Charles H. Ritchie
Pittsburgh 1871

PRELIMINARY REPORT

WITH REFERENCE TO EXTENSION OF THE

New Pittsburgh Water Works,

BY

W.M MILNOR ROBERTS,

CONSULTING ENGINEER.

1870-1881

AS MADE TO WATER EXTENSION COMMITTEE OF COUNCILS.

WITH

ACCOMPANYING PAPERS.

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1869.

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In Councils, March 10, 1868, it was

"*Resolved*, That a Committee of Five, two from the Select and three from the Common Council, be appointed in accordance with the recommendation of the Water Committee in their last annual report, to investigate and report upon the feasibility and expense of procuring pure water from the Allegheny or other streams, together with such other matters as may properly come within the scope of such a committee." Read three times and passed. Messrs. Brown and Shipton appointed on the part of Select Council, and Messrs. Herron, Scott and Weldon appointed on the part of the Common Council.

In Councils, December 17, 1868, Report presented by W. R. Brown, Esq., chairman, read and,

Ordered that one thousand copies be printed in pamphlet form.

REPORT

OF

WATER EXTENSION COMMITTEE.

To the Select and Common Councils of the City of Pittsburgh.

Gentlemen:—The Water Extension Committee herewith present the Report of W. Milnor Roberts, Esq., Consulting Engineer, dated December 12, 1868, relative to the surveys made by him with a view of obtaining decided and reliable data to guide in the selection of a new water works site, basins, &c. Also, containing much valuable information and observations touching the same matter; which report we recommend to be printed in pamphlet form, and ask your early consideration of its highly important suggestions and recommendations.

W. R. BROWN,
JOHN SHIPTON,
R. G. HERRON,
J. G. WELDON,
A. SCOTT.

December 16, 1868.

PRELIMINARY REPORT

OF

W. MILNOR ROBERTS, Consulting Engineer,

On the Subject of the Proposed New Water Works

FOR THE

CITY OF PITTSBURGH.

To Messrs. W. R. Brown, John Shipton, J. G. Weldon, Andrew Scott and R. G. Herron, Water Extension Committee of Councils:

GENTLEMEN:—Late last summer at the request of your committee I accompanied them, in company with some of the members of the city councils, the city engineer, superintendent of the water works, and other gentlemen, on an examination of the site of Fort Herron, in view of its adaptability as a place for a high reservoir; and afterwards, in company with most of the above gentlemen, joined in a preliminary examination of the Allegheny river from a point about ten miles up, down to Sharpsburg.

After several informal interviews with members of the committee I addressed a letter to the chairman, W. R. Brown, Esq., which was read at a regular meeting of the committee on the 12th day of September, on which occasion I attended. At that meeting, as your consulting engineer, I was authorized by the committee to organize a party of engineers to make such surveys as I might deem necessary to enable me to present my views upon the whole subject of the future supply of an abundance of wholesome water for the city.

I accordingly organized a corps, with Mr. Thos. S. Russell in charge as assistant engineer, and the party commenced the survey on the 28th of September. The services of a special party were needed to ascertain the elevations and distances along the rivers and tributary streams, and of the irregular ground between the two rivers, so as to connect them with existing surveys of the old city and with the works now in use, including the upper and lower city basins or reservoirs, and the system of pipes already in operation and in course of extension.

This duty has been carefully performed to a certain extent. The maps and profiles of the lines traced are in part finished, and sufficient data have been obtained in various ways to enable me to offer a preliminary report.

The survey was begun at the lower engine house at the river, and the levels were carried up to the lower basin, thence to the upper basin, thence out Webster street to Erin, along Erin to Centre Avenue, and out Centre Avenue to Fort Herron, obtaining the topography of the hill by contour lines traced at intervals of ten feet difference of level for seventy feet below its summit. We find the extreme summit of Fort Herron to be 564 feet above the Allegheny river. The line was continued from Fort Herron to East Liberty; the dividing ground in East Liberty between the head waters of Negley's Run and Yellow Run is 428 feet above the river. Another line was run from the old engine house up the Allegheny river as far as Plum Creek, a distance of $10\frac{65}{100}$ miles. This may be considered as a base line, from which several branch lines were traced, namely: up Negley's Run, up Shade's Run, and up Sandy Creek to their sources; all of which were connected by transit and level with the line traced from the old upper reservoir, passing through East Liberty, and presenting a continuous series of profiles which will always be available and useful in connection with any high service reservoir system that may be adopted. Previous to the beginning and during the progress of these surveys, I visited the ground and observed the general topography between the two rivers, which presents a hilly aspect generally, and in many places remarkably

picturesque features, which in numerous instances are occupied by magnificent mansions and highly ornamented grounds. Assisted by the well trained boat crew of the United States Steamer Tidioute, I made careful observations and soundings, and took a number of cross-sections of the Allegheny river between Sandy Creek and the old water works, at a time when the water was within about two feet of its lowest stage, under favorable circumstances. The comparison of the data thus obtained in connection with the elevations and distances along the Allegheny and its Kiskiminitis tributary, and along the Monongahela and its Youghiogheny tributary, together with my previous personal knowledge of all these streams, enable me to offer some preliminary views, although a full report in detail will necessarily require more time and labor.

GENERAL VIEWS.

Experience in a majority of our American cities has shown that the increase of population has been more rapid than even the most sanguine calculators had anticipated, and that the demand for water for private and public uses has been proportionally greater than the augmented population. One consequence of this has been inadequate water provision for their future growth and requirements. It is true that even if we were sure that the city of Pittsburgh would within thirty years contain a million of inhabitants to be supplied with water, it would not be the duty of the present generation to pay the cost of erecting at this time works capable of supplying the wants of so large a number; but experience in other cities admonishes us of the propriety, and perhaps necessity, of looking forward to a much greater demand than the present, and of providing in an efficient manner for the additional requirements, as far as this may be accomplished, in planning new works without taxing too much the present population. At this time this great industrial region, at the head of the Ohio river, is divided into several distinct municipalities, each of which has been procuring water, or dispensing with proper wa-

ter supply, as the case may be, in an independent manner. Thus the water supply of Allegheny City, with a population assumed to be about 60,000, has no connection whatever with the supply for the city of Pittsburgh proper; and neither of these municipalities furnishes water to Birmingham, South Pittsburgh, East Liberty, &c., all of which to the eye of a stranger would appear but parts of one city.

Recently Lawrenceville, East Liberty, Oakland, and other suburban districts have become consolidated with Pittsburgh proper, and now constitute a part of the same, and main water pipes have been extended outside of the old city limits into Lawrenceville and Oakland during the present season, thus adding considerably to the area to be supplied from the old city water works.

The day may not be distant when the municipality of Pittsburgh will include Allegheny, Manchester and all the other separate municipalities and adjacent suburbs. Even if separate governments should long be maintained on the two sides of the Allegheny river, the same source of water supply might be advantageously employed for all.

If the city of Pittsburgh, by judicious arrangements, shall succeed in obtaining an abundant supply of purer water than can now be procured in the city of Allegheny, and the other separate districts referred to, it is but reasonable to anticipate that the inhabitants of those places will desire to partake of the same. It is obvious that if the supply should be ample for all, that it would only involve the cost of laying mains across the Allegheny and Monongahela rivers to introduce the water from the same principal reservoirs into the districts across those streams. It would therefore seem to be no more than ordinary prudence to anticipate that within a reasonable future the entire population that may be concentrated around the head of the Ohio could be most advantageously and economically supplied with water from the same source and through one general system. In round numbers the population now included in the districts requiring a supply of pure water may be assumed at two hundred thousand. An increase of but five per cent. per annum on each year over the

previous year gives a population in 1877, or only eight years, of three hundred and ten thousand eight hundred, and in 1887, or only eighteen years hence, something over five hundred thousand. Five per cent. annual increase, as above, doubles the population in about fourteen years. These figures are not here offered as an estimate to be relied upon of the future population of Pittsburgh; it may prove to be more or it may be less. They are presented merely to show that if this favored point continues to thrive as it has in the past and as other eastern cities are thriving, that within a very brief period, in the life of a city, the population to be supplied will be more than half a million. It is not then unreasonable to assume that within the next quarter of a century, or certainly before the expiration of the present century it may exceed half a million.

It is to be considered also in this connection that owing to the peculiar characteristics of the place, a larger supply of water, per capita, is required than would be sufficient in many other localities. Bituminous coal is the fuel universally used for all purposes; and Pittsburgh is and must always be eminently a manufacturing city, consuming in consequence an unusual quantity of water. At present in round numbers over seven millions of gallons daily are used in the city of Pittsburgh proper, embracing a population of about one hundred and twenty thousand. This gives about sixty gallons per capita daily; a quantity double of that assumed a few years ago as the probable requirement of the city of Brooklyn; and this is the case now with an incomplete sewerage, which when perfected, as it must be in time, will of course cause an additional draught upon the water supply. The fact is that modern sanitary arrangements in our large cities are very properly of such a nature that what was formerly regarded as only a luxury has now come to be a necessity, so that an abundant supply of water can by no means be dispensed with without serious injury to the relative standing, the reputation and the actual health of a dense population.

These views and others which can readily be adduced, have led me to estimate the probable future water demands of Pitts-

burgh at a full supply for half a million of inhabitants, consuming at the rate of not less than sixty gallons each daily, requiring a daily supply of thirty millions of gallons. This is about four times the present consumption in the city proper.

It is not necessary or expedient to erect at this time all the works adequate to supply this quantity; but it might exhibit a want of proper foresight to enter upon any system which would not, without extraordinary extra expense, admit of enlargement so as to readily command the quantity above assumed.

These considerations have also a direct bearing upon the plan proper to be recommended, for the cost of the water supply upon different plans must of course be materially affected by the total quantity to be furnished. Thus, in certain cases, a natural flow of water through a conduit, requiring no pumping engines, if only a small quantity were needed, might be the best and cheapest system, but which in the case of a much larger quantity might be so costly as to be inadmissable.

Calculations might also show that for a very much larger population, two millions of people for example, it might be cheaper and better to procure their supply through a natural flow even from distant sources in preference to pumping from streams just at hand. In the case of the Croton Aqueduct, forty miles in length, constructed for the supply of the city of New York, although it cost in round numbers over twenty millions of dollars, there can be no question respecting its propriety; and although that work was deemed to be ample for many years, the city has already attained to a size which already needs it all, and which must soon have more than that great aqueduct can furnish.

SUPPLY BY NATURAL FLOW.

In regard to a supply by natural flowage, which would render pumping unnecessary, it may be assumed that the minor streams in the immediate vicinity are too small during the summer and fall months to afford a natural supply to be relied

upon; and if they should be chosen it would involve the construction of extensive reservoirs at a great elevation above the river level, in order to command the high grounds, four hundred feet or more above the river, upon which much of the future city must be built. It would be necessary in such case to provide reservoirs capable of containing a supply for at least half the year; or, say for 180 days, which at 30,000,000 gallons per day, the quantity before assumed, would be 5,400,000,000 gallons, which, allowing 7½ gallons per cubic foot, gives 720,000,000 cubic feet. This would require 827 acres of reservoir having an available depth of 20 feet. Allowing 14 inches out of 36 inches, the annual rain fall in this vicinity, to be available for actual use, it would consume the available drainage of 13,784 acres—equal to 21 square miles area of territory. We know that the rain fall of twenty-one square miles of territory between the two rivers might be stored in reservoirs, but not at a height that would command the high grounds of the city; so that if this plan of *collecting reservoirs* were adopted it would still involve the cost of pumping from a low distributing reservoir or reservoirs to a high service reservoir or reservoirs. No detailed examinations on the ground in connection with this plan have been made; there has not been sufficient time or engineering force to do it, and it may not be deemed necessary. We know that for a reservoir sufficiently elevated to supply the high grounds of East Liberty and Oakland and intermediate places between them, and between them and the old city, there is not sufficient area high enough without going a great distance.

Such a system might be admissable and expedient if the great rivers Allegheny and Monongahela were less convenient

Leaving the further present consideration of a natural flow supply from the minor streams in the immediate vicinity, we may now refer to the two great rivers and their main tributaries, in view of that system.

First, as to the MONONGAHELA.—This stream, while it is peculiarly advantageous for the main purpose to which it has been rendered subservient, namely: an artificial slackwater navigation, is ill adapted as a means of furnishing a natural flow to

reservoirs for supplying Pittsburgh. In the distance of ninety miles from the State line of West Virginia to its mouth at the City Point, it falls only 90 feet, so that it is practically unavailable for the purpose proposed.

Its main tributary, the Youghiogheny, is somewhat better adapted to the purpose, having more fall; but at the distance of 76 miles it is only 491 feet above the river level at Pittsburgh.

In order to secure a supply by natural flow it would require the construction of a conduit about 80 miles in length of a very costly character, on either of two plans for conveying the water—either by a "high-grade" gradually descending canal or conduit, or by iron pipes strong enough to resist very extraordinary pressure, such as would occur in the low valleys, and large enough to carry the quantity required. The cost by pipes would probably be $15,000,000 or more.

The Allegheny river has much more fall than the Monongahela, but to attain heighth enough to afford a natural flow to the high service reservoirs, we should be obliged to tap it more than 150 miles above the city; and the water would have to be conveyed at great cost in one of the two ways just mentioned.

Its tributary, the Kiskiminitis, including 28 miles of the Allegheny river, has a fall of only 225 feet in 74 miles (about 3 feet per mile,) between Blairsville and Pittsburgh; the fall from Johnstown to Pittsburgh a distance of 104 miles—is only 474 feet or 4½ feet per mile. But as the proposed high service reservoir would be not less than five hundred feet above the river level, even if the streams were tapped at Johnstown, (where it is called the Conemaugh river,) it could only be available at Pittsburgh for a lower or middle height reservoir, while the enormous cost of conveying the water a distance of more than one hundred miles would not now be warranted by the circumstances of the problem.

It would appear therefore that only some imperative necessity should compel the citizens of Pittsburgh at this time to look to these far off sources, seeing that they must unavoidably involve a much greater expenditure than is required to

obtain the requisite supply of wholesome water from abundant, never-failing sources much nearer to the city—almost or quite within its present limits.

We have the two rivers, the Allegheny and the Monongahela, between which Pittsburgh stands, from which to choose. At present the city is wholly supplied by water taken from the Allegheny river, at the old city water works, which, when they were originally located, 39 years ago, stood above most of the city drainage, and at that day had no hurtful manufactories situated on the stream to contaminate the water. Now a very considerable amount of city drainage, embracing a length of nearly three miles of dense population, empties into the stream above the old water works on the same side of the river, and there are numerous oil refineries, &c. scattered along the shore constantly throwing into the stream large quantities of refuse, which in low stages injuriously affect the water. The Monongahela river has since that day been converted into an important slackwater, steamboat and coal boat navigation, and in low stages its pools are drawn down so that at times there is no flow over the wiers of the dams—all excepting the leakage being used for navigation purposes in passing vessels through the large locks. At all times excepting in very low stages the waters of the Monongahela are more subject to alluvial impurities than are those of the Allegheny. The question originally, as to which river was preferable for a supply of water for the city, was doubtless correctly determined when the works were first located. The Allegheny river was chosen because its water is clearer during a much longer portion of the year; and because its water was and is, when not artificially contaminated, remarkable for its purity and its admirable culinary properties, being sufficiently soft, and every way excellent. To obtain this water in its purity is now an important desideratum; and my examinations lead me to believe that this can be accomplished without going more than eight miles above the present water works.

I would not recommend any point below Negley's run as in all respects a fitting place for taking the water from the river; first, on account of the number of refineries, &c., below

enters the river below Shade's Run, but chiefly at and below Negley's Run, which, as already stated, is about one and a fourth miles below Shade's Run, and $6\frac{12}{100}$ miles above the water works.

It is to be considered that the quantity of water which flows in the Allegheny river, even in its very lowest stage, is so considerable that no trifling amount of deleterious substances would affect it perceptibly. In ordinary low water the flow is not less than one hundred thousand cubic feet per minute, and in an extremely low stage, such as occurs only once in ten or more years there are about eighty thousand cubic feet; or, taking the lowest quantity, six hundred thousand gallons per minute. This gives a volume of eight hundred and sixty-four millions of gallons per day; so that in a single day in the low stages of the river, the flow in the Allegheny is sufficient to supply the city, at the rate of thirty millions of gallons per twenty-four hours, for nearly twenty-nine days; and generally in ordinary stages or moderately low water, the quantity flowing is nearly double of that minimum amount. Putting the present daily supply required by the city at seven millions of gallons, the minimum flow of one day above referred to, would be sufficient for one hundred and twenty-three days present consumption. These figures are given chiefly for the purpose of showing the abundance of the Allegheny waters as a source for supplying a future city of any extent that could reasonably be anticipated at the head of the Ohio.

The Monongahela river is quite different in this important respect; for in extremely low stages most of its tributaries below the West Virginia line become entirely dry at their mouths, and the quantity of water flowing in the main stream, therefore, becomes less below than it is above, owing to evaporation.

The drainage area of the Monongahela and its tributaries is very much less than that of the Allegheny and its tributaries. In its very lowest stage the natural flow in the Monongahela has been known to be less than two thousand cubic feet per minute, which would furnish only about twenty-one and a half millions of gallons per day, or eight and a half

millions of gallons per day less than the quantity assumed as necessary for the wants of a population of five hundred thousand people.

As pertinent to this branch of the subject I will mention some facts stated in a letter to me from E. S. Chesbrough, Esq., the distinguished civil engineer who has so successfully conducted the Chicago Lake-tunnel water works to completion, and which are now in daily practical use. "The Chicago water works were planned originally by Mr. McAlpine in 1851. His estimates for the future extended to 1875. For 1868 he supposed the population, water consumption, and water tax, (or rents) might be respectively 115,000 (persons,) 4,140,000 (U. S. gallons), and $95,000 (rents.) They prove to be not less than 250,000 (persons) 15,000,000 (gallons) and $400,000 (rents) respectively. Mr. McAlpine's estimate for the same items in 1875 was 162,000 (persons), 5,832,000 (gallons) and $130,000 (rents) respectively; but if the law of increase in the future can be deduced from the actual experience of the past, then those items will be respectively not less than 480,000 (persons), 35,000,000 (gallons,) and $900,000 (rents). Mr. McAlpine was limited in his estimate by instructions from the water commissioners."

It will be observed from the above that in Chicago the consumption is already sixty gallons per day, per capita, of the inhabitants, and that it is going on in a greater ratio than the increase of inhabitants, according to the observations of Mr. Chesbrough, the city engineer. And this is in accordance with the general experience in all cities of modern times in which an abundant supply of water has been introduced. It is in fact but the natural result of an ever-advancing civilization, in which the luxuries of to-day become the necessities of the morrow. Considering therefore the reasonable probability that within a very few years the necessary water consumption for this vicinity will be not less than 30,000,000 gallons per day, the circumstances according to my judgment appear to point strongly to the Allegheny river, at some place a few miles above the old water works, as the source of supply. The vicinity of Negley's run, or that of Shade's run, may be

found advantageous as points from which the water may be pumped up to high receiving and distributing reservoirs. If arrangements can be made with the oil refineries, etc., above Negley's run to prevent any refuse material from passing into the river, a point just above the mouth of Negley's run might then be favorable as a site for the main pumping works, whence the pipes could be laid up the valley of Negley's run to a first or low service reservoir, where a second pumping engine could force the water to the high service reservoir for supplying the most elevated parts of the city.

Owing, however, to the fact that the dividing ground in East Liberty is so much elevated above the river (428 feet,) it is obvious that the service mains from any reservoir materially lower than the divide established in the valley of Negley's run could not be laid to the old city, *by that route*, but would have to be laid along the main valley of the Allegheny river, entering the city through Lawrenceville. The same sort of difficulty would be encountered at Shade's run, even to a greater extent, where the dividing ground is a hundred feet higher than at East Liberty; requiring also the addition of a mile and a fourth more main pipe along the Allegheny river between Shade's run and Negley's run. A main pipe, for the supply of parts of the future city lower than the level of two hundred and fifty feet above the river, should be at least three feet in diameter, and the cost of such a pipe complete would be not less than $90,000 per mile.

It would, therefore, cost for such a main, from Negley's run to the old water works, (say $6\frac{12}{100}$ miles, @ $90,000 per mile, = $550,800; and from Shade's run to the old water works, say $7\frac{4}{10}$ miles, @ $90,000 per mile, = $666,000.

Since almost the only object in seeking a point on the river above the vicinity of Negley's run is to obtain purer water, and as this involves the construction of a mile and a fourth of additional pipe at an increased cost in the first instance of $115,200, it may be well to inquire into the practicability of effecting an arrangement which would secure as good water at the lower point near Negley's run, or even further down, before determining the site for the new engine house, in case

the Allegheny river should be chosen as the source of supply. Two modes present themselves for consideration: one by cutting off from the river all the refuse from oil refineries, etc., from Shade's run down to the Point, whence the water should be drawn out by the pumps; the other by laying a brick conduit from the source of pure water along the left bank of the river down to the pumping place, and allowing the pure water of the river to flow through it.

It might become a matter of arrangement between the city authorities, representing the entire population interested, and the individual owners of the works which now contaminate the waters, under which all future trouble on this score should cease. It appears to me that an annual expenditure of $500 or $600 at each works, or the cost of one constant laborer, ought to suffice to prevent any of the refuse from entering the river above a point to be agreed upon.

For six works this would cost $3600 per annum, or say 6 per cent. on $60,000.

Or, all the refuse of these works might be turned into a special pipe laid along the river, communicating with each works and delivering the refuse, along with a constant flow of water passing through the same, at some point below, even below the present city water works, if necessary. The city drainage of the three or four miles below the Sharpsburg bridge might also be collected in a longitudinal sewer having its delivery at some point below. But this last would be very costly on account of the size of the sewer required to cover the accumulated drainage of so great a distance, and the expense of constructing it so as to be safe, out of the way of the numerous works along shore, and clear of the navigation interest. The cost of a light 15-inch cast iron pipe with the necessary connections with the works, would be about $25,000 per mile; or, between Shade's Run and Negley's Run, ($1\frac{28}{100}$ miles) $32,000. The natural fall in the river from Shade's Run to Negley's Run is 2 feet, or at the rate of $1\frac{56}{100}$ feet per mile. But in the pipe this could easily be arranged with the upper end several feet higher, giving so much additional fall available for increased flow through the pipe, excepting in high water, when

of course it could have no more difference of level than the regular fall of the river surface at such stage of the water. By having the upper portion of the pipe entirely above the level of the highest flood, even much more of a descent could be obtained for the free passage of the refuse of the works. The interest on cost and annual repairs, &c., of such a pipe would not be more than about $2,500 per mile, or $5,200 per annum for the distance from Shade's run to Negley's run.

The other mode, in case the oil refineries, &c., are allowed in the future to carry on their operations without change—still throwing their refuse into the river, would be by the construction of a brick conduit large enough to carry all the water that would require to be pumped up to all the reservoirs. As there would not be any great pressure upon it, a conduit one brick, or rather two half bricks thick, not over 5 feet in diameter, would be ample. This would cost for excavation, &c., and laying complete, say $50,000 per mile, or about $64,000 for the distance from Shade's run to Negley's run. And since the cost of a three foot cast iron main pipe strong enough for heavy pressure would be about $90,000 per mile, or $115,200 for the distance, the saving in cost ($51,200) would seem to favor the plan of establishing the engine house at some point on the river below Shade's run, or below Negley's run. The point at Negley's run is advantageous on account of being convenient to East Liberty, for taking the supply for a high reservoir, which might be located on Fort Herron hill; but it has the objection already mentioned, that all the water for the low service as well as the high service, would have to be forced at least as high as the "divide" in East Liberty, which is 428 feet above the river. So that it would be found necessary or expedient to carry one pipe up the valley of Negley's run for the high service reservoir, and another pipe down the river to Lawrenceville, and thence to some convenient point for the new lower reservoir, or else into connection with the old lower reservoir. These investigations therefore tend to show that the best plan may be to carry the pure water by a conduit still farther down the river to such other point as may after mature consideration be deemed most advantageous and convenient

for pumping to a medium height reservoir, say at an elevation of about 250 feet above the river, which could hereafter supply a large portion of the old city, Lawrenceville, Allegheny, South Pittsburgh, Birmingham, &c., (all places not more than 230 feet above the river) from which lower reservoir another engine would pump the water for the high service up to Fort Herron hill, or to wherever a high reservoir might be located. A high reservoir, say 500 feet above the river, circling Fort Herron hill, to contain about 10 acres, 20 feet deep, is practicable at reasonable cost; and, at no distant period either a reservoir or a stand pipe at that elevation will be needed for the supply of the high portions of East Liberty, Oakland, and the higher parts of the old city plateau, which are now rapidly being built upon. Whenever reservoirs are reasonably practicable they are preferable to stand pipes, which, the instant anything is out of order—either with the engine, the pumps or the pipe, ceases to furnish water; whereas a reservoir of even no more than ten acres, 20 feet deep, will contain 65,000,000 of gallons, or enough for over two days' supply for the whole future city, as estimated with 500,000 inhabitants, and enough for more than nine days' present needed supply.

Recurring to the mode of supplying the city from a distance by a natural flow, although it may be regarded as impracticable or unadvisable at present to bring the water by gravity on a level high enough to flow into the high service reservoir, some five hundred feet above the level of the river at Pittsburgh, on account of the great distance and cost; yet it is still possible that water might be brought at comparatively reasonable cost to a reservoir of medium height, or even as high as the present lower basin, which is one hundred and sixty-two feet above the river. More extended surveys than there has yet been opportunity to make will be required to determine with accuracy the cost of bringing water by gravity to such lower elevation; whence of course the water would still have to be pumped to a high service reservoir, or to a stand-pipe, for the supply of the higher portions of the city. But I am prepared to offer at this time approximate estimates of the probable cost of supplying 30,000,000 gallons per day

on the two principal modes referred to in this report, which may serve to aid the committee in their judgment respecting the several plans. The plan of erecting a dam across the Allegheny river, and using the water of the stream as power for pumping the necessary supply to the reservoirs, has some advantages over all others.

The annual cost of running the works would be much less than the cost of working steam engines; and with turbine wheels there would generally be only a few days at a time, during high floods, when they would not pump, at which periods the old engines, if still maintained, as in such case they should be, and a new one at the dam could be used to keep up the supply for the time being.

The chief objection to this plan is that the natural navigation of the stream would be obstructed. This could be remedied in part by a lock of sufficient size to pass the class of steamers and other vessels using the Allegheny river, and by a chute, so arranged that the descending rafts, &c., could safely pass. A dam raising the water about eight feet, would afford ample water power for the purpose, and during a portion of the year there would be a large surplus of power.

Even allowing that there should be no more than the minimum flow, of 80,000 cubic feet per minute, or 864,000,000 gallons per day, and that it should require twenty gallons for supply, flow and waste, to raise one gallon to the required height of the reservoir, it would consume only 600,000,000 out of the 864,000,000, leaving 264,000,000 gallons per day unused. It should be recollected in this connection that at the period of such minimum flow there is practically no navigation on the Allegheny river.

At the Fairmount works in Philadelphia, the Schuylkill river—a much smaller stream than the Allegheny—a dam furnishes water power sufficient to raise more than 22,000,000 of gallons daily, ninety-four feet high, to the reservoirs, besides maintaining the Schuylkill canal navigation locks, through which boats are passed every few minutes of the entire twenty-four hours, during the dryest part of the season, carrying a very heavy trade in coal, &c. The running

expenses of the Philadelphia Fairmount works for 1867, raising an average quantity daily of 21,951,694 gallons, were $175,572 82.

Cost of raising water into reservoir, per million gallons, - - - - - - $12 26

Cost of raising water per million gallons, one foot high, - - - - - - - $02\frac{1}{7}$

Compare this with the cost by steam power:

The Philadelphia "Schuylkill Works" (steam) furnished in 1867 an average of 5,500,000 gallons per day, at a cost of - - - - $20,382 24

Cost of raising water into reservoir, per million gallons, - - - - - - $12 82

Cost of raising water per million gallons, one foot high, - - - - - - - $11\frac{1}{10}$

Thus, leaving out the first cost of the works, the cost of pumping by water power at the "Fairmount" works is only one-fifth of the cost, per foot of height, at the "Schuylkill" steam works. At Fairmount the water is raised ninety-four feet, and at the Schuylkill works one hundred and fifteen feet.

At the Philadelphia "Delaware water works" (steam) with an average daily quantity of 4,000,000 gallons, the cost in 1867 was, per million gallons, - - - $39 41

and cost of raising water, per million gallons, one foot high, - - - - - - $29\frac{2}{10}$

The Philadelphia "Twenty-fourth ward works" (steam) furnished a daily average in 1867 of 1,856,759 gallons, at a cost, per million gallons, of $19 12

and cost of raising water, per million gallons, one foot high, of - - - - - - $08\frac{3}{10}$

The Philadelphia "Germantown works" (steam) furnished a daily average of 562,236 gallons, at a cost per million gallons of - - - - - $43 $\frac{26}{100}$

and cost of raising water, per million gallons, one foot high, of - - - - - - $19\frac{1}{10}$

Or more than eight times the cost of water power.

The average quantity pumped per day by all the Philadelphia works during the year 1867 was 29,771,018 gallons.

Putting the quantity now raised at the Pittsburgh water works from the river to the lower reservoir, one hundred and sixty-two feet high, at 7,200,000 gallons daily, the cost is per million of gallons, - - - - - - - $10 94

and the cost of raising water, per million of gallons, one foot high, - - - - - - - $06\frac{8}{10}$

Or about three times, per foot of height, the cost of raising by water power at the Fairmount works.

It may be noted that the cost, per foot of height, in Pittsburgh for 1867 was considerably less than at any of the Philadelphia steam water works, owing probably to the cheapness of fuel in Pittsburgh.

These statistics of the cost of raising water will be useful in comparing the different plans for supplying the future city of Pittsburgh; they may be referred to hereafter in connection with the cost in other cities.

I will now submit an estimate of the cost of supplying 30,000,000 gallons daily to Pittsburgh and vicinity, with an additional city pipe distribution of eighty miles, on the plan of pumping from the Allegheny river.

ESTIMATE.

5 miles of brick conduit, @ $50,000,	$ 250,000
3 miles 36-inch cast iron main, @ $90,000,	270,000
2 engine houses and 4 engines and pumps at river, @ $230,000,	460,000
1 engine house and 2 engines and pumps at reservoirs, @ $150,000	150,000
2 miles of 20-inch main @ $40,000	80,000
2 reservoirs, including cost of land and all fixtures complete, each with double basins, @ $175,000,	350,000
80 miles of new pipe distribution, various sizes, average $17,000 per mile,	1,360,000
Contingencies and minor items, including engineering and superintendence,	290,000
Total,	$3,210,000

Though the final or ultimate cost of the water works, reservoirs and general pipe distribution, on the plan of pumping by steam engines from the Allegheny river, may amount to the above approximate estimate of cost; a considerable portion of the expenditure would not be immediately encountered, or be paid for by the present population.

The works should be so planned as to provide for the present erection of but two engines at the river, each capable of raising 15,000,000 gallons daily. This is a trifle more than double the quantity now raised by the old engines. There are at present about thirty-seven miles of pipes of all sizes, from four inches to twenty inches in diameter.

The foregoing approximate estimate covers cost of eighty miles of additional pipe distribution of a larger average size of pipes, the expenditure for which would be gradual, divided through a number of years, as the population should increase.

But allowing that within twenty or twenty-five years the combined districts to be supplied should contain a population of 500,000, consuming 30,000,000 gallons of water daily, it would be a moderate cost for an abundant supply of pure water to so large a number.

I will here present an approximate estimate of the amount that may be required within two or three years on the foregoing general plan:

5 miles of brick conduit, @ $50,000	$ 250,000
1 engine house, 2 engines, &c.,	230,000
3 miles of 36-inch main, @ $90,000	270,000
1 engine house, 2 engines, &c., at reservoir,	150,000
2 miles of 20-inch main, @ $40,000,	80,000
2 reservoirs, including land, &c.,	350,000
15 miles of pipes, various sizes, average $17,000 per mile,	255,000
Contingencies and minor items, including engineering, superintendence, &c.,	158,000
Total,	$1,743,000

This is a liberal estimate of the cost of securing a supply of 15,000,000 gallons, daily, of pure water, including a considerable portion of the cost of work applicable towards the future supply of 30,000,000 gallons daily.

I would state in this connection that the city of Providence, Rhode Island, has been engaged for two years in the investigation of plans for supplying that place with water, and the very elaborate report recently submitted by the Chief Engineer, J. Herbert Shedd, Esq., describes four different plans, the cheapest of which he estimates at a cost of $3,686,023.65, and the most expensive at $4,477,035.08. This is for a present population of only 60,000 persons and an assumed supply of only 12,000,000 of gallons per day.

The city of Memphis is also about erecting water works after a very thorough set of surveys and investigations completed during the present year under the direction of Charles Hermans, Chief Engineer, and E. S. Chesbrough, of Chicago, Consulting Engineer. Three principal plans are proposed, one taking the water from Wolf river, another from the Mississippi river, and another from Hatchie Lake; the estimated cost of these respectively is as follows: Wolf river plan $2,329,428: Mississippi river plan, $1,910,248; Hatchie lake plan, $2,244,112. These works for the city of Memphis are based on a population of only 75,000, and a daily supply of but 6,000,000 gallons of water.

During the autumn of this year I was called as consulting engineer, in connection with Col. J. C. Trautwine, civil engineer, to examine water works now in the course of construction for the city of Rochester, which is assumed to contain a population of about 70,000. These works which are expected to be in operation in the spring of 1869, with a pipe distribution of only twelve miles, will cost about one and one quarter millions of dollars.

I refer to these different cities and their water works systems merely to show that the sum for which it is estimated the city of Pittsburgh can be supplied with a much larger quantity of water sufficient for a much greater population is proportionally small.

I will now offer an approximate estimate of the cost of plan with a dam across the Allegheny river, with lock and chute for navigation.

ESTIMATE OF DAM, &c.

2 abutments of dam, cut stone,	$ 25,000
1,200 feet lineal of dam, 8 feet left @ $80,	96,000
1 lock, 50x250 feet, chamber 8 feet left, cut stone,	140,000
1 chute in dam,	22,000
Forebay, and fixtures at river,	35,000
Pumping buildings at river,	40,000
Turbines, pipes and fixtures for raising 30,000,000 gallons daily 250 feet high,	120,000
2 reservoirs, land, &c., complete,	350,000
1 engine house and 2 engines, &c., at reservoir,	150,000
3 miles 36-inch main @ $90,000,	270,000
2 miles 20-inch main @ $40,000,	80,000
80 miles pipe distribution @ 17,000	1,360,000
Contingencies, damages and minor items, including engineering and superintendence,	260,000
Total,	$2,948,000
Add cost of engine house and one engine, needed at the dam during high floods, say	150,000
Total,	$3,098,000

The following reductions may be made from the above when considering only the amount that might be necessary to expend during the next two or three years, namely:

Half the estimated cost of the pumping buildings at the river,	$ 20,000
Half the cost of Turbines, &c.,	60,000
Cost of distribution of 65 miles of pipes @ $17,000 per mile,	1,105,000
Contingencies,	100,000
Total,	$1,285,000

Which sum of $1,285,000 deducted from the foregoing total estimate cost of $2,948,000, leaves $1,663,000 as the amount estimated to be expended within two or three years, necessary to secure a supply of 15,000,000 gallons daily; and which expenditure would also include a considerable portion of the cost of work applicable towards the future supply of 30,000,000 of gallons daily.

There can be no question that the plan of a dam in the Allegheny river, with a reserve engine, (to be used only in case of continued high water preventing the Turbines from working, which could only be the case at most for about one-twelfth of the year,) would make a material future saving to the citizens of Pittsburgh. The difference in the first cost is not materially different, but the saving in the annual expense of running the works is so large as to be worthy of serious attention.

By referring to the stated cost of raising water at different places, it will be seen that the cost of raising a million gallons one foot high is only 2¼ cents at the "Fairmount" water power works, while by the cheapest steam works about Philadelphia, namely: at the Philadelphia "24th Ward" works it is $8\frac{3}{10}$ cents. (In Pittsburgh it is now $6\frac{8}{10}$ cents.)

Therefore, to raise 30,000,000 gallons daily 250 feet high, at the cost of the Fairmount works, it would cost per day (water power,) $153.75, and for 365 days, (water power,) $55,918.75. While to raise 30,000,000 gallons daily 250 feet high at the cost of the present Pittsburgh works it will cost per day, (steam,) $510, and for 365 days, (steam,) $185,150. Owing, however, to the fact that for about one-twelfth of the year the assistance of steam may possibly be required at the dam, one-twelfth of the difference, or $10,769.27 should be added to the annual cost of pumping by water power, for Pittsburgh, making it $64,688.02 for cost of raising by water power, with partial steam power, at the dam, as compared with $185,150, the assumed cost by all steam power. The difference is $120,461.98 per annum. If we now deduct from this the interest at six per cent. on the sum of $150,000, (which would be ample to allow for the first cost of the requisite assistant steam works,

buildings, engines, &c.,) this would be $9,000, which, deducted from $120,461.98, leaves $111,461.98, which sum represents approximately the annual saving to the citizens of Pittsburgh from using water power, in the cost of raising 30,000,000 gallons of water daily 250 feet high. This is a large sum, representing at 6 per cent. per annum in round numbers an original capital of $1,800,000.

The difference in the cost of raising water by the water power of the Allegheny as compared with the cost of raising by steam, according to the statistics presented, appears to be so considerable as to be worthy of further and more careful investigation before determining the kind of power to be used for the probable future requirements of the city.

It remains for your consulting engineer to offer such conclusions and recommendations for your consideration as his brief examinations and the preceding presentation of facts may justify. The general plan indicated is to provide in the first instance works sufficient to supply 15,000,000 gallons daily, or about double of the present supply, so arranged that by a simple extension of the same system, when the increased population shall need it, the supply may be doubled—by doubling the steam engines, or other pumping power, as the case may be.

I have not presented any detailed estimates of the cost of bringing water by natural flow from the upper waters of the Monongahela or Allegheny, or their tributaries, the Youghiogheny and Kiskiminitis, because I have shown that the distance from the nearest available, the Youghiogheny, would not be less than about eighty miles, and in the case of the Youghiogheny at the distance of eighty miles it is doubtful whether the supply would be adequate in low water without storing in a dam or artificial reservoir, at or near the source of supply.

My general experience, with more than a general knowledge of the kind of ground over which a sufficient conduit would necessarily pass, either in the shape of very large pipes, or a high-grade, costly canal, warrant the assumption that the cost might amount to nearly $200,000 per mile, nearly sixteen

millions of dollars. I therefore dismiss for the present the further consideration of the plan of supplying the city by gravity from the rivers, as a matter which may more appropriately come up a generation or two later. Not having yet had opportunity to obtain a proper analysis of the waters of the rivers, to be taken in low water from different portions of the streams, it would perhaps be premature on my part to make at this time a positive recommendation respecting the particular point on the river whence the water should be taken. I cannot object to state, however, that so far as my examinations have been made, I entertain no doubt that the water of the Allegheny river, in a state of purity equal to most of the finest river streams, and quite possibly equal to the best in the country, can be had within eight miles of the present water works. My opinion is that it will probably be found most advantageous to the interests, as well as to the general health of the citizens, to take the water from the Allegheny river not farther up than the mouth of Shade's run, which is $7\frac{4}{10}$ miles above the present water works. The precise point will depend upon the general plan that may be adopted.

The plan of a dam across the river seems to offer such an advantage in point of annual saving in the cost of raising the water, as in my opinion to deserve more extended and careful examination. If it be favored by the Committee, it is probable that some additional legislation might be needful before it could be adopted. But whether the power to be employed for raising the water to a lower or midway reservoir be steam or the water power of the river, the future main reservoirs will be equally necessary.

The details of the pipes, conduits, &c., may however be materially affected by the particular location and plan that may be adopted for pumping by steam, and they will be different with a dam for water power; and these again may be materially different, owing to the particular location of the dam or of the pumping works, which location, even if a dam were to be adopted, could not be made without further investigation. These and analagous questions arising out of

the examinations and observations thus far made, serve to show that the right settlement of the whole question is no light task; and that to decide it hastily might be very bad policy and permanently injurious to the citizens.

As your consulting engineer you may expect me to make at this time, as far as I can, definite recommendations for the consideration of the Committee, as the result of our recent examinations combined with my general experience, and the study I have been able to give to the subject.

If it is the determination of Councils to proceed, with as little delay as possible, with the construction of the works, in the most advantageous manner, I would respectfully suggest that the whole active charge of the entire subject in all its branches should be vested in three (or some other number not too great) Water Commissioners. These gentlemen could appoint, or sanction the appointment of a competent engineer corps, which in such event will be necessary, whose special duty it would be to conduct all surveys, make maps and drawings of plans, to be approved by your consulting engineer, and generally to supervise all matters relating to the engineering and construction of the new water works. The party I have had temporarily engaged in preliminary surveys was a small improvised corps, merely sufficient for the preliminary duty deemed necessary to afford me sufficient data for my present report, but not having experience enough to undertake the important engineering labors hereafter to be performed.

The work of the engineer department of the water works should proceed under the immediate supervision and direction of the said Commissioners, to whom the consulting engineer and all other engineers would be responsible. In fact no engineer of experience could in future act intelligently and to the advantage of the city as consulting engineer unless he had a perfectly reliable and competent engineer corps under the charge of an experienced chief engineer, in whose skill and judgment he could repose confidence.

The cost of a good engineer corps, in connection with the extensive works needed for the future supply of the growing

city of Pittsburgh, is a small item compared with the importance of securing the best locations, the best plans, and the best constructions of all the works.

There is one other point to which I may now properly advert. If the Committee or Councils determine that the higher parts of the consolidated city are to be supplied from the future city water works, no matter how the water may be furnished, a high reservoir or reservoirs will some day be needed. Fort Herron hill presents an advantageous site for one high reservoir, and I think it would be no more than the dictate of prudence to secure it for that purpose as soon as convenient.

The proper particular location of a lower reservoir or reservoirs must depend on the place and manner of taking the water from the river, which cannot be satisfactorily determined until additional accurate surveys are made. When a regular experienced engineer corps shall be appointed, various economical questions in connection with the whole subject, which there has not yet been time to investigate, may be examined into and submitted from time to time to the committee, or to the water commissioners, if such should be appointed. Although I may be often absent from the city, I can visit the lines of survey and the works as they progress, often enough to direct them generally, and so as to act in harmony with the committee or the water commission, as the case may be.

In this preliminary report I have not undertaken to enter minutely into all the matters which have presented themselves for consideration. Thus, in regard to the subject of ridding the river of the impurities now thrown into it by the works along its shores, which I have but glanced at, I consider it a question for further careful investigation and calculation, believing that it admits of a satisfactory solution on a basis which, while it would not impair the value of those works, would materially and permanently benefit nearly a quarter of a million of people, including all the citizens of Pittsburgh and its vicinity.

Respectfully submitted,

W. MILNOR ROBERTS,

Consulting Engineer Pittsburgh New Water Works.

PITTSBURGH, Dec. 12, 1868.

REPORT

OF

Superintendent & Engineer of Water Works,

FOR 1868.

To the Water Committee:

GENTLEMEN:—The following exhibit of operations of the Water Works covers the leading items of interest in the two years ending January 31st, 1870.

A full report of 1868 was presented to the Water Committee last year, with accompanying papers. It was submitted to Councils, and after some delay, was ordered to be printed. By some accident, the City Job Printers lost the copy, which they have been unable to trace, and in order that some record of the important proceedings of that year should be preserved, they are included in this statement:

An act of Assembly approved February 28th, 1868, authorized Councils to issue bonds to the amount of ten hundred thousand dollars, to be used for the purpose of improving and extending the Water Works. Councils directed the issue of $250,000 in 1868, and by joint resolution, empowered the Water Committee to make extensions of water pipe throughout the city, as constituted under the act of consolidation, and to make such repairs and improvements to the existing works as they might deem needful.

The committee adopted a programme, embracing needed repairs and additions to machinery, and water mains of a permanent character, on the leading thoroughfares in the newly added wards nearest the old city. Much of the work was done in 1868, and the remainder in the year just ended.

In the early part of the summer of 1868 it was brought to notice of Councils that the existing works had become so heavily taxed by the demands of a rapidly increasing population, that new works

must be at once located, and their construction prosecuted without delay, Councils created a special committee on the subject, and their report, transmitting an able preliminary report of W. Milnor Roberts, Esq., their consulting engineer, was published by order of Councils, near the end of the year. From time to time, the question of new works was brought up in Councils in 1869. The Water Committee of that year made most careful inquiry into the subject, and no doubt used every argument to bring about a final decision upon the subject, now become one of very grave importance to every tax-payer of the city.

During the past two years, a set of new boilers have been erected both at the lower and upper works; a new pump has been procured at the lower works; thorough repairs and some additions have been made to the machinery; a new and substantial boiler house has been built at the upper works; a very heavy and well-constructed retaining wall has been built at the lower basin, and a long list of extensions of water mains of a permanent and important character have been added, largely increasing the daily duty of the machinery. It is my duty to warn you, and through you the Councils of the city, that, in order to secure without interruption a supply of water, hitherto so lavishly and unrestrictedly furnished, some new and larger mode of supply is absolutely and imperatively necessary. I fear that this year the supply will be sadly deficient if an engine and pump be not placed at the upper end of the Seventeenth ward, to pump direct from the river into the twenty inch supply main. This would, for a brief time, materially aid the supply, but the reports of running time show that nearly all the hours in the year are needed, even now, to furnish a sufficient quantity of water; and if the enormous quantity of coal daily consumed is considered, will it not be much the wisest policy to endeavor to secure a cheap and permanent supply without further delay.

The revenue has not been materially increased, nor can it be until the sections of the city most rapidly improving are reached, and therefore the interest on issues of water extension bonds already made, amounting to $418,000, will have to be met from revenue realized nearly altogether from the old city; while, if new works are erected, it will be practicable to supply an immense number of dwellings, always the most profitable source of revenue to the

works, and convert into a good paying investment all the extensions so far made, which otherwise will diminish, instead of adding to the surplus hitherto realized from the works.

The demands upon the lower works are so great, that repairs to machinery cannot now be made, so, that with wear and tear, it will, before long, require most thorough overhauling. The Water Committee have contracted for a new engine and pump for the upper works. A new house for the same will have to be erected this spring, and some important changes in pipes and attachments made. When the new engine is successfully in operation, the upper works will be relieved, and the old machinery in that house can be repaired.

In 1868, at the lower works, the Hercules engine ran 21 hours per day, and the Sampson engine ran 12⅔ hours per day. Average consumption of coal, 837 bushels per day. Average daily supply of water, 1,107,222 cubic feet. These calculations are made for 313 running days.

In 1869, at the lower works, the Hercules engine ran 20¾ hours per day, and the Sampson engine 14 hours per day. Average consumption of coal, 860 bushels per day. Average daily supply of water, 1,165,021 cubic feet. These calculations are made for 365 running days, or in other words, it has become necessary to keep up steam nearly night and day.

In 1868, at the upper works, the running time was 16⅛ hours per day. Coal consumed, 183 bushels per day. Average daily supply of water, 202,969 cubic feet. Total running time, 313 days.

In 1869, at the upper works, the running time was 22⅐ hours per day. Coal consumed, 253¾ bushels per day. Average daily supply of water, 278,140 cubic feet. Total running time, 313 days.

The Following Extensions were made in 1868.

			Feet.
Three inch pipe on	Reed	street,	458
Four inch pipe on	Mulberry	alley,	217
" "	Almond	alley,	664
" "	St. Patrick's	alley,	433
" "	Peach	alley,	133
" "	Beach	alley,	603
" "	Exchange	alley,	1,075
" "	Wide	alley,	523
" "	Diamond	alley,	390
		Carried forward	4,496

	Feet.
Brought forward,	4,496
Four inch pipe on Cherry alley,	207
" " Railroad street,	36
" " Maria "	26
" " Miller "	400
" " Colwell "	220
" " Stevenson "	272
" " Congress "	199
" " Chestnut "	233
" " Crawford "	650
" " Pike "	373
" " Centre avenue,	200
" " Bedford "	270
" " Craft "	1,080
" " Braddock street,	1,017
" " Brady "	653
" " Reed "	336
" " Turnbull "	668
Six inch pipe on Lafayette alley,	1,790
" " Almond "	39
" " Boundary street,	487
" " Wilson "	82
" " Smallman "	1,619
" " Railroad "	43
" " Butler "	24
" " Carroll "	65
" " Allen "	1,081
" " Prospect "	112
" " Sycamore "	49
" " Wainwright "	150
" " Dravo "	217
" " South "	56
" " Main "	12
" " Borough "	1,150
" " Washingt'n "	800
" " North "	583
" " Seneca "	176
" " Canal "	267
" " Smallman "	490
" " Wood "	718
" " Vickroy "	460
" " Brady "	48
" " Pike "	239
" " Park "	500
" " Robinson "	93
" " Craft avenue,	44
" " Sixth "	275
" " Fifth "	800
" " Jumonville avenue,	24
" " Washington avenue, 17th ward,	286
Eight inch pipe on Railroad street,	3,195
" " Boundary "	655
" " Penn "	96
" " Locust "	635
" " Greensburg pike,	42
" " Pike street,	188
" " Centre avenue,	6,150
Carried forward,	35,026

	Feet.
Brought forward,	35,026
Six inch pipe on Bedford "	580
" " Fifth "	2,223
Twelve inch pipe on Liberty street,	505
" " Smith street,	280
Fifteen inch pipe on Fifth avenue,	2,938
Twenty inch pipe on Penn street,	1,526
" " Butler street,	3,942
Amount laid in 1868,	41,018
Add former amount, less 2,983 feet removed,	180,055
Total, 43 miles, or feet,	227,073

Pipe Removed, as Follows:

Four inch pipe on Centre avenue,	800
Six inch pipe on Wood street,	718
Five inch pipe on Exchange alley,	1,075
Four inch pipe on Diamond alley,	390
Total amount removed, feet,	2,983

Pipe Lowered, as Follows:

Four inch pipe on Smallman street,	421
Six inch pipe on Green street,	288
Total amount lowered, feet,	709

Pipe Raised, as Follows:

Four inch pipe on Mulberry alley,	479
Eight inch pipe on Erin street,	156
Total amount raised, feet,	635

Number of fire plugs made and put in,	60	
" " repaired and reset,	56	
" " removed,	2	
Number of fire plug boxes put in,	30	
" " renewed,	16	
Whole number of fire plugs in the city,	368	
Number of flood-gates made and put in,	62	
" " repaired,	11	
Number of flood-gate boxes put in,	62	
Number of flood-gates renewed,	52	
Whole number of flood-gates in the city,	590	
Number of leaks in mains repaired,	79	
Number of ferrules inserted, $\frac{3}{8}$ inch,	6	
" " " $\frac{1}{2}$ inch,	279	
" " " $\frac{5}{8}$ inch,	221	
" " " $\frac{3}{4}$ inch,	66	
" " " 1 inch,	33	
605 at $2 each,		$1,210 00
Extra drilling,		25 00
Amount received and paid to City Treasurer,		$1,235 00

Appropriations and Expenditures for 1868

Appropriations by Councils,	64,000 00
Cash for material sold,	562 99
Water Extension Bonds,	250,000 00
Balance on hand January 31st, 1868,	215 54
	$314,778 53

Expenditures of Lower Works.

Coal,	$20,336 62
Labor, Engineers and Firemen,	9,035 65
Labor at Pipes and Plugs,	2,157 24
" Cleaning basin,	320 50
" at Vaults and Pits,	895 40
Smith Work and Castings,	530 98
Brass Work and Castings,	140 51
Yarn and Rope,	162 18
Brick and Brick Work,	189 20
Lumber,	197 62
Plumbing,	71 93
Oil,	873 44
Hauling,	112 25
Hardware,	23 03
Gas fitting,	15 55
Bolts,	21 63
Tools and Blacksmithing,	85 60
Iron and Nails,	16 75
Tin and Copper Works,	51 27
Soap and Candles,	28 30
Hickory Brooms,	23 00
Wheel barrows,	23 00
Gum Packing,	7 20
Freight, Printing, Ice, Ashes, Stamps, Glass, Chimneys, &c.,	176 72
	$35,495 61

Expenditures of Upper Works.

Coal,	$4,687 03
Labor Engineers and Firemen,	3,603 52
" at Pipes and Plugs,	1,197 25
" Cleaning Basin,	108 75
" at Vaults and Pits,	122 66
Air Vessel,	78 67
Smith Work and Castings,	109 40
Brass Work and Castings,	73 90
Yarn and Rope,	95 50
Lumber,	75 00
Plumbing,	43 87
Oil,	283 97
Hauling,	92 23
Hardware,	15 45
Tools and Blacksmithing,	52 40
Soap and Candles,	19 02
Hickory Brooms,	18 00
Wheelbarrows,	10 00
Metallic Packing,	114 00
Iron and Nails,	10 50
Hay, Carpenter work, Wire sieve, Clock, &c.,	48 11
	$10,859 23

Expenditures for Permanent Extension.

Pipe,	$121,654 80
Laying Pipe,	31,235 49
Lead,	12,686 03
Laying Pipe in former years,	23,162 92
New Pump &c., Lower Works, on ac't.,	5,627 00
New Boiler House, Upper Works,	4,667 06
New retaining Wall, Upper Works,	3,659 91
New Boilers, Upper Works, on ac't.,	9,750 00
Smith Work and Castings,	2,213 69
Brass Work and Ferrules,	1,062 43
Plugs and Gates,	13,879 55
Hemp and Tow,	372 05
Brick and Brick work,	200 00
Platform and scale,	242 25
Lumber,	893 68
Plumbing,	347 50
Hauling,	829 00
Hardware,	66 90
Bolts,	45 71
Leather,	8 96
Tools and Blacksmithing,	404 64
Iron and Nails,	103 31
Gravel,	55 00
Lithographing, Stamps, &c.,	1,098 40
Shovels and Picks,	55 50
Surveys and Plans,	2,630 37
Pine Plugs,	69 82
Locust Posts,	50 50
Advertising,	99 50
Curb-Stone, Cement, Gum Packing, Pipe, Guage, &c.,	133 80
	$234,304 27

Water Works Account.

To Appropriations by Councils, No. 6,	64,000 00
To Water Extension 7 per cent. Loan per ac't. 28th Feb., 1868,	250,000 00
To Material sold by Superintendent,	562 99
To balance Jan. 31st, 1868,	215 54
To Cash per Superintendent paid Treasurer,	1,235 00
To Cash per Assessor paid Treasurer,	1,170 43
Total	$317,183 96
By Warrants for Current Expenses,	46,354 84
do. do do. Permanent Expenses,	234,304 27
Cash paid Treasurer by Superintendent,	1,235 00
do. do. do. Assessor,	1,170 43
Balance in hands of Superintendent,	257 00
Balance Extension Loan on hand,	29,862 42
By transfer to App. No. 6, Dec. 23, 1868,	4,000 00
Total,	$317,183 96

Revenue.

Water Rents Assessed on various establishments,	$139,774 48
Five per cent. arrears, October 1, 1868,	2,163 94
Water Rents for Building purposes,	890 33
Water Rents for sprinkling streets,	76 25
House and Ground Rents at Basin lot,	203 85
Ferrules and Drillings,	1,235 00
Old metal sold,	562 99
Balance on hand Feb. 1st, 1868,	215 54
Total Revenue,	$145,122 38

Report of Assessor of Water Rents for 1868.

To the Water Committee.

Gentlemen:—The water rents assessed on the various establishments in the city, using hydrant water, for the year ending March 31, 1869, amounts to one hundred and thirty-nine thousand, seven hundred and seventy-four dollars and forty-eight cents, from the following sources, viz:

1	Court House and Jail,	$1,000 00
1	Gas Works,	950 0
1	Custom House and Post Office,	200 00
3	Hospitals,	144 50
59	Churches,	556 32
25	Schools and Colleges,	868 91
27	Theatres and Lecture Halls,	395 75
8	Public Bathing Establishments,	455 68
1	Steam Laundry,	75 00
2	Flour Mills,	220 00
64	Confectionary and Bake Houses,	1,252 13
4	Chandlers,	180 00
10	Cabinet and Chair factories,	367 50
3	Coke Works,	128 00
11	Glass Works,	429 00
2	Distilleries,	450 00
25	Rectifying Distilleries,	564 25
4	Steel Spring and Shovel factories,	1,522 50
12	Brick Yards,	394 56
33	Printing Offices and Binderies,	685 00
11	Planing and Saw Mills,	740 62
5	Oil Refineries,	1,350 00
3	Tanneries,	177 50
24	Tobacco factories,	461 00
121	Livery and other Stables,	2,100 66
72	Engine Shops, Foundries and Boiler Yards,	4,249 50
13	Rolling Mills, Forges and Steel Works,	6,767 12
16	Breweries and Malt Houses,	2,766 50
17	Rail Roads and Rail-Way Depots,	12,625 00
48	Miscellaneous Manufactories,	1,892 00
514	Hotels, Taverns and Boarding Houses,	12,075 50
1030	Warehouses, Stores, Offices and Work Shops,	11,560 80
806	Stores with dwellings attached,	9,062 55
9458	Dwellings,	63,106 63
13034	Assessments,	$139,774 48

Brought forward,	$139,774 48
Five per cent. Arrears, Oct. 1868,	2,163 94
Water Rents for building purposes,	890 33
do. Sprinkling streets,	76 25
House and ground rents at basin lot,	203 85
Ferrules and Drilling,	1,235 00
Old Metal sold and exchanged,	562 99
Balance on hand February 1, 1868,	215 54
Total Revenue,	$145,122 38

Respectfully submitted,

Edward S. Wright,
Assessor of Water Rents.

Sept. 13, 1869.

REPORT

OF THE

WATER COMMITTEE,

FOR 1869.

To the Select and Common Councils of the City of Pittsburgh.

GENTLEMEN:—The Water Committe Report that the revenues from the water works for the year 1869, amounts to the sum of one hundred and forty-six thousand fifty-eight dollars and thirty-three cents ($146,058.33), and the expenditures for the same period amounts to the sum of one hundred and eighty-four thousand one hundred and three dollars and fifty-five cents ($184,103.55), which will more fully appear in the Reports of the Superintendant of the Water Works and Assessor of Water Rents herewith submitted, to which your attention is invited.

HENRY LLOYD,	CHAS. W. BATCHELOR,
JOHN DAUM,	G. W. COFFIN,
WM. J. FRIDAY,	R. M. SNODGASS,
HENRY MOSELEY,	GEO. B. CHALMERS,
JAMES VERNER,	JOHN SHIPTON,
J. J. ALBIETZ,	J. D. SCULLY,
THOMAS A. PENDER,	HENRY MEYER,
R. G. HERRON,	CHARLES A. KEHEW,
	D. W. C. CARROLL.

February 28, 1870.

REPORT OF SUPERINTENDENT AND ENGINEER AT THE WATER WORKS.

Running time at the Lower Works.—The Hercules engine ran 20¾ hours per day, and the Sampson engine 14 hours per day; average consumption of coal, 860 bushels per day; average daily supply of water, 1,165,021 cubic feet. These calculations are made for 365 running days, or in other words it has become necessary to keep up steam nearly night and day.

Running time at the Upper Works—22 1-7 hours per day; coal consumed, 253¾ bushels per day; average daily supply of water, 278,140 cubic feet. Total running time nearly 313 days.

The following extensions were made in 1869.

	Feet.
Three inch pipe on Reed street,	312
" " " Trumbull,	180
Four inch pipe on Second Avenue,	1,625
" " " Diamond Street,	84
" " " Chislett "	366
" " " Washington "	463
" " " Cross "	53
" " " Baxter alley,	168
" " " Mulberry "	227
" " " Whitesides "	292
" " " Keatings "	700
" " " Craft Avenue,	615
" " " Niagara Street,	621
" " " Enoch "	550
" " " Pasture "	517
" " " Vine "	294
" " " Vickroy "	496
" " " Mercer "	206
" " " Townsend "	324
" " " Roberts "	360
" " " Wylie "	410
" " " Washington "	170
" " " Eighth "	30
" " " Forty-first "	305
" " " Forty-ninth "	25
" " " Charlotte "	46
" " " Craig "	28
" " " Dithridge "	56
" " " Fifth Avenue,	41
" " " Smallman Street,	100
" " " Forty-third "	75
Four inch pipe on Twenty-eighth street,	89
Six inch pipe on Craig Street,	659
" " " Dithridge Street,	1,016
" " " Duquesne Way,	150

Six inch pipe on	Butler Street,	30
" "	" North "	75
" "	" Willow "	424
" "	" Smallman "	650
" "	" Diamond Alley,	516
" "	" Lafayette "	561
" "	" Twenty-sixth Street,	186
" "	" Twenty-ninth "	108
" "	" Thirtieth "	180
" "	" Forty-third "	1,823
" "	" Forty-fourth "	2,053
Eight inch pipe on	Charlotte Street,	1,866
" "	" Duquesne Way,	428
" "	" Roberts Street,	172
" "	" Webster Avenue,	750
" "	" Thirty-first Street,	271
" "	" Thirty-second "	225
" "	" Thirty-ninth "	1,056
" "	" Forty-fifth "	1,729
Twelve inch pipe on	Liberty Street,	1,438
Fifteen inch pipe on	Fifth Avenue,	8,342
Twenty inch pipe on	Butler Street,	2900
	Amount laid in, 1869,	36,534
	Add former amount less 516 feet renewed,	226,557
	Total amount over 49 8-10 miles, or feet,	263,091
Four inch pipe removed on	Diamond Alley,	516
" "	Lowered Roberts Street,	144
" "	" Wylie "	950
" "	" Miller "	367
Eight "	" Erin "	140
	Total amount lowered,	1,601
	Number of fire plugs made and put in,	45
" "	repaired and re-set,	40
	Fire plug boxes put in,	18
	Fire plug boxes renewed,	10
	Number of flood gates made and put in,	53
" "	repaired,	13
	Number of flood gate boxes put in,	53
" "	renewed,	35
	Whole number of flood gates in the City,	643
	Number of leaks in mains repaired,	83
	Whole number of fire plugs in the City,	413
	Number of ferrules inserted ¾ inch, 5	
" "	" 1 " 15	
" "	" 1¼ " 194	
" "	" 1½ " 216	
" "	" 2 " 76	
" "	" 1 " 37-543 @ $2 each	$1,086 00
	Extra drilling,	28 00
		$1,114 00
	Amount received and paid to City Treasurer,	1,080 00
		34 00

JOSEPH FRENCH, *Sup't.*

The Superintendent paid to the City Treasurer, February 28th, 1870, $45,445, which will appear in the Receipts for that year.

REPORT OF THE ASSESSOR OF WATER RENTS FOR 1869.

To the Water Committee.

GENTLEMEN:—The undersigned respectfully Reports, that the Cash items paid to the City Treasurer, during the year 1869, amounted to the sum of eight hundred and sixty-seven dollars and eighty-five cents, as follows, viz:

Water Rents for building purposes,	$599 14
Water Rents for sprinkling streets,	98 00
House and Ground Rent at Basin	170 71
	$867 85

The water rents assessed on the various establishments in the City, using the hydrant water, for the year ending on the 31st day March, 1870, amounts to the sum of one hundred and forty-one thousand five hundred and thirty-five dollars and ninety cents. Add five per cent. on arrears remaining unpaid on the first day of October, 1869, ($2,283.58); water rents for building purposes, ($599.14); water rents for sprinkling streets, ($98.00); house and ground rent, at basin lot, ($170.71); ferrules and drilling, ($1,114.00); old material, ($257.00); making a total revenue of ($146,058.33); as set forth in the following schedule.

1	Court House and Jail,	$ 1,000 00
1	Gas Works,	950 00
2	Flour Mills,	185 56
1	Custom House and Post Office,	200 00
1	Steam Laundry,	80 00
3	Chandleries,	167 50
6	Cabinet and Chair Factories,	198 00
4	Hospitals,	240 00
4	Public Bathing Establishments,	254 00
6	Oil Refineries,	1,317 00
4	Steel, Spring, and Shovel Factories,	783 00
10	Glass Works,	587 50
2	Coke Works,	190 00
16	Planing and Saw Mills,	964 21
56	Confectionary and Bake Houses,	489 10
14	Brick Yards,	483 21
42	Printing Offices and Binderies,	842 25
58	Churches,	434 25
31	Schools and Colleges,	720 00
18	Theatres and Lecture Halls,	345 00

2	Distilleries,	128 50
12	Rectifying Distilleries,	390 00
345	Livery and other Stables,	2,150 40
14	Rolling Mills, Forges, and Steel Works,	5,312 75
73	Engine Shops, Foundries, and Boiler Yards,	4,160 00
12	Breweries and Malt Houses,	2,675 95
14	Railroad and Railway Depots,	13,416 21
60	Miscellaneous Manufactories,	2,343 00
932	Hotels and Boarding Houses,	12,892 50
1,760	Warehouses, Stores, Offices, and Work-shops,	12,320 25
862	Stores with Dwellings attached,	7,915 50
10,950	Dwellings,	67,399 76
15,316	Assessments,	$141,535 90
	Amount assessed,	141,535 90
	Add five per cent. on arrears, October 1st, 1869,	2,283 58
	Add Water Rents for building purposes,	599 14
	Add Water Rents for sprinkling streets,	98 00
	Add House and Ground Rents at Basin lot,	170 71
	Add Ferrules and Drilling,	1,114 00
	Add Old Material,	257 00
	Total Revenue,	$146,058 33

Current Expense.

Salary of Superintendent and Assessor,	$ 3,208 26	
Expenditures for Lower Works,	36,937 15	
Expenditures for Upper Works,	13,625 45	
Expenditures in the Streets,	9,337 45	63,108 31
Balance Revenue over Current Expense,		$82,950 02

Expenditures for Lower Works.

Labor, Engineer and Fireman,	$ 7,837 62	
Tin and Copper Work,	16 57	
White Lead,	36 61	
Packing,	417 39	
Soap and Candles,	44 22	
Brooms and Buckets,	14 10	
Coal,	23,109 18	
Hauling,	177 00	
Stove,	15 50	
Hose,	98 65	
Refreshments,	4 00	
Plumber Work,	14 33	
Smith Work,	1,303 71	
Tow,	35 20	
Oil,	577 65	
Carpenter Work,	249 87	
Hardware,	35 88	
Flour,	1 25	
Shovels,	30 50	
Nails,	10 00	

Brass Work,	421 58
Repairing Roof,	84 70
Lumber,	252 25
Blocks,	12 50
Repairing Boilers,	490 44
Brick Work,	162 05
Table in Office,	13 00
Sheet Lead,	2 10
Grate-Bars,	377 34
Cleaning Boilers and Vaults,	836 00
Cleaning Lower Basin,	246 96
Total,	$36,937 15

Expenditures for Upper Works.

Labor, Engineers and Firemen,	$ 3,396 88
Tin and Copper Work,	4 27
Clock,	5 50
Packing,	75 75
Coal,	8,006 35
Hauling,	21 50
Hose,	85 00
Plumber Work,	21 60
Smith Work,	276 21
Oil,	487 44
Hardware,	2 00
Ladder,	9 00
Brooms, Buckets, and Soap,	4 81
Shovels,	13 50
Brass Work,	51 99
Repairing Boilers,	641 46
Glazing,	8 35
Brick Work,	271 60
Beeswax,	1 05
Cleaning Boilers and Paving,	126 00
Cleaning Upper Basin,	114 74
Total,	$13,625 45

Expenditures in Streets.

Labor on Plugs and Hydrants,	3,008 97
Tools,	217 20
Hauling,	225 55
Tow,	21 00
Smith Work,	701 81
Hardware,	7 05
Shovels,	44 00
Blasting Powder,	7 25
Judgment and Cost,	758 16
Mason Work,	11 00
Packing,	15 00
Hydrants, Stop Cocks,	3 67
Labor on Pipes and Plugs,	4,316 79
Total,	$9,337 45

Expenditures for Permanent Extensions.

Labor, Street Hands,	4,096 37
Fire Brick,	243 66
Hauling,	503 89
Brass and Copper Works,	488 41
Painting,	182 28
Repairing Survey Instruments,	10 75
Stationery,	5 99
Brick Work,	15 47
Plugs and Gates,	4,446 03
Stone Work,	30 00
Castings,	73,249 15
Laying Pipe,	8,829 96
Survey,	358 33
Smith Work,	97 14
New Boilers,	5,210 38
New Pump,	5,673 00
Hardware,	3 25
Laying Railway Track,	70 67
Ferrules,	250 13
Paving,	5,063 05
Lead,	6,925 90
Lumber,	532 24
Freight,	147 68
Nails,	36 50
Tow,	152 80
Blasting Powder,	22 25
Brick,	385 15
Coal Scales,	180 00
Expense of Water Extension Bonds,	165 25
Tools,	49 95
Lithographing Water Extension Bonds,	120 25
Analyzing Water,	81 75
Patent Grate Bars,	109 83
Patent Tapping Drill,	1,675 00
Sheet Iron, Copper, and Tin Work,	682 83
Total,	$120,995 24
Expenditures for Current Expense of Lower Works,	36,937 15
Expenditures for Current Expense of Upper Works,	13,625 45
Expenditures for Current Expense of Streets,	9,337 45
Salary of Superintendent and Assessor,	3,208 26
Total Expenditures,	$184,103 55

Water Works' Account.

1869—January 29th,	to Appropriation No. 6,	$ 45,000 00
February 1st,	to balance Water Extension Loan, No. 24,	29,862 42
June 15th,	to Water Extension Loan, No. 24,	250,000 00
November 15th,	to transfer from No. 2,	4,280 09
" 15th,	" " 18,	1,798 69
" 29th,	" " 18,	5,000 00
December 31st,	" " 3,	526 80
" 31st,	" " 9,	369 66
" 31st,	" " 10,	650 47
" 31st,	" " 16,	267 03

1870—January 11th,	to Appropriation No.	4,	567 29
"	" "	5,	554 25
"	" "	13,	207 87
February 1st,	" "	6,	3,980 16
			$342,970 73

1869—December 31st, by Sundry Warrants, Current Expense, Lower Works,	$36,937 15	
December 31st, by Sundry Warrants, Current Expense, Upper Works,	13,625 45	
December 31st, by Sundry Warrants, Current Expense in Streets,	9,337 45	
December 31st, by Sundry Warrants, Permanent Extensions,	20,995 24	
December 31st, by Salary Superintendent and Assessor,	3,208 26	$184,103 55
Balance Water Extension Loan,		$158,867 18

The increase in the assessments for the year 1869, one thousand seven hundred and sixty-one dollars and forty-two cents over the previous year, is not in proportion to the extensions made, for the reason that a number of large consumers felt aggrieved by the assessments, and made arrangements to procure a supply from wells and pumping from the river, and a portion of the pipes laid will not produce a revenue in proportion to the outlay until the pumping facilities are increased.

The cost of the Water Works for permanent extensions from the 16th day of February, 1824, the time the first ordinance was passed providing for the raising of a sum of money, on loan, for supplying the City of Pittsburgh with water, till the 1st day of February, 1870, amounts to the sum of one million one hundred and twelve thousand nine hundred and fifty-seven dollars and ninety-four cents. Respectfully submitted,

ROBERT KING,

Assessor of Water Rents.

February 28, 1870.