22 feet wide on top; earth, with spilling wall; 2d, 46 feet high; 245 feet base; 35 feet wide on top; gravel and hard pan.
 Cost of dams: No. 1, \$38,239; No. 2, \$32,500.
 Water first introduced: In 1872.
 Description of main conduit: Length 1½ mile, diameter 2 feet; brick.
 Sizes of distributing mains: 16, 14, 12, 10, 8, 6, 4, and 2 inches.
 Available head: 264 to 373 feet.
 Total length of distributing mains: About 24 miles.
 Number of water-takers: 1,913.
 Consumption of water: 1,250,000 gallons per day (estimated).
 First cost of water-works: \$173,000.
 Average annual cost of maintenance and repairs: About \$3,000.
 Number of fire-plugs: 200.

GREENFIELD:

Population: 3,903 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Brook.
 Total area of water-shed available: 3,000 acres.
 Capacity of receiving reservoir: 2,000,000 gallons.
 Character and dimensions of dam: 60 feet long, 35 feet high, 16 feet broad at base, 12 feet broad on top; solid masonry, built between solid rocks.
 Cost of dam: \$8,500.
 Water first introduced: In 1870.
 Description of main conduit: Length 5 miles, diameter 8 and 6 inches; iron, coated.
 Discharging capacity: 500,000 gallons; head, 235 feet (average).
 Sizes of distributing mains: 4 and 3 inches.
 Available head: 80 pounds (average).
 Total length of distributing mains: 6 miles.
 Number of water-takers: 603.
 Consumption of water: 75,000 gallons per day (estimated).
 First cost of water-works: \$80,000.
 Average annual cost of maintenance and repairs: \$600.
 Number of fire-plugs: 41.

HINGHAM:

Population: 4,485 inhabitants.
 Name of corporation: Hingham Water Company (private).
 Water obtained from: Accord pond.
 Total area of water-shed available: 365 acres.
 Character and dimensions of dam: 250 feet long, 2 feet thick through middle, 8 feet high above bottom of conduit; two waste-ways, 7 and 10 feet wide; earthwork with concrete stop-water.
 Cost of dam: \$3,000.
 Water first introduced: June, 1880.
 Description of main conduit: Part 1—diameter 16 inches; cast iron; part 2—length 2½ miles, diameter 14 inches; part 3—length 3 miles, diameter 12 inches; wrought iron, cement-lined.
 Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
 Available head: 75 to 120 feet.
 Total length of distributing mains: About 14 miles.
 Number of water-takers: 250.
 First cost of water-works: \$80,000.
 Average annual cost of maintenance and repairs: \$2,200.
 Filtering system: Water screened through copper screen, ¼-inch mesh; cleaned yearly.
 Number of fire-plugs: 75.

HOLYOKE:

Population: 21,915 inhabitants.
 Name of corporation: Holyoke Water-Works (municipal).
 Water obtained from: Mountain lakes.

HOLYOKE—Continued.

Total area of water-shed available: 1,726 acres.
 Character and dimensions of dam: 401 yards of stone masonry;
 7 feet above natural level of lakes at overflow.
 Cost of dam: \$14,000.
 Water first introduced: August, 1873.
 Description of main conduit: Part 1—length 1,647 feet, diameter 20 inches; part 2—length 17,332 feet, diameter 16 inches; cast iron.
 Discharging capacity: 2,266,000 gallons.
 Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
 Available head: 171 feet (average); water-supply sometimes deficient.
 Total length of distributing mains: About 22 miles.
 Consumption of water: 75 to 80 gallons per head per day (estimated).
 Average annual cost of maintenance and repairs: About \$4,000.
 Number of fire-plugs: 150.

LEOMINSTER:

Population: 5,772 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Morse brook.
 Total area of water-shed available: 1,215 acres.
 Area and capacity of receiving reservoirs: 85 acres; 160,000,000 gallons; total of 3 reservoirs.
 Character and dimensions of dams: No. 1—698 feet long, 15 feet high, 22 feet wide on top; gravel, with cement-laid stone priming wall; face 2 to 1, paved with cobbles. No. 2—304 feet long, 23 feet high; same material as No. 1. No. 3—200 feet long, 12 feet high, 12 feet wide on top; common gravel bank.
 Cost of dams: Nos. 1 and 2, \$25,000; No. 3, \$4,000.
 Water first introduced: December, 1873.
 Description of main conduit: Length $1\frac{1}{4}$ mile, diameter 12 inches; wrought-iron cement-lined.
 Description of distributing reservoir: Area, 5 acres; capacity, 10,000,000 gallons; in a ravine between two abrupt rises of land; dam, 304 feet long and 23 feet high.
 Sizes of distributing mains: 12 to 4 inches.
 Available head: 175 feet (average).
 Total length of distributing mains: 18 miles.
 Number of water takers: 510.
 Consumption of water: 60 gallons per head per day.
 First cost of water-works: \$170,000.
 Average annual cost of maintenance and repairs: \$1,683 48.
 Number of fire-plugs: 109.

MALDEN:

Population: 12,017 inhabitants.
 Name of corporation: Malden Water-Works (municipal).
 Water obtained from: Spot pond.
 Total area of water-shed available: 1,100 acres.
 Area and capacity of receiving reservoirs: 296 acres; 1,600,000 gallons.
 Character and dimensions of dam: 25 feet wide; stone.
 Cost of dam: \$1,000.
 Water first introduced: In 1870.
 Sizes of distributing mains: 16, 12, 8, 6, 4, and 2 inches.
 Available head: 125 feet (average); water-supply deficient on highest lands.
 Total length of distributing mains: 35 miles.
 Number of water-takers: 2,500.
 Consumption of water: 40 gallons per head per day (estimated).
 First cost of water-works: \$350,000.
 Average annual cost of maintenance and repairs: \$4,000.
 Number of fire-plugs: 196.

MEDFORD:

Population: 7,573 inhabitants.
 Name of corporation: Medford Water-Works (municipal).
 Water obtained from: Spot pond.
 Total area of water-shed available: About 1,100 acres.
 Area and capacity of receiving reservoir: 296 acres; 1,600,000 gallons.

MEDFORD—Continued.

Character and dimensions of dam: 25 feet wide; stone.
 Cost of dam: \$2,500.
 Water first introduced: In 1870.
 Description of main conduit: Diameters, 14 and 12 inches; iron, cement-lined, and Scotch clay.
 Sizes of distributing mains: 12 to 4 inches.
 Available head: 143 feet (average).
 Total length of distributing mains: About 33 miles.
 Number of water-takers: About 1,600.
 Consumption of water: 500,000 gallons daily (estimated).
 First cost of water-works: \$300,000.
 Average annual cost of maintenance and repairs: About \$3,000.
 Number of fire-plugs: 150.

MELROSE:

Population: 4,560 inhabitants.
 Name of corporation: Melrose Water-Works (municipal).
 Water obtained from: Spot pond.
 Total area of water-shed available: 1,100 acres.
 Area and capacity of receiving reservoir: 296 acres; 1,600,000 gallons.
 Character and dimensions of dam: 25 feet wide; granite; overflow when full.
 Cost of dam: \$2,500.
 Water first introduced: In 1870.
 Description of main conduit: Length 6,364 feet, diameter 16 inches; wrought iron and cement.
 Description of distributing reservoir: Natural; 140 feet above marsh-level.
 Sizes of distributing mains: 6 and 4 inches.
 Available head: About 80 feet (average). Water supply sometimes deficient on high ground.
 Total length of distributing mains: About 16 miles.
 Number of water-takers: 980.
 First cost of water-works: \$60,000.
 Average annual cost of maintenance and repairs: \$2,500.
 Number of fire-plugs: 85.

NORTHAMPTON:

Population: 12,172 inhabitants.
 Name of corporation: The Northampton Water-Works (municipal).
 Water obtained from: Roberts' Meadow brook.
 Total area of water-shed available: 9.24 square miles.
 Area, capacity, and description of receiving reservoir: 3 acres; 7,000,000 gallons; depends on flow of brook; western and northern sides of granite and gravel; southern and eastern sides of earth, with puddled center wall 400 feet long.
 Character and dimensions of dam: 50 feet wide; 14 feet high; parapets, 5 feet above; rubble stone.
 Cost of dam: \$12,913 40.
 Water first introduced: In 1871.
 Description of main conduit: Length, part, $2\frac{1}{2}$ miles, diameter 16 inches; and part, $2\frac{1}{2}$ miles, diameter 12 inches; cast iron, coated with coal-pitch varnish—leaded joints.
 Discharging capacity: 2,350,000 gallons in 24 hours; head, 244 feet (average).
 Description of distributing reservoir: Area, 3 acres; capacity, 7,000,000 gallons.
 Sizes of distributing mains: 6, 4, 3, etc., inches.
 Available head: 186 to 209 feet.
 Total length of distributing mains: About 22 miles.
 Number of water-takers: 1,224.
 Consumption of water: 65 gallons per head per day (estimated).
 First cost of water-works: \$173,117 45.
 Average annual cost of maintenance and repairs: \$2,194 88.
 Filtering apparatus: Three copper-wire screens.
 Number of fire-plugs: 136.

NORTHFIELD:

Population: 1,603 inhabitants.
 Name of corporation: Northfield Aqueduct Company (private).

NORTHFIELD—Continued.

Water obtained from: Small brook.
 Water first introduced: In 1805.
 Description of main conduit: $1\frac{1}{2}$ mile long; diameter, 2 inches; bored logs.
 Size of distributing mains: 1 inch.
 Total length of distributing mains: $1\frac{1}{2}$ mile.
 Number of water-takers: 12.
 Average annual cost of maintenance and repairs: \$7 to \$8.

PEABODY:

Population: 9,028 inhabitants.
 Name of corporation: Salem and Danvers Aqueduct Company (municipal).
 Water obtained from: Spring and Brown pond.
 Cost of dam: \$178,296.
 Water first introduced: In 1797.
 Description of main conduit: 1st, diameter 16 inches, cement; 2d, diameter 12 inches, iron.
 Discharging capacity: 1,250,000 gallons per day; head, 54 feet (average).
 Sizes of distributing mains: 10 to 4 inches.
 Available head: 10 to 40 feet; water-supply sometimes deficient.
 Total length of distributing mains: Old pipe, unknown; new pipe, 23,500 feet.
 Number of water-takers: 1,233.
 Consumption of water: 1,000,000 gallons per day (estimated).
 First cost of water-works: \$125,000.
 Average annual cost of maintenance and repairs: \$2,500.
 Number of fire-plugs: 55.

PITTSFIELD:

Population: 13,364 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Ashley lake and Ashley and Sackett brooks.
 Capacity of receiving reservoirs: 1,100,000 gallons.
 Character and dimensions of dams: No. 1—40 feet wide, 8 feet thick, 8 feet high; rough stone, sheathed with chestnut plank. No. 2—At outlet of Ashley lake, 20 feet wide, 6 feet thick, 10 feet high; cemented.
 Cost of dams: \$25,000.
 Water first introduced: In 1855.
 Description of main conduit: One part, length 3 miles, diameter 12 inches; the other part, length 2 miles, diameter 10 inches; iron.
 Sizes of distributing mains: 10, 8, 6, 4, 3, 2, and $1\frac{1}{2}$ inches.
 Available head: 128 feet (average); water-supply deficient sometimes in hot weather.
 Total length of distributing mains: About 20 miles.
 Number of water-takers: 1,600.
 Consumption of water: 1,000,000 gallons per day (average).
 First cost of water-works: \$50,000.
 Average cost of maintenance and repairs: \$1,800.
 Filtering apparatus: Water is run through wire screens.
 Number of fire-plugs: 75.

SOUTH ADAMS:

Population: 5,593 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Springs.
 Capacity of receiving reservoir: About 3,000,000 gallons.
 Character and dimensions of dam: 60 feet long, 12 feet high; stone and cement.
 Cost of dam: \$125,000.
 Water first introduced: In 1873.
 Description of main conduit: Diameter, 12 inches; iron.
 Sizes of distributing mains: 12, 8, 6, 4, $\frac{1}{2}$, and $\frac{3}{4}$ inches.
 Available head: 30 to 70 pounds per square inch.
 Total length of distributing mains: About 6 miles.
 Number of water-takers: 615.
 First cost of water-works: \$110,000.
 Average annual cost of maintenance and repairs: \$600.

SOUTH ADAMS—Continued.

Filtering apparatus: The water passes through gravel and sand before it enters the main.
 Number of fire-plugs: 118.

SOUTHBRIDGE:

Population: 6,464 inhabitants.
 Name of corporation: Southbridge Water-Supply Company (private).
 Water obtained from: Brook and surface-water.
 Total area of water-shed available: 179 acres.
 Character and dimensions of dam: 240 feet long, 18 feet high, 57 feet base, 10 feet wide on top; earth, with stone battered on pond side, 6 feet thick at highest point, 8 feet thick at base.
 Cost of dam: \$15,000.
 Water first introduced: November, 1880.
 Description of main conduit: 12-inch, cast iron; runs through the dam, with cut-off.
 Description of distributing reservoir: A long basin, narrow and deep, covering only 3 acres.
 Sizes of distributing mains: 12, 10, 8, and 6 inches.
 Available head: 30 to 115 feet; water-supply deficient in some parts of the village.
 Total length of distributing mains: 6,800 feet.
 Number of fire-plugs: 10.

SOUTH HADLEY FALLS:

Population: 2,750 inhabitants.
 Name of corporation: South Hadley Falls Water-Works (municipal).
 Water obtained from: Springs.
 Total area of water-shed available: 1 acre.
 Character and dimensions of dam: 200 feet long, 8 feet high; earth, with 3-inch plank in center.
 Cost of dam: \$2,000.
 Water first introduced: In 1872.
 Description of main conduit: Length 3,840 feet, diameter 12 inches; length 3,240 feet, diameter 10 inches; length 1,632 feet, diameter 8 inches; and length 14,784 feet, diameter 4 inches; cast iron.
 Available head: 50 to 120 feet.
 Number of water-takers: 230.
 First cost of water-works: \$55,716 65.
 Average annual cost of maintenance and repairs: \$300.
 Number of fire-plugs: 50.

STOCKBRIDGE:

Population: 733 inhabitants.
 Name of corporation: Stockbridge Water Company (private).
 Water obtained from: Springs.
 Total area of water-shed available: 500 acres.
 Character and dimensions of dam: 100 feet long, 12 feet high; stone.
 Cost of dam: \$14,000.
 Water first introduced: In 1862.
 Description of main conduit: Length, 2 miles; diameter, 4 inches; iron.
 Size of distributing mains: 3 inches.
 Available head: 70 feet (average); water-supply sometimes deficient.
 Total length of distributing mains: 3 miles.
 Number of water-takers: 100.
 First cost of water-works: About \$20,000.
 Average annual cost of maintenance and repairs: About \$100.
 Description of filtering apparatus: Built of brick; 15 feet long, 10 feet wide, 14 feet deep; filled with alternate layers of perforated tile, and charcoal and gravel.
 Number of fire-plugs: 1.

WESTBOROUGH:

Population: 5,214 inhabitants.
 Name of corporation: Westborough Water-Works (municipal).
 Water obtained from: Brook.
 Total area of water-shed available: 1,225 acres.

WESTBOROUGH—Continued.

Cost of dam: About \$5,000.
 Water first introduced: July, 1879.
 Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
 Available head: 133 feet (average).
 Total length of distributing mains: 35,019½ feet.
 Number of water-takers: 240.
 First cost of water-works: \$53,000.
 Average annual cost of maintenance and repairs: \$400.
 Number of fire-plugs: 57.

WESTFIELD:

Population: 7,587 inhabitants.
 Name of corporation: Westfield Water-Works (municipal).
 Water obtained from: Brook.
 Total area of water-shed available: 4½ square miles.
 Capacity of receiving reservoir: 184,000,000 gallons.
 Character and dimensions of dams: No. 1—350 feet long, 30 feet high, 20 feet wide on top; earth embankment, with cement wall 8 feet thick above foundation, 3 feet thick at top, 2 feet above water-line. No. 2—193 feet long, 28 feet high, 14½ feet thick at base, 7 feet thick at top; bulkhead of cut-off wall across bottom, 50 feet down main wall.
 Cost of dams: \$42,000.
 Water first introduced: In 1874.
 Description of main conduit: Length 4½ miles, diameter 14 inches; cast iron.
 Capacity of distributing reservoir: 4,064,000 gallons.
 Sizes of distributing mains: 10, 8, 6, and 4 inches.
 Available head: 120 pounds per square inch; head, 291 feet (average).
 Total length of distributing mains: About 16 miles.
 Number of water-takers: 696.
 First cost of water-works: \$250,000.
 Average annual cost of maintenance and repairs: \$1,250.
 Number of fire-plugs: 115.

WEST SPRINGFIELD:

Population: 4,149 inhabitants.
 Name of corporation: West Springfield Aqueduct Company (private).
 Water obtained from: Small stream.
 Total area of water-shed available: About 300 acres.
 Character and dimensions of dam: 450 feet long on top, 18 feet high (center), 20 feet wide on top; slope inside, 4 to 1; lower side, 1 to 1; earth, clay, and sand; center puddle all the way up, with dike of clay.
 Cost of dam: \$6,000.
 Water first introduced: October, 1875.
 Description of main conduit: Diameter, 16 inches; wrought iron, cement-lined.
 Sizes of distributing mains: 8 and 6 inches.
 Available head: 90 feet (average).
 Total length of distributing mains: About 6 miles.
 Number of water-takers: 170.
 First cost of water-works: \$50,000.
 Number of fire-plugs: 15.

WEST STOCKBRIDGE:

Population: 1,923 inhabitants.
 Name of corporation: East Mountain Water Company (private).
 Water obtained from: Spring.
 Character and dimensions of dam: 10 or 15 feet long, 6 feet high, 2 feet thick; stone laid in cement.
 Cost of dam: \$200.
 Water first introduced: In 1873.
 Description of main conduit: Part length 500 feet, diameter 2 inches; part length 3,500 feet, diameter 1½ inch; wrought-iron gas-pipe.
 Size of distributing mains: ½ inch.
 Available head: 160 feet (average).
 Total length of distributing mains: 2,100 feet (estimated).
 Number of water-takers: 31.

WEST STOCKBRIDGE—Continued.

Consumption of water: 25 gallons per day per family (estimated).
 First cost of water-works: About \$2,300.
 Average annual cost of maintenance and repairs: \$10.

WILLIAMSTOWN:

Population: 984 inhabitants.
 Name of corporation: Williams Aqueduct Company (private).
 Water obtained from: Springs.
 Capacity of receiving reservoir: 1,764 gallons.
 Cost of dam: \$75 to \$100.
 Water first introduced: In 1862.
 Description of main conduit: Length 1¼ mile, diameter 6 to 3 inches; cast iron.
 Sizes of distributing mains: 6 and 3 inches.
 Available head: 20 to 40 feet.
 Total length of distributing mains: About 2 miles.
 Number of water-takers: 75.
 First cost of water-works: \$12,000.
 Average annual cost of maintenance and repairs: \$20.
 Number of fire-plugs: 4.

WINCHESTER:

Population: 3,802 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Water-shed.
 Total area of water-shed available: About 460 acres.
 Capacity of receiving reservoir: 259,000,000 gallons.
 Character and dimensions of dam: 120 feet wide at bottom, 30 feet high; stone wall in cement in center 2½ to 1½ feet thick; earth; overflow, 34 feet wide; gate-house of brick and stone, with waste-gate 30 inches; supply, 18 inches.
 Cost of dam: \$41,573.
 Water first introduced: July, 1874.
 Description of main conduit: Length, 1,500 feet; diameter, 12 inches; wrought iron, cement-lined.
 Sizes of distributing mains: 12, 10, 8, 6, 4, and 2 inches.
 Available head: 123 feet (average); water-supply sometimes deficient.
 Total length of distributing mains: About 18 miles.
 Number of water-takers: About 630.
 Consumption of water: 70,000 to 90,000 gallons daily (variable), by measurement.
 First cost of water-works: \$160,000.
 Average annual cost of maintenance and repairs: \$1,500 to \$1,700.
 Number of fire-plugs: 73.

WORCESTER:

Population: 58,291 inhabitants.
 Name of corporation: Worcester City Water-Works (municipal).
 Water obtained from: Lynde lake.
 Total area of water-shed available: 1,727 acres.
 Capacity of receiving reservoir: 681,827,000 gallons.
 Character and dimensions of dams: Main dam, 550 feet long, 50 feet high, 225 feet base, 50 feet wide on top; earth, with puddle-wall and mortar-wall. Side dam, 1,400 feet long, 115 feet base, 20 feet high, 45 feet wide on top; earth, with mortar-wall in center.
 Cost of dams: \$1,273,068 10.
 Water first introduced: In 1864.
 Description of main conduit: Cast iron; wrought iron, cement-lined.
 Discharging capacity: 3,800,000 gallons per day; head, 150 feet (average).
 Description of distributing reservoir: Partly excavation and partly embankment; capacity, 3,000,000 gallons.
 Sizes of distributing mains: 24 to 3 inches.
 Available head: About 60 pounds (average).
 Total length of distributing mains: 80 miles.
 Number of water-takers: 40,000.
 Consumption of water: 3,000,000 gallons per day (estimated).
 First cost of water-works: \$17,699 60
 Number of fire-plugs: 633.

UXBRIDGE:

Population: 3,111 inhabitants.
 Name of corporation: Uxbridge Water Company (private).
 Water obtained from: Spring.
 Cost of dam: \$6,000.
 Water first introduced: In 1880.
 Description of main conduit: Part length 2,136 $\frac{3}{4}$ feet, diameter 6 inches; part length 594 $\frac{1}{4}$ feet, diameter 4 inches; tarred iron pipe.
 Size of distributing mains: 1 inch.
 Available head: 135 feet (average).
 Number of water-takers: 11.
 First cost of water-works: \$3,800.
 Number of fire-plugs: 1.

MICHIGAN.**NILES:**

Population: 4,197 inhabitants.
 Name of corporation: Niles Water-Works (private).
 Water obtained from: Berrien lake.
 Area and capacity of receiving reservoir: 1 mile long, $\frac{1}{4}$ mile wide; 300,000 gallons.
 Cost of dam: \$4,500.
 Water first introduced: July, 1879.
 Description of main conduit: 5 miles long, 12 inches diameter; iron.
 Description of stand-pipe: 37 feet deep, 36 feet in diameter; built of boiler-iron.
 Sizes of distributing mains: 12 and 6 inches.
 Available head: 75 to 100 feet.
 Total length of distributing mains: About 10 miles.
 Number of water-takers: 125.
 Consumption of water: 100 gallons per head per day (estimated).
 First cost of water-works: \$50,000.
 Number of fire-plugs: 50.

MINNESOTA.**SAINT PAUL:**

Population: 41,473 inhabitants.
 Name of corporation: Saint Paul Water Company (private).
 Water obtained from: Lakes.
 Total area of water-shed available: 60,000 acres.
 Area of receiving reservoir: 1,800 acres.
 Cost of dam: \$10,000 to \$15,000.
 Water first introduced: In 1869.
 Description of main conduit: Part length $\frac{1}{4}$ mile, diameter 24 inches, glazed earthenware; part length $\frac{1}{4}$ mile, diameter 16 inches, cement and gravel.
 Discharging capacity: 7,000,000 gallons per day.
 Description of distributing reservoir: Lake; area, 230 acres.
 Sizes of distributing mains: 16, 12, 6, and 4 inches.
 Available head: 165 feet (average).
 Total length of distributing mains: 22 miles.
 Number of water-takers: 1,850.
 Consumption of water: 25 gallons per head per day (estimated).
 First cost of water-works: \$200,000.
 Average annual cost of maintenance and repairs: About \$8,000.
 Number of fire-plugs: 188.

NEVADA.**AUSTIN:**

Population: 1,679 inhabitants.
 Name of corporation: Austin City Water-Works (private).
 Water obtained from: Springs.
 Total area of water-shed available: 50 acres.
 Cost of dam: \$7,000.
 Water first introduced: In 1865.
 Description of main conduit: Length 7,200 feet, diameter 3 $\frac{1}{2}$ inches; galvanized iron.
 Discharging capacity: 15 to 20 gallons per minute.
 Description of distributing reservoir: Capacity, 50,000 gallons; brick, cemented.

AUSTIN—Continued.

Sizes of distributing mains: 6, 2 $\frac{1}{2}$, 2, 1, and $\frac{1}{2}$ inches.
 Available head: 80 to 125 pounds per square inch; water-supply deficient in July and August.
 Total length of distributing mains: 4,025 feet.
 Number of water-takers: 270.
 Consumption of water: 15,000 to 18,000 gallons per day (estimated).
 Number of fire-plugs: 15.

EUREKA:

Population: 4,207 inhabitants.
 Style of corporation: Private.
 Water obtained from: Springs.
 Total area of water-shed available: 40 square miles.
 Capacity of receiving reservoir: 240,000 gallons.
 Cost of dam: \$3,000.
 Water first introduced: In 1871.
 Description of distributing reservoir: Tanks, of lumber, set under and above ground.
 Size of distributing mains: 6 inches.
 Available head: 92 feet (average).
 Total length of distributing mains: 4 miles.
 Number of water-takers: 500.
 Consumption of water: 20 gallons per head daily (estimated).
 Number of fire-plugs: 20.

PROCHE:

Population: 745 inhabitants.
 Name of corporation: Floral Springs Water-Works (private).
 Water obtained from: Springs.
 Capacity of receiving reservoir: 60,000 gallons.
 Water first introduced: In 1872.
 Description of main conduit: Length 400 feet, diameter 5 inches; sheet iron.
 Description of distributing reservoir: Capacity, 150,000 gallons.
 Size of distributing mains: 5 inches.
 Available head: 112 feet (average).
 Total length of distributing mains: About 7 miles.
 Number of water-takers: About 50.
 Consumption of water: 10 gallons per head daily (estimated).
 First cost of water-works: \$200,000.
 Average annual cost of maintenance and repairs: \$7,500.
 Number of fire-plugs: 20.

RENO:

Population: 1,302 inhabitants.
 Name of corporation: Reno Water Company (private).
 Water obtained from: Truckee river.
 Cost of dam: \$3,500.
 Water first introduced: August, 1879.
 Description of distributing reservoir: Located on a flat point of land, crescent shape; area, 5 $\frac{1}{4}$ acres; 10 feet deep; 200 feet above town.
 Sizes of distributing mains: 24 to 8 inches.
 Total length of distributing mains: About 5 miles.
 Number of water-takers: 400.
 First cost of water-works: \$15,000 to \$18,000.
 Average annual cost of maintenance and repairs: \$1,500 to \$2,000.

VIRGINIA CITY:

Population: 10,917 inhabitants.
 Name of corporation: Virginia City and Gold Hill Water Company (private).
 Water obtained from: Lakes.
 Total area of water-shed available: 25 square miles.
 Capacity of receiving reservoir: 30,000,000 cubic feet.
 Character and dimensions of dams: No. 1—200 feet long, 30 feet high; earth and timber. No. 2—180 feet long, 38 feet high; cemented rock wall.
 Cost of dams: \$89,000.
 Water first introduced: August, 1873.
 Description of main conduit: Part 16 miles long, 18 by 16 $\frac{1}{2}$ wide; 1 $\frac{1}{4}$ -inch plank. Part 7 miles long, diameter 12 inches; riveted iron. Part 7 miles long, diameter 10 inches; lap-welded iron.

VIRGINIA CITY—Continued.

Discharging capacity: 4,500,000 gallons per day; head, 465 feet (average).
 Description of distributing reservoirs: 13 tanks, situated 180 feet above town; distributed through about 2 miles.
 Sizes of distributing mains: 4 inches to 1 inch.
 Available head: 180 feet (average).
 Total length of distributing mains: About 19 miles.
 Number of water-takers: About 2,300.
 Consumption of water: 110 gallons per head daily (estimated).
 First cost of water-works: \$1,780,000.
 Average annual cost of maintenance and repairs: About \$30,000.
 Filtering apparatus: Cleaned once a year.
 Number of fire-plugs: 91.

NEW HAMPSHIRE.

BETHLEHEM:

Population: 1,400 inhabitants.
 Name of corporation: Crystal Springs Water Company (private).
 Water obtained from: Several large springs.
 Capacity of receiving reservoir: 250,000 gallons.
 Cost of dam: \$14,000.
 Water first introduced: In 1879.
 Description of main conduit: Diameters, 6 and 3 inches; wrought and cast iron, tarred.
 Description of distributing reservoir: One side solid ledge, one side masonry, and two sides railroad embankment.
 Size of distributing mains: 6 inches.
 Available head: 150 feet (average).
 Total length of distributing mains: 6,000 feet.
 Number of water-takers: 40.
 Consumption of water: 150,000 gallons per day (estimated).
 First cost of water-works: \$10,000.
 Average annual cost of maintenance and repairs: About \$300.
 Number of fire-plugs: 6.

DOVER:

Population: 11,687 inhabitants.
 Style of corporations: Private; three.
 Water obtained from: Springs and ponds.
 Water first introduced: In 1824.
 Description of main conduit: Diameter, 6 inches; cast iron.
 Available head: 40 feet (average); water-supply not often deficient.

HANOVER:

Population: 1,134 inhabitants.
 Name of corporation: Hanover Aqueduct Association (private).
 Water obtained from: Springs.
 Water first introduced: In 1822.
 Description of main conduit: Length 2 miles, diameter 2 inches; lead.
 Discharging capacity: 12,600 gallons per day; head, 50 to 100 feet.
 Sizes of distributing mains: 1½, 1½, 1½, and 1 inch.
 Available head: 60 to 70 feet; water-supply sometimes deficient.
 Number of water-takers: About 170.
 Consumption of water: 7,000 gallons per day (estimated).
 First cost of water-works: About \$7,000.
 Average annual cost of maintenance and repairs: \$50 to \$100.

KEENE:

Population: 6,764 inhabitants.
 Name of corporation: Keene Water-Works (municipal).
 Water obtained from: Ponds.
 Total area of water-shed available: About 1,900 acres.
 Area and capacity of receiving reservoir: Pond area, 53 acres; 135,000,000 gallons.
 Character and dimensions of dams: 1st, 300 feet long, 8 feet high, earth; main dam, 150 feet long, 20 feet high, center wall laid in cement, sloped with earth, water-side paved with stone; dam at reservoir, 225 feet long, 22 feet high.
 Cost of dams: \$20,000.
 Water first introduced: In 1869.

KEENE—Continued.

Description of main conduit: Part length 500 feet, diameter 16 inches; part length 500 feet, diameter 14 inches; part length 2½ miles, diameter 12 inches; mostly cement.
 Discharging capacity: 12 inches diameter; head, 130 feet (average).
 Sizes of distributing mains: 10, 8, 6, 4, and 2 inches.
 Available head: 58 pounds or 150 feet (average).
 Total length of distributing mains: About 25 miles.
 Number of water-takers: 764.
 First cost of water-works: \$168,699 58.
 Average annual cost of maintenance and repairs: \$1,200.
 Number of fire-plugs: 121.

PORTSMOUTH:

Population: 9,690 inhabitants.
 Name of corporation: Portsmouth Water Company (private).
 Water obtained from: 20 bubbling springs.
 Water first introduced: In 1797.
 Description of main conduit: One cement-lined iron pipe, laid in 1868, 2 miles long; one 10-inch wood pipe, laid in 1875, about 3¼ miles long; two other 5-inch wood-pipes (original pipes), 2½ miles long each.
 Description of distributing reservoir: Size, 70 by 100 by 10 feet; capacity, 500,000 gallons; two divisions excavated in hill-side; sloping walls inside and outside; hill-side face, 1 foot thick; exposed side-wall, 5 feet base, 3 feet on top.
 Sizes of distributing mains: 10, 5, and 4 inches.
 Available head: Water-supply deficient during droughts.
 Total length of distributing mains: About 16 miles.
 Number of water-takers: 2,000.
 Consumption of water: 750,000 to 1,000,000 gallons per day.
 First cost of water-works: \$90,000.

NEW JERSEY.

MORRISTOWN:

Population: 5,418 inhabitants.
 Name of corporation: Morris Aqueduct Company (private).
 Water obtained from: Springs.
 Capacity of receiving reservoir: 20,475,000 gallons.
 Character and dimensions of dams: One reservoir, earthwork lined with stone, capacity, 16,380,000 gallons; two smaller stone dams, capacity, 350,000 gallons.
 Cost of dams: \$44,132.
 Water first introduced: In 1799.
 Description of main conduit: Diameters, 6 and 4 inches; iron.
 Description of distributing reservoir: 130 feet long, 70 feet wide, 14 feet deep; stone wall laid up with cement, 4 feet wide on bottom, 2½ feet wide on top; bottom laid with concrete, faced inside with cement; capacity, 930,000 gallons.
 Sizes of distributing mains: 6, 4, 3, and 2 inches.
 Available head: 75 feet (average).
 Total length of distributing mains: About 12 miles.
 Number of water-takers: 550.
 Consumption of water: 30 gallons per head daily (estimated).
 First cost of water-works: \$33,000.
 Average annual cost of maintenance and repairs: \$2,500.
 Filtering apparatus: Gravel and charcoal; cleaned yearly.
 Number of fire-plugs: 67.

NEW YORK.

ATTICA:

Population: 1,935 inhabitants.
 Style of corporation: Private.
 Water obtained from: Crow creek.
 Total area of water-shed available: 4 square miles.
 Dimensions of receiving reservoir: Length 300 feet, width 40 feet, depth 5½ feet (average).
 Character and dimensions of dam: 75 feet long, 11 feet high, average 4 feet thick; stone, faced with brick.
 Water first introduced: December, 1879.
 Description of main conduit: 1 mile 10-inch iron pipe, 1 mile 8-inch iron pipe, and ¼ mile 6-inch iron pipe.
 Sizes of distributing mains: 4 and 3 inches.

ATTICA—Continued.

Available head: 120 feet (average); water-supply deficient in summer.

Total length of distributing mains: 4 miles.

Number of water-takers: 50.

First cost of water-works: About \$30,000.

Average annual cost of maintenance and repairs: \$50.

Filtering apparatus: Wire screen; cleaned yearly from leaves.

Number of fire-plugs: 20.

AVON:

Population: 1,617 inhabitants.

Name of corporation: Avon Water-Works (private).

Water obtained from: Springs.

Capacity of receiving reservoir: About 2,000,000 gallons.

Cost of dam: \$3,000.

Water first introduced: In 1858.

Description of main conduit: Diameter, 4 inches; American wrought iron, cement-covered.

Description of distributing reservoir: 150 by 150 feet, 17 feet deep; banks puddled with clay; embankment, earth; slope, 2 to 1.

Sizes of distributing mains: 3 inches to $\frac{1}{2}$ inch.

Available head: About 50 pounds to square inch (average).

Number of water-takers: About 70.

First cost of water-works: About \$15,000.

Average annual cost of maintenance and repairs: \$200.

Number of fire-plugs: 10.

DELIH:

Population: 1,384 inhabitants.

Name of corporation: Delhi Water Company (private).

Water obtained from: Steel's brook.

Character and dimensions of dam: 200 feet long; sets back 200 feet; average depth, 6 feet; solid masonry.

Cost of dam: About \$5,000.

Water first introduced: In 1872.

Sizes of distributing mains: 6 and 3 inches.

Available head: 85 feet (average).

Total length of distributing mains: Over 2 miles.

Number of water-takers: About 160.

First cost of water-works: \$2,000.

Average annual cost of maintenance and repairs: About \$100.

Filtering apparatus: Sand and gravel filter in center of dam; water-supply passes through into pipes; cleaned once a year.

Number of fire-plugs: 32.

ELLENVILLE:

Population: 2,750 inhabitants.

Style of corporation: Municipal.

Water obtained from: Mountain brooks.

Total area of water-shed available: $2\frac{1}{2}$ miles by 1 mile.

Dimensions of receiving reservoir: 18 by 25 by 45 feet.

Character of dam: Rock; three sides of stone; wall along creek; reservoir independent of main channel.

Cost of dam: \$34,592 85.

Water first introduced: In 1872.

Description of main conduit: Part 5,700 feet long, 8 inches diameter; part 1,400 feet long, 6 inches diameter; part 13,900 feet long, 4 inches diameter; iron.

Sizes of distributing mains: 8, 6, and 4 inches.

Available head: 140 feet (average).

Total length of distributing mains: 21,000 feet.

Number of water-takers: 129.

First cost of water-works: \$33,995 84.

Average annual cost of maintenance and repairs: \$588 55.

Number of fire-plugs: 40.

GENEVA:

Population: 5,878 inhabitants.

Name of corporation: The Geneva Water-Works Company (private).

Water obtained from: Springs.

Area and capacity of receiving reservoirs: One 20 feet higher than the other, supplied by springs 150 feet square; lower one, 100 feet diameter; capacities, 2,000,000 and 500,000 gallons.

GENEVA—Continued.

Water first introduced: In 1796.

Description of main conduit: Diameters, 10, 8, 6, and 4 inches; cast iron.

Size of distributing mains: 4 inches.

Available head: 125 to 150 feet.

Total length of distributing mains: About 4 miles.

Consumption of water: 500,000 gallons per day (estimated).

First cost of water-works: \$50,000.

Average annual cost of maintenance and repairs: \$250.

Number of fire-plugs: 24.

GLENS FALLS:

Population: 4,900 inhabitants.

Style of corporation: Municipal.

Water obtained from: Springs.

Total area of water-shed available: About 650 acres.

Capacity of receiving reservoirs: Main one, earth with concrete, 300 feet on top, 52,000,000 gallons. Two small ones, stone, laid in cement, about 4,000,000 gallons each.

Cost of dam: \$20,000.

Water first introduced: In 1872.

Description of main conduit: 8 miles long, 12 and 10 inches diameter; sheet iron, cement-lined.

Sizes of distributing mains: 6 and 4 inches.

Available head: 250 feet (average).

Total length of distributing mains: About 7 miles.

Number of water-takers: About 450.

First cost of water-works: \$125,000.

Average cost of maintenance and repairs: \$650.

Number of fire-plugs: 90.

GLOVERSVILLE:

Population: 7,133 inhabitants.

Name of corporation: Gloversville Water-Works (municipal).

Water obtained from: Springs and mountain brook.

Capacity of receiving reservoirs: No. 1, 3,000,000 gallons; No. 2, 500,000 gallons; No. 3, 1,500,000 gallons.

Character and dimensions of dams: Two of stone and gravel, and one of stone; they rest against hills in each instance.

Cost of dams: \$2,756 11.

Water first introduced: In 1877.

Available head: 250 feet (average).

Total length of distributing mains: 6 miles.

Number of water-takers: 500.

Number of fire-plugs: 65.

GOSHEN:

Population: 2,557 inhabitants.

Name of corporation: Goshen Water-Works (municipal).

Water obtained from: Water-sheds and springs.

Total area of water-shed available: 100 acres.

Area and capacity of receiving reservoir: 40 acres; 30 feet deep.

Character and dimensions of dam: 500 feet long 20 feet high, 100 feet at base and 40 feet on top; center puddled.

Cost of dam: \$63,000.

Water first introduced: In 1872.

Description of main conduit: Length $1\frac{1}{4}$ mile, diameter 12 inches; sheet iron, lined and covered with cement.

Sizes of distributing mains: 8, 6, and 4 inches.

Available head: 150 feet (average).

Total length of distributing mains: 6 miles.

Number of water-takers: 144.

First cost of water-works: \$40,000.

Average annual cost of maintenance and repairs: \$200.

Number of fire-plugs: 70.

MALONE:

Population: 4,193 inhabitants.

Name of corporation: Malone Water-Works Company (private).

Water obtained from: Three springs.

Cost of dam: \$1,200.

Water first introduced: In 1857.

Description of main conduit: Length 3 miles, diameter 4 inches; iron, lined with cement.

MALONE—Continued.

Discharging capacity: 50 gallons per minute; head, 90 feet (average).

Description of distributing reservoir: 45 by 90 feet; stone, concrete puddled; covered by shingle roof.

Sizes of distributing mains: 3, 2, and 1½ inches.

Available head: 80 feet (average).

Total length of distributing mains: 4 miles.

Number of water-takers: 436.

First cost of water-works: \$40,000.

Average annual cost of maintenance and repairs: \$1,200.

MIDDLETOWN:

Population: 8,494 inhabitants.

Name of corporation: Middletown Water-Works (municipal).

Water obtained from: Springs.

Total area of water-shed available: 500 acres.

Area and capacity of receiving reservoir: 350,000,000 gallons.

Character and dimensions of dam: 500 feet long, 15 to 20 feet high; earth and stone.

Cost of dam: \$12,000.

Water first introduced: In 1867.

Description of main conduit: 2 miles long, 12 inches diameter, iron; 2 miles long, 10 inches diameter, cement.

Sizes of distributing mains: 10, 8, 6, and 4 inches.

Available head: 50 feet (average).

Total length of distributing mains: 8 miles.

Number of water-takers: 400.

Consumption of water: 1,000,000 gallons per day.

First cost of water-works: \$150,000.

Average annual cost of maintenance and repairs: \$2,000.

Number of fire-plugs: 88.

MOUNT MORRIS:

Population: 1,899 inhabitants.

Name of corporation: Mills Water-Works Company (private).

Water obtained from: Quicksand springs.

Total area of water-shed available: About 1 square mile.

Capacity of receiving reservoir: 1,025,000 gallons.

Water first introduced: November, 1879.

Description of main conduit: Length 1 mile, diameter 4 inches; cast iron, coated inside and out with asphaltum cement.

Discharging capacity: 106,704 gallons in 24 hours; head, 15 feet (maximum).

Description of distributing reservoir: Size, 80 by 80 feet (bottom), 140 by 140 feet (top); 12 feet 6 inches (maximum) depth of water; face of banks, stone and cement; bottom, 6 inches gravel, concrete, and cement.

Sizes of distributing mains: 10, 8, and 6 inches.

Available head: 30 to 115 feet.

Total length of distributing mains: 3 miles.

Number of water-takers: About 80.

Consumption of water: 20 gallons per head daily (estimated).

First cost of water-works: \$30,000.

Number of fire-plugs: 25.

NEWBURG:

Population; 18,049 inhabitants.

Name of corporation: Newburg City Water-Works (municipal).

Water obtained from: Lake.

Total area of water-shed available: 1,000 acres.

Area and capacity of receiving reservoir: About 75 acres; depth, 15 feet (average).

Character and dimensions of dam: Earthworks for increasing capacity of lake.

Cost of dam: \$422,014 38.

Water first introduced: In 1854.

Description of main conduit: Length 3,128 feet, diameter 24 inches; length 12,360 feet, diameter 20 inches; cast iron.

Sizes of distributing mains: 12, 8, 6, and 4 inches.

Available head: Water-supply deficient only when pumping to mains is resorted to.

Total length of distributing mains: 13 miles.

Number of water-takers: 2,767.

First cost of water-works: About \$107,000.

Average annual cost of maintenance and repairs: \$2,000.

PLATTSBURG:

Population: 5,245 inhabitants.

Style of corporation: Municipal.

Water obtained from: Mountain brooks.

Total area of water-shed available: About 20 square miles.

Area and capacity of receiving reservoir: 3 acres; 6 feet deep (average); 3,456,000 gallons.

Water first introduced: In 1870.

Description of main conduit: Length, 2 miles; diameter, 12 inches.

Sizes of distributing mains: 10, 8, 6, 4, and 2 inches.

Available head: 200 feet (average).

Total length of distributing mains: 52,289 feet.

Consumption of water: 1,200,000 gallons per day (estimated).

First cost of water-works: \$180,000.

Average annual cost of maintenance and repairs: \$2,486.

Number of fire-plugs: 24.

PORT JERVIS:

Population: 8,678 inhabitants.

Name of corporation: Port Jervis Water-Works Company (private).

Water obtained from: Running streams and surface-water.

Total area of water-shed available: About 4,000 acres.

Capacity of receiving reservoir: 200,000,000 gallons.

Character and dimensions of dam: 30 feet high, 20 feet wide on top; slope, 2 to 1 front, 1½ to 1 back; 6 feet above high-water mark.

Cost of dam: About \$40,000.

Water first introduced: In 1870.

Description of main conduit: Length 2 miles, diameter 12 inches; cast iron.

Sizes of distributing mains: 10, 8, 6, and 4 inches.

Available head: About 120 feet (average).

First cost of water-works: About \$105,000.

Average annual cost of maintenance and repairs: About \$1,500.

Number of fire-plugs: 118.

RICHFIELD SPRINGS:

Population: 1,307 inhabitants.

Name of corporation: Richfield Springs Water-Works (municipal).

Water obtained from: Springs and surface-water.

Total area of water-shed available: About 1,000 acres.

Capacity of receiving reservoirs: No. 1—1,000,000 gallons. No. 2—7,000,000 gallons.

Character and dimensions of dam: 300 feet long; at bottom, 150 feet; 25 feet high; puddled in center, and made in a semi-circle.

Water first introduced: October, 1879.

Description of main conduit: Length 1,200 feet, diameter 10 inches; vitrified pipe.

Size of distributing mains: 10 inches.

Available head: 15 to 180 feet.

Total length of distributing mains: About 3 miles.

Number of water-takers: About 20.

First cost of water-works: \$22,500.

Average annual cost of maintenance and repairs: About \$300.

Number of fire-plugs: 23.

UTICA:

Population: 33,914 inhabitants.

Name of corporation: Utica Water-Works Company (private).

Water obtained from: Graefenburg springs and Starch Factory creek.

Total area of water-shed available: About 2,000 acres.

Area and capacity of receiving reservoirs: Graefenburg river—7 acres; 35,000,000 gallons. Starch Factory creek—26 acres; 28,000,000 gallons.

Character and dimensions of dams: Graefenburg dam—400 feet long (top); 55 feet high; slope, 1½ to 1 outside, 2 to 1 inside. Starch Factory Creek dam—540 feet long; 20 feet wide; 70 feet high; slope, 1½ to 1 outside, 2 to 1 inside; all earth. Distributing reservoir dam—660 feet long, 10 feet wide, 28 feet high.

Cost of dams: \$500.

Water first introduced: In 1849.

UTICA—Continued.

Description of main conduit: 1 mile long; diameter, 12 inches, brick; diameters 20 and 12 inches, iron.
 Description of distributing reservoir: Area, 9 acres; capacity, 30,000,000 gallons; water taken from surface by movable flume into well, thence to city.
 Sizes of distributing mains: 12, 10, 8, 6, 5, 4, and 3 inches.
 Available head: 15 to 16 pounds.
 Total length of distributing mains: About 30 miles.
 Number of water-takers: About 1,200.
 Consumption of water: 125,000 gallons per day (estimated).
 First cost of water-works: \$75,000.
 Average annual cost of maintenance and repairs: \$5,000.
 Number of fire-plugs: 200.

WALTON:

Population: 1,389 inhabitants.
 Name of corporation: Walton Water Company (private).
 Water obtained from: Brook fed by springs.
 Total area of water-shed available: 4 square miles.
 Area and capacity of receiving reservoir: 2½ acres; 12,000,000 gallons.
 Character and dimensions of dam: 140 feet long, 96 wide (bottom), 20 feet wide (top), 24 feet high; weir, 60 feet long, 20 feet high.
 Cost of dam: \$3,279.
 Water first introduced: September, 1879.
 Description of main conduit: 150 feet long, 10 inches diameter; 8,814 feet long, 8 inches diameter; cast iron.
 Description of distributing reservoir: Area, 2½ acres; capacity, 12,000,000 gallons.
 Sizes of distributing mains: 8, 6, and 4 inches.
 Available head: 206 feet (average).
 Total length of distributing mains: 3-7/8 miles.
 Number of water-takers: 61.
 Consumption of water: 40,000 gallons per day (estimated).
 First cost of water-works: \$17,000.
 Average annual cost of maintenance and repairs: \$10.
 Filtering system: Size, 12 feet deep, 9 feet long, divided into three compartments by wire screens filled with charcoal and sponges; cleaned every four months.
 Number of fire-plugs: 22.

WARSAW:

Population: 1,910 inhabitants.
 Name of corporation: Warsaw Water-Works Company (private).
 Water obtained from: Springs and brooks.
 Total area of water-shed available: 3¼ square miles.
 Capacity of receiving reservoirs: 300,000 and 600,000 gallons.
 Cost of dam: \$1,500.
 Water first introduced: In 1870.
 Description of main conduit: Length 2½ miles, diameter 4 inches; iron.
 Discharging capacity: 10,000 gallons per day; head, 70 feet (average).
 Description of distributing reservoir: 60 feet square, 18 feet deep.
 Size of distributing mains: 4 inches.
 Available head: 275 feet (average).
 Total length of distributing mains: 6 miles.
 Number of water-takers: 250.
 Consumption of water: 4,000 gallons daily (estimated).
 First cost of water-works: \$18,000.
 Average annual cost of maintenance and repairs: \$200.
 Filtering apparatus: Cleaned every five years.
 Number of fire-plugs: 26.

WARWICK:

Population: 1,043 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Springs and small stream.
 Total area of water-shed available: About 3 square miles.
 Capacity of receiving reservoir: 2,500,000 gallons.
 Character and dimensions of dam: 70 feet long, 30 feet high, 70 feet wide at bottom, 20 feet wide on top; puddled earth faced with stone.

WARWICK—Continued.

Cost of dam: \$5,000.
 Water first introduced: In 1871.
 Description of main conduit: Length 100 feet, diameter 12 inches, cast iron; length 1½ mile, diameter 8 inches; length 1¼ mile, diameter 6 and 4 inches; sheet iron lined with cement.
 Sizes of distributing mains: 12, 8, 6, and 4 inches.
 Available head: 120 feet (average).
 Total length of distributing mains: 2½ miles.
 Number of water-takers: 80.
 First cost of water-works: \$25,000.
 Average annual cost of maintenance and repairs: \$50.
 Number of fire-plugs: 30.

WAVERLY:

Population: 2,767 inhabitants.
 Name of corporation: Waverly Water Company (private).
 Water obtained from: Water-shed.
 Total area of water-shed available: 2 square miles.
 Capacity of receiving reservoir: 95,000,000 gallons.
 Character and dimensions of dam: 60 feet high, 220 feet wide (bottom), 10 feet wide (top); slope, 1½ to 1 back, 2 to 1 front; stone wall in center 36 feet high, 8 feet at bottom, 4 feet at top; earth.
 Cost of dam: About \$15,000.
 Water first introduced: December, 1880.
 Description of main conduit: Diameter, 12 inches; cast iron.
 Discharging capacity: 4,000,000 gallons per day; head, 190 feet (average).
 Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
 Available head: 200 feet (average).
 Total length of distributing mains: 5 miles.
 First cost of water-works: About \$50,000.
 Number of fire-plugs: 18.

NORTH CAROLINA.

FAYETTEVILLE:

Population: 3,485 inhabitants.
 Name of corporation: Fayetteville Water-Works (private).
 Water obtained from: 4 springs.
 Total area of water-shed available: 200 square feet.
 Water first introduced: About 1819.
 Description of main conduit: Diameter, 3 inches; bored pine logs.
 Description of distributing reservoir: Size, 8 by 12 feet, and 6 feet pitch; brick house.
 Size of distributing mains: 2 inches.
 Available head: 30 to 40 feet; water-supply often deficient.
 Total length of distributing mains: About 2 miles.
 Average annual cost of maintenance and repairs: \$150 to \$200.
 Number of fire-plugs: 8.

OHIO.

NEW LISBON:

Population: 2,028 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Springs and small stream.
 Total area of water-shed available: About 200 acres.
 Character and dimensions of dam: 60 feet long (on top), 20 feet high; built across ravine, of stone, grouted; fed from springs.
 Cost of dam: \$2,000.
 Water first introduced: About 1841.
 Description of main conduit: Diameter, 10 inches; wooden pipe.
 Sizes of distributing mains: 6 and 4 inches.
 Available head: About 100 feet (average); water-supply deficient in dry seasons.
 Total length of distributing mains: About 2 miles.
 Number of water-takers: 26.
 Average cost of maintenance and repairs: \$50 to \$80.
 Number of fire-plugs: 21.

WOOSTER:

Population: 5,840 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Springs and surface-water.

WOOSTER—Continued.

Total area of water-shed available: About 700 acres.
 Character and dimensions of dams: Main—breast, 300 feet long, 18 feet high, capacity, 5,000,000 gallons; 500 feet from this is a dam 200 feet long, 15 feet high, to arrest storm-water which passes through a 12-inch pipe under the main dam.
 Cost of dams: \$11,000.
 Water first introduced: In 1876.
 Description of main conduit: . Diameter, 12 inches; cast iron.
 Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
 Available head: 50 to 160 feet; water-supply sometimes deficient.
 Total length of distributing mains: About 8½ miles.
 Number of water-takers: 175.
 First cost of water-works: \$80,000.
 Average annual cost of maintenance and repairs: About \$500.
 Number of fire-plugs: 88.

OREGON.

DALLAS:

Population: 2,232 inhabitants.
 Name of corporation: Dallas Water-Works (private).
 Water obtained from: Mountain streams.
 Total area of water-shed available: 100 square miles.
 Area and capacity of receiving reservoirs: No. 1, 16 by 200 feet; built of stone. No. 2, 90 by 80 feet; three sides natural stone walls, fourth side earth and timber.
 Description of dam: 13 feet high.
 Cost of dam: \$1,500.
 Water first introduced: In 1862.
 Description of main conduit: Length 1¼ mile, diameters 10 and 8 inches; red-fir timber, 1¼ inch thick.
 Discharging capacity: 55,000 gallons per hour; head, 22 feet (average).
 Description of distributing reservoir: Located on a perpendicular precipice of rock; 102 feet elevation; area, 16 by 20 feet; 8 feet deep.
 Sizes of distributing mains: 8 and 4 inches.
 Available head: 40 feet (average).
 Total length of distributing mains: 14,000 feet.
 Number of water-takers: 400.
 Consumption of water: 51 gallons per head per day (estimated).
 First cost of water-works: \$12,000.
 Average annual cost of maintenance and repairs: \$2,500.
 Number of fire-plugs: 6.

PENNSYLVANIA.

ALTOONA:

Population: 19,710 inhabitants.
 Name of corporation: Altoona City Water-Works (municipal).
 Water obtained from: Base of Alleghany mountains.
 Capacity of receiving reservoir: 100,000,000 gallons.
 Cost of dam: \$300,000.
 Water first introduced: April or May, 1872.
 Description of main conduit: Length 6 miles, diameter 12 inches.
 Description of distributing reservoir: Capacity, 3,500,000 gallons; lined with clay; faced with brick on bottom and sides.
 Sizes of distributing mains: 12 to 4 inches.
 Available head: 55 pounds per square foot (average); water-supply sometimes deficient in very dry weather.
 Total length of distributing mains: About 13 miles.
 Number of water-takers: About 1,300.
 Consumption of water: 450,000 gallons daily (estimated).
 First cost of water-works: \$200,000.

ARCHBALD:

Population: 3,049 inhabitants.
 Name of corporation: Archbald Water Company (private).
 Water obtained from: Laurel Run creek.
 Total area of water-shed available: 4,000 acres.
 Character and dimensions of dam: 300 feet long, 90 feet face (top), 20 feet deep; log cribbing filled with stone planked over, which is puddled clay.
 Cost of dam: \$15,000.

ARCHBALD—Continued.

Water first introduced: October, 1875.
 Description of main conduit: 1,400 feet length, 10 inches diameter, terra cotta; 2,000 feet length, 10 and 8 inches diameter, iron reducer.
 Description of distributing reservoir: Area, 90 feet face, 8 feet deep (average); in driest season supplied 60,000 gallons in 24 hours.
 Sizes of distributing mains: 6, 4, and 3 inches.
 Available head: 190 pounds per square inch (average).
 Total length of distributing mains: 2 miles.
 Number of water-takers: 80.
 First cost of water-works: \$14,000.
 Number of fire-plugs: 9.

ASHLAND:

Population: 6,052 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Little Mahawnoy creek.
 Total area of water-shed available: About 9 square miles.
 Capacity of receiving reservoir: 3,000,000 gallons.
 Character and dimensions of dam: 175 feet long, 19 feet high, 12 feet thick at base, tapered to 4 feet 6 inches on top; breast of rough stone, laid in cement and tamped with clay; built across valley.
 Cost of dam: \$4,200.
 Water first introduced: April, 1877.
 Description of main conduit: Length 27,800 feet, diameter 12 inches; cast iron.
 Sizes of distributing mains: 8, 6, 4, and 3 inches.
 Available head: 65 to 232 feet.
 Total length of distributing mains: 14,000 feet.
 Number of water-takers: 538.
 Consumption of water: 150 gallons per head per day (estimated).
 First cost of water-works: \$62,300.
 Average annual cost of maintenance and repairs: \$750.
 Number of fire-plugs: 29.

CANTON:

Population: 1,194 inhabitants.
 Name of corporation: Canton Water Company (private).
 Water obtained from: Mountain stream.
 Total area of water-shed available: 1¼ square mile.
 Water first introduced: October, 1877.
 Description of main conduit: Diameters, 10, 6, 8, and 4 inches; cast iron.
 Sizes of distributing mains: 6 and 4 inches.
 Available head: 100 feet (average).
 Total length of distributing mains: 1¼ mile.
 Number of water-takers: 100.
 First cost of water-works: \$37,500.
 Average annual cost of maintenance and repairs: \$350.
 Number of fire-plugs: 2.

CARBONDALE:

Population: 7,714 inhabitants.
 Name of corporation: Crystal Lake Water Company (private).
 Water obtained from: Springs and streams.
 Total area of water-shed available: About 2 square miles.
 Capacity of receiving reservoirs: No. 1, 29,403,000 gallons; No. 2, 6,534,000 gallons.
 Character and dimensions of dams: No. 1, earth embankment with wood bulkhead; No. 2, earth embankment with stone bulkhead.
 Water first introduced: In 1867.
 Description of main conduit: Length 4,847 feet, diameter 12 inches; iron and cement.
 Description of distributing reservoir: Simply stone bulkhead.
 Sizes of distributing mains: 10, 8, 6, and 4 inches.
 Available head: 90 to 112 pounds per square inch.
 Total length of distributing mains: About 3 miles.
 Number of water-takers: 274.
 First cost of water-works: \$11,625.
 Average annual cost of maintenance and repairs: About \$400.

COATESVILLE:

Population: 2,766 inhabitants.
 Name of corporation: Coatesville Water-Works (municipal).
 Water obtained from: Springs.
 Capacity of receiving reservoir: 2,000,000 gallons.
 Character and dimensions of dam: Where stream is tapped, made of stone and earth; capacity, 600,000 gallons.
 Cost of dam: \$70,000.
 Water first introduced: December, 1870.
 Description of main conduit: Diameter, 10 inches; iron.
 Description of distributing reservoir: Built of earth and puddled clay, with brick floor.
 Sizes of distributing mains: 8, 6, 4, and 3 inches.
 Available head: 100 feet (average).
 Total length of distributing mains: About 5 miles.
 Number of water-takers: 400.
 Consumption of water: 200,000 gallons per day (estimated).
 First cost of water-works: \$65,000.
 Average annual cost of maintenance and repairs: \$250.
 Number of fire-plugs: 57.

DOWNINGTON:

Population: 1,480 inhabitants.
 Name of corporation: The Gas and Water Company of Downington (private).
 Water obtained from: Springs.
 Total area of water-shed available: 10 square miles.
 Size of distributing mains: 6 inches.
 Available head: 17 feet (average).
 Total length of distributing mains: 7 miles.
 Number of water-takers: 200.
 Consumption of water: 200,000 gallons daily (estimated).
 First cost of water-works: \$50,000.
 Number of fire-plugs: 1.

DUNMORE:

Population: 5,151 inhabitants.
 Name of corporation: Dunmore Gas and Water Company (private).
 Water obtained from: Little Roaning brook.
 Total area of water-shed available: 1,500 acres.
 Character and dimensions of dam: Stone and gravel.
 Cost of dam: About \$20,000.
 Description of main conduit: Diameter, 12 inches; iron and cement.
 Sizes of distributing mains: 12, 6, and 4 inches.
 Available head: 100 to 150 feet.
 Total length of distributing mains: 3 miles.
 Number of water-takers: About 330.
 First cost of water-works: \$34,000.

EPHRATA:

Population: 302 inhabitants.
 Name of corporation: Ephrata Water Company (private).
 Water obtained from: Ephrata mountains.
 Area and capacity of receiving reservoir: 7 acres; 63,000 gallons.
 Cost of dam: \$3,500.
 Water first introduced: In December, 1878.
 Description of main conduit: 3,700 feet long, 6 inches diameter; 300 feet long, 4 inches diameter; 600 feet long, 2 inches diameter; cast iron.
 Description of distributing reservoir: Built of sandstone, lined with brick, inlaid with cement.
 Sizes of distributing mains: 6 and 4 inches.
 Available head: 265 feet (average).
 Total length of distributing main: About 4,000 feet.
 Number of water-takers: About 40.
 Consumption of water: 1,000 gallons per day (estimated).
 First cost of water-works: \$3,500.
 Average annual cost of maintenance and repair: \$50.
 Number of fire-plugs: 5.

FRANKLIN:

Population: 5,010 inhabitants.
 Name of corporation: Venango Water Company (private).
 Water obtained from: Springs.

FRANKLIN—Continued.

Total area of water-shed available: About 500 acres.
 Receiving reservoirs: 2 small; temporary.
 Cost of dam: \$2,500 to \$3,000.
 Water first introduced: In 1864.
 Sizes of distributing mains: 8 to 2 inches.
 Available head: Water-supply deficient in dry seasons.
 Total length of distributing mains: 50,000 feet.
 Number of water-takers: About 630.
 Consumption of water: 30 gallons per head daily (estimated).
 First cost of water-works: \$80,000.
 Number of fire-plugs: 17.

GETTYSBURG:

Population: 2,814 inhabitants.
 Name of corporation: Gettysburg Water Company (private).
 Water obtained from: Springs.
 Total area of water-shed available: About 150 acres.
 Size of distributing mains: 3 inches.
 Total length of distributing mains: About 2 miles.
 Number of water-takers: 149.
 Average annual cost of maintenance and repairs: \$350.

HANOVER:

Population: 2,317 inhabitants.
 Name of corporation: Hanover Water Company (private).
 Water obtained from: Spring.
 Capacity of receiving reservoirs: No. 1—2,500,000 gallons; No. 2—1,600,000 gallons.
 Character and dimensions of dams: They are thrown up across a ravine.
 Cost of dams: \$5,725 94.
 Water first introduced: January, 1874.
 Description of main conduit: Length 17,931 feet, diameter 6 inches; cast iron.
 Discharging capacity: 350,000 gallons in 24 hours; head, 206 feet (average).
 Size of distributing mains: 4 inches.
 Available head: 190 feet (average).
 Total length of distributing mains: About 13,100 feet.
 Number of water-takers: 213.
 Consumption of water: 30,000 to 40,000 gallons per day (estimated).
 First cost of water-works: \$37,000.
 Average annual cost of maintenance and repairs: \$300.
 Number of fire-plugs: 25.

HAZLETON:

Population: 6,935 inhabitants.
 Name of corporation: Hazleton Water Company (private).
 Water obtained from: Springs and artesian wells.
 Capacity of receiving reservoirs: 5 reservoirs; capacity, 600,156 cubic feet.
 Water first introduced: In 1860.
 Description of main conduit: Length 3,205 feet, diameter 8 inches; cast iron.
 Sizes of distributing mains: 6 inches.
 Available head: Water-supply sometimes deficient.
 Total length of distributing mains: 4½ miles.
 Average annual cost of maintenance and repairs: \$3,500.
 Number of fire-plugs: 17.

HOLLIDAYSBURG:

Population: 3,150 inhabitants.
 Name of corporation: Hollidaysburg Water-Works (municipal).
 Water obtained from: Roaring run.
 Total area of water-shed available: 560 acres.
 Area and capacity of receiving reservoir: 528 acres; 928,000 cubic feet.
 Cost of dam: \$17,258.
 Water first introduced: November, 1867.
 Description of main conduit: Length 11½ miles, diameters 6, 5, 4, and 3 inches; wood.
 Sizes of distributing mains: 6, 5, 4, and 3 inches.

HOLLIDAYSBURG—Continued.

Available head: 28 to 120 feet; water-supply deficient only in dry months.

Total length of distributing mains: $8\frac{1}{2}$ miles.

Number of water-takers: 763.

First cost of water-works: \$47,600.

Average annual cost of maintenance and repairs: About \$1,200.

Number of fire-plugs: 47.

JOHNSTOWN:

Population: 8,380 inhabitants.

Name of corporation: Johnstown Water Company (private).

Water obtained from: Mountain streams, Mill run, Laurel run, Wild Cat, and Conemaugh.

Total area of water-shed available: 191 square miles.

Capacity of receiving reservoir: 36,000,000 gallons.

Character and dimensions of dams: No. 1—550 feet long, 16 feet deep. No. 2—300 feet long, 20 feet wide; the two made in valleys with an overflow for surplus; overflow 50 feet wide.

No. 3—150 feet long, 6 feet high; timber frame with overflow.

Cost of dams: No. 1, \$22,235; No. 2, \$9,000; No. 3, \$3,900.

Water first introduced: July, 1868.

Description of main conduit: No. 1, length 3 miles, diameter 12 inches; No. 2, length $4\frac{1}{2}$ miles, diameter 16 inches; No. 3, length 5 miles, diameter 20 inches; cast iron.

Sizes of distributing mains: 20, 16, 12, 6, and 4 inches.

Available head: 50 to 60 pounds; 178 feet (average).

Total length of distributing mains: 30 miles.

Number of water-takers: 2,000.

First cost of water-works: \$375,000.

Average annual cost of maintenance and repairs: \$3,000.

Number of fire-plugs: 54.

LEBANON:

Population: 8,778 inhabitants.

Name of corporation: Lebanon Borough Water-Supply Company (municipal).

Water obtained from: Cornwall hills.

Total area of water-shed available: 1,111.7 acres.

Capacity of receiving reservoir: 3,000,000 gallons per day.

Character and capacity of dam: Across valley; capacity, 20,000,000 gallons.

Cost of dam: \$300,000.

Water first introduced: In 1872.

Description of main conduit: Length $3\frac{1}{2}$ miles, 16 inches diameter; length $2\frac{1}{2}$ miles, 12 inches diameter; iron.

Discharging capacity: 1,000,000 gallons per day; head, 152 feet (average).

Sizes of distributing mains: 12, 8, and 6 inches.

Available head: 100 feet (average); water-supply sometimes deficient.

Total length of distributing mains: About 16 miles.

Number of water-takers: 930.

Consumption of water: 270,000 gallons per day; 30 gallons per head (estimated).

First cost of water-works: About \$280,000.

Average annual cost of maintenance and repairs: \$1,000.

Number of fire-plugs: 70.

MAHANAY CITY:

Population: 7,181 inhabitants.

Name of corporation: Mahanoy City Water Company (private).

Water obtained from: Springs and streams.

Total area of water-shed available: About 2,000 acres.

Character and dimensions of dams: 2 dams; cover about 20 acres; breast 22 feet high, made of earth.

Cost of dams: \$77,500.

Water first introduced: In 1867.

Description of main conduit: 2 miles long, 10 inches diameter; $\frac{1}{2}$ mile long, 6 inches diameter; 1 mile long, 4 inches diameter; cast iron.

Size of distributing mains: 10 inches.

Available head: 350 feet (average).

Total length of distributing mains: $3\frac{1}{2}$ miles.

MAHANAY CITY—Continued.

Number of water-takers: 734.

First cost of water-works: \$45,000.

Average annual cost of maintenance and repairs: About \$2,000.

Number of fire-plugs: 17.

MECHANICSBURG:

Population: 3,018 inhabitants.

Name of corporation: Mechanicsburg Gas and Water Company (private).

Water obtained from: Springs.

Total area of water-shed available: About 1 square mile.

Capacity of receiving reservoir: About 1,000,000 gallons.

Character and dimensions of dams: Water passes from No. 1 through tunnel to No. 2; tunnel 700 feet long, 6 by 3 feet, with many springs in it.

Cost of dams: \$1,500.

Water first introduced: In 1856 or 1857.

Description of main conduit: Length 2 miles, diameter 6 inches; cast iron.

Description of distributing reservoir: Size, 90 by 60 feet; 14 feet deep; built in ravine; breast made of excavated earth, lined with red sandstone; dams are similar, and partly lined with boards.

Sizes of distributing mains: 6, 4, 3, and 2 inches.

Available head: 25 feet (average); water-supply sometimes deficient.

Total length of distributing mains: About 2 miles.

Number of water-takers: About 500.

First cost of water-works: \$25,000.

Average annual cost of maintenance and repairs: About \$100.

Filtering apparatus: When water leaves receiving dam it runs through one copper and five galvanized iron strainers in a wooden trough; cleaned about once in six or eight weeks.

Number of fire-plugs: 21.

MINERSVILLE:

Population: 3,249 inhabitants.

Name of corporation: Minersville Water Company (private).

Water obtained from: Springs.

Total area of water-shed available: 25 square miles.

Cost of dam: \$1,000.

Water first introduced: In 1860.

Description of main conduit: 4 miles long, 8 inches diameter; cast iron.

Sizes of distributing mains: 8 to 3 inches.

Available head: About 120 feet (average).

Total length of distributing mains: $7\frac{1}{2}$ miles.

Number of water-takers: About 625.

First cost of water-works: About \$53,000.

Average annual cost of maintenance and repairs: \$900.

Number of fire-plugs: 40.

PLYMOUTH:

Population: 6,065 inhabitants.

Name of corporation: The Plymouth Water Company (private).

Water obtained from: Springs.

Total area of water-shed available: 5 square miles.

Capacity of receiving reservoirs: One water-shed, four reservoirs; 10,000,000 gallons.

Character and dimensions of dams: No. 1—80 feet long, 15 feet deep; cut stone, cemented. No. 2—110 feet long, 20 feet deep; cut stone, cemented. No. 3—130 feet long, 25 feet deep; stone sheet, piled and puddled. No. 4—330 feet long, 12 feet deep; stone sheet, piled and puddled.

Cost of dams: No. 1, \$2,500; No. 2, \$7,500; No. 3, \$4,500; No. 4, \$4,000.

Water first introduced: In 1876.

Description of main conduit: Length 1,200 feet, diameter 12 inches; cast iron.

Discharging capacity: About 750 cubic feet per minute; head, 165 feet (average).

Description of distributing reservoir: A dam built of stone, cemented; 80 feet long, 15 feet high; capacity, 175,000 gallons.

PLACEMOUTH—Continued.

Sizes of distributing mains: 10, 8, 6, 3, and 2 inches.
 Available head: 250 feet (average).
 Total length of distributing mains: 30,000 feet.
 Number of water-takers: 840.
 Consumption of water: 175,000 gallons daily (estimated).
 First cost of water-works: \$55,000.
 Average annual cost of maintenance and repairs: \$1,200.
 Filtering system: Pipes cleaned once a year.
 Number of fire-plugs: 1.

POTTSVILLE:

Population: 13,253 inhabitants.
 Name of corporation: The Pottsville Water Company (private).
 Water obtained from: Streams.
 Area and capacity of receiving reservoir: 70 acres; 300,000,000 gallons.
 Character and dimensions of dam: 1,350 feet long, 42 feet high, 40 feet wide on top; slope 2 to 1 inside, 1½ to 1 outside; earth wasteway 40 feet wide, 4 feet deep.
 Cost of dam: \$90,000.
 Water first introduced: In 1855.
 Description of main conduits: 7 miles long, 12 inches diameter; 4 miles long, 12 inches diameter; cast-iron.
 Sizes of distributing mains: 12 to 3 inches.
 Available head: 20 to 80 pounds.
 Total length of distributing mains: 24 miles.
 Number of water-takers: 3,160.
 First cost of water-works: \$300,000.
 Average annual cost of maintenance and repairs: \$3,000.

READING:

Population: 43,278 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Springs.
 Total area of water-shed available: 20 square miles.
 Area and capacity of receiving reservoir: 27 acres; 115,000,000 gallons.
 Cost of dams: \$240,000.
 Water first introduced: In 1865.
 Description of main conduit: Length, 4 miles; diameters, 24 and 10 inches; cast iron.
 Description of distributing reservoir: Area, 1 acre; 15 feet deep.
 Capacity: 6,000,000 gallons.
 Sizes of distributing mains: 24 to 4 inches.
 Available head: 45 pounds (average).
 Total length of distributing mains: 35 miles.
 Number of water-takers: 9,000.
 Consumption of water: 3,000,000 gallons daily; 50 gallons per head (estimated).
 First cost of water-works: \$300,000.
 Average cost of maintenance and repairs: \$5,200.
 Number of fire-plugs: 375.

RENOVO:

Population: 3,708 inhabitants.
 Name of corporation: Renovo Water-Works (municipal).
 Water obtained from: Mountain stream.
 Capacity of receiving reservoir: 4,000,000 gallons.
 Cost of dam: \$9,000.
 Water first introduced: In 1873.
 Size of distributing mains: 10 inches.
 Available head: Water-supply sometimes deficient.
 Total length of distributing mains: 5 or 6 miles.
 Number of water-takers: 250.
 First cost of water-works: \$60,000.
 Average annual cost of maintenance and repairs: \$200.
 Number of fire-plugs: 19.

SCRANTON:

Population: 45,850 inhabitants.
 Name of corporation: Scranton Gas and Water Company (private).
 Water obtained from: Mountain lake and stream.
 Total area of water-shed available: 30 square miles.

SCRANTON—Continued.

Capacity of receiving reservoirs: Lake, 400,000,000 gallons; reservoir, 90,000,000 gallons.
 Character and dimensions of dams: 320 feet long, 22 feet wide bottom, 8 feet wide on top; 37 feet high above natural bed of creek; solid masonry.
 Cost of dams: \$90,000.
 Water first introduced: In 1860.
 Description of main conduits: 1,600 feet long, 16 inches diameter; and 1,600 feet long, 16 inches diameter; cast and wrought iron and cement.
 Discharging capacity: 12,000,000 gallons in 24 hours; head, 50 to 400 feet.
 Description of distributing reservoir: Area, 25 acres; capacity, 90,000,000 gallons; rocky bottom.
 Sizes of distributing mains: 16 to 14 inches.
 Available head: 50 pounds (average).
 Total length of distributing mains: 27½ miles.
 Number of water-takers: 2,100.
 Consumption of water: 5,000,000 gallons per day.
 First cost of water-works: \$640,000.
 Average annual cost of maintenance and repairs: \$8,000.
 Number of fire-plugs: 115.

SEWICKLEY:

Population: 2,053 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Springs.
 Total area of water-shed available: About 100 acres.
 Character and dimensions of dam: 12 feet wide; flood-gate in center, to allow impure water to run off during heavy rains.
 Cost of dam: \$75,000.
 Water first introduced: In 1874.
 Description of main conduit: 75 feet long, 12 inches diameter; cast iron.
 Description of distributing reservoir: 300 feet long, 200 feet wide, 19 feet deep; 3 outlets on stand-pipe; water drawn from bottom; capacity, 4,000,000 gallons.
 Sizes of distributing mains: 12, 8, 6, and 4 inches.
 Available head: 50 pounds (average).
 Total length of distributing mains: About 10 miles.
 Number of water-takers: 350.
 Consumption of water: 10,650,000 gallons per day (estimated).
 First cost of water-works: \$75,000.
 Average annual cost of maintenance and repairs: \$600.
 Number of fire-plugs: 4.

SLATINGTON:

Population: 1,634 inhabitants.
 Name of corporation: Slatington Water Company (private).
 Water obtained from: Springs.
 Water first introduced: In 1862.
 Description of main conduit: Length 1½ mile, diameter 4 inches; iron.
 Sizes of distributing mains: 4 and 3 inches.
 Available head: 100 to 150 feet; water-supply deficient in long dry spells in summer.
 Number of water-takers: 150.
 Consumption of water: 50 gallons per head daily.
 First cost of water-works: \$8,000.
 Average annual cost of maintenance and repairs: \$100 to \$200.

STROUDSBURG:

Population: 1,860 inhabitants.
 Name of corporation: Stroudsburg Water Company (private).
 Water obtained from: Springs.
 Water first introduced: October, 1876.
 Description of main conduit: Diameter, 6 inches.
 Discharging capacity: 1,000 gallons per minute.
 Description of distributing reservoir: Capacity, 1,000,000 gallons.
 Sizes of distributing mains: 6, 4, 3, and 2 inches.
 Available head: 135 feet (average); water-supply is deficient; dam is too small.
 Total length of distributing mains: 1 mile.

STROUDSBURG—Continued.

Number of water-takers: 100.
Average cost of maintenance and repairs: \$20 75.
Number of fire-plugs: 15.

SUSQUEHANNA:

Population: 3,467 inhabitants.
Name of corporation: Susquehanna Water Company (private).
Water obtained from: Springs.
Cost of dam: \$300.
Water first introduced: In 1876.
Description of main conduit: $\frac{1}{2}$ mile long, 6 inches diameter; cast iron.
Size of distributing mains: 6 inches.
Available head: 99 feet (average).
Total length of distributing mains: $\frac{1}{2}$ mile.
Number of water-takers: 64.
First cost of water-works: \$5,000.
Average annual cost of maintenance and repairs: Nothing.

TIDLOUTE:

Population: 1,255 inhabitants.
Name of corporation: Tidloute Water Company (private).
Water obtained from: Springs and brooks.
Total area of water-shed available: About 12 square miles.
Capacity of receiving reservoir: 39,200 cubic feet.
Water first introduced: In 1871.
Description of main conduit: Length $3\frac{1}{2}$ miles, diameter 4 inches; cast iron.
Description of distributing reservoir: Capacity, 39,200 cubic feet; constructed of stone on bed of cement.
Sizes of distributing mains: 8 and 4 inches.
Available head: 60 pounds (average).
Total length of distributing mains: $2\frac{1}{2}$ miles.
Number of water-takers: 90.
Consumption of water: 150 gallons per day per head (estimated).
First cost of water-works: \$26,000.
Average annual cost of maintenance and repairs: \$850.
Number of fire-plugs: 13.

TOWANDA:

Population: 3,814 inhabitants.
Name of corporation: Towanda Water-Works (private).
Water obtained from: Springs.
Total area of water-shed available: 5 square miles.
Capacity of receiving reservoir: 750,000 gallons.
Water first introduced: In 1880.
Description of main conduit: Cast iron.
Description of distributing reservoir: Earth bank.
Sizes of distributing mains: 12 to 6 inches.
Available head: 20 to 225 feet.
Total length of distributing mains: About 9 miles.
Filtering system: Sand, gravel, and charcoal; cleaned twice a year.
Number of fire-plugs: 50.

TREMONT:

Population: 1,785 inhabitants.
Name of corporation: The Tremont Water and Gas Company (private).
Water obtained from: Springs and ravines.
Total area of water-shed available: About 6 square miles.
Capacity of receiving reservoirs: 1st, 3,000 gallons; 2d, 18,000 gallons; 3d, 60,000 gallons; 4th, 600,000 gallons; one built in ravine, 3 excavated.
Cost of dam: \$1,600.
Water first introduced: In 1867.
Description of main conduit: Diameters, 6, 4, and 3 inches; cast iron.
Discharging capacity: 100 gallons per minute.
Sizes of distributing mains: 6, 4, and 3 inches.
Available head: 75 feet (average).
Total length of distributing mains: About 12,000 feet.
Number of water-takers: 30.
Consumption of water: 15,000 gallons per day (estimated).

TREMONT—Continued.

First cost of water-works: About \$20,000.
Average annual cost of maintenance and repairs: About \$40.
Number of fire-plugs: 3.

TUNKHANNOCK:

Population: 1,116 inhabitants.
Name of corporation: The Tunkhannock Water Company (private).
Water obtained from: Springs.
Total area of water-shed available: About 200 acres.
Character of dam: The water from five springs in a ravine is impounded by a dam immediately below each spring, making a series of reservoirs at different altitudes.
Cost of dam: About \$150.
Water first introduced: In 1870.
Description of main conduit: Length 675 feet, diameter 8 inches; length 4,050 feet, diameters 4 and 3 inches; cast iron.
Size of distributing mains: 3 inches.
Available head: 125 to 150 feet.
Total length of distributing mains: $4\frac{1}{2}$ miles.
Number of water-takers: 200.
Consumption of water: 5 gallons per head per day (estimated).
First cost of water-works: About \$12,000.
Average annual cost of maintenance and repairs: About \$150.
Number of fire-plugs: 10.

WILKESBARRE:

Population: 23,339 inhabitants.
Name of corporation: Crystal Springs Water Company (private).
Water obtained from: Running streams.
Total area of water-shed available: About 40,000 acres.
Area and capacity of receiving reservoir: 1,100 acres; depth, 5 feet (average).
Cost of dam: \$162,757 66.
Water first introduced: In 1871.
Description of main conduit: 7,632 feet long, 10 inches diameter; 11,494 feet long, 8 inches diameter; 20,038 feet long, 6 inches diameter; 6,040 feet long, 4 inches diameter—cement; 5,652 feet long, 12 inches diameter; 6,408 feet long, 10 inches diameter; 3,000 feet long, 8 inches diameter; 11,200 feet long, 4 inches diameter—iron coated with coal-tar.
Description of distributing reservoir: Area, 11 acres; on very high ground; can supply consumers for 6 months; water runs through rocky bed.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 260 feet (average).
Number of water-takers: 1,100.
First cost of water-works: \$80,000.
Average annual cost of maintenance and repairs: \$800.
Number of fire-plugs: 60.

WILLIAMSPORT (1):

Population: 18,934 inhabitants.
Name of corporation: The Citizen and Gas Company of Williamsport (private).
Water obtained from: Mountain streams.
Total area of water-shed available: About 25 square miles.
Area and capacity of receiving reservoir: 70 by 70 by 8 feet.
Water first introduced: In 1867.
Description of main conduit: 3 miles long, 10 inches diameter; cast iron, coated.
Sizes of distributing mains: 12, 8, 6, 4, and 3 inches.
Available head: About 40 pounds (average).
Total length of distributing mains: About 7 miles.
Number of water-takers: About 800.
First cost of water-works: About \$250,000.
Number of fire-plugs: 50.

WILLIAMSPORT (2):

Population: 18,934 inhabitants.
Name of corporation: Williamsport Water Company (private).
Water obtained from: Mountain springs.
Total area of water-shed available: About 5 square miles.
Capacity of receiving reservoir: 15,000,000 gallons.

WILLIAMSPORT (2)—Continued.

Character of dam: 20 feet high.
 Water first introduced: In 1856.
 Description of main conduit: Diameters, 16 and 8 inches.
 Sizes of distributing mains: 10 to 4 inches.
 Available head: 46 pounds (average).
 Total length of distributing mains: 20 miles.
 Number of water-takers: 1,838.
 First cost of water-works: \$173,000.
 Average annual cost of maintenance and repairs: \$3,500.
 Number of fire-plugs: 120.

RHODE ISLAND.**WESTERLY:**

Population: 6,104 inhabitants.
 Style of corporation: Private.
 Water obtained from: Springs.
 Water first introduced: In 1876.
 Description of distributing reservoir: Size, 12 by 30 feet by 9½ feet deep; built on hillside; fed by springs.
 Sizes of distributing mains: 4 and 3 inches.
 Available head: 30 to 40 feet.
 Total length of distributing mains: 5,000 feet.

UTAH.**LOGAN:**

Population: 3,396 inhabitants.
 Name of corporation: Logan City Water-Works (municipal).
 Water obtained from: Logan river.
 Total area of water-shed available: 130,000 acres.
 Capacity of receiving reservoir: 130 gallons for one district.
 Character and dimensions of dam: Water-supply comes into reservoir through L. and R. Canal Company, which dam is ½ mile from reservoir.
 Cost of dam: \$13,000.
 Water first introduced: September, 1870.
 Description of distributing reservoir: Size 65 feet by 25 feet, 14 feet deep; built of rock laid in cement; 6 large and 2 small compartments. This reservoir is also the settler; water passes through screens, drains at bottom and cleans out sediment.
 Size of distributing mains: 6 inches.
 Available head: 100 to 150 feet.
 Total length of distributing mains: About 2 miles.
 Number of water-takers: 15.
 Consumption of water: 50 gallons per head daily (estimated).
 First cost of water-works: About \$13,000.
 Filtering system: Only screens in reservoir.
 Number of fire-plugs: 11.

SALT LAKE CITY:

Population: 20,768 inhabitants.
 Name of corporation: Salt Lake City Water-Works (municipal).
 Water obtained from: City creek.
 Capacity of receiving reservoirs: 3 small ones; total capacity, 103,350 gallons.
 Character and dimensions of dam: One small one of wood and rock, near the head of flume supplying reservoirs.
 Cost of dam: \$10,000.
 Water first introduced: In 1873.
 Description of main conduit: 269 feet long; 4 feet wide, and 3 feet high; California redwood.
 Discharging capacity: 24,000,000 gallons per day; head 3 feet (average).
 Description of distributing reservoir: Ordinary tank, 28 by 16 feet; 10 feet deep; three compartments for cleaning and repairing.
 Sizes of distributing mains: 20, 18, 10, 6, and 4 inches.
 Available head: 70.01 pounds (average).
 Total length of distributing mains: 10½ miles.
 Number of water-takers: 700.
 Consumption of water: 200,000 gallons per day (estimated).
 First cost of water-works: About \$100,000.

SALT LAKE CITY—Continued.

Average annual cost of maintenance and repairs: Between \$2,000 and \$3,000.
 Filtering system: Ordinary screens, cleaned once a week.
 Number of fire-plugs: 116.

VERMONT.**BELLOWS FALLS:**

Population: 2,229 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Pond.
 Total area of water-shed available: ¼ square mile.
 Character and dimensions of dam: 225 feet long, 3 feet high; earth; trenching and planking across outlet, and filling sides with heavy gravity rails 12 feet wide.
 Cost of dam: \$1,000.
 Water first introduced: In 1849.
 Description of main conduit: 9,440 feet long, 8 inches diameter; cast iron.
 Sizes of distributing mains: 7 and 6 inches.
 Available head: 280 feet (average).
 Total length of distributing mains: 5.56 miles.
 Number of water-takers: 290.
 Consumption of water: 84,000 gallons per day (estimated).
 First cost of water-works: \$10,000.
 Average annual cost of maintenance and repairs: \$400.
 Number of fire-plugs: 33.

BRANDON:

Population: 3,280 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Hitecock pond.
 Total area of water-shed available: 1 mile by ¼ mile.
 Cost of dam: \$500.
 Water first introduced: January, 1879.
 Description of main conduit: 7,000 feet long, 12 inches diameter; 23,465 feet long, 8 inches diameter; 7,853 feet long, 6 inches diameter; 7,938 feet long, 4 inches diameter; cast iron, coated with coal-tar inside and outside.
 Description of distributing reservoir: A lake 1 mile long, ¼ mile wide; pipe enters 10 feet below surface; stone-paved (by nature) with cobble-stones; supplied entirely by springs.
 Sizes of distributing mains: 8, 6, and 4 inches.
 Available head: 150 to 175 feet.
 Total length of distributing mains: 3½ miles.
 Number of water-takers: 125.
 First cost of water-works: About \$40,000.
 Average annual cost of maintenance and repairs: About \$50.

FAIR HAVEN:

Population: 2,211 inhabitants.
 Name of corporation: Fair Haven Water-Works (municipal).
 Water obtained from: Inman pond.
 Area of receiving reservoir: Pond, ¼ mile long, ¼ mile wide; banks of stone, 10 feet above water-line; overflow at one end 10 feet wide.
 Cost of dam: \$10.
 Water first introduced: December, 1880.
 Sizes of distributing mains: 6, 4, and 2 inches.
 Available head: 80 to 100 pounds.
 Total length of distributing mains: About 4 miles.
 Number of water-takers: 65.
 First cost of water-works: \$36,000 or \$37,000.
 Number of fire-plugs: 26.

SAINT ALBANS:

Population: 7,193 inhabitants.
 Name of corporation: Saint Albans Water-Works (municipal).
 Water obtained from: Small streams.
 Total area of water-shed available: 2,000 acres.
 Character and dimensions of dam: 400 feet long, from 1 to 25 feet high; embankment, 2,150 feet long.
 Cost of dam: \$160,000.
 Water first introduced: In 1872.

SAINT ALBANS—Continued.

Description of main conduit: $3\frac{1}{2}$ miles long, 12 inches diameter; wrought iron, cement-lined.
 Description of distributing reservoir: Receiving and distributing reservoirs are the same.
 Sizes of distributing mains: 12 to 3 inches.
 Available head: 60 to 150 feet.
 Total length of distributing mains: 13 miles.
 Number of water-takers: 550.
 Consumption of water: 30 gallons per head daily (estimated).
 First cost of water-works: \$150,000.
 Average annual cost of maintenance and repairs: \$1,500.
 Number of fire-plugs: 54.

VIRGINIA.

UNIVERSITY OF VIRGINIA:

Name of corporation: University of Virginia (state).
 Water obtained from: Reservoir.
 Area and capacity of receiving reservoir: About 12,000,000 gallons.
 Character and dimensions of dams: 100 feet long at top, 40 feet long at bottom, 15 feet high; brick, laid in cement, built across ravine.
 Cost of dam: \$2,218 12.
 Water first introduced: In 1869.
 Description of main conduit: 2 miles long, 4 inches diameter; cast iron.
 Discharging capacity: 60 gallons per minute; head, 70 feet (average).
 Sizes of distributing mains: 3 and 2 inches.
 Available head: 70 feet (average); water-supply sometimes deficient.
 Total length of distributing mains: About $1\frac{1}{4}$ mile.
 Number of water-takers: 18.
 Consumption of water: 20 gallons per head per day (estimated).
 First cost of water-works: \$22,380.
 Filtering apparatus: Strainer, surrounded by brick structure 3 feet square, 10 feet high; well is double, space filled with charcoal; cleaned once in ten years.
 Number of fire-plugs: 6.

WINCHESTER:

Population: 4,958 inhabitants.
 Style of corporation: Municipal.
 Water obtained from: Limestone spring.
 Water first introduced: In 1864.
 Size of distributing mains: 6 inches.
 Available head: 42 feet (average).
 Total length of distributing mains: 20 miles.
 First cost of water-works: \$14,000.
 Average annual cost of maintenance and repairs: \$800 to \$1,000.
 Number of fire-plugs: 24.

WASHINGTON TERRITORY.

WALLA-WALLA:

Population: 3,528 inhabitants.
 Name of corporation: Walla-Walla Water Company (private).
 Water obtained from: Springs.
 Cost of dam: \$5,000.
 Water first introduced: In 1868.
 Description of distributing reservoir: 125 by 75 feet; 9 feet deep.

WALLA-WALLA—Continued.

Sizes of distributing mains: 10 to 4 inches.
 Available head: 20 pounds (average).
 Total length of distributing mains: 23,000 feet.
 Number of water-takers: 175.
 First cost of water-works: \$10,000.

WISCONSIN.

FOND DU LAC:

Population: 13,094 inhabitants.
 Style of corporation: Private.
 Water obtained from: Flowing fountain.
 Water first introduced: In 1840.
 First cost of water-works: From \$100 to \$1,500.

KENOSHA (1):

Population: 5,039 inhabitants.
 Name of corporation: North Side Water Company (private).
 Water obtained from: Artesian wells.
 Water first introduced: December, 1880.
 Description of main conduit: Length $1\frac{1}{4}$ mile, diameters 6 and 4 inches.
 Discharging capacity: 7,000 gallons per minute; head, 55 pounds (average).
 Size of distributing mains: 6 and 4 inches.
 Available head: 30 pounds (average).
 Total length of distributing mains: $1\frac{1}{4}$ mile.
 Number of water-takers: 23.
 Consumption of water: 50,000 gallons per day (estimated).
 First cost of water-works: \$8,000.
 Average annual cost of maintenance and repairs: About \$800.
 Number of fire-plugs: 9.

KENOSHA (2):

Population: 5,039 inhabitants.
 Name of corporation: Park City Water Company (private).
 Water obtained from: Artesian wells.
 Area and capacity of receiving reservoir: Well, 1,368 feet deep, 6 inches bore; 1,500 gallons per minute.
 Water first introduced: June, 1880.
 Sizes of distributing mains: 6 and 4 inches.
 Available head: 100 feet (average).
 Total length of distributing mains: 5 miles.
 Number of water-takers: 230.
 First cost of water-works: \$17,000.
 Average annual cost of maintenance and repairs: About \$1,200.
 Number of fire-plugs: 22.

PRAIRIE DU CHIEN:

Population: 2,777 inhabitants.
 Name of corporation: Prairie du Chien Artesian Well Company (private).
 Water obtained from: Artesian wells.
 Capacity of receiving reservoir: 640 gallons per minute.
 Cost of dam: \$3,000.
 Water first introduced: In 1876.
 Size of distributing mains: 6 inches.
 Available head: 20 to 40 feet; water-supply sometimes deficient.
 Total length of distributing mains: 1,500 feet.
 Number of water-takers: 24.
 First cost of water-works: \$4,500.
 Average annual cost of maintenance and repairs: \$50.
 Number of fire-plugs: 7.