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SPECIAL REPORT

ON THE

# Extension and Enlargement

OF THE

CINCINNATI

# WATER WORKS,

BY T. R. SCOWDEN, C. E.

Published by Order of the Trustees of Water Works.

*Cincinnati, January 1, 1872.*



BLOCH & Co., CITY PRINTERS, 150 WEST FOURTH STREET.

*Resolved*, That the Committee on Law and Claims and Water-works be instructed to examine sites with a view of establishing Water-works, and that they be and are hereby authorized to employ a competent engineer, whose duty it shall be to prepare plats, specifications, profiles and estimates of cost of improvement and all other necessary information, for at least two separate points, which shall be in the State of Ohio, and that the said Committee be instructed to report their action to either of the Boards of Common Council, as soon as such engineer shall have completed *his investigation and surveys*.

The above is a correct copy of the resolution, adopted June 9, 1871.

J. F. BLACKBURN, City Clerk.

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WATER WORKS OFFICE, July 22, 1871.

Copy of resolution passed by the Board of Trustees City Water works, July 22, 1871, as per Minutes of Board.

A resolution from the Committee of Law and Claims and Water-works of the Common Council was received requesting the appointment of T. R. Scowden, Esq., to make surveys, plans and estimates of the proposed extension of the Water-works.

After some discussion on the subject, the following preamble and resolution was adopted.

WHEREAS, In order to complete plans, estimates and specifications of the proposed extension of the Water-works in time to avail ourselves of the refusal of the site offered by Mr. Jacob Markley, and inasmuch as the time of the Superintendent of the Water-works, Mr. Henry Earnshaw, is now and probably will be wholly occupied in the management and erection of the present Works, as also in the construction of the Garden of Eden Reservoir, as to render the employment of an engineer necessary to make surveys, plans and estimates, accompanied by a report to this Board, at as early a day as practicable, and in conformity with a resolution passed by a Committee of the Common Council, July 18, 1871, recommending this Board to appoint T. R. Scowden, Esq., be it therefore

*Resolved*, That T. R. Scowden, Esq., be and is hereby appointed to survey two sites for pumping, etc., on the Ohio side of the river, and report from time to time to this Board during the progress of the work, and complete the same as soon as practicable.

## Engineer's Office of Water Works Extension.

CINCINNATI, January 1, 1872.

### *BOARD OF TRUSTEES:*

GENTLEMEN : Special attention is hereby directed to the copy of proceedings of Council and your Board, to be found on the opposite page, with regard to the appointment of engineer to make surveys and report on two sites for locating Pumping House and Reservoir for extension of the present Water-works.

Immediately following the appointment, surveys, in accordance with the instructions given, were commenced, and when finished, a brief report, of which the following is the substance, was made to your Board :

OFFICE OF NEW WATER-WORKS, }  
CINCINNATI, September 21, 1871. }

In pursuance of the instructions received upon my appointment as Engineer, I have made careful examination and surveys with reference to two sites, on this side of the Ohio River, to locate Pumping House and Reservoir for the extension of the present Water-works.

The first and most desirable site found to locate Works was at a point about ten and one-third miles distant, by the nearest practicable route, from the Garden of Eden Reservoir, or what is known as the Markley Farm.

The examinations and surveys were started where the easterly line of Hamilton County intersects the Ohio River, and were extended along the shore and adjacent hills to the city.

The second, but objectionable, site for Water-works was found some three miles above the Garden of Eden Reservoir,

and about the same distance below the mouth and offensive discharge of the Little Miami River. This location, although favorable in many respects, intercepts the drainage of the upper portion of the city and all of that from the Miami Valley emptied into the Ohio River, which render that site wholly inadmissible for Water-works purposes.

The first location referred to, the best, is a point where the water of the Ohio River is deep and free from drainage or any other vitiating influence to affect its quality, perhaps for a century to come, if ever. The shore is bold, and with the bed of the river, is of gravel and rock formation, washed clean by an active current at all seasons of the year. Pumping Works may be located at this point without any objectionable and expensive Inlet Pipe, while the adjacent hill affords an excellent site for a storage reservoir, three hundred and seven feet above extreme low water and seventy-five feet above the Garden of Eden Reservoir. On the lower level there is a fine plateau for locating not only the Pumping House, but Subsiding Reservoir and Filtering Basins.

The Force Main extending from the Pump House to the Storage Reservoir will be short, or about fourteen hundred and fifty feet long, whereas, Works located on the second site or any other sites examined would require Force Mains several thousand feet in length. By the first site, water from the river would be lifted by the pumps and forced to the Reservoir with the least amount of power, friction and expense of fuel to do the work. This site also commands an excellent and safe landing for boats supplying the Works with coal.

With regard to intermediate points between the County line and the mouth of the Little Miami River, I found the Ohio River lined with the sand bars, some of which projected from the shore nearly to the middle of the river miles in length, while the bottom or bed of the river was for the most part covered with logs and craggy stones. I was told by fishermen, who had spent most their lives along the shore, and by steamboat pilots familiar with the course and channel of the river, that in many of these places the water was formerly deep and navigable for steamers; but from year to year bars had been forming and

making the water more and more shallow. The banks from which these sand bars project, I found to be low and often flooded by the river. Pumping Works could not be built there without involving serious engineering difficulties and consequent cost of construction, which even then would be subject to many contingencies and great expense of operating them when finished, from which Works located at the point selected would be entirely exempt.

I, therefore, regard the first and best site, known as the Markley Farm, as one commanding all the advantages sought, where Works may be erected combining greater simplicity of construction, economy of cost, and maintenance when put in operation than could be built at any of the other points mentioned. I, therefore, respectfully recommend the adoption of that site by your Board, to locate Pumping House and Reservoir for the extension of the present Water-works.

Respectfully submitted,

T. R. SCOWDEN, Engineer.

At a special meeting of the Committee on Law Claims and Water-works, and your Board, called for the purpose of hearing the above report, resolutions were passed requesting the Trustees of Water-works to purchase the Markley Farm for Water-works purposes, which was subsequently authorized by Council. Since then plats and general plan of the Works, illustrated by a map, which, with the estimate of the cost of constructing the New Works, carefully made, have been prepared, and accompany this report.

#### NECESSITY FOR NEW AND ENLARGED WORKS.

In view of the limited and impure supply of water furnished by the present inadequate Water works, as well as of the necessity to provide new and efficient Works, it should be generally known how unreliable the present supply of water is. To make this clear, it is necessary to explain that during the summer months and frequently during the winter months, when the river is low, it is difficult on certain days of the week, with all the available pumping machinery of the Works in operation, to

maintain a constant supply of water. The demand is frequently so great as to nearly drain the Reservoir, and cut off the supply from the city. Should such a contingency arise, which may happen at any time, the critical situation of the city, and disastrous consequences that may follow, are so well understood and appreciated, as to render description unnecessary.

Warned by the fate of Chicago, and pressed by a great public necessity, such as the want of water supply, presents a case and a claim, so manifestly clear and strong, as not to be mistaken or resisted. The timely policy and prudent measures of your Board to provide new and capacious Water-works to meet that want, and thus escape perhaps a terrible calamity, ought to receive the encouragement and firm support of all who take any interest in the welfare and security of the city.

All the cities of any magnitude in the country appear at this time to be awakened to the importance of an abundant and uninterrupted supply of water. New York, Boston, Philadelphia, Baltimore, and various other cities of the East are directing their attention and energies to that end. Water supply or extension of their Works, at a cost variously estimated at from five to ten millions of dollars each, are being projected or are in progress. In the West, St. Louis has taken the lead in erecting new Water-works, recently put in operation, which, when completed, will cost some five millions of dollars. Chicago and Cleveland are making extensive additions to their Water-works, while Pittsburg is preparing to build Works on a large scale for that city. Milwaukee, stimulated by urgent necessity, and the example of other cities, is actively engaged in the same direction.

With respect to Cincinnati, it may be justly said that the present Water-works, though inadequate, are good of their kind; no fault attaches to them, except they have outlived their usefulness, the city has outgrown them. Much can be said, however, of their faithful performance in times past, and of the management in every department for maintaining them as an element of comfort, protection, and great value in developing the growth and general prosperity of the city. But now the varied and multiplied requirements of an increased population

have created a demand they can not supply, hence the necessity for new Works to supercede the old ones, which should be commenced without delay, and pushed forward to completion with all the means and energy at the command of your Board. This is so well understood, that prompt legislation and the cordial support of the citizens will be readily extended. The exigency of the case demands it, for if the wants of all the cities mentioned were estimated by their population, none would be found in a more critical and perilous situation, from scanty supply of water, than Cincinnati.

The consequences of delay are real, not imaginary: they present themselves too forcibly to be mistaken, for should any one or two of the Pumping Engines now in use become disabled, the city would be put on short allowance of water, which would seriously incommode private families, and materially damage the large manufacturing interests at stake. The loss and suffering incident to fire is impossible to estimate or foresee. The whole damage would not end there, for should the remaining Pumping machinery, doubly taxed and strained, become disabled, as the present Reservoir affords no storage, and the consumption of water being great, it would soon be exhausted, and the city would be totally deprived of a supply of water. Such a condition of things, though improbable, is possible, and may doom Cincinnati to a fate no more improbable than that which recently laid a sister city in ashes.

To meet the contingencies mentioned, plans of two new Pumping Engines, made at this office, of capacity to deliver jointly 10,000-000 gallons of water at the Garden of Eden Reservoir in twenty-four hours, to be built and put in operation next summer, will, when brought into use, afford temporary but not permanent relief. When the new Works are put in operation these engines may be transferred to Hunt street, to supply water to Clifton, Mt. Auburn, and other high levels.

Considering the increasing population and consumption of water, it is probable that at the end of three or four years at most, and before new Works could be erected and put in practical operation, the present Works, even with the new auxiliary engines and Eden Reservoir in use, would be again reduced to a

limited and uncertain supply of water, for these auxiliaries meet the immediate demand only.

### QUALITY OF THE WATER SUPPLIED.

Aside from the foregoing considerations, the pressing necessity of a plentiful supply of pure and healthful water, which no pumping facilities attached to the present Works would attain, can not be neglected or overlooked. The water now furnished is rendered foul by the refuse and drainage, together with the filth of privies, washed into the river from the eastern portion of the city, and from Fulton, Pendleton and Columbia, extending to the Little Miami River, to the discharge of which add that of Eggleston Sewer and adjacent eddy, in close proximity to the Water-works, a just conception of the impurity of the present supply may then be formed.

In this connection, I beg leave to quote the following from my late report on Newport Water-works. It will be apparent in view of the continued growth and extension of Newport to Dayton, which at no very distant day will become a consolidated city, densely built, and thickly populated, that Taylor Creek, having its course and branches dotted with manufacturing establishments, will become like what was once Deer Creek at Cincinnati, but now called Eggleston Avenue. I have seen Eggleston Sewer disgorging refuse, consisting of hogs' livers, excrement, and other putrescent matter, which befouled the air with an offensive stench, and discolored the water with blood, for a considerable distance in the river.

There are still other pernicious influences which would operate against and contaminate the supply of water in this regard. It is proper to anticipate results, in so far at least as consolidation of the three places mentioned is concerned, all discharging their offal into the Ohio. Cincinnati is already extended and compactly built, opposite to and beyond Dayton. Still above and beyond that, the Little Miami River enters the Ohio River and contributes largely by its discharges to the general taint and discoloration of the water.

The valley of the Miami forms a water shed of several hundred square miles area. Upon the surface of this vast plain is



deposited the dead carcasses of animals, and the droppings from cattle of all kinds. The ground is covered with decayed vegetable matter, and the soaking of stable yards, hog pens, slaughter-houses, distilleries, stagnant ponds, &c. This refuse is washed off by rain-storms into the Miami, which is the common receptacle and drain for the country, and is carried at times by sudden floods down the stream with such impetuous force, when discharged into the Ohio River, as to almost reach the opposite shore. To this diffusion of filth, add the drainage that will be discharged from Newport when extended, and Cincinnati now reaching out, and will soon extend to the Miami, and also take into consideration, the body of water contained in the Ohio at its lowest stage, when the stream is shallow and confined to narrow limits between the bar on the Kentucky side and the Ohio shore. The current being sluggish, and taking up the discharged refuse, liquid and solid, cast off and washed into the river from all these sources, at a time, too, when the weather is hottest, and the greatest demand is made on Water-works for the supply of a city. It is easy to perceive what the effect would be, and that the Ohio River, between the mouth of the Little Miami River, and the westerly extremity of Cincinnati, already tainted, is destined to become fearfully contaminated, so that any enlightened community would condemn it as a source of supply to a city.

The means lately devised to procure a better supply of water, by extending the Inlet Pipe from the present Works to the channel of the river, was well intended but can not be effectual, because the shore of the river being filled out, and graded to the channel where the Inlet Pipe terminates, the water with all its impurities flowing past must be drawn in and forced by the Pumps to the Reservoir. This improvement, under the circumstances, was the best that could be made, but it is needless to state that the supply continues bad, and from the reasons assigned must be daily growing worse.

The analyses of waters lately taken at the Water-works, and at the Markley Farm, clearly indicate the superior quality, purity and healthfulness of the latter.

## EXTENSION AND ENLARGEMENT OF THE WORKS.

As a preliminary step before any plans were made a thorough investigation of all the important Water-works of the country was instituted. Through the courtesy of the officers and engineers in charge, which I here take pleasure in acknowledging, the object of my visits was much facilitated. I had free access to plans, and the Works built from them, during the different stages of progress, as well as after completion, by which I was enabled to procure the latest improvements in planning the Water-works intended for this city.

So much has been said in the public prints and discussed on the streets with regard to the selection of the Markley Farm as a site for locating the Pumping House and Reservoir for the extension and enlargement of the present Works, that I feel it incumbent upon me to state my reasons for the course I have pursued.

The fact that the land is cheap and the water obtained is pure at Markley Farm, the first site examined, and that the land is dear and water impure below the mouth of the Little Miami, the second site examined, and because the difference of cost of constructing Water works at the different places would be trifling, as may be shown, I selected and recommended that site which would insure the inestimable benefits of a pure and wholesome supply of water. Aside from the cost, which should not weigh against the blessings of pure water and health, and relying on the good counsels and candid judgment of those whose opinion I could respect, as well as in the discharge of a great public trust, I selected the Markley Farm for Water-works purposes. Had I done otherwise with these facts before me, and disregarded my duty as an Engineer, I would have deserved the censure and just indignation of the whole community.

It has been suggested that the offal from one or more distilleries, said to be in operation at New Richmond, some ten miles above the Markley Farm, would leave its taint in the water reaching the latter point. My answer is, that in this case the river so slightly affected at New Richmond, and flowing ten miles to reach the Markley Farm, would, from agitation and di-

lution, and from the well-known self-purifying property of water, become pure.

Bearing directly upon the question, and applying to the water of the Miami, it is stated by unquestionable authority that discoveries in Pneumatic Chemistry have failed to reveal any infection, malarious or poisonous, known to exist in the air, so, also has science failed to discover the presence of malaria in water. It has been ascertained, however, by actual observation, that the greatest quantity of organic matter contained in the air is over stagnant pools, with which the Miami Valley abounds, and which is known to be the prolific cause of intermittent fever, ague, and other malignant diseases which prevail in districts where stagnant water is found.

The malaria from these sources arises from the exhalation of the water; how, then, can water from which such poisons emanate, be fit to drink, or use for the supply of a city? That question does not admit of argument.

The water of the Miami has long been known by the residents along its course, for the reasons given, to be unfit for drinking and culinary purposes, but only fit for mill power, manufacturing purposes, and for cattle to drink.

With respect to water of bad quality from any source, to people of refined tastes, and habits of cleanliness, it is not only repulsive, but to them disease and mortality are so intimately associated with it, and so easily traceable to it, that it is difficult, if not impossible, to divest their minds of the relationship. It is a cause to which the highest medical authority attributes so many virulent and unmanageable diseases, to which pure water is an antidote, hence the necessity of establishing Water-works free from such influences becomes indispensable.

It is only necessary first to disease the water, then disease the man, and it is clear, therefore, that Water-works located below the Miami, would, by wholesale pollution, disease the whole community.

There is no city in the civilized world so regardless of the cleanliness and health of its citizens, as to adopt a plan of water supply to foist upon them the concentrated filth from sewerage and the impurities of a stream, the water of which is only fit for

mill power, manufacturing purposes, and for cattle to drink, and I did not think that Cincinnati was emulous of setting the example.

I was not appointed by your Board as Engineer to select and report upon any designated location or plan of Water-works. If I had been, my course would have been a plain one; but I was informed that you had no preference for places or persons, although you and your Superintendent had examined and approved of the Markley Farm, still there were the sources of supply and surrounding heights that you wished me to make careful examinations, surveys and estimates of cost, and select the very best site, and recommend the best plan of Water-works, calculated to insure the city of Cincinnati a plentiful and unfailling supply of pure and healthful water.

Acting under these directions, I have been influenced by no other motive in the selection of the Markley Farm but what appeared my plain duty to do, and what I had reason to believe would be endorsed by your Board, and every disinterested and impartial man.

As an Engineer, what I have done in planning and constructing Water-works is before the world. It does not become me to speak of their merits; I may, however, with propriety say, if the plans of Water-works I have recommended be adopted and permitted to progress, I am confident they will produce Works when finished equally as successful and cheap as any I have built, and, I trust, will be unsurpassed by any in the country.

#### GENERAL DESCRIPTION OF THE WORKS.

The Pumping House for these Water-works will be located at the shore of the river, so that the water will flow without an Inlet Pipe directly to the Pump Basin within. The foundation of the house will be of stone, arranged to support the pumping machinery, and will be provided with gates to let in and turn off water from the river at pleasure. The superstructure will be spacious and commodious; it will be built principally of brick, stone and iron, so as to be proof against fire.

### PUMPING ENGINES.

There will be six Pumping Engines, three of them direct action and condensing for low service, each to be of capacity to lift twenty million gallons of water from the river and deliver it through a Feed Pipe, sixty inches diameter, four thousand five hundred and fifty feet long, at the Subsiding Reservoir in twenty-four hours. The Pumping Engines for high service, each of the same capacity as the former, will be of the kind known as Combination or Duplex, also condensing. They will be supplied with water from the Subsiding Reservoir or Filter Basin, as the case may be, and force it to the Storage Reservoir. One engine for low service and one for high service will be kept in reserve for repairs and contingencies. The pumping capacity of the Works for daily service, using two engines of each class—that is to say, two engines for low service and two for high service, will be forty million gallons of water delivered at the Storage Reservoir in twenty-four hours, and the total capacity, should any emergency arise to bring the reserve engines in requisition, sixty million gallons in twenty-four hours. For many years to come all the pumping for the supply of the city may be done by daylight.

### FORCING MAINS.

There will be three cast iron Forcing Mains, each forty-six inches diameter, 1,450 feet long, to connect with the high service engines, to deliver the water at the Reservoir.

### SUBSIDING RESERVOIR.

The grounds for the Subsiding or low service Reservoir embraces fifty acres of bottom land and 2,500 feet of river front. The Reservoir will be situated near the bank, some 3,500 feet lower down the river than the Pumping House, and will be built of earth, and be divided into four compartments, twenty-five feet deep, lined with concrete or stone. Each compartment or settling basin will contain 25,000,000 gallons of water when filled to a depth of twenty feet. The water will be drawn but from one basin at a time, the other three will be kept full and the water

drawn from the adjoining one in turn, as the subsidence goes on, and the water becomes clear, and so on in regular succession.

The surface of the water in the settling basin, when full, will be 100 feet above extreme low water in the river. At one end of the 60 inch Feed Pipe there will be three cast iron branch-pipes, forty-six inch diameter and 150 feet long; one end of each branch-pipe will connect with the Feed Pipe, the other with one of the pumps. At the other end of the Feed Pipe there will be four cast iron branch-pipes of the same diameter, but longer than the former. The connection between the Feed Pipe and each settling basin will be effected in the same manner as between the Feed Pipe and pumps at the opposite end. Every branch-pipe will be provided with a stop gate to close or open the communication between the Feed Pipe and pumps or the settling basin, as occasion requires.

Substantial water-tight sluice gates will be provided to let out the deposit from each settling basin, which will be discharged through a connecting culvert into the river and washed away by the current.

The water rendered clear in the settling basin, will be drawn off through similar branch pipes to those already described, to a brick conduit, extending from the Subsiding Reservoir to a clear water well, near the Pumping House. From this well, the clear water flows to the basin within the house where it is taken up by the high service engines, and forced to the Storage Reservoir.

When the consumption of water in the city reaches nearly that supplied by two pumping engines, running day and night, the rapid transit of the water from the river through the pumps and Subsiding Reservoir to the Storage Reservoir will be such as to leave no time for subsidence and clarification; percolation through sand and gravel beds, under a thorough system of filtration, will then become necessary. The water will be conveyed from the Subsiding Reservoir to the Filter Basin as provided, and will appear in the accompanying map. After filtration, the water will pass into the clear water well, and be pumped to the Storage Reservoir as before.

### STORAGE RESERVOIR.

The grounds for the Storage or high service Reservoir embrace one hundred and fifty acres and nearly two thousand feet of river front. The reservoir will be located on the summit of the adjacent hill, overlooking the river and Pumping House. The top of the hill forms a natural basin, with a single outlet or gap in the hill side; by simply closing the gap with earth compactly and imperviously laid, will form a Reservoir, when properly shaped and finished, of 300,000,000 gallons capacity.

From the Pumping Works to the Reservoir, the slope is regular and favorable for laying the Force Mains.

The surface of the water in the Storage Reservoir when full will be three hundred and seven feet above extreme low water in the Ohio River, and seventy-five feet above high water line at the Garden of Eden Reservoir.

The crest of the hill in front of the Reservoir, and every portion of the summit commands a fine view of the Ohio River and valley of many miles extent. The grounds are susceptible of a high state of landscape cultivation, and at moderate cost, may be made with the surroundings and natural beauties, a very ornamental and attractive place.

There will be three Influent Pipes, and the same number of Effluent Pipes, two of the latter at the start will extend from the Storage Reservoir to the city. The remaining one will terminate outside the Reservoir to be brought in requisition for future use, when the necessities for increased water supply may require it.

### SUPPLY MAINS.

There will be two Supply Mains, forty-two inch diameter, ten and one-third miles long, extending from the Storage Reservoir at the Markley Farm, to the Garden of Eden Reservoir in the city.

These two lines of Supply Mains have been adopted, instead of one large one capable of the same delivery of water in a given time, so that in the event of accident to one of the two lines, a partail supply of water to the city would be maintained, while repairs were being made to the other line, whereas with a single

large line, the supply of water, in the event of accident to it, would be entirely cut off from the city.

The course of the two lines of mains or pipes, taking their rise in the Reservoir, will be along the slopes of the hill down to the turnpike, thence along the turnpike to California, where they will diverge slightly to the south and extend along the bottom lands, to and under the Miami River, and nearly parallel with the Ohio River until they intersect the pike again; following the pike for a short distance they will diverge slightly to the north, and extend through Columbia, Pendleton, and eastern portion of the city, and terminate at the Garden of Eden Reservoir, where the water conveyed from the Storage Reservoir will be delivered for general distribution and use.



## COST OF WATER WORKS

FOR THE

## CITY OF CINCINNATI.

## ENGINE HOUSE AND GROUNDS.

For Real Estate, 10 acres, part of the Markley Farm.....	\$150 00	\$1,500 00	
For Earth excavation, 21,500 cubic yards .....	40	8,600 00	
For Rock excavation, 3,520 cubic yards.....	2 00	7,040 00	
For Coffor Dam of earth and stone, 350 feet lineal	10 00	3,500 00	
For Stone Foundations, laid in cement, 14,750 cubic yards.....	9 00	132,750 00	
For Brick Superstructure (fire-proof) chimney stacks, etc.....		152,000 00	
For extra labor, hauling and handling.....		5,000 00	
For 1,600 feet of inclosing fence, wood pickets, painted and sanded.....	1 50	2,400 00	
			\$312,790 00

## PUMPING ENGINES.

Three condensing direct action Pumping Engines, for low service .....	\$115,000 00	\$345,000 00	
Three condensing duplex or combination Engines, for high service.....	135,000 00	405,000 00	
			\$750,000 00

## FORCE MAINS.

Line No. 1, for high service, 46" diam. and 1/4" thick, 1,450 feet long = 435 tons.....	\$56 00	\$24,360 00	
Delivery and laying same.....	10 00	4,350 00	
Line No. 2, 1,450 feet long = 435 tons.....	56 00	24,360 00	
Delivery and laying same.....	10 00	4,350 00	
Line No. 3, 1,450 feet long = 435 tons.....	56 00	24,360 00	
Delivery and laying same.....	10 00	4,350 00	
For three 46 in. check valves, for high service.....	1,000 00	3,000 00	
For three 46 in. check valves, for low service.....	1,000 00	3,000 00	
			\$92,130 00

## STORAGE RESERVOIR.

For Real Estate, 140 acres .....	\$150 00	\$21,000 00	
For Mucking reservoir area, 96,777 cubic yards...	35	33,871 95	
For Retaining Embankments, puddled, 281,000 cubic yards.....	55	154,550 00	
For Stone Masonry, rock face, 750 cubic yards....	9 00	6,750 00	
For 198,440 sup. yards concrete, 6 in. thick.....	1 00	198,440 00	
For Brick Masonry, hard burnt brick laid, 20,000		280 00	
For Turfing reservoir embankments, 62,000 sup. yards .....	20	12,400 00	
For Gravel walks, 4,700 sup. yards, 6 in. thick....	40	1,880 00	
For Macadamizing in roadway 21,000 sup. yards, 1 foot thick.....	50	10,500 00	
For Iron fencing, to inclose reservoir basin, 6,850 feet lineal.....	2 50	17,125 00	
For two lines, 42 in. pipe, 525 feet extra, for future use, 262 1/2 tons.....	55 00	14,437 50	
For Delivery and laying same, per ton.....	10 00	2,625 00	
For two lines, 24 in. sluice pipe, 500 feet = 125 tons .....	56 00	7,000 00	
For Delivery and laying same per ton.....	10 00	1,250 00	
For two stop gates for same.....	500 00	1,000 00	
For one line, 24 in. waste pipe, 350 feet = 35 tons	56 00	1,960 00	
For four effluent chambers, coping and strainers.	750 00	3,000 00	
			\$488,069 45
Amount carried forward.....			\$1,642,989 45

## COST OF WATER WORKS.—CONTINUED.

## STORAGE RESERVOIR.—CONTINUED.

Amount brought forward.....			\$1,642,989 45
For 7 stop gates, 42 in. Water ways.....	\$750 00	5,250 00	
For front fence 3,540 feet wood pickets, sanded...	1 50	5,490 00	
For 13,500 feet lineal rear fence, painted and sanded.....	1 50	20,250 00	
Tenement for reservoir keeper.....		2,500 00	33,460 00

## SUBSIDING RESERVOIR.

For Real Estate, 50 acres.....	\$200 00	\$10,000 00	
For Muck removed, 89,000 cubic yards.....	30	26,700 00	
For Reservoir Embankments, puddled, 232,500 cubic yards.....	40	93,000 00	
For concrete lining, 94,656 superficial yards.....	1 00	94,656 00	
For Masonry of stone, 2,400 cubic yards.....	9 00	21,600 00	
For Masonry of brick, 180,000 laid.....	14 00	2,520 00	
For Sod on Reservoir Embankments, 34,740 suppl. yards.....	20	6,948 00	
For Gravel walk on summit, 1,500 suppl. yards....	40	600 00	
For Flight of iron steps on Embankment slope.....		970 00	
For Iron fence on summit, 2,144 feet lineal.....	2 50	5,360 00	
For Feed Pipe, from low service engine to settling basins, 60 inch diameter, 4,550 feet long = 1,638 tons.....	56 00	91,728 00	
For Delivery and laying same per ton.....	10 00	16,380 00	
For Four influent pipes to supply unsettled water to subsiding basins, 46 in. diam., 250 feet = 240 tons.....	56 00	13,440 00	
For Delivery and laying same per ton.....	10 00	2,600 00	
For Four stop gates, 46 in. Water ways.....	650 00	2,600 00	
For Clear water, conduit 5 x 8 feet of brick to connect settling basins with clear water well 4,500 feet lineal.....	24 00	108,000 00	
For Four effluent pipes, 46 in. diam., to connect clear water conduit with settling basins, 250 feet = 240 tons.....	56 00	13,440 00	
For Delivery and laying same per ton.....	10 00	2,400 00	
For Four stop gates, 46 in. water way.....	650 00	2,600 00	
For Four discharge culverts to draw off deposit from settling basins, 60 in. diam., 250 feet long = 360 tons.....	56 00	20,160 00	
For Delivery and laying same.....	10 00	3,600 00	
For Metal sluice gate.....	1,200 00	4,800 00	
For Macadamizing Roadway, 6,000 suppl. yards...	40	2,400 00	
For Rip Rap to protect River Slope, 1,000 cubic yards.....	3 00	3,000 00	
For Wood picket fence, painted and sanded for inclosing the grounds, 5,000 feet lineal.....	1 50	8,250 00	
Tenement for Reservoir keeper.....		2,500 00	560,252 00

## CLEAR WATER WELL.

For Earth excavation, 1,956 cubic yards.....	\$ 40	\$782 40	
For Concrete, 6 inch thick, 294 suppl. yards.....	1 00	294 00	
For Masonry, brick laid in cement, 220,000.....	14 00	3,080 00	
For Stone curbing, 642 feet.....	60	385 20	
For three supply pipes, 50 in. diam., 120 feet long to connect clear Water well, with high service engines, 108 tons.....	56 00	6,048 00	
For Delivery and laying same per ton.....	10 00	1,080 00	
For three stop gates, 50 inch Water way.....	1,000 00	3,000 00	
			14,669 60
Amount carried forward.....			\$2,251,371 05

## COST OF WATER WORKS.—CONTINUED.

Amount brought forward.....		\$2,251,371 05
<b>PRINCIPAL SUPPLY MAIN.</b>		
For first line of Supply Main, 42 in. diam., 10 miles, 1,814 feet to connect storage, with distributing reservoir, 13,654 tons.....	\$56 00	\$764,624 00
For Delivery and laying same per ton.....	10 00	136,540 00
For five stop gates, 42 inch water way.....	650 00	3,250 00
For Duplicate Line of Supply Main, 13,654 tons..	56 00	764,624 00
For Delivery and laying same per ton.....	10 00	136,540 00
For Five stop gates, 42 in. water way.....	650 00	3,250 00
For Ten air, crocks and boxes.....	25 00	250 00
For Five 16 inch blow off valves and boxes.....	400 00	2,000 00
		1,811,078 00
<b>MISCELLANEOUS.</b>		
For right of way and land damages.....	\$50,000 00	
For Brick Tenement and Office for Engineer in charge of Works.....	5,000 00	
For two Brick Tenement for Engineers in charge of Engines..	5,000 00	
For two Brick Tenements for operatives at Engines.....	3,500 00	
For Implements and outfit for Engine House and Machinery	5,000 00	
For Subsidizing River.....	500 00	
For Storage River.....	500 00	
		69,500 00
For contingencies add ten per cent.....		\$4,131,949 05
		413,194 90
Total cost.....		\$4,545,143 95
<b>RECAPITULATION.</b>		
For Engine, House and Grounds.....	\$312,790 00	
For Pumping Engines.....	750,000 00	
For Force Mains.....	92,130 00	
For Storage Reservoir.....	521,529 45	
For Subsidizing Reservoir.....	560,252 00	
For Clear Water Well.....	14,669 60	
For Principal Supply Main.....	1,811,078 00	
Miscellaneous expenses.....	69,500 00	
		4,131,949 05
Add ten per cent.....		413,194 90
Total cost.....		\$4,545,143 95