# BUREAU OF WATER

# ANNUAL REPORT

## PHILADELPHIA

1896.

# SECOND ANNUAL MESSAGE

OF

# CHARLES F. WARWICK

Mayor of the City of Philadelphia

WITH

## ANNUAL REPORT

OF

## THOMAS M. THOMPSON

Director of the Department of Public Works

AND OF THE

# BUREAU OF WATER

FOR THE

YEAR ENDING DECEMBER 31, 1896.

ISSUED BY THE CITY OF PHILADELPHIA, 1897.

PHILADELPHIA:
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1897.

# OFFICE OF THE MAYOR

PHILADELPHIA.

*Mayor:*

**CHARLS F. WARWICK.**

*Secretary:*

**JOHN K. McCARTHY.**

*Chief Clerk:*

**HARRY C. GILL.**

*Contract and License Clerk:*

JOSEPH F. JONES.

*Stenographer and Typewriter.*

HENRY W. PEIRSON.

*Ass't Stenographer and Typewriter.*

HARRY M. FISLER.

*Messenger:*

WILLIAM G. LEE.

# SECOND
# ANNUAL MESSAGE

OFFICE OF THE MAYOR, CITY HALL.

*Philadelphia, April 5, 1897.*

TO THE SELECT AND COMMON COUNCILS
OF THE CITY OF PHILADELPHIA.

GENTLEMEN:—In accordance with the provisions of the Act of Assembly of June 1, 1885, I herewith transmit to your Honorable Bodies this, my Second Annual Message, upon the financial and general conditions of the Municipality. I also send the annual reports of the Directors of the Departments of Public Safety and Public Works, and of the President of the Department of Charities and Correction for the year 1896.

## FINANCE.

The City Controller's report shows that the total receipts from all sources for the year 1896 were $27,965,890.26; and that there has been credited a proportion of the moneys due by the State for Personal Property Tax and Schools, in accordance with a resolution of Councils dated January 22, 1897, amounting to $1,459,569.03 making a total of $29,425,459.29. The total expenditures were $29,228,617.82 showing an excess of receipts over expenditures of $196,841.47.

This is an improvement over the condition of affairs as shown by the report made in 1896 for the year 1895, in which year there was an excess of expenditures over receipts.

The net funded debt of the City for the year 1896 is about the same as it was for the year 1895; the report of the Controller for 1896 shows that there is but a slight increase of about $240,000.

The real estate owned by the City of Philadelphia as appraised by the Board of Revision of Taxes for the year 1897 shows an increase over the appraisement of January 1, 1896, of $1,934,600.

The City's credit has been steadily maintained as has been shown during the last year in the sale of her bonds.

The question in relation to the capacity of the City to further borrow money under certain loans authorized by your Honorable Bodies is to be submitted to the Court at an early date for an opinion. It is to be hoped that this matter will reach a speedy termination as many improvements of a pressing and urgent nature are dependent upon a favorable opinion in this case.

Councils very properly passed ordinances providing for the creation of loans having in view the appropriation and expenditure of moneys for important public work, and until this money be made available many improvements will be delayed, and the progress of the City, in a great measure, held in check.

The City has continued to advance and her progress is very perceptible, but it will still require vast sums of money to bring about many improvements that are absolutely necessary and essential to her well being.

## DEPARTMENT OF PUBLIC SAFETY.

The present Director of the Department of Public Safety took office on the seventeenth day of February, 1896. He has loyally and intelligently discharged the duties of his office.

*Bureau of Police.*

On the evening of April 29, 1896, a railway strike was ordered by the Board of Street Railway employees. Every precaution was taken for the preservation of order, and it was known that the authorities were fully prepared and equipped to enforce obedience to law and to maintain the public peace. Fortunately the excitement subsided and the peril passed away.

The police force is under complete discipline, and too much commendation cannot be given to the officers and men for the faithful discharge of their duties.

In this connection let me say that it will be greatly to the advantage of the City to further increase the number of patrolmen. There are some localities that do not receive sufficient police surveillance, and it requires constant and careful watching to provide ample protection. The increased traffic in the centre of the City necessitated the stationing of Reserve officers at street corners and crossings to protect the lives of pedestrians.

It will be seen that the Director in his report suggests that there should be an increase of about seven hundred patrolmen, which would be sufficient to meet every requirement, and would protect not only the crowded sections of the City, but the suburbs as well. Let me say, just here, that the Park Guards should be brought under the direction and control of the Department of Public Safety as provided for by law.

Philadelphia has a large area, and every foot of it if possible should be fully protected and amply guarded.

A most efficient arm of the service is the mounted squad. Not only is this body able to cover extensive beats in the rural sections, but it is of the greatest use in times of excitement and turbulence.

A matter of importance for the consideration of your Honorable Bodies is that provision should be made for the erection of more station houses and the improvement of many of those that now exist.

*Bureau of Fire.*

This Bureau is in a high state of efficiency, and the heroism so often displayed by the members of the force is worthy of special comment.

I must urge that appropriations be made providing in many instances better accommodations for the men and for the fire apparatus.

The case in which the question has been raised as to the right of the City to appropriate money to the Police and Firemen's Pension Funds has been argued in the Supreme Court, but the opinion has not yet been delivered. It is, however, most anxiously awaited, and, as I stated in my last message, it is to be hoped that the Courts may find some way that will allow the Municipality to make appropriations for the relief of those men who undergo such dangers and perform such heroic work. This is a matter in which the Municipality has a deep interest.

Even brave men will hesitate to assume a risk in the face of danger when they feel that in case of accident or death there is no provision made for them or their families, and surely these men who so often are compelled to imperil their lives in the preservation of the public peace or in the protection of property should, if possible, from simple motives of gratitude and humanity, be provided for in case they meet with injury.

During the last year three deaths of firemen occurred, resulting from injuries received in the actual performance of duty and 190 men sustained injuries.

*Electrical Bureau.*

The Electrical Bureau is one of the best equipped Bureaus of this character in this or in any other country.

Our Municipal Electrical Plant has attracted attention throughout the world. Its reputation has gone abroad, and strangers visiting this City who are interested in electrical matters make it a point to visit and investigate the plant. After careful and critical inspection it has received the approval and unqualified praise of some of the most scientific men of this and other countries.

The underground system has shown its usefulness and should be continued until overhead wires are entirely removed from the streets.

This system for police and fire service extends throughout the centre of the City, and is most effective in every way. We have, however, but 885 fire alarm boxes, which the Director, in his report, is compelled to say, after careful consideration, is totally inadequate, considering the area of the City. New York has over 2,500 such boxes and I cannot too strongly urge that appropriations be made providing for the extension of this system in all directions throughout the City.

Philadelphia is one of the best lighted cities in this country. We have at this time in use 6,361 electric lights, of which number the City pays for 6,228.

These lights are a great protection to life and property, and it is in no sense false economy to increase the number of lights in every section of the City. This matter involves not only the question of illumination but of protection.

The matter of the establishment of an Electric Light Plant to be owned by the City has not made much progress. An Ordinance was passed by Councils providing for the selection of an expert by the Mayor, one by Councils and another by the two experts so named. Pursuant to that ordinance I appointed an expert, Councils did the same, but the expert named by Councils declined to serve, and subsequently your Honorable Bodies appointed another. The matter is now in the hands of these two experts, to decide upon a third and make report.

*Bureau of Health.*

The Bureau of Health still maintains its great efficiency and the members of that Bureau deserve the highest praise for the loyal and devoted service they give to the matters that fall under their supervision.

Every section of the City is carefully inspected and every precaution is taken to prevent the spread of disease. It is a matter of congratulation that our City last year was not visited by any epidemic and that its general health was good. Nothing induces to health more than cleanliness, and it may be said that in this direction improved pavements have accomplished much good. Further appropriations should be made by your Honorable Bodies, providing for the paving of the small streets, alleys and by-ways of the City with improved pavements and for underground drainage. During the heated term of last summer arrangements were made to utilize the unoccupied wharves on the river front as places of resort after nightfall for the public in the crowded districts. Benches were procured and the wharves were made places of rest and recreation.

There is nothing that is of greater necessity in all large cities than facilities for bathing, and provisions should be made for the erection of public bath houses throughout the City. This matter has received special attention in the cities of the old world, and the results flowing therefrom have been most useful and beneficial.

*Bureau of City Property.*

The public squares may be called the lungs of the City; they are the breathing spots, and I am glad to say that much of the land condemned by the City for this purpose has been utilized. There is nothing that so adds to the appearance of a city or is more conducive to health and to the pleasure of the people than public parks.

Independence Hall will soon be restored to its condition as it existed in 1776. Plans have been prepared and arrangements made to go on with the work at the earliest practicable moment, and it is to be hoped that by the end of this year, the work will be almost completed and that this property so restored and improved will be the most interesting historical spot on this continent.

### *Building Inspection.*

I have again to call the attention of your Honorable Bodies to the inadequate force of Elevator Inspectors, as required by Ordinance of April 10, 1894. No action has yet been taken to provide for the carrying out of the provisions of this ordinance. At the lowest calculation it would take 20 Inspectors to do the work required. With our present force it is utterly impossible for us to fully comply with the law, and it must be borne in mind that this is a matter of importance in view of the fact that so many tall buildings are being erected in the centre of the City, and that the elevators in these buildings are being used day after day without that inspection which should be given and which the law demands. It would be better to repeal the ordinance and do away with the inspection altogether rather than to provide for it inadequately.

## DEPARTMENT OF PUBLIC WORKS.

The Director of the Department of Public Works is to be commended for his intelligent administration of that most important office. The report herewith annexed gives but a faint idea of the work done under his direction.

*Bureau of Gas.*

An examination of the report of the Chief of this Bureau shows that the receipts for the year 1896 were $162,188.61 more than during the previous year, or, in other words, they were $3,318,145.08 for 1896 as against $3,155,956.47 for 1895.

The total output of gas was 501,489,580 cubic feet in 1896 more than during the year 1895. The largest amount of gas made in any twenty-four hours was 19,128,000 cubic feet, and the greatest consumption of gas in any one day was 20,010,000 cubic feet, on December 24th.

A number of improvements have been made, including a pumping station at the Twenty-fifth Ward Works, five charging machines at the Point Breeze Works, together with all the necessary apparatus for breaking and conveying the coal to the machines, the erection of a new holder of 3,000,000 cubic feet capacity, the placing of a third lift on the holder at the Germantown Station, and the construction of a Wilbraham 15-horse power vertical exhaust engine at the Manayunk Station, together with the laying of 42.44 miles of mains and distributing pipes.

In order, however, to bring the City's plant to a proper standard, it will be necessary that large sums of money be expended not only in the introduction of additional improved and modern machinery for the manufacture of gas but in the laying of new and larger mains for its proper distribution and the further increase of the holder capacity.

The gas manufactured by the Philadelphia Gas Works is equal in quality with that made in any City of the Union. In other words, the gas in the holder before distribution is a good illuminant of the necessary candle power, but unfortunately, by reason of our method of distribution, when it reaches the consumer it has lost much of its illuminating quality. This is not due to any fault of the gas itself but to the inefficient and insufficient methods of distribution. The gas has to be forced by great pressure through many miles of small sized or inadequate mains, and by reason of this great pressure the candle power is necessarily reduced because of the excessive friction to which the gas is subjected; it is thereby robbed of its hydro-carbon, which is its light giving quality. This matter of distribution should be taken up and considered with the greatest care, and perhaps it would be advisable under all the circumstances to have an estimate made of the cost that would be involved in effecting the desired changes. Plans should be drawn showing the location, the capacity and the life of the mains, in order that this work may be done systematically and economically. For instance, in one section of the City leading from the Gas Works to supply a certain locality, years ago, a three inches main was laid, which was in that day considered of sufficient size and capacity, but as population increased and passed beyond the limit of the original calculation it was necessary to further extend the main and a six inches main was added, and subsequently, to supply the still growing demand, an eight inches main was laid; thus we have three different sized mains joining each other and used for the purpose of distributing the gas, when in truth and in fact a 20 inches main for the proper distribution of gas in that locality is absolutely required. The fault does not lie in the manufacture of our gas, which is produced from the best coal that can be purchased for the purpose and with the application of scientific methods but in the inadequate and insufficient means of distribution, and until better methods be adopted there can be but little if any improvement.

The Gas Works are a most valuable asset and should never pass from the absolute control of the City. The plant is valued at about $30,000,000, close to the actual debt of the City at this time, and money will be well expended if the changes suggested are carried out.

*Bureau of Highways.*

The highways of the City of Philadelphia are not surpassed by those of any City on this Continent, but work in this direction cannot be continued to any great extent until the City is able to negotiate the loans provided for by ordinance of Councils approved July 16, 1896.

There is nothing that so characterizes a City and gives it a reputation as clean, well paved and well lighted streets. They make travel easy and safe and comparatively noiseless, thus adding to the comfort, convenience and the health of all the citizens.

Under the head of the Bureau of Health I have already referred to the paving of the small streets, but in this connection I desire to say that nothing so induces to cleanliness and comfort in a large City as the paving with asphalt of all the narrow thoroughfares, and this work should go on without interruption until every court and alley is in that condition which will prevent the accumulation of filth, or at least make its removal comparatively an easy task.

*Bureau of Street Cleaning.*

The work of this Bureau is being carefully supervised, and it is a matter of gratification to know that the complaints of all kinds were 1,815 less than during the year 1895; or, in other words, they fell off about one-half from the number made the previous year. It is the purpose of the authorities to insist upon a strict compliance with the specifications, and to enforce a rigid obedience to the terms of all contracts.

The authorities cannot act alone in this matter of street cleaning and much depends upon the intelligent co-operation of the citizens. The sweeping of refuse into the streets is a clear violation of law, and when receptacles for ashes are placed upon the sidewalks the contents should be at least three or four inches below the top of the barrel. The observance of a few rules in these particulars will do much towards assisting the authorities in the keeping of the streets in a cleanly condition.

There should be an ordinance passed providing an appropriation for the removal of snow from the principal business streets in the centre of the City. The suggestions made by both the Director of the Department of Public Safety and the Director of the Department of Public Works in this regard are worthy of careful consideration. As it stands to-day there is no ordinance providing for such removal.

*Bureau of Surveys.*

One of the most important pieces of work in hand at this time is the construction of the Pennsylvania Avenue Subway and Tunnel. The preparatory work incident to this improvement required the preparation of elaborate plans at the hands of this Bureau. The questions involved were intricate and called for careful and scientific study. $4,500,000 of the loan authorized for this purpose has been utilized up to this time. Proposals for the greater part of the work were received after public advertisement on May 12, 1896, the contracts were awarded, and have been most actively pushed forward.

The winter weather unfortunately has in a measure interfered with the progress of the work, but so soon as the weather permits the work will be most vigorously pushed to completion. It is one of the greatest improvements that the City has ever undertaken. It will not only result in great convenience to the public, but will materially enhance the value of property in the immediate neighborhood of the improvement; at the same time it will provide a safe and beautiful access to Fairmount Park and abolish many dangerous grade crossings.

The work of deepening the channels of the Delaware and Schuylkill rivers has been industriously carried on whenever the weather would permit. From Schooner Ledge, in the Delaware river, there have been removed 95,000 cubic yards of overlying material and 3,455 cubic yards of rock. The excavations have been made so as to give 26 feet clear water depth for the full width of the channel. Under the appropriation of $500,000 made by Ordinance of Councils, approved April 13, 1896, from the loan authorized January 13, 1896, surveys have been made and plans prepared for dredging at Greenwich Point, Mifflin Bar, and Schooner Ledge, and every arrangement has been made to begin the work as soon as possible.

The work of widening Delaware avenue and the extension of the City piers is well under way. Plans and specifications have been drawn and the work will be pushed to completion.

This improvement will be of incalculable benefit to the Commerce of the City, and in thus giving facilities for navigation it is to be hoped that much of the trade that has left Philadelphia will again return. Many of the owners of the property on the Delaware river front have shown a most commendable spirit in uniting with the authorities in helping forward this great project.

These matters to which I have referred under the head of the Bureau of Surveys are given in detail in the report of that Bureau, and are worthy of careful consideration.

Let me urge upon your Honorable Bodies the necessity of providing sufficient appropriations for the further construction of main and intercepting sewers. Much of the work of this Bureau in the construction of sewers is hidden from view, and improvements not seen are not sufficiently appreciated; but nothing so conduces to the health of a community as an extensive and scientific system of main and intercepting sewers. To make the system complete it will require at your hands in the neighborhood of $2,000,000, but money so used will bring an adequate return for every penny of outlay.

*Bureau of Water.*

The Report of the Bureau of Water for the past year shows an increase in receipts of $49,276.09 over the year 1895. The total receipts for 1896 were $2,879,133.26, and the expenditures for the same period were $1,825,610.89, showing a net revenue of $1,053,522.37 over all expenditures, both for permanent improvements and the cost of maintenance.

In 1896 there were 37 miles of additional distributing mains laid, making in all 1,212 miles of water-pipe now in use by the City. The work of relining the south basin of the Queen Lane Reservoir has been completed, and on September 10, 1896, water was turned into that basin. The work on the north basin was in progress when the cold weather compelled a cessation. We are now furnishing water from that Reservoir to a locality which heretofore has been compelled to depend upon direct pumpage from the river.

It is of the utmost importance that provision should be made for the construction of a reservoir to supply the people of West Philadelphia; this matter should be taken up and considered at the earliest possible moment. When we have a complete system of subsiding basins and a filtration plant that will answer the purpose, the question of a pure and adequate water supply for our City, for many generations at least, will be settled. The supply and the quality of the Schuylkill water will then meet every demand and requirement. The selection, however, of a filtration plant is one that should be most carefully considered, and experiments should be scientifically made before a final decision is reached.

A supply of pure potable water is the greatest need of our City at this time. The supply has been very much improved by the construction of subsiding basins, and it remains alone for us to introduce a system of filtration that will make that supply pure and healthful. The people are interested in this question, and, so soon as it is decided that the City can create a loan, the matter should be undertaken with an eye single to the introduction of the best plant or system that can be adopted.

Another matter in relation to the use of water to which I desire to call your attention is the necessity of legislation providing against its waste. The ordinance of July 25, 1872, providing for the introduction of meters into mills and factories where water is used in great quantities for manufacturing purposes is defective in that it requires the consent of the mill owner before the meter can be introduced. Taking in view the increase in our population, there must be some provision made against the wasteful use of our water supply. Unless this be done, the time will come when our supply, no matter how great it may be, will fall short of the demand. If we insist upon measuring our gas, there is no reason why we should not measure our water. It has been stated, and no doubt the statement is based upon truth, that there is more water wasted than is legitimately used.

If there were but little waste, the demand upon our reservoir capacity would be lessened, and this in a great measure would result in furnishing a better quality of water to the consumer.

## DEPARTMENT OF CHARITIES AND CORRECTION.

The members of this Department have given their time and devotion to the public service without remuneration save the satisfaction which comes to an official who faithfully performs his duties.

In my last message, I said it would be of great advantage to the Almshouse if it could be removed from its present situation, as that section of the City in which it now stands is improving rapidly and filling up with a new population. It would be a vast improvement if this removal could be effected.

The removal of the Almshouse to the rural districts would provide better and cleaner accommodations for its inmates. Its removal would add greatly to the advantage of the City and the institution.

The Philadelphia Hospital is not included in this suggestion, and should remain in its present location. Both institutions, the Almshouse and Philadelphia Hospital, would be greatly benefited by their separation.

It would be a wise measure to provide for the consolidation of all the poor districts in this county, and place them under the control of the Department of Charities and Correction. The Almshouse at present is overcrowded, while some of the poor houses have comparatively but very few inmates, and they could be used most advantageously by the City to relieve the overcrowded condition of the Almshouse proper. A bill has been offered in the present Legislature providing for such consolidation, and if Councils would pass a resolution urging the passage of that measure, it no doubt would have a good effect and bring about a result which would be of great benefit at this time.

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The progress made by the Free Library since its establishment has been most remarkable, and the people have shown their appreciation of its usefulness.

By a reference to the report of the Board of Trustees fort he year ending September 30, 1896, it will be found that the circulation has reached 1,293,004 volumes.

No institution in this country of a similar character can equal this record. The results have been most beneficent, and speak well for the intelligence of our community.

The success of the library has even surpassed the expectations of its most sanguine friends.

In view of this unparalleled success, your Honorable Bodies will have every reason to provide most liberal support in the matter of future adequate appropriations.

The Commercial Museums have already brought us in touch with the business interests of the world. They have been most useful to merchants and manufacturers, and the exhibits give many lessons daily in those matters with which our business men could not so easily familiarize themselves without the existence of such an institution in our midst. The reputation of the museums has gone abroad, and has done much to advance the commercial importance of our City. They have brought many strangers here who have been impressed with the importance and usefulness of these institutions, and already movements are on foot in another large city to establish museums of like character, and it remains with us as Philadelphians to support them in every honorable way and to maintain their supremacy and usefulness.

In my message I have not gone into details, but have only touched upon those questions which appeal to me as most important, urgent and pressing at this time.

I desire to take this occasion to thank the Select and Common Councils for the loyal and generous support which they have at all times given the administration in its efforts to advance the interests of our great City. If we continue to work together with one purpose, having but one object in view, our united efforts must necessarily reach important results. Together we will be able to accomplish much for the interests of our City, and the honor will be ours to enjoy in common.

I hope that in the future, as in the past, I may receive your loyal assistance in urging forward those improvements that will promote our City to the first position in her rank.

There are some matters to which we should give our early and persistent attention; the improvement of our water supply, increased facilities in the matter of the distribution of our gas, the further extension of paving as well in the courts and smaller streets as upon the principal highways, additional police protection in every section of the City, the building of main and intercepting sewers, adequate provision for the support and maintenance of the Free Library and the Commercial Museums, and last, but by no means least, ample school accommodations for our children.

These are improvements that will materially add to the comfort and prosperity of our people, and redound to the credit and honor of our City.

I am, respectfully,

CHAS. F. WARWICK,

*Mayor.*

ANNUAL REPORT

OF THE

# Department of Public Works,

FOR THE

Year ending December 31, 1896.

# OFFICERS

OF THE

# Department of Public Works.

*Director,*

THOMAS M. THOMPSON.

*Assistant Director,*

HARRY W. QUICK.

CHIEF CLERK—WILLIS SHEBLE.
CLERK—ERNEST T. HANEFELD.
ASSISTANT CLERK—ANDREW L. TEAMER.
STENOGRAPHER AND CLERK—FRED. D. BIDDLE.
STENOGRAPHER AND TYPEWRITER—HARRY. S. STOY
MESSENGER—JOHN P. JUNIOR.

*Superintendent of City Ice Boats,*

H. E. MELVILLE.

*Chiefs of Bureaus.*

GAS—WILLIAN K. PARK.
HIGHWAYS—THOMAS L. HICKS.
LIGHTING—JOHN J. KIRK.
STREET CLEANING—SYLVESTER H. MARTIN.
SURVEYS—GEORGE S. WEBSTER.
WATER—JOHN C. TRAUTWINE, JR.

# TENTH ANNUAL REPORT

OF THE

# Department of Public Works.

**THOMAS M. THOMPSON, Director.**

*Philadelphia, January 2, 1897.*

HON. CHAS. F. WARWICK,
**Mayor of Philadelphia.**

DEAR SIR :—In compliance with the Act of Assembly approved June 1, 1895, I have the honor to present the report of the Department of Public Works for the year ending December 31, 1896—the tenth annual report of the Department.

Included in this report is a summary of the character and extent of the work performed by the Department during the past year. For detail information of the work done, I respectfully refer to the accurate and elaborate statistical reports of the Chiefs of the various Bureaus, which are herewith submitted.

This Department has been administered during the past year with an eye solely to economy and efficiency. It is one of the most difficult branches of the City government to administer; our main trouble has been trying to conduct the affairs of a great Department, with its ever extending necessities, upon a narrow and inadequate appropriation. The sums appropriated to some of the Bureaus were manifestly insufficient for absolutely necessary expenses. For example, the appropriation to the

Bureau of Gas (Item 2) for wages of employees engaged in the manufacture of gas was $905,303.98, while the actual cost of the labor employed was far in excess of this amount. The appropriation to the same Bureau (Item 6) for the purchase of water gas was $700,000, while the Department was required to purchase gas to the extent of $736,100.71. Now, if we had limited the manufacture and purchase of gas according to the appropriation, our citizens would have been, during the latter part of December, absolutely without light. The same condition of affairs existed in the Bureau of Water. The appropriation for maintenance and the purchase of coal for the several pumping stations was absolutely inadequate, and in both of these Bureaus we have been compelled to carry over the deficiencies and pay them out of the appropriation for the next year.

The work done by the Department during the past year has been limited only by the appropriations made for it, and it would be well to state at the outset of this report, that during the year 1896 no money has been available for main sewers, bridges, or for the extension of the water system, or for repaving streets with improved pavements. The few miles of streets repaved were done out of an appropriation made during the latter part of the year 1895, and which was carried over to the year 1896.

### *City Ice Boats.*

On account of the open winter, but two boats were put in commission during the season of 1895-96. Boat No. 1 was in commission thirty-one days and Boat No. 2 thirty-two days, during parts of January and February, 1896.

In accordance with Ordinance of Councils approved June 29, 1896, authorizing the Director of the Department of Public Works to put in commission two City Ice Boats for the use of the naval militia of the State of Pennsylvania for their annual tour of duty, boats Nos. 2 and 3 were commissioned July 10, 1896, for this purpose. They left the City July 11 and returned July 18. The services rendered by the boats on this occasion were eminently satisfactory, as is stated in a letter received by the Department from Francis Shunk Brown, Commander of the Naval Militia, thanking the City for the use of the boats for the annual tour of his command.

Bids were received September 15, 1896, for the electric lighting of Ice Boat No. 3, including a search light. The contract was awarded to the lowest bidder after public advertisement, and the work completed and plant tested December 23. The placing of a search light on this boat will increase its efficiency, and similar plants should be placed on each of the other boats.

The repairs made during the year were of the usual character, and the boats are in good condition for work when needed. At the date of this report (January 2, 1897), the services of the boats have not been required. They are in their dock at the grounds of the House of Correction, with fires under their boilers, and will be put in commission immediately their services are needed.

The current expenditures for the year 1896 were $10,-830.22 less than during the preceding year.

The following comparative summary is an abstract of the work done by the City Ice Boats, and of the receipts and expense of maintenance during the years 1894-95 and 1895-96.

| | 1894 and 1895. | | 1895 and 1896. | |
|---|---|---|---|---|
| | No. | Tonnage. | No. | Tonnage. |
| Vessels Outward | ........ | .............. | 1 | 190 |
| Vessels Inward | 2 | 1,925 | | |
| Veasels Assisted | | | | |
| Totals | 2 | 1,925 | 1 | 190 |

| | 1894 and 1895. | 1895 and 1896. |
|---|---|---|
| Amount received for towage and assistance rendered | $437 08 | $40 00 |
| Amount received for the sale of old material | ................ | 28 12 |
| Total paid City Treasurer | $437 08 | $68 12 |

| | 1895. | 1896. |
|---|---|---|
| Total amount of warrants drawn | $33,597 71 | $22,767 49 |
| Deduct cash paid City Treasurer | 437 08 | 68 12 |
| Actual current expenditure | $33,160 63 | $22,699 37 |

## *Bureau of Gas.*

The report of the Chief of the Bureau shows an increase in the cash receipts and in every item of manufacture and output.

The receipts for 1896 were $162,188.61 more than during the previous year. The statement of profit and loss appended to the report of the Chief of the Bureau, shows a gross profit for the pear of $352,988.80.

To reach correct conclusions as to the actual financial results, there should be added to the receipts of the Bureau, the amount of gas furnished free during the year in lighting buildings used by the City, street lamps, etc., which amounted to 674,031,512 cubic feet. If this had been sold at the present rate ($1.00 per 1,000 cubic feet) it would have added to the receipts of the Bureau $674,-031.51; but under the present system, neither money nor credit is received for the gas thus consumed.

The receipts as reported in detail by the Chief of the Bureau for the year 1896, are as follows:

| | |
|---|---|
| For gas service, etc. | $2,985,925 72 |
| Coke, tar, etc. | 321,620 04 |
| Miscellaneous | 5,976 26 |
| Insurance on building destroyed by fire | 4,623 06 |
| Total | $3,318,145 08 |

To the receipts for gas should be added the value, at $1.00 per 1,000 cubic feet, of the increased quantity of gas sold, for which payment is not due, as follows:

| | |
|---|---|
| December 31, 1896 | 787,387.850 cubic feet |
| December 31, 1895 | 655,074,900 cubic feet |
| | 132,312,950 cubic feet = $132,312.95 |

In addition to the cost for current operations, there was paid out on account of new holder at the Point Breeze Works, for charging machines and appurtenances at the same works, for third lift on holder at Germantown Station, for pumping-house, engine and exhauster at the Twenty-fifth Ward Works, and for supply mains in the various parts of the City, $322,947.41.

The total output of gas was 5,568,535,900 cubic feet, or 501,489,580 cubic feet more than during the previous year. The largest amount of gas made in any twenty-four hours was 19,128,000 cubic feet; and the greatest consumption of gas in the City in any one day was 20,-010,000 cubic feet on December 24th.

There were 313,145 tons of coal carbonized, with an average yield of 4.74 cubic feet of gas to the pound of coal. The average candle power of the gas manufactured during the year was 19.15.

The following are the most important of the improvements made during the year:

Ninth Ward Works.—Rebuilding the coal shed, which was destroyed by fire on January 9, 1896.

Twenty-fifth Ward Works.—Erection of a pumping station, which will enable the Bureau to distribute an increased quantity of gas to Chestnut Hill and the intervening territory; the completion of the coal shed destroyed by fire September 24, 1895; re-erecting Retort House No. 1, which was condemned by the Bureau of Building Inspectors, because of its unsafe condition.

Point Breeze Works.—Five charging machines, with all the necessary appurtenances for breaking and conveying the coal to them. The introduction of these machines will result in a great saving in the labor account. Four turntables for the convenience of the charging and discharging machines. With the increased manufacturing facilities at the Point Breeze Works, we require an enlargement of the coal shed for the reception of coal by rail. When this is provided we will have a thoroughly equipped plant at these works; equal, if not superior, to any in the United tSates.

The new holder of 3,000,000 cubic feet capacity, which was to have been completed December 1, 1896, owing to unavoidable delays, was not finished, but unless some unforeseen accident occurs it will be completed in the early part of 1897.

A third lift was placed on the holder at Germantown Station, and a Wilbraham 15-horse power vertical exhaust engine was put in at the Manayunk Station.

There were laid 42.44 miles of mains and distributing pipes, of which 33 miles were of the smaller sizes, from 4 inches down.

Unaccounted for gas, etc.—The increased amount of leakage or unaccounted for gas each year is due to the insufficient size of many of the distributing mains, which are extended in length from year to year, as the growth of the City makes it necessary to supply gas in new territories. To force the gas through the small mains and reach these extreme distances requires greater pressure at the works or holder stations. To secure a proper distribution of gas we should carry at the works not over two and five-tenths (2.5) water pressure; but in order to meet the demand and supply gas to some sections of the City we are compelled to carry as high as four and nine-tenths (4.9) pressure; this excessive pressure increases condensation in the mains, and in many cases forces leakage at joints, which probably would not leak under less pressure.

The condition of our gas plant to-day implies that additional holder stations should be located in other sections of the City, so as to equalize the pressure, and that the mains should be sufficiently increased in size, so as to pass freely the volume of gas required in any section of the City with the least pressure at the works or holder station ; and the minimum percentage charged to leakage will only be obtained when mains are of adequate size to deliver the quantity of gas required with the least possible resistance at the lowest pressure.

The gas manufactured by the Philadelphia Gas Works is of as good, if not better, quality than that made by any gas works in the United States; but when we are compelled to force gas by great pressure through many miles of small-sized or inadequate mains the candle power will necessarily be reduced by reason of the excessive friction to which the gas is subjected, thereby robbing it of the hydro carbon, which is its light-giving quality ; hence the complaint of poor gas.

Small and insufficient mains are responsible for the unsatisfactory quality of gas furnished our citizens, and which will not be remedied until Councils provide by appropriation for laying larger mains for distributing purposes, and for establishing new holder stations in various parts of the City, that the distribution of gas to all sections shall be at the lowest pressure possible.

The fault is not in the quality of the gas manufactured, but in the system of distribution; this was again demonstrated during the past year. At the period of heaviest consumption it was utterly impossible to meet the demands upon the distributing system in West Philadelphia, Chestnut Hill and other outlying districts ; the service was absolutely inadequate to furnish anywhere near a satisfactory quantity of gas at the time of night when it was most needed.

The Chief of the Bureau, in his report, treats in detail on the subject of leakage; also shows in detail the operations of this Bureau during the past year, and refers to the special needs of the current business.

The following tables give the manufacturing and holder capacities, also the comparative statements of the operations of the Bureau of Gas during the years 1895 and 1896:

*Manufacturing Capacity.*—The following table gives in detail the capacity of the several works:

| Works. | Stacks. | Retorts per Stack. | Total Retorts. | Grand Total. | Maximum Capacity per Works, 24 hours. | Total Maximum Capacity 24 hours. |
|---|---|---|---|---|---|---|
| Ninth Ward........................ | 4 | 150 | 600 | | | |
| | 2 | 194 | 388 | | | |
| Experimental Bench........... | ............ | ............ | 3 | | | |
| | | | | 991 | 6,600,000 | |
| Twenty-first Ward.............. | 1 | 30 | 30 | 30 | 200,000 | |
| Twenty-fifth Ward.............. | 6 | 120 | 720 | 720 | 5,500,000 | |
| Twenty-sixth Ward............ | 6 | 144 | 864 | 864 | 8,000,000 | |
| | | | | | | 20,300,000 |

The above does not include the plant of the Philadelphia Gas Improvement Company, which has a capacity of 11,000,000 cubic feet per day.

There are at the Ninth Ward Works, in addition to the above, eight (8) retorts used exclusively for vaporizing naphtha, for maintaining clear pipes about the works.

The followign table gives in detail the date of construc-tion, the location and capacity of all holders:

| Location. | When Erected. | Dimensions. | Capacity. | Total. |
|---|---|---|---|---|
| | | Feet. | Cubic feet. | |
| Ninth Ward Works | 1851 | 140 x 70 | 1,000,000 | |
| " " | 1871 | 140 x 70 | 1,000,000 | |
| " " | 1844 | 80 x 60 | 300,000 | |
| " " | 1847 | 80 x 60 | 300,000 | 2,600,000 |
| Twenty-fifth Ward Works | 1876 | 140 x 105 | 1,500,000 | |
| " " " | 1876 | 140 x 70 | 1,000,000 | |
| " " " | 1885 | 140 x 105 | 1,500,000 | |
| " " " | 1885 | 140 x 70 | 1,000,000 | |
| " " " | 1889 | 140 x 70 | 1,000,000 | 6,000,000 |
| Point Breeze Works | 1852 | 160 x 90 | 1,800,000 | 1,800,000 |
| Twenty-first Ward Works | ............... | 60 x 38 | 103,000 | |
| " " " | 1884 | 78 x 44 | 200,000 | 303,000 |
| Frankford: Frankford avenue and Buckius street | ............... | 50 x 16 | 31,000 | |
| Frankford: Frankford avenue and Buckius street | ............... | 45 x 16 | 25,000 | |
| Frankford: Frankford avenue and Buckius street | 1869 | 80 x 26 | 130,000 | 186,000 |
| Bridesburg: Richmond and Bridge street | 1869 | 60 x 21 | 59,000 | 59,000 |
| Ninth and Diamond streets | 1869 | 140 x 105 | 1,500,000 | |
| " " " | 1874 | 140 x 105 | 1,500,000 | 3,000,000 |
| Ninth and Mifflin streets | 1874 | 115 x 62 | 600,000 | |
| " " " | 1890 | 160 x 84 | 1,577 00 | 2,177,000 |
| Twenty-fifth and Callowhill sts | 1851 | 100 x 75 | 700,000 | |
| " " " | 1888 | 80 x 42 | 203,000 | 903,000 |
| Germantown: Near Wister Station, P. & R. R. R | 1870 | 100 x 60 | 500,000 | 500,000 |
| Total | | | | 17,528,000 |

*Comparative Statement of the Pipe laid during the years 1895 and 1896.*

| | 1895. | 1896 |
|---|---|---|
| | Feet. | Feet. |
| 2 inch | 1,755 | 922 |
| 3 " | 7,581 | 18,556 |
| 4 " | 157,534 | 158,924 |
| 6 " | 37,517 | 44,671 |
| 8 " | 12,904 | 1,028 |
| 10 " | 368 | |
| 12 " | 8,960 | 24 |
| 20 " | 6,378 | |
| 30 " | | |
| Total | *233,046 | †224,125 |

* 1895 equal te 44.13 miles † 1896 equal to 42.44 miles.

The following is a summary of the receipts and expenditures for the years 1895 and 1896 :

*Comparative Statement of Receipts.*

| Year. | Receipts. | Increase. |
|---|---|---|
| 1895 | $3,155,956 47 | $12,525 18 |
| 1896 | 3,318,145 08 | 162,188 61 |

*Comparative Statemeut of Expenditures.*

| | 1895. | 1896. |
|---|---|---|
| Current expenses | $2,985,513 85 | $3,229,155 70 |
| Extensions | 54,589 59 | 322,947 41 |
| Total | $3,040,103 41 | $3,552,103 11 |

The following table gives in detail the total output of gas and its distribution during the years 1895 and 1896 :

## *Total Output and Distribution of Gas.*

| | 1895. Cubic feet. | 1896. Cubic feet. |
|---|---|---|
| Stock delivered and not paid for, and on hand January 1........ ................................................ | 641,294,320 | 655,074,900 |
| Manufactured and purchased during the year ... { 1895 — Manufactured. 2,728,065,000 — Purchased. 1,694,687,000; 1896 — Manufactured. 2,997,065,000 — Purchased. 1,916,396,000 } ........ | 4,422,752,000 | 4,913,461,000 |
| Total to be accounted for....................................................................... | 5,067,046,320 | 5,568,536,900 |

| | 1895. | | 1896. | |
|---|---|---|---|---|
| | Cubic feet. | Per cent. | Cubic feet. | Per Cent. |
| Delivered to private consumers, for which bills have been rendered............................................. | 2,744,496,900 | 54.16 | 2,945,335,800 | 52.90 |
| Delivered to consumers (bills not rendered) and in holders, December 31.............................................. | 655,074,900 | 12.93 | 787,387,850 | 14.14 |
| Public lighting, etc. (see below) | 1[illegible]7,7[illegible]6,899 | 02.32 | 128,710,042 | 02.30 |
| Street lamps.......................................................................................... | 520,707,106 | 10.28 | 545,321,470 | 09.80 |
| Used at works, offices, stations, etc.............................................................. | 26,840,200 | 00.53 | 29,074,600 | 00.52 |
| Unaccounted for, leakage, etc..................................................................... | 1,002,140,315 | 19.78 | 1,132,646,138 | 20.34 |
| Total................................................................................ | 5,067,046,320 | 100.00 | 5,568,535,900 | 100.00 |

| Public lighting, etc. | 1895. | | 1896. | |
|---|---|---|---|---|
| | Cubic feet. | Per cent. | Cubic feet. | Per cent. |
| Bureau of Police........................................ | 23,261,900 | 00.46 | 23,792,800 | 00.43 |
| Bureau of Fire........................................... | 17,653,400 | 00.35 | 17,421,100 | 00.31 |
| Bureau of Water......................................... | 3,056,800 | 00.06 | 3,026,400 | 00.05 |
| Public Buildings ................................ ....... | 26,895,700 | 00.53 | 36,468,500 | 00.66 |
| Almshouse ................................................. | 20,113,500 | 00.40 | 18,473,900 | 00.33 |
| City Property.............................................. | 3,580,300 | 00.07 | 3,529,800 | 00.06 |
| Public Squares............................................ | 6,621,299 | 00.13 | 6,377,742 | 00.11 |
| Park Commission..... .................................. | 639,900 | 00.01 | 651,000 | 00.01 |
| Schools ....................................................... | 15,964,100 | 00.31 | 17,972,800 | 00.33 |
| Free Libraries........ ................................ .... | ........................ | .................. | 996,000 | 00.01 |

*Comparative Statement of Operations of the Bureau of Gas during the Years 1895 and 1896.*

| | 1895. Cubic Feet. | 1896. Cubic Feet. |
|---|---|---|
| Total output | 4,423,804,000 | 4,911,967,000 |
| Largest production of gas in any 24 hours | ¶ 17,478,000 | * 19,128,00 |
| Largest consumption in any 24 hours | *a* 19,608,000 | *b* 20,010,000 |

* ¶ On December 13th and 24th.
*a b* On December 24th and 24th.

| | Bushels. | Bushels. |
|---|---|---|
| Quantity of coke on hand January 1 | 117,000 | 23,000 |
| Made during the year | 8,256,889 | 8,563,290 |
| Total | 8,373,889 | 8,586,290 |
| Coke sold during the year | 4,009,378 | 3,826,933 |
| Breeze sold during the year | 1,357,480 | 1,532,395 |
| Used under retorts | 2,460,836 | 2,685,382 |
| Used under boilers and lime-kilns | 428,604 | 426,710 |
| In offices, yards and in pipe-laying | 94,591 | 111,870 |
| On hand December 31 | 23,000 | 3,000 |
| Total | 8,373,889 | 8,586,290 |

| | 1895. | 1896. |
|---|---|---|
| Number of meters introduced during the year | 6,535 | 6,698 |
| Total in use | 160,082 | 166,780 |
| Services introduced during the year | 7,106 | 7,082 |
| Total in use | 204,126 | 211,208 |
| Lights added during the year | 131,457 | 139,629 |
| Total in use | 2,904,026 | 3,043,655 |
| Total number of consumers | 161,245 | 168,644 |
| Number of public lamps | 21,621 | 21,614 |

The following table gives the amount of gas consumed in the several Departments of the City during the past two years, and for which the Bureau of Gas receives neither money nor credit:

| | | |
|---|---|---|
| Quantity of gas burned free in 1895 | 638,494,005 | cubic feet. |
| " " " " 1896 | 674,031,512 | " " |

*Bureau of Highways.*

In no direction has greater progress been made in Philadelphia during the past nine years than in the matter of street paving. The system of improved street pavements, which was inaugurated in the year 1887, under the administration of the late ex-Mayor Edwin H. Fitler, has been continued, until to-day we have the best paved streets of any City in the Union. At the close of 1896, there were 968.14 miles of paved streets, of which 633.24 miles are paved with improved pavements; 97.38 miles with cobble; 76 miles with rubble; and 161.52 miles are macadam roads. There are also 406.86 miles of dirt roads.

The report of the Chief of the Bureau shows in detail the work done during the past year, and while in some directions the work has not been as great as in previous years, it has only been limited by the amount appropriated for it. The actual expenditures for the year were $109,060.86 greater than in 1895, but the amount of work done is very much greater than these figures would indicate. The extent of streets repaved or newly paved were 41 miles, 551 linear feet; almost two-thirds of which is new paving. No appropriation was made by Councils during the past year for repaving with improved pavements; the few miles of streets repaved were done out of an appropriation of $500,000 made during the latter part of the year 1895, and which, owing to the lateness of the season, was carried over to 1896.

The amount of grading done during the year was 1,138,778 cubic yards, being a slight increase over 1895. Much more work of this character was authorized by Ordinances of Councils and should have been done, but no money was available for the purpose.

The many small streets, generally known as "tramway" streets, are being rapidly repaved with improved pavement, the work done in 1896 being equal to 1.48 miles. This improvement is an admirable one, both from a sanitary and business standpoint, and will be continued to the extent of the money available for such work, until all these streets have been placed in good condition.

The unpaved and macadamized highways in the suburban districts received the constant attention of the contractors, and at no time have they been found in better condition than at the end of the year just closed.

The sprinkling of macadam roads during the heated term (a system which was inaugurated during the past year) has proven eminently satisfactory, both as a matter of economy in the maintenance of these roads, and in adding to the pleasure and comfort of those driving upon them by keeping the roads free from dust.

Three hundred and ten (310) of the three hundred and twenty-eight (328) bridges under the care of this Bureau received repairs of a greater or lesser extent at a total cost of $56,424.10. There is still under contract, repairs to a few bridges which have not yet been completed but will be in the early part of 1897; also those not reached last year will be put in good condition during 1897 to the extent of the money appropriated for this work.

Owing to the costliness of maintaining bridges, particularly those carrying the highways over railroads, and the rapid deterioration of the iron work, the question of a preservative is of the first importance. In view of this fact, the Bureau of Surveys is now engaged in experimenting upon paint for bridge girders. Plates have been prepared and placed in position on bridges over railroads, with a view of determining the ingredients for the best preservation of iron work exposed under similar conditions.

The sewers of the City have received careful attention, and such repairs as were required have been promptly made at a cost of $16,097.85.

The highways have been greatly improved by the placing of curved curb corners of granite at the intersections of streets paved and repaved, thereby enhancing not only the appearance of the street, but securing more room for vehicles and lessening the liability of accidents. This work has been continued to the full extent of the amount appropriated for the purpose.

The only material decrease was in the item of repairs to paved streets, being 25,116.17 square yards less than in 1895, which fact is due to the limited amount of money appropriated for this character of work.

The following tables give comparative statements in detail of the work done during the years 1895 and 1896, and of the receipts and expenditures of the Bureau of Highways.

*Comparative Statement of Work done.*

| | 1895. | 1896. | |
|---|---|---|---|
| New paving | 149,515.05 | 169,832.14 | Linear ft. |
| Macadamizing (new) | 66,813. | 47,199. | " " |
| Grading | 1,114,823.88 | 1,138,778.93 | Cubic yds. |
| New footway paving | 110,086.50 | 115,478.27 | Square yds. |
| Repairs to paved streets | 329,598.14 | 304,481.97 | " " |
| Footways repaved | 19,448.24 | 23,071.67 | " " |
| Ditches repaved | 109,860.47 | 113,658.18 | " " |
| Gutter stone laid | 21,462.50 | 20,252. | Linear ft. |
| Crossing stone laid | 26,437.68 | 24,090.55 | " " |
| Tramway stone laid | 4,397.41 | 2,825. | " " |
| Curbstone reset | 356,687. | 250,411.29 | " " |
| Wooden trunks | 4,972.66 | 7,263.40 | " " |
| Brick and stone drains | 1,744.50 | 1,104. | " " |
| Hand railings | 3,125.90 | 3,020.90 | " " |
| Broken stone used | 15,964.68 | 20,708.75 | Tons. |
| Macadmizing (resurfacing) | 42,920. | 81,641. | Linear ft. |
| Footway, curb and railroad notices served | 46,025. | 28,755. | |

## *Summary of Work Done in Improved Pavements—New Streets.*

| | 1895. | | 1896. | |
|---|---|---|---|---|
| | Square Yards. | Linear Feet. | Square Yards. | Linear Feet. |
| Granite blocks | 90,090 | 28,293 | 28,244.75 | 8,384.50 |
| Sheet asphalt | 110,342 | 28,544 | 133,995.77 | 39,236.87 |
| Vitrified bricks | 131,051 | 68,629 | 119,011.17 | 46,484.05 |
| Asphalt blocks | 1,309 | 795 | | |
| Macadamizing | 146,024 | 66,313 | 93,773 | 47,199 |
| Total | 478,816 | * 193,074 | 375,024.69 | † 141,304.42 |

## *Replacing Cobblestone with Improved Pavements—Old Streets.*

| | 1895. | | 1896. | |
|---|---|---|---|---|
| | Square Yards. | Linear Feet. | Square Yards. | Linear Feet. |
| Granite blocks | 2,977 | 1,525 | 70,690.16 | 18,608.29 |
| Sheet asphalt | 2,834 | 390 | 116,054.18 | 43,674.90 |
| Vitrified brick | 6,901.03 | 3,795.05 | 17,153.30 | 5,208 |
| Granolithic | 15,722.10 | 16,561 | 6,553.44 | 7,449.96 |
| Slag block | 1,812 | 983 | 1,477.82 | 785.57 |
| Total | 30,246.13 | * 23,254.05 | 211,838.90 | † 75,726.72 |

* 1895. Total amount of new paving 216,328.03 linear feet, equal 40 miles 5,128.05 linear feet.
† 1896. Total amount of new paving 217,031.14 linear feet, equal 41 miles 551 linear feet.

In addition to the work done by the City in paving and repaving of streets with improved pavement, the following statement shows in detail the work done by the passenger railway companies during the year 1896:

| | Paving Linear Feet. | Repaving Linear Feet. | Total Linear Feet. |
|---|---|---|---|
| Granite blocks | 2,335 | 32,985 | 35,320 |
| Granite blocks (old blocks relaid) | ........ | 40,135 | 40,135 |
| Sheet asphalt | ........ | 15,792.17 | 15,792.17 |
| Vitrified bricks | ........ | 15,074 | 15,074 |
| Vitrified bricks (old bricks relaid) | ........ | 280 | 280 |
| Macadam | 2,652 | ........ | 2,652 |
| Remacadamizing | ........ | 40,809 | 40,809 |
| Total | 4,987 | 145,075.17 | 150,062.17 |

Equal to 28 miles 2,222 linear feet at an estimated cost of $425,000.

*Comparative Statement of Receipts.*

| Year. | Receipts. | Increase. |
|---|---|---|
| 1895 | $150,513 24 | |
| 1896 | 155,054 06 | $4,540 82 |

*Comparative Statement of Expenditures.*

| | 1895. | 1896. |
|---|---|---|
| Current expenses | $415,861 82 | $546,931 82 |
| For extensions | 1,006,796 37 | 984,787 23 |
| Totals | $1,422,658 19 | $1,531,719 05 |

*Board of Highway Supervisors.*

The transactions of this Board and its employees are given in detail in the reports of the Secretary and of the

Chief Draughtsman. The report shows a very large increase in the net receipts.

The following is a statement of the number of permits authorized to be issued for electrical conduits during the year 1896:

| | |
|---|---|
| Edison Electric Light Co | 25 |
| Philadelphia Traction Co | 30 |
| Electric Traction Co | 1 |
| Columbia Electric Light Co | 1 |
| Bell Telephone Co | 155 |
| Penn Electric Light Co | 2 |
| Kensington Electric Light Co | 1 |
| Spring Garden Institute | 1 |
| Philada. Standard Telephone and Telegraph Co | 47 |
| Penna. Heat, Light and Power Co | 11 |
| Peoples Passenger Railway Co | 3 |
| Hillcrest Avenue Passenger Railway Co | 1 |
| Total | 278 |

The additions to the plans of underground structures already on file, and the making of new plans, are invaluable aids to corporations and individuals laying sub-structures in our streets.

A study of the plans on file with the Board of Highway Supervisors shows, that in the old City limits the sub-structures are becoming so numerous, that it is quite a difficult problem to determine where to place new ones, and it seems that the only remedy, and, in fact, the proper thing to do, would be to construct subways within which pipes, whether for gas, water, or for wires, can be placed. These structures are costly, but could be made the source of large revenues to the City. Furthermore, when completed, with proper house connections carried to the curb line, there would be no further excuse for breaking the street pavements except such as may be required to repair any possible breaks in the subway itself.

The following is a summary of the transactions of the Board of Highway Supervisors and of the work of the draughting department for the years 1895 and 1896.

## *Transactions of the Board of Highway Supervisors.*

| Permits authorized to be issued. | 1895. | 1896. |
|---|---|---|
| For vaults | 18 | 16 |
| For railroad tracks, curves and turnouts | 192 | 113 |
| For underground pipes | 37 | 17 |
| For electrical conduits | 81 | 278 |
| For erecting bridges | 2 | ........... |
| For tunnels | ........... | 1 |
| For miscellaneous | 2 | ........... |
| For awnings | 360 | 345 |

## *Work done by the Draughtsmen of the Board of Highway Supervisors.*

| | 1895. | 1896. |
|---|---|---|
| Plans of iron awnings drawn | 360 | 341 |
| New street record plans prepared | 176 | 43 |
| Blue print plans placed on file | 167 | 190 |

## *Receipts and Expenditures.*

| | 1895. | 1896. |
|---|---|---|
| Receipts | $10,975 90 | $14,354 36 |
| Expenditures | 4,400 00 | 5,198 93 |
| Profit to the City | $6,575 90 | $9,155 43 |

## *Bureau of Lighting.*

There has been very little increase in the number of public lamps erected during the past year. 2,072 lamps of all kinds were erected and 2,015 were discontinued—a net increase of 57, leaving a total of 39,946 public lamps on December 31, 1896, divided as follows :

| | |
|---|---|
| Gas lamps supplied free with gas from the City works..... | 21,614 |
| Gas lamps supplied from the Northern Liberties works... | 128 |
| Gas lamps maintained by the Bureau of Correction......... | 239 |
| Gasoline lamps.......................................................... | 11,604 |
| Electric arc lights under the care of the Department of Public Safety (Electrical Bureau)............................. | 6,361 |
| Total.............................................................. | 39,946 |

There are 21,614 public lamps under the immediate care of this Bureau. Of this number 2,441 are not lighted, but require to be maintained and cared for. 19,173 were lighted and supplied free with gas from the City works, consuming during the year 545,321,470 cubic feet of gas.

The report of the Chief of the Bureau shows that 43,830 broken glasses were replaced during the year—a little more than two breakages to each lamp. During the year 1895 the breakage was 46,282 lights. These figures are startling, and more stringent measures should be adopted by the proper authorities to prevent the malicious breaking of public lamps.

The gas lamps have been well attended to and kept in good condition by the employees of the Bureau. The gasoline lamps furnished by the Pennsylvania Globe Gas Light Company have been satisfactorily maintained and cared for, and every condition of the contract with the City has been promptly complied with.

The following comparative statement shows the number of gas and gasoline lamps and the expenditures of the Bureau of Lighting during the years 1895 and 1896:

| | 1895. | | 1896. | |
|---|---|---|---|---|
| | No. | Cost. | No. | Cost. |
| Gas lamps under charge of Bureau of Lighting.................................. | 21,621 | $202,548 33 | 21,614 | $202,583 82 |
| Gasoline lamps................................ | 11,538 | 238,728 66 | 11,604 | 242,371 86 |
| Gas lamps supplied by the Northern Liberty Gas Company.................. | 130 | 3,268 07 | 128 | 2,592 85 |
| Gas lamps under charge of Bureau of Correction................................ | 239 | | 239 | |
| Total.......................................... | 33,528 | $444,545 06 | 33,585 | $447,348 53 |

* Not lighted because of proximity to electric lights—1895, 4,182; 1896, 2,441.

*Bureau of Street Cleaning.*

The work of this Bureau during the past year has been of a satisfactory character. The streets of the City have been kept cleaner than ever before, and the garbage and other offal have been promptly removed.

The number of complaints of all kinds was 3,213—1,815 less than during the previous year. This is gratifying, and is attributable partly to a more rigid enforcement of the terms of the contracts, but still more to a conscientious endeavor for honest and efficient service by the contractors.

During the year there have been cleaned 1,178,757 squares, equal to about 117,875 miles of streets, an increase of 29,709 miles over the preceding year; 476,351 inlets have been cleaned, from which were removed 235,681 loads of dirt; 625,228 loads of ashes and house waste have been collected and removed from buildings. This work, which is all done under the street cleaning contracts, cost during 1896, $490,161, or an average of $4.16 per mile per year. This is an exceptionally low figure. The collection and disposal of garbage and dead animals cost $287,060.

It is greatly to be regretted that our citizens, to a great extent, fail to exercise proper care in the filling of ash receptacles and the placing of waste paper therein. Even in some of the best residential streets, receptacles may be seen on the sidewalks filled far above their proper capacity with waste paper, etc., which the first breeze scatters far and wide over the streets.

Legislation governing the filling of ash receptacles and co-operation on the part of property holders and storekeepers would aid in keeping the streets free from litter of all sorts, and greatly improve the appearance of our thoroughfares.

In this connection the Department wishes to acknowledge the good work of the Woman's Health Protective Association and the Civic Club in their efforts to secure cleaner streets and to prevent the scattering of waste paper thereon, also to state that we are in full sympathy with the object of their associations to improve the cleanliness of the City.

The contracts for street cleaning, the collection of ashes, etc., and the removal and disposal of garbage for the year 1897 have been awarded to the lowest bidders after public advertisement, the aggregate amount of which is $843,094—an increase over the contract price of 1896 of $61,176. This increase is attributable to the growth of the City and the increased work required. Many of the streets which last year were cleaned but two or three times each week are required under the specifications for 1897 to be cleaned daily.

I beg to refer to the statement made in my last report, to wit, that if legislation could be effected to permit the making of contracts for the cleaning of streets, the removal and disposal of garbage and other similar work for a term not exceeding five years, the work would be done better and at a less aggregate cost than under the present system of one year contracts.

I would recommend as a matter of health and convenience to the public, that provision be made for the removal of snow from the streets in the business centre of the City, from the Delaware river to Broad street, and from some of the narrow streets lying east and west, where the winter's sun never shines. The cleaning of these streets could then be continued at all seasons, and thereby prevent the accumulations which now occur at each snow fall.

The following is a statement in detail of the operations of the Bureau of Street Cleaning during the year 1896; also the totals for the year 1895 :

## *Total work done during the year 1896.*

| DISTRICTS. | CLEANED. | | | | | REMOVED. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Squares. | Inlets. | Crossings. | Market Houses. | Snow from Fire Plugs. | Number of Dead Animals. | NUMBER OF LOADS. | | | Number of Complaints of all kinds. |
| | | | | | | | Dirt. | Ashes. | Garbage. | |
| First | 285,822 | 158,960 | 34,500 | 299 | 5,110 | 1,467 | 38,253 | 149,630 | 25,593 | 569 |
| Second | 296,690 | 117,813 | 30,798 | 1,230 | 1,959 | 1,532 | 60,411 | 109,805 | 28,499 | 894 |
| Third | 80,557 | 25,609 | 10,951 | 7 | | 1,078 | 10,338 | 46,257 | 15,864 | 723 |
| Fourth | 349,918 | 120,667 | 34,036 | | 289 | 4,427 | 98,915 | 191,631 | 49,455 | 529 |
| Fifth | 144,810 | 36,897 | 49,195 | | 958 | 1,811 | 17,238 | 127,905 | 33,318 | 491 |
| Sixth | 20,960 | 16,405 | 3,672 | | 1,718 | | 10,526 | | | 7 |
| Totals 1896 | 1,178,757 | 476,351 | 163,152 | 1,536 | 10,034 | 10,315 | 235,681 | 625,228 | 152,729 | 3,213 |
| Totals 1895 | 881,664 | 553,501 | 397,738 | 1,546 | 24,525 | 10,295 | 235,866 | 620,065 | 136,513 | 5,028 |

The total expenses of the Bureau of Street Cleaning, for the year 1896, were $801,462.30.

*Bureau of Surveys.*

The works devolving upon the Bureau of Surveys are of the utmost importance, and the proper execution of them has much to do with the present and future welfare of the City. The work of sewer construction does not appeal to the eye, but no municipal work is more essential to the health or comfort of the citizens, and none better repays outlay.

During the year 1896 plans for important improvements have been made as follows: For the revision of streets; construction of main and branch sewers; bridges; widening of Delaware avenue and extension of City piers; for the elevation of the Philadelphia and Trenton Railroad, between Norris and Butler streets; the proposed extension of Fairmount Park; Fairmount Park Concourse; City Hall Plaza; Esplanade on the west bank of the Schuylkill River, and many others of more or less importance.

Main Sewers.—No appropriation having been made during the year 1896 to continue the extension of our main sewer system, it resulted in a lack of construction such as the City has not experienced in many years. The two main sewers authorized December 23, 1895 (one of which was a connection to the intercepting sewer in Manayunk), and one in June, 1896, were practically completed during the year.

The principal main sewer work was done under contracts made in the latter part of the year 1895, and which were carried over and completed during the past year, a detailed account of which will be found in the report of the Chief Engineer.

The construction of a main sewer is the first step in the improvement of any section of a city, and is a subject which should receive the earnest and careful consideration of Councils, and liberal appropriations should be made for this character of work.

There is now listed a number of main sewers, all of which are necessary for the health and proper development of the City, and the construction of which will require an appropriation amounting to upwards of two million (2,000,000) dollars.

Intercepting Systems.—The extension of sewers in territory tributary to the intercepting system is of the utmost importance, and appropriations should be made by Councils to continue the work.

Work upon the intercepting systems during the past year was carried as far as the small amount appropriated for the purpose would permit.

In accordance with the resolution passed by the Bureau of Health, requesting the Department of Public Works to obtain legislation to divert the drainage of numerous streets away from the Schuylkill River, an ordinance was prepared and introduced in City Councils to authorize the extension of intercepting sewers through various streets, to the number of forty, the estimated cost of which amounts to $125,000. The ordinance is still in Councils awaiting an appropriation.

An appropriation should be made to commence the construction of the high level sewer from Rittenhouse street and Wissahickon Drive to the outlet at Twenty-fourth street and Indiana avenue; also, to extend the low level sewer on the west side of the Wissahickon Creek.

Aramingo Canal System.—The work upon the five sewers of this system, commenced in 1895, was completed during the past year, and the beneficial result of the work is apparent in the improved sanitary condition of the neighboring territory. The outlet of the Aramingo Canal sewer at Norris street should be extended to the Delaware River, and it is hoped that Councils will, at an early day, make an appropriation for this work.

Wingohocking System.—Owing to the lack of appropriation, but one small contract was authorized and completed in connection with this system. Mt. Airy, comprising hundreds of suburban homes, with many miles of paved streets, has no sewerage, and must be deprived of efficient drainage until one of the sewers of this system is extended, so as to reach this section. This is urgent and should receive early attention.

I would here call attention to the recommendation made by the Chief Engineer for the drainage of Frankford, one of the most populous and important sections of the City.

Frankford is environed by open streams, which receive all the drainage within its territory, and this sewage reaches the Delaware river through Frankford croek, which is a tidal stream, foul at all times, but worse when the tide recedes, leaving deposits of objectionable matter upon the mud flats to decompose and become still more offensive to the surroundings.

Plans for a drainage system for this section have been prepared; the system is expensive, but it is for the relief of a large area, and the matter should receive early consideration by Councils and an appropriation made sufficient to begin the construction of the system.

The old Cohocksink Sewer was repaired in several places to the extent of the amount appropriated for the work; with the money appropriated for 1897, repairs will be continued wherever the condition of the sewer demands attention.

During the year 22.09 miles of branch sewers were constructed by the City, and under private contract, 8.45 miles.

There were eight contracts for the construction and reconstruction of inlets, not included in sewer contracts, under which 916 inlets were built or rebuilt, 7,249.17 feet of curved granite curbing placed, and 26,338 feet of lateral sewer connections built.

Bridges.—No new bridges were authorized during the past year, consequently active operations in bridge construction have been delayed. To permit of direct communications between certain sections of the City that are now cut off, either by intersecting railroads or where a river or large stream intervenes, new bridges are a necessity, and the demand for them is scarcely less urgent than that for main sewers.

The policy of the City to abolish all grade crossings, prohibits the opening of streets at grade across railroads. This delays the development of those sections of the City unprovided for with bridges.

A list of bridges has been prepared by the Chief Engineer of the Bureau of Surveys, all of which are urgent, and for which ordinances have been introduced in Councils, the approximate cost of which will amount to about $2,000,000. It is therefore apparent to the most casual observer that liberal appropriations for the construction of bridges is very important.

The only active operation upon bridge work during the past year, was the completion of those bridges commenced in previous years, and completed in 1896, a detailed account of which is given in the report of the Chief Engineer.

In the appropriations for the year 1896 (Bureau of Surveys), $250,000 was appropriated for the construction of a bridge over the Schuylkill River at Gray's Ferry. The proviso attached requiring the railroad companies to pay the excess of cost, made the ordinance inoperative. Several conferences were held with the officials of the railroad companies, but as no satisfactory agreement could be reached, Councils finally diverted the money to other purposes.

The ordinance making appropriation to this Department (Bureau of Surveys) for the year 1897 appropriates

$400,000, without a proviso, for the construction of this bridge. Plans for the same are being completed, and the work will be proceeded with immediately upon their completion.

The following three bridges are the most important of those recommended and should receive immediate attention:

The bridge on the line of Thirty-third street, over the Philadelphia and Reading Railroad and over the Connecting Railroad, work upon which has been partially constructed, should be completed in order to utilize the money already expended. The completion of this bridge will give an outlet, by way of Girard avenue and Thirty-fourth street, to the southern part of West Philadelphia, and will complete the eastern boundary of Fairmount Park; also, furnish a beautiful approach to the Park entrances north of Girard avenue.

The bridge built during the year 1895 on the line of Wyoming avenue, over a branch of Frankford Creek, cannot be brought into full service until an additional bridge is constructed over Frankford Creek, near "L" street. When provision is made for the construction of this new bridge, it will open up Wyoming avenue from Germantown to Frankford, and result in developing a large section of the City.

The bridge on the line of Seventeenth street, under the Connecting Railway, has been completed, but the full benefits of the expenditure already made cannot be realized until an additional bridge is constructed on the line of this street over the Philadelphia, Germantown and Norristown Railroad. The construction of this additional bridge will open up a thoroughfare between the main portion of the City and Tioga, which is a rapidly growing suburb.

All three of these bridges are very important structures, and ordinances should be passed authorizing their construction, and making appropriations to pay for the work.

Pennsylvania Avenue Subway and Tunnel.—There has been no work devolving upon the Chief Engineer of the Bureau of Surveys heretofore which has been more complicated or included such a variety of engineering problems as the construction of the Pennsylvania Avenue Subway and Tunnel. If the ground were clear, the task would not be so difficult, but to do this work while the railroad system is in use, without impeding traffic and without disturbing the business of the great manufacturturing concerns dependent on it, involved a series of problems, all of which had to be foreseen and provided for before the work could be begun.

After elaborate study and the preparation of all general and detail drawings and specifications, proposals for this work were received after public advertisement on May 12, 1896. The contracts were awarded, and work was actively begun in the month of August, 1896, and has been prosecuted with much vigor.

The summary of work done up to the present time is shown in detail in the report of the Chief Engineer. Owing to the severe winter weather, the work on the subway has practically ceased, but will be taken up again in the early spring and pushed vigorously throughout the year.

Delaware and Schuylkill Rivers.—The contracts for improving the channels of the Delaware and Schuylkill Rivers, which were in force at the beginning of the year 1896, were proceeded with as soon as the condition of the river would permit. From Schooner Ledge, in the Delaware River, there has been removed 95,000 cubic yards of overlying material and 3,455 cubic yards of rock. The excavations have been carried on as far as the money appropriated for the purpose would permit, so as to give 26 feet clear water depth for the full width of the channel. There has been blasted but not yet removed, all the rock it is intended to take out under the present contract.

Councils by ordinance approved April 13, 1896, appropriated $500,000 from the loan authorized January 13, 1896, for additional dredging in the Delaware River. Surveys have been made and plans prepared for dredging at Greenwich Point, Mifflin Bar and Schooner Ledge, and active work will be commenced as soon as possible after the loan has been negotiated. With the completion of this work, there will be a clear water depth of 26 feet between the harbor and Cherry Island Flats, where the United States Government is now operating.

With the removal of the Dan Baker Shoal and the dredging of a passage over Duck Creek Flats, all of which work has been initiated by the Government, there will be a free and uninterrupted channel to the sea, so that vessels of the deepest draft need have no hesitation and find no trouble in coming to our port.

The dredging of the Schuylkill River has progressed during the past year. Contract No. 2 was completed August 22, 1896. Under this contract there were removed 89,370 cubic yards of material, consisting of mud and gravel, all of which was removed within a channel of 250 feet, and a clear water depth of 22 feet, for a distance of 2,900 feet north from Penrose Ferry Bridge. Appropriations have been made to continue the dredging of the Schuylkill River, from a point about one-half mile above Penrose Ferry Bridge to Fifty-eighth street and from Fifty-eighth street to Walnut Street Bridge. Contracts have been made and the work will be proceeded with early in the spring.

Widening of Delaware Avenue and Extension of City Piers.—Surveys for this work have been made and plans and specifications are being completed, and it is expected that active operations will be begun early in 1897.

District Surveyors.—The thirteen District Surveyors and Regulators have had under their direction during 1896 119 assistants, and the work done by them aggregates in value $255,670.26. The profit to the City from their offices for the year 1896 has been $85,006.32. Thirty-nine meetings were held, nine of which were road day meetings; five hundred and thirty-one references from the Survey Committee were received, acted upon and reported back to the Committee. Seventy-two plans showing changes in street railways were approved, and one hundred and sixty revisions of City Plans confirmed.

On December 27, 1895, an ordinance was approved, entitled "An Ordinance to authorize the Department of Public Works to revise and change the names of intermediate streets." This subject has occupied the attention of the Board of Surveyors during the past year, and good progress has been made.

The following is a summary of the receipts and expenditures of the District Surveyors for the year 1896 and in totals for the year 1895:

## Summary of Receipts and Expenses of District Surveyors.

| Districts. | Surveyors. | Cash Receipts. | Credit for work done for the City. | Total Credit. | Expenses. Salaries. | Expenses. Pay of Assistants. | Expenses. Miscellaneous. | Expenses. Total. | Balance Profit to the City. | Profit to the City in 1895. | Increase. | Decrease. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Thomas Daly...... | $8,401 93 | $9,521 74 | $17,923 67 | $3,000 00 | $6,564 96 | $1,155 30 | $10,720 26 | $7,203 41 | $16,203 20 | ............ | $8,999 79 |
| 2 | Charles W. Close.... | 5,932 79 | 5,635 87 | 11,568 66 | 3,000 00 | 6,300 00 | 1,199 09 | 10,499 09 | 1,069 57 | 7,082 90 | ............ | 6,013 33 |
| 3 | W. C. Cranmer...... | 7,857 73 | 11,481 38 | 19,339 11 | 3,000 00 | 10,099 92 | 1,399 72 | 14,499 64 | 4,839 47 | 9,215 80 | ............ | 4,376 33 |
| 4 | Frits Bloch.......... | 6,421 45 | 11,255 15 | 17,676 60 | 3,000 00 | 7,194 16 | 1,405 84 | 11,600 00 | 6,076 60 | 5,969 57 | $107 03 | |
| 5 | Walter Brinton...... | 9,710 69 | 9,803 82 | 19,514 51 | 3,000 00 | 7,763 96 | 1,834 53 | 12,598 49 | 6,916 02 | 8,472 12 | ............ | 1,556 10 |
| 6 | Joseph Mercer........ | 17,873 49 | 15,126 17 | 32,999 66 | 3,000 00 | 8,339 97 | 1,800 03 | 13,140 00 | 19,859 66 | 34,735 22 | ............ | 14,875 56 |
| 7 | Wm. K. Carlile...... | 5,893 58 | 7,221 61 | 13,115 19 | 3,000 00 | 5,585 96 | 1,513 56 | 10,099 52 | 3,015 67 | 9,002 56 | ............ | 5,986 89 |
| 8 | C. A. Sundstrom..... | 4,827 47 | 12,776 51 | 17,603 98 | 3,000 00 | 10,699 92 | 2,200 06 | 15,899 98 | 1,704 00 | 181 64 | 1,522 36 | |
| 9 | Jos. C. Wagner...... | 11,041 14 | 8,535 68 | 19,576 82 | 3,000 00 | 9,482 00 | 2,169 14 | 14,651 14 | 4,925 68 | 2,840 09 | 2,085 59 | |
| 10 | Jno. H. Webster, Jr | 9,678 22 | 12,997 09 | 22,675 31 | 3,000 00 | 11,349 92 | 2,450 08 | 16,800 00 | 5,875 31 | 9,416 52 | ............ | 3,571 21 |
| 11 | Joseph Johnson..... | 10,860 56 | 12,288 19 | 23,148 75 | 3,000 00 | 9,545 96 | 2,254 04 | 14,800 00 | 8,348 75 | 7,285 54 | 1,063 21 | |
| 12 | J. H. Gillingham... | 8,958 03 | 9,943 53 | 18,901 56 | 3,000 00 | 6,543 29 | 1,879 84 | 11,423 13 | 7,478 43 | 8,912 98 | ............ | 1,434 55 |
| 13 | H. M. Fuller.......... | 15,382 71 | 6,243 73 | 21,626 44 | 3,000 00 | 9,163 96 | 1,768 73 | 13,932 69 | 7,693 75 | 7,577 91 | 115 84 | |
| | Total, 1896... | $122,839 79 | $132,830 47 | $255,670 26 | $39,000 00 | $108,633 98 | $23,029 96 | $170,663 94 | $85,003 32 | $126,926 05 | $4,894 03 | *46,813 76 |
| | Total, 1895... | 151,081 45 | 152,693 71 | 303,775 16 | 39,000 00 | 112,816 53 | 25,032 58 | 176,849 11 | 126,926 05 | 202,527 17 | 7,236 76 | †82,837 88 |

† Net decrease, 1895, $75,601.12. * Net decrease, 1896, $41,919.73.

Registry Division.—The report of the Chief Engineer gives in detail the work of the Registry Division, which has materially increased during the past year. In the matter of renewing worn-out plan books far more work was accomplished during the past year than in any previous year. Keeping the books of the Registry Division completed and up to date is a feature of its work, which is becoming more important every year.

The following is a comparative summary of the operations of the Registry Division of the Bureau of Surveys, during the years 1895 and 1896:

| | 1895. | 1896. |
|---|---|---|
| Number of certificates registered owners issued | 13,620 | 13,770 |
| Number issued for use of the Law Department | 498 | 569 |
| Receipts from certificates of registered owners | $3,381 00 | $3,432 50 |
| Number of original lots plotted | 13,103 | 13,269 |
| Number of transfers registered | 26,978 | 29,026 |
| Number of plans made for use of City departments, bureaus, etc. | 305 | 494 |
| Number of examinations of registry plan books made by the public | 30,490 | 35,673 |
| Number of descriptions of property filed for registry | 39,680 | 42,690 |
| Number of titles perfected | 2,215 | 2,560 |
| Number of certificates of legal opening of streets issued to bureaus, etc | 2,794 | 3,141 |
| Number of certificates of registered owners in municipal lien cases for Law Department | 2,854 | 2,177 |

The following tables give a comparative summary of the operations of the Bureau of Surveys, in the active construction of work; also of receipts and expenditures during the years of 1895 and 1896:

## *Comparative Summary of Main, Branch, and Private Sewers and Bridges built during the years 1895 and 1896.*

| | 1895. | | 1896. | |
|---|---|---|---|---|
| | No. | Linear Feet. | No. | Linear Feet. |
| Bridges | 16 | ........ | 6 | |
| Intercepting sewer (section) | 5 | 9,865 | | |
| Intercepting sewer connections | ........ | ........ | 2 | 5,990 |
| Wissahickon Valley sewer (section) | | | | |
| Main sewers | 22 | 25,012 | 2 | 12,671 |
| Branch sewers | 328 | 224,693 | 294 | 116,633 |
| Private sewers | 109 | 59,181 | 94 | 44,611 |
| Subway sewers | 5 | 13,886 | | |
| Total | 485 | *332,637 | 398 | †179,905 |

*1895, equal to 62.97 miles. †1896, equal to 34.07 miles.

## *Comparative Statement of Work upon Bridges during he Years 1895 and 1896.*

| | 1895. | 1896. |
|---|---|---|
| Finished | 16 | 6 |
| Begun | 5 | 1 |
| Authorized | ........ | 1 |
| Planned | 8 | 8 |

## *Comparative Statement of Receipts.*

| Year. | Receipts of Bureau. | Receipts of istrict Surveyors. | Total. | Decrease. |
|---|---|---|---|---|
| 1895. | 62,585 17 | 151,081 45 | 213,666 62 | |
| 1896. | 58,558 70 | 122,839 79 | 181,398 49 | $32,268 18 |

*Comparative Statement of Expenditures.*

| | 1895. | 1896. |
|---|---|---|
| Current expenses | $246,404 34 | $245,951 48 |
| For extensions | 1,610,347 65 | 896,641 45 |
| Total | $1,856,751 99 | $1,142,592 93 |

*Bureau of Water.*

The financial statement of the Bureau of Water for the past year shows an increase in receipts of $49,276.09 over the preceding year. The total receipts for the year were $2,879,133.26. The expenditures for the same period were $1,825,610.89, showing a net revenue of $1,053,522.37 over all expenditures both for permanent improvements and the cost of maintenance.

During the past year the service has been improved by the laying of 37 miles of additional distributing mains, making an aggregate of 1,212 miles of water pipe now in use by the City.

The two new pumping engines at the Queen Lane Pumping Station referred to in my report for the year 1895, have been completed and put in service, increasing the pumping capacity 40,000,000 gallons daily. The four pumping engines at the Queen Lane Pumping Station are now all in running order and the Queen Lane Reservoir is in condition to hold its full depth of water, but owing to the lack of appropriation, the Department has been unable to lay the second pumping main between the Station and the Reservoir—therefore we are unable to utilize this station to its full pumpage capacity. The lack of this main also prevents us from supplying from the Queen Lane Reservoir, the whole of what was known as the direct pumpage district, and should an accident occur to the one pumping main we have at present, the whole of this system would be thrown out of service and we would be compelled to resort to direct pumpage for the entire district.

Necessary repairs were made to the pumping engines and boilers at the several stations, and minor repairs have been made to several of the reservoirs in addition to the relining of the Queen Lane reservoir. During the past summer. while the water in the Schuylkill river was at a low level, the dam at Fairmount was inspected and as far as possible the leaks were repaired.

Owing to the fact that no appropriations were made during the year for extensions or improvements except for repairs to reservoirs, for which special appropriations were made, but little work other than repairs to reservoirs has been accomplished.

The increasing consumption of water is rapidly outgrowing the facilities of our distribution system, resulting in numerous complaints from the central and other sections of the City where the supply is very inadequate, and it cannot be long before the restriction of the water supply by reason of inadequate mains, must become a serious menace to various sections of the City.

There was pumped during the past year 87,693,642,529 gallons of water. The average daily pumpage was 239,600,116 gallons, an increase of 23,775,872 gallons daily over that of the previous year, or over 8,000,000,000 gallons more than the total pumpage of the year 1895. The increase in the consumption of water continues. The average increase in our daily consumption during the past year was 22,393,837 gallons. The daily consumption per capita was 172.5 gallons. The question naturally arises, what are the causes of this great and constantly increasing use of water? Is the increase due to legitimate use or is it due to wasteful and extravagant uses of the water? There is no subject more intimately connected with the health of the community than the water supply—in fact, a plentiful supply of pure water is necessary for the realization of the best development of a modern civilized community.

The amount of water actually needed by a City is not to be measured by the quantity supplied, for in most of our cities the quantity wasted is larger than that legitimately used. This is shown by the decrease in consumption when measures are adopted to check waste. People never think of saving what costs them nothing, and this holds true in the matter of the water supplied by the City. If the City should abolish gas meters and furnish gas at a fixed price per annum, does any one doubt that the consumption would be doubled?

The experience of almost every City is alike in this respect, and when water meters have been put into the houses, so that the occupants have been obliged to pay for the water which they use, the quantity used was greatly decreased. The waste of water is a municipal sin and a movement to restrict our water supply to its legitimate use should precede the movement to increase the amount of supply.

Queen Lane Reservoir.—The work of relining the South basin of the Queen Lane Reservoir was completed, and on September 10, 1896, water was turned into that basin. The slope work on the North basin was completed, and about two-thirds of the floor covered, when the approach of cold weather caused a cessation in the work. The contractors carefully protected the exposed edges of the finished floor work, and on December 15th water was turned into the North basin. During the repairs to each of the basins at the Queen Lane Reservoir, a considerable depth of water was kept in the other basin and this was utilized for the relief of the larger portion of the direct pumpage district and with very satisfactory results. Sections of this district which heretofore have suffered because of inadequate pressure, have been given relief, and when the second pumping main between the pumping station and the reservoir, and the balance of the mains which comprise the Queen Lane Distribution System are laid, satisfactory pressure from the reservoir can be maintained throughout what has heretofore been known as the direct pumpage district.

On July 6th a 48-inch pumping main at Spring Garden Pumping Station broke, near the east side of the Philadelphia and Reading R. R.; and on July 11th a 48-inch supply main broke near Thirty-third and Oxford streets, both the breaks bringing down great quantities of earth and gravel to the doors of the Spring Garden Pumping Station. Owing to the precaution taken after the breaks in 1895 of building diverting walls in front of most of the openings in the building of this station, in neither case was the quantity of dirt washed into the pump wells such as to prevent the operation of the pumps.

During the past year several schemes have been submitted by private corporations for a future water supply, the conditions of which required the turning over to them more or less of the functions of the Bureau of Water. Two of these propositions received serious consideration by Councils, but their intrinsic merit appeared to be overshadowed because of diverting large sums of money from the City Treasury without adequate returns. The time will come when it will be found that from the data gathered and the surveys and inspections heretofore made by the City Engineers, the Department can, within any reasonable time, present plans for the future permanent water supply of our City, and this without the intervention of either capitalists or promoters of joint stock companies.

The operations of the construction and repair shop have grown with the increased work of the Bureau. The output of material from the shop is of better quality and is more rapidly secured than from private establishments, and the saving of time is an important factor of its work.

A new electric light plant was installed at the Spring Garden Pumping Station, and the two engines and dynamos which were removed from this station have been placed at the Queen Lane Station, and are giving satisfactory service.

In my estimate of the requirements of this Department for the year 1896, and which was submitted to the Finance Committee of Councils in December, 1895, I stated that over $2,000,000 would be required by the Bureau of Water for the improvement of the pumping stations and for the extension of the pumping and supply mains. This amount was increased in my estimate for 1897, but thus far no appropriation has been made, consequently several of our pumping stations cannot be utilized to their full capacities, and but little improvement has been made to the distribution system.

I cannot too strongly recommend the construction of two additional reservoirs—one at George's Hill, in the Twenty-fourth Ward, for the supply of West Philadelphia, a section of our City which is growing rapidly. The present reservoir is inadequate, containing only one and one-half ($1\frac{1}{2}$) days' supply. We should have at least a 200,000,000 gallon reservoir, so that, when the water from the Schuylkill River is discolored, we would not be compelled to resort to direct pumpage.

I would also recommend that an additional reservoir be constructed in connection with the Wentz Farm Basin at Frankford, to be not less than 75,000,000 to 100,000,000 gallons capacity.

The most pressing needs of the Bureau of Water at this time are as follows:

A new reservoir in Fairmount Park to supply West Philadelphia.

The Belmont Reservoir, in West Philadelphia, holds less than two days' supply, and should the pumps at Belmont shut down for forty-eight hours, all of West Philadelphia would be without water.

A new reservoir to connect with the Wentz Farm Reservoir, to aid in supplying the district now inadequately supplied from this reservoir.

A new 3,000,000 gallon pump at the Belmont high service station, and a new 5,000,000 gallon pump at the Roxborough high service station. At both these stations we are compelled to run the engines night and day, and during the past year they were kept in constant operation without repairs of any kind. An accident to either of these pumps would throw the station out of service and deprive the district supplied by it of water. It is very important that supplemental or relief engines be provided for both these stations.

Belmont.—Five new boilers, engine house and stack.

The No. 4 Worthington high duty pump, removed in 1894 from the Spring Garden Pumping Station to Belmont, is without other protection from the weather save the rude house of boards placed over it by the employes of the Bureau.

Roxborough.—A new 10,000,000 gallon triple expansion pump and boilers, with the necessary engine and boiler house, and stack and intake. As all the water for the supply of Manayunk, Germantown, Chestnut Hill and Roxborough is pumped at this station, it is a question of a short time only as to its ability to meet the demands made upon it, with its present facilities.

Queen Lane.—Coal shed and tunnel. This station is still supplied with coal hauled from Wissahickon Station at a cost of 29 cents per ton in excess of the price paid at

Spring Garden and other stations. This coal shed should be built or other means provided for the proper and economical supply of fuel.

Laying a second pumping main from the pumping station to the reservoir.

Spring Garden.—A new coal shed and storage yard are needed at this station.

Fairmount.—The buildings at this station have long been in need of repairs and it is important that the roof over wheels Nos. 7, 8 and 9 should receive prompt attention, in order that the machinery may be protected from water which percolates through the roof.

Large distributing mains are absolutely necessary in many parts of the City to increase the supply in the older portions and to supply the many thousands of new houses erected annually.

Filtration.—In my estimate for the year 1896, I asked for an appropriation of $250,000 for the purpose of establishing one or more filter plants, to determine the best method to adopt for filtering our water supply; also demonstrate the advantages to be obtained by filtration. This appropriation was not granted.

On December 9, 1896, Councils passed an ordinance authorizing a loan of $3,000,000 for the purposes of filtration, but the legality of the ordinance having been questioned, the loan has not been negotiated and cannot be until the question under dispute is decided by the Court. Therefore, the important matter of filtration is still held in abeyance.

Filtration, as carried on under the latest improved methods, is not a costly matter. It is vastly cheaper than sickness or death to a community. Filter beds, it is unanimously agreed upon by almost all expert engineers, is the only true and absolutely safe method, as far as is known at the present time, of filtering water for domestic purposes, when the supply comes from the surface as from rivers and other similar sources.

The pollution of the water supply of the City has become such a serious matter that some definite and positive action must be taken in the very near future for its purification.

The following tables give the number and types of engines, the locations of reservoirs, and a comparative summary of the operations of the Bureau of Water; also, receipts and expenditures for the years 1895 and 1896:

*Statement of the Number and Type of Engines and their Several Aggregate Capacities at the Various Stations.*

| Pumping Station. | | Designated number of engine or turbine. | Type of Engine. | Designed capacity in million gallons per day. | Total. |
|---|---|---|---|---|---|
| Spring Garden. | Old Station | 5 | Compound Rotary | 20,000,000 | |
| | " " | 6 | Simpson's Compound Rotary | 10,000,000 | |
| | " " | 7 | Marine Compound Rotary | 20,000,000 | |
| | " " | 8 | Worthington Duplex | 10,000,000 | |
| | " " | 11 | Gaskill | 20,000,000 | |
| | New Station | 9 | Worthington Duplex | 15,000,000 | |
| | " " | 10 | " " | 15,000,000 | |
| | " " | 2 | Holly | 30,000,000 | |
| | " " | 3 | " | 30,000,000 | 170,000,000 |
| Queen Lane | | 1 | Southwark | 20,000,000 | |
| " " | | 2 | " | 20,000,000 | |
| " " | | 3 | " | 20,000,000 | |
| " " | | 4 | " | 20,000,000 | 80,000,000 |
| Belmont | | 1 | Worthington Duplex | 5,000,000 | |
| " | | 2 | " " | 5,000,000 | |
| " | | 3 | " " | 8,000,000 | |
| " | | 4 | " " | 20,000,000 | 38,000,000 |
| Belmont Auxiliary | | 1 | Worthington | 2,000,000 | |
| " " | | 2 | Snow | 500,000 | 2,500,000 |
| Roxborough | | 1 | Southwark | 12,000,000 | |
| " | | 2 | Worthington Duplex | 5,000,000 | |
| " | | 3 | " " | 7,500,000 | 24,500,000 |
| Roxborough Auxiliary | | 1 | Worthington | 5,000,000 | 5,000,000 |
| Mt. Airy | | 1 | Davidson | 1,000,000 | |
| " " | | 2 | " | 1,000,000 | |
| " " | | 3 | Knowles | 1,000,000 | 3,000 000 |
| Chestnut Hill | | 1 | Knowles | 250,000 | |
| " " | | 2 | Worthington Duplex | 500,000 | 750,000 |
| Frankford | | 1 | Marine Compound Rotary | 10,000,000 | |
| " | | 2 | Corliss Compound Rotary | 10,000,000 | |
| " | | 3 | Southwark Rotary | 15,000,000 | 35,000,000 |
| Fairmount. | New House | 1 | Turbine Wheels | 2,000,000 | |
| | " " | 3 | " " | 5,330,000 | |
| | " " | 4 | " " | 5,330,000 | |
| | " " | 5 | " " | 5,330,000 | |
| | Old " | 7 | " " | 5,100,000 | |
| | " " | 8 | " " | 5,100,000 | |
| | " " | 9 | " " | 5,100,000 | 33,290,000 |
| Total | | | | | 392,040,000 |

## *Statement of the Location, Date of Completion, Elevation, and Capacity of the City's Reservoirs.*

| | Name of Reservoir. | Location. | Date of Completion. | Height above City Datum. | Capacity in Gallons, |
|---|---|---|---|---|---|
| Fairmount. | Reservoir No. 1 | East Fairmount Park | 1815 | 94 feet. | 26,350,000 |
| | " " 2 | | 1821 | | |
| | " " 3 | | 1827 | | |
| | " " 4, Section 1 | | 1835 | | |
| | " " 4, " 2 | | 1836 | | |
| | " " 4, " 3 | | 1836 | | |
| Lehigh | Section 1 | Sixth and Lehigh avenue | 1852 and 1871 | 114 " | 28,910,000 |
| | " 2 | | | | |
| | " 3 | | | | |
| | Spring Garden | Twenty-sixth and Master streets | 1844 | 120 " | 12,950,000 |
| | Corinthian | Corinthian avenue and Poplar street | 1852 | 120 " | 37,341,400 |
| East Park. | Section 1 | East Fairmount Park | 1887 | 133 " | 62,738,000 |
| | " 2 | | 1888 | | 306,400,000 |
| | " 3 | | 1889 | | 319,480,000 |
| Queen Lane. | North Basin | Thirty-third street and Queen lane | 1894 | 238 " | 205,620,000 |
| | South Basin | | | | 177,480,000 |
| | Frankford | Oxford Turnpike and Comly street | 1877 | 167 " | 36,046,000 |
| | Belmont | West Fairmount Park | 1870 | 212 " | 39,758,000 |
| | Mount Airy | Allen's lane and Mower street, Germantown | 1851 | 363 " | 4,546,000 |
| | Roxborough | Ridge and Shawmont avenues | 1866 | 366 " | 12,838,000 |
| New Rox-borough. | North Basin | Port Royal avenue and Ann street | 1893 | 414 " | 71,59[illegible],000 |
| | South Basin | | | | 75,438,000 |
| | Manatawna tanks—2 | Manatawna and Ridge avenues | 1878 | 442 " | 107,000 |
| | Chestnut Hill tank | Hartwell avenue and Chestnut Hill Railroad, Chestnut Hill | 1860 | 481 " | 52,000 |
| | Belmont Stand Pipe | West Fairmount Park | 1895 | 148 " | 106,000 |
| | Roxborough Stand Pipe | Port Royal avenue and Ann street | 1895 | 490 " | 106,000 |
| | Total | | | | 1,417,860,400 |

*A Comparative Statement of the Total Pipe Laid, and of other Work done during the Years 1895 and 1896.*

| YEAR. | PIPE LAID. | | | *PIPE RELAID. | FIRE HYDRANTS PLACED IN POSITION. | | | SUBSTITUTED FOR DEFECTIVE HYDRANTS. | | | Fire Hydrants in use. | Water Attachments in use. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FEET. | EQUAL TO | | | | | | | | | | |
| | | Miles. | Feet. | Feet. | New Style | Old Style. | Total. | New Style | Old Style. | Total. | | |
| 1895 | 209,295 | 39 | 3,375 | 31,063 | 902 | ........ | 902 | 379 | 4 | 383 | 10,038 | 10,410 |
| 1896 | 196,839 | 37 | 1,479 | 71,189 | 732 | 1 | 733 | 384 | 6 | 390 | 10,624 | 7,860 |

Total pipe laid, 1,212 miles, 301 linear feet.

*Adds nothing to feet in ground.

## *Comparative Statement of Receipts and Expenditures for the years 1895 and 1896.*

### *Receipts.*

| | 1895 | 1896 |
|---|---|---|
| Receipts from water rents | $2,367,057 60 | $2,441,683 95 |
| " " fractional rent | 166,713 87 | 193,684 38 |
| " " water pipes | 161,285 14 | 131,602 69 |
| " " City Solicitor's office | 46,994 07 | 43,806 52 |
| " " penalties | 37,498 56 | 36,417 98 |
| " " delinquent rent | 28,920 75 | 19,132 75 |
| " " Chief Engineer's office | 11,676 44 | 4,875 91 |
| " " searches | 5,539 25 | 5,633 50 |
| " " delinquent penalties | 4,171 49 | 2,295 58 |
| Total | $2,829,857 17 | $2,879,133 26 |

### *Expenditures.*

| | 1895 | 1896 |
|---|---|---|
| Current expenses | $1,509,902 97 | $1,307,696 40 |
| For extensions | 387,322 23 | 517,914 49 |
| Total | $1,897,225 20 | $1,825,610 89 |

## *Comparative Statement of Pumpage for the years 1895 and 1896.*

### *Pumpage.*

| | 1895. Gallons. | 1896. Gallons. |
|---|---|---|
| Pumped to reservoirs | 78,775,849,104 | 87,693,642,529 |
| Equal to gallons pumped 100 feet high | 132,040,954,195 | 161,776,711,[illegible]13 |

NOTE.—The "pumped to reservoir, etc.," includes 1,465,281,570 gallons of repumpage to higher levels at the Mt. Airy, Roxborough and Belmont Auxiliary Stations.

This deducted from the total pumped, gives 86,228,360,959 gallons as the total consumption.

The cost of pumpage is calculated on the total pumpage, and the consumption per capita on the smaller quantity.

| | 1895. Gallons. | 1896. Gallons. |
|---|---|---|
| Pumped by water-power | 7,587,193,211 | 8,959,846,128 |
| Pumped by steam-power | 71,188,655,893 | 78,738,796,401 |
| Largest quantity pumped in 24 hours | 258,838,527 | 286,955,648 |
| Smallest quantity pumped in 24 hours | 133,916,719 | 72,148,883 |

| Year. | Average daily Consumption. | Average consumption in gallons per capita per day, estimating the population at* | Increase of | Increase per capita per day. | Cost per 1,000,000 gallons pumped 100 ft. high. |
|---|---|---|---|---|---|
| | Gallons. | Gallons. | Gallons. | Gallons. | |
| 1895 | 213,202,777 | 160 3 | 6,381,670,823 | 2.2 | 3.69 |
| 1896 | 235,596,614 | 172.5 | 8,409,347,349 | 12.2 | 3.43 |

*1895—1,329,957 estimated.

1896—1,367,815 estimated.

The cost of pumping one million gallons lifted one hundred feet high was $3.43, or 26 cents less than in the previous year.

Nine per cent. of the total pumpage was by water-power, the turbine wheels using....268,795,383,840 gallons.
To pump.... 8,959,846,128 "

Notwithstanding that the average increase in the cost of coal was 5 cents per ton in excess of the price paid during 1895, yet the cost of pumpage was reduced 26 cents for lifting 1,000,000 gallons of water 100 feet high. This is attributable to the improved condition of the machinery at the several pumping stations.

*Director's Office.*

The amount of labor required from the office of the Director of the Department of Public Works, grows with the increase in the operations of the several Bureaus. During the past year, every requirement of this office has been promptly met and every duty discharged in an efficient and satisfactory manner.

In this connection I desire to call attention to the valuable and efficient aid rendered by the Assistant Director and the clerks connected with this office. They have been attentive to details, and the vast amount of work devolving upon them has been performed in a satisfactory and prompt manner.

The following is a comparative statement of the expenditures of the Director's Office during the years 1895 and 1896.

| Item. | | 1895. | 1896. |
|---|---|---|---|
| 1 | Salaries | $17,790 00 | $18,690 00 |
| 2 | Keep of horses | 487 50 | 750 00 |
| 3 | Printing, stationery, etc | 2,499 74 | 2,318 38 |
| | Total | $20,777 24 | $21,758 38 |

Receipts and Expenditures.—The appropriations, expenditures and receipts of the Department for the year 1896, are set forth in the following table in detail by Bureaus; also in totals for the year 1895.

SUMMARY OF APPROPRIATIONS, EXPENDITURES, RECEIPTS, ETC., OF THE DEPARTMENT OF PUBLIC WORKS, DURING THE YEAR 1896, AND TOTALS FOR THE YEAR 1895.

| Bureaus. | Appropriation for 189[illegible]. | Balance available from previous years. | Additional appropriations and transfers. | Total. | Number of Warants Drawn. | Amount of Warrants Drawn. | | | Transfers From. | Balance Available 1897. | Total. | Amount Merging. | Receipts. | Number of employees December 31, 1896. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Current Expenses. | Extensions. | Total. | | | | | | |
| Director's Office | $21,2[illegible]0 00 | ...... | $900 00 | $22,120 00 | 158 | $21,758 38 | ...... | $21,758 38 | $180 00 | ...... | $21,938 38 | $181 62 | ...... | 8 |
| City Ice Boats | 32,400 00 | 2,161 00 | ...... | 34,561 00 | 155 | 22,767 49 | ...... | 22,767 49 | 11,400 00 | ...... | 34,167 49 | 393 51 | 68 12 | 10 |
| Gas | 2,583,7[illegible]8 00 | 289,040 81 | 774,627 34 | 3,647,4[illegible]6 15 | 1,267 | 3,229,155 70 | 322,947 41 | 3,552,103 11 | 49,113 85 | 34,184 43 | 3,635,401 39 | 12,054 76 | 3,318,145 08 | 1,698 |
| Highways | 938,198 00 | 708,982 96 | 266,820 36 | 1,914,001 32 | 3,233 | 546,931 82 | 984,787 23 | 1,531,719 05 | 79,864 60 | 280,815 45 | 1,892,399 10 | 21,602 22 | 155,054 06 | 109 |
| Board of Highway Supervisors | * ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 14,354 36 | 5 |
| Lighting | 446,904 00 | ...... | 2,850 00 | 449,754 00 | 314 | 434,917 79 | 12,430 74 | 447,348 53 | 1,194 24 | ...... | 448,542 77 | 1,211 23 | 192 63 | 354 |
| Street Cleaning | 810,138 00 | ...... | ...... | 810,138 00 | 481 | 801,462 30 | ...... | 801,462 30 | 7,501 38 | ...... | 808,963 68 | 1,174 32 | ...... | 14 |
| Surveys | 807,789 59 | 800,247 86 | 1,577,531 21 | 3,185,568 66 | 4,595 | 245,951 48 | 896,641 45 | 1,142,592 93 | 250,000 00 | 1,792,125 94 | 3,184,718 87 | 849 79 | 58,558 70 | 288 |
| District Surveyors | † ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 122,839 79 | 13 |
| Water | 928,154 00 | 599,117 15 | 752,400 00 | 2,279,671 15 | 2,728 | 1,307,696 40 | 517,914 49 | 1,825,610 89 | 48,000 00 | 392,274 42 | 2,265,885 31 | 13,785 84 | 2,879,133 26 | 837 |
| Total 1896 | $6,568,591 59 | $2,399,549 78 | $3,375,128 91 | $12,343,270 28 | 12,931 | $6,610,641 36 | $2,734,721 32 | $9,345,362 68 | $447,254 07 | $2,499,400 24 | $12,292,016 99 | $51,253 29 | $6,548,346 00 | 3,336 |
| Total 1895 | $6,870,710 42 | $2,722,630 15 | $2,983,362 78 | $12,576,703 35 | 13,632 | $6,409,416 46 | $3,072,032 65 | $9,481,449 11 | $478,803 51 | $2,399,549 78 | $12,359,802 40 | $216,900 95 | $6,361,533 19 | 3,499 |

* Included in the appropriation and in the expenditures of the Bureau of Highways.

† Included in the appropriation and in the expenditures of the Bureau of Surveys.

## RECOMMENDATIONS.

The Department desires to present the following recommendations, some of which were suggested in my report for the year 1895, but upon which no legislative action has been taken.

*Bureau of Gas.*

Appropriations should be made for laying a 36-inch main from the Point Breeze Gas Works to the Ninth Ward Works.

20-inch main from the Twenty-fifth Ward Works to Chestnut Hill.

20-inch main on Allegheny avenue, from Twenty-second street to Ridge avenue, to Main street, to Cotton street, Manayunk.

20-inch main on Walnut street, from Twenty-fourth to Thirty-fourth streets, to Wallace street, to Lancaster avenue.

For other mains ranging in sizes from 6 to 12 inches in various parts of the City, in order to secure a proper distribution of gas.

To increase the holder capacities at the Ninth Ward Works, Twenty-fifth Ward Works, Ninth and Diamond Streets and Manayunk Holder Stations, and for locating additional holder stations in other sections of the City.

*Bureau of Highways.*

Legislation should be enacted requiring all owners of property to have set 6-inch granite curbing in front of their property on the line of streets to be paved or repaved under ordinances of Councils.

Appropriations should be made to continue the repaving of streets not occupied by passenger railway tracks, with improved pavement; also, liberal appropriations should be made for the repaving of tramway streets and for the maintenance of bridges.

Councils, by ordinance, made it obligatory for the passenger railway companies to keep the streets occupied by them in repair, but by reason of other corporations receiving franchises and privileges to occupy the streets, the railway companies have notified this Department that they will not be responsible for repairs to streets, so long as said corporations have used and torn up the streets.

In the near future a question of liability must be considered, and believing that the maintenance of our highways should be under direct municipal control, I recommend that some arrangement or agreement be entered into with the railway companies to pay into the City Treasury a certain sum annually, the sum so paid to be expended exclusively for street repairs. The amount to be determined by taking the amount expended by the railway companies for the last five or ten years and making an average. All other corporations occupying the highways should be compelled to pay a certain sum of their gross receipts for repairs; or else the City should make the repairs and collect the amounts so expended from the various companies.

A system of this kind would, I believe, be satisfactory to all the parties in interest.

*Bureau of Street Cleaning.*

That legislation be obtained, authorizing the Department to award contracts for the cleaning of streets and the collection and disposal of garbage for a period of not less than three years.

Provision should be made for the removal of snow from the streets in the business centre of the City.

*Bureau of Surveys.*

That appropriations be made to continue the extension of the main and intercepting sewer systems; also, for the construction of bridges, several of which are important, and are mentioned in the body of this report.

*Bureau of Water.*

Adopt ordinances to restrain the waste of water.

Make appropriations for the following requirements, all of which are urgent:

New reservoir for West Philadelphia.

New reservoir for the Frankford district.

Additional pumping engines at Belmont and Roxborough Auxiliary Pumping Stations.

Five new boilers, engine house and stack at the Belmont Pumping Station.

New 10,000,000 gallon pump and boilers, with the necessary engine and boiler house and stack and intake, at the Roxborough Pumping Station.

Coal shed and tunnel at the Queen Lane Pumping Station; also, additional pumping main from this station to the Queen Lane Reservoir.

New storage yard and coal shed at the Spring Garden Pumping Station.

Laying additional large distributing mains in various parts of the City.

All of the foregoing suggestions are believed to be in the direction of improving the public service, and are dependent upon future legislation and appropriations.

*Appropriations, 1897.*

The following is an abstract from the ordinance making an appropriation to this Department for the year 1897, with a statement of balances available from previous years for work ordered and for which contracts are executed:

| Bureaus. | Annual Appropriation for the year 1897. | Balance Available from previous years. | Total. |
|---|---|---|---|
| Director's Office | $27,320 00 | ........ | $27,320 00 |
| City Ice Boats | 32,400 00 | ........ | 32,400 00 |
| Gas | 2,983,688 00 | $34,184 43 | 3,017,872 43 |
| Highways | 1,246,155 71 | 280,815 45 | 1,526,971 16 |
| Lighting | 471,490 00 | ........ | 471,490 00 |
| Street Cleaning | 871,814 00 | ........ | 871,814 00 |
| Surveys | 938,760 00 | 1,792,125 94 | 2,730,885 94 |
| Water | 1,119,654 00 | 392,274 42 | 1,511,928 42 |
| Total | $7,691,281 71 | $2,499,400 24 | $10,190,681 95 |

In concluding this report, it is gratifying to me to record the fact that the Chiefs and employees of the various Bureaus comprising this Department are generally giving their best service to the City and discharging their duties faithfully and efficiently. For myself and the officers of this Department, I desire to thank you for the active and continued support you have given us in our efforts to discharge the onerous duties of our several places.

Very respectfully submitted,

THOMAS M. THOMPSON,

*Director.*

# ANNUAL REPORT

OF THE

# BUREAU OF WATER

For the year 1896.

# OFFICERS

OF THE

# BUREAU OF WATER.

*Chief,*

JOHN C. TRAUTWINE, Jr.

*Assistants,*

Allen J. Fuller, William Whitby.

*Draughtsmen.*

John E. Codman, William Farrell, Martin Murphy.
John R. Gorman.

*Chief Clerk*—Job T. Hickman.
*Assistant Clerk*—James G. Dixon.
*Correspondence Clerk*—P. DeHaven.
*Search Clerk*—H. J. Johnson.
*Assistant Search Clerk*—Wm. J. Duffy.
*Clerk*—Thomas Spence.
*Assistant Clerk*—K. McNeal.
*Assistant Clerk*—J. J. Barney.
*Time Clerk*—W. J. Innes.
*Pipe Inspector*—Theodore S. S. Baker.
*Pipe Clerk*—George G. Whitby.
*Messenger*—Haines Lewis.

*Telephone Operators,*

Frances Shields, Calvin Craner.

*General Superintendent,*

F. L. HAND.

*Clerk to General Superintendent*—John A. Hayes.
*Assistant Clerk to General Superintendent*—John B. Wright.

## Works—General.

*Foreman Machinist*—Robert Bromily.
*Foreman Carpenter*—Henry Guest.
*Foreman Bricklayer*—Frank A. Mooney.
*Foreman Stonemason*—Michael Farrell.
*Foreman Rigger*—James Forrest.
*Foreman Painter*—Joseph Work.
*Foreman Laborer*—William Calhoun.
*General Storekeeper*—S. C. Buchanan.
*Electrician*—Henry P. Morgan.
*Superintendent of Shop*—James H. Dean.
*Clerk to Superintendent of Shop*—Morris P. Getz.

## Purveyors.

*First District*, John H. Holmes.
*Clerk*—William J. Mackey.
*General Foreman*—Thos. Preston. *Foreman of Repairs*—W. W. Wellington.
Office, 1120 Wharton street.

*Second District*, David A. Craig.
*Clerk*—Charles H. Green.
*General Foreman*—Michael Young. *Foreman of Repairs*—Edw. Homan.
Office, 918 Cherry street.

*Third District*, Charles J. Lowry.
*Clerk*—J. A. Spanagle.
*General Foreman*—Elias Abrams. *Foreman of Repairs*—William Magee.
Office, Beach street and Susquehanna avenue.

*Fourth District*, John Montgomery.
*Clerk*—Arthur B. Cook.
*General Foremen*—George W. Showaker, James Hutchinson.
*Foreman of Repairs*—John Richards.
Office, Twenty-sixth and Master streets.

*Fifth District*, Henry Dawson.
*Clerk*—F. J. Cornman. *General Foreman*—Charles Frank.
Office, Lyceum Building, Roxborough.

*Sixth District*, George H. Laut.
*Clerk*—William D. Kinsler. *General Foreman*—Samuel Loeb
*Foreman of Repairs*—Jas. W. DeHart.
Office, Town Hall, Germantown.

# ANNUAL REPORT

OF THE

# BUREAU OF WATER.

## For the year 1896.

*Philadelphia, February 15, 1897.*

THOMAS M. THOMPSON, ESQ.,
Director of the Department of Public Works.

SIR:—I have the honor to submit herewith the ninety-fifth annual report of the operations connected with the supply of water to the City. This is the tenth annual report of the Bureau of Water and the second which it has been my duty to prepare.

### *Estimates and Appropriations.*

As stated in my report of 1895, my estimates for extensions and improvements for the year 1896, amounted to $2,835,150, of which $1,819,150 were for additional pumping and supply mains. Councils, however, declined to make any appropriations for extensions or improvements other than those for the repairs of reservoirs.

### *Results of Deficiency of Appropriations.*

As a consequence, but little work, other than the repairs of reservoirs, for which special appropriations were made, has been carried on. The service is, therefore, greatly crippled and unable to give satisfaction to our people; besides which, the work is necessarily carried on expensively and with considerable risk of accident involving serious shortage.

The four pumping engines designed for the new Queen Lane Pumping Station are now all in running order, and the Queen Lane Reservoir is evidently in condition to hold, with entire safety, its full 30 feet depth of water, but, owing to the lack of the $88,000 required to lay the second pumping main between the station and the reservoir, we are unable to utilize the full pumpage capacity. We are therefore unable to supply, from the reservoir, the whole of what was known as the direct pumpage district, and we are in daily fear that the whole system may be thrown out of service by an accident to the one existing main. Such an accident would compel us to resort to direct pumpage for the entire district, reducing, at the same time, our capacity for pumpage into East Park Reservoir.

The increasing consumption is rapidly outgrowing the facilities provided by our distribution system, and bitter complaints come to us from the central and other portions of the City where the supply is quite inadequate.

While we have thus far escaped the disaster of widespread conflagration, it cannot be long before the restriction of the supply by reason of inadequate mains, must become a serious menace to the thickly settled and poorly supplied business portions of the City.

The forebays at Fairmount and at Spring Garden, and the older wheel house at Fairmount, remain in a condition disgraceful to the City.

The No. 4 Worthington high-duty pump, removed in 1894, from Spring Garden to Belmont, remains without other protection than the rude house of boards placed over it by employees of the Bureau, and, owing to lack of proper boiler facilities, we have been unable to economize in fuel by using the high-duty attachment.

At Belmont and at Roxborough high-service stations we are dependent upon one pump, any accident to which would throw the station out of service and deprive the district of water.

The inhabitants of West Philadelphia are obliged to put up with what is practically direct pumpage, and the Bureau is powerless to relieve them. A similar condition exists upon the Delaware side of the City, owing to the entire inadequacy of the Wentz Farm Reservoir to furnish anything like a proper degree of sedimentation to the water furnished to that district.

As stated in the report of the General Superintendent, Appendix B, we are still obliged to haul, in carts, all coal for the Queen Lane Pumping Station, as well as for the high service stations at Roxborough and Belmont, of course at considerably increased expense; and the Spring Garden works, by far our largest and most important station, has an entirely inadequate storage capacity for coal, and is thus subjected to risk of stoppage in the event of a coal famine. This would involve the stoppage of water supply to the greater portion of the City.

The absence of appropriations for extensions and improvements during 1896, has, of course, resulted in an increase in the amount asked for 1897; and, as Councils have again declined to grant any appropriations for these purposes, the same unfortunate condition of affairs must continue in a still further aggravated form during 1897, with corresponding increase in the amount which it will be necessary to ask for 1898.

### *Projects for Future Supply.*

The year, however, has been a fruitful one in the development of schemes submitted by private corporations, looking to the turning over to them of more or less of the functions of the Bureau.

Chief among these are (1st), the proposition of the Philadelphia Water and Filter Company to acquire and turn over to the City the properties and franchises of the Philadelphia and Reading Railroad Company, lessee of the Schuylkill Navigation Company, with a view to utilizing the storage capacity of the company's pools and bringing the Schuylkill water by aqueduct from a point near Norristown, in consideration of a payment, by the City, of $375,000 per annum, for 50 years, at the end of which time the properties and franchises leased become the property of the City; and (2d), that of the Philadelphia Water Supply Company to construct two aqueducts and bring water from the Delaware river at two points, one above Trenton and one above Point Pleasant, in consideration of an annual payment of 60 per cent. of the gross receipts of the Bureau for 50 years, at the end of which time the City must either renew the lease for another period of fifty years or purchase the works from the company. The revenues from the operations of this Bureau, during 1896, were $2,879,133.26.

Both of these propositions received serious consideration at the hands of Councils.

These propositions, in detail, and my comments upon that of the Philadelphia Water Supply Company, are contained in Appendix G, to this report.

The proposition of the Philadelphia Water and Filter Co. will be recognized as practically a revival of that made by the Philadelphia and Reading Railroad Company under the presidency of Mr. McLeod, in 1891.

On November 21, in company with Mr. Joseph Wharton, I visited the property of that gentleman in southern New Jersey, and drove over a considerable portion of it, in order to learn something of its nature as a source of water supply. His proposition is mentioned in my report for 1895.

On June 10, the late Mr. Charles Parrish, of Wilkesbarre, called and brought to my attention the advantages claimed by him for the upper Lehigh and its tributaries as a source of supply for this City. I requested Mr. Parrish to write me fully in the premises and to supply me with plans in illustration of his suggestions; but, owing, probably, to pressure of other matters, he failed to do so.

At this writing, still another proposition has been brought before Councils by a company (the Schuylkill Valley Water Co.), said to be composed of New England and New York capitalists. This scheme contemplates the construction of impounding reservoirs upon the Schuylkill and its tributaries, and the construction of a small additional reservoir near the present one at Wentz Farm, and of two sand filtration plants, one for the Schuylkill and one for the Delaware supply. The compensation asked is $900,000 per annum, for 50 years, at the end of which time the works revert to the City.

This proposition, which was referred to the Water and Finance Committees, is given in full in Appendix G.

*Officers and Employees.*

I can do no less than repeat my testimony of last year to the fidelity and efficiency of my principal assistants and of the employees of the Bureau in general. Every day of my association with them increases my appreciation of their devotion to the City's interests.

Notwithstanding the insufficiency of the funds appropriated for maintenance and operation, the works, by incessant vigilance and intelligently directed industry on the part of those in charge of them, have been kept in fairly good condition and in nearly constant operation, and the business relations of the Bureau with the public have been maintained with a minimum of friction and annoyance to the latter.

On April 14, Captain Job T. Hickman, Chief Clerk of this Bureau, was taken seriously ill, largely on account of his prolonged and arduous labors in the discharge of his duties, and for a long time his final recovery was a matter of serious doubt. It was not until July that he was able to return to his duties, and, in the meantime, our clerical operations were seriously embarrassed by the want of his faithful and intelligent assistance. This experience emphasized painfully the necessity, which I had previously felt, of providing Captain Hickman with an assistant who could so familiarize himself with the affairs of the Bureau as to represent him properly in case the Bureau should be again deprived of his services. Mr. Arthur E. Mustin, who is carried upon the per diem roll as Inspector, was accordingly detailed to act as asssistant to Captain Hickman, and he has since performed the duties of the position in a most acceptable manner.

On December 2d it became my painful duty to advise you of the death, by suicide, of Mr. Amasa Ely, who for about fourteen years had acted as assistant engineer in this Bureau, first under Mr. Rudolph Hering, in his investigations respecting future supply, and afterward in the construction of East Park Reservoir and in the construction and repair of the Queen Lane and new Roxborough Reservoirs. In connection with these latter works he acted as engineer in charge.

On the afternoon of December 1, Mr. Ely had testified in Court in the case of Filbert, Porter & Co., contractors for the construction of Queen Lane Reservoir, against the City, to recover the 10 per cent. of the contract price retained, and he was to have undergone cross-examination on the morning of his death.

Inasmuch as his death, under these circumstances, might have led to the suspicion that he was possessed of facts which he feared, on his own account, to reveal, I hastened to assure you that, so far as my official acquaintance with Mr. Ely extended and so far as I could learn from the testimony of Mr. Hand, General Superintendent, and of others who had known him officially for many years, his record was absolutely free from all shadow of stain.

Mr. Ely was an assistant of exceptional value, and his loss is deeply felt in the Bureau.

On April 3, Mr. James M. Smiley, lineman of the Bureau, fell from a pole and sustained injuries which kept him in the hospital and at home for several weeks, and from which he has not yet fully recovered.

During the progress of the work in the south basin, at Queen Lane Reservoir, Mr. Bernard Phillips, employed as inspector on the work, lost his footing at the top of the slope, and fell to the bottom, seriously injuring one of his legs, and was compelled to remain for some time in hospital.

In my report for 1895 I remarked: "Most of my assistants are greatly underpaid, and in my estimate for the expenses of the Bureau for 1896 I included the very small sums necessary to make provision for certain increases in their salaries; limiting my requirements, in view of the unfavorable condition of the City Treasury, to those cases where the discrepancy between desert and recompense appeared most glaring. Greatly to my regret, Councils have found it inexpedient to comply with these suggestions."

In my estimate for the current year I included all such increases of salary as it seemed to me incumbent upon the City to make, but none of these have been granted.

### *Financial Statistics.*

The following table shows the amounts appropriated to, and expended for, the several items of the Bureau's expenditure, together with the amounts merging and not merging:

## *Appropriations and Expenditures (Itemized).*

| Appropriated, December 28, 1895. | | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|---|
| Item 1. Salaries: | | | | | |
| Office, Chief of Bureau.. | $114,304 00 | | | | |
| Fairmount Pumping Station | 14,310 00 | | | | |
| Spring Garden Pumping Station | 79,300 00 | | | | |
| Belmont Pumping Station | 19,800 00 | | | | |
| Belmont Auxiliary Pumping Station | 4,750 00 | | | | |
| Queen Lane Pumping Station | 26,400 00 | | | | |
| Roxborough Pumping Station | 17,270 00 | | | | |
| Roxborough Auxiliary Pumping Station | 4,750 00 | | | | |
| Mt. Airy Pumpi'g Station | 3,070 00 | | | | |
| Chestnut Hill Pumping Station | 1,500 00 | | | | |
| Frankford Pumping Station | 16,700 00 | | | | |
| | $302,154 00 | | | | |
| Transferred from | 14,000 00 | | | | |
| Item 2. General suppplies, including fuel, oil and small stores, | | $288,154 00 | 287,707 94 | 446 06 | |
| | $150,000 00 | | | | |
| Increased by additional appropriations | 150,000 00 | | | | |
| Item 3. Repairs to machinery, including the conveyance of workmen incident thereto... | $50,925 13 | 300,000 00 | 297,445 72 | 2,554 28 | |
| Increased by add. appro'n | 40,000 00 | | | | |
| | | 90,925 13 | 89,077 49 | 1,847 64 | |
| Item 4. Maintenance of, and improvement to, buildings, grounds and reservoirs | $50,000 00 | | | | |
| Increased by additional appropri't'ns and transfers | 51,000 00 | | | | |
| | | 101,000 00 | 100,006 85 | 993 15 | |
| Item 5. Repairs and improvement of the distribution, including the purchase of material in connection therewith and expenses incident thereto | $100,000 00 | | | | |
| Increased by additional appropriations and transfers | 79,900 00 | | | | |
| | | 179,900 00 | 178,454 72 | 1,445 28 | |
| Item 6. Supplies, including fuel and labor at the City Construction and Repair shops | $50,000 00 | | | | |
| Increased by additional appropriations | 23,200 00 | | | | |
| | $73,200 00 | 70,200 00 | 69,069 27 | 1,130 73 | |
| Dimished by Transfer... | 3,000 00 | | | | |

## *Appropriations and Expenditures*—Continued.

| Appropriated, December 28, 1895. | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging. |
|---|---|---|---|---|
| Item 7. General, incidental and contingent expenses, including keep of horse for Chief of Bureau, General Superintendent and Assistant, each $400............ $15,000 00<br>Increased by additional appropriations and transfers.................... 2,800 00 | $17,800 00 | $17,458 02 | $341 98 | |
| Item 8. For the purchase of material and cost of labor in connection with the laying of service mains and expenses incident thereto, $204,000 00<br>Increased by additional appropriations.......... 55,500 00 | 259,500 00 | 256,107 43 | 3,392 57 | |
| Item 9. For service pipes and meters. | 10,000 00 | 9,783 47 | 216 53 | |
| Item 10. For the purchase of telephones and new switch board...... | 1,000 00 | 124 00 | 876 00 | |
| Total for current expenses........ | $1,318,479 13 | $1,305,234 91 | $13,244 22 | |
| Item 10 A. Extensions, balance January 1, 1896............................... | $273,812 86 | $189,924 74 | $175 82 | $83,712 30 |
| Item 10½. Repairs to, and improvement of, reservoirs, balance January 1, 1896 .............. $156,169 49<br>Increased by additional appropriations.......... 350,000 00<br>$506,169 49<br>Diminished by transfer. 31,000 00 | 475,169 49 | 289,339 14 | ................. | $185,830 35 |
| Item 11. For the construction and completion of Queen Lane Reservoir, balance January 1, 1896....... | 122,731 77 | ................. | ................. | 122,731 77 |
| Item 11½. New water mains, balance January 1, 1896 ........................ | 39,016 41 | 38,650 61 | 365 80 | |
| Total for extensions................. | $910,730 53 | $517,914 49 | $541 62 | $392,274 42 |
| Item 12. Refunding Joseph J. Martin for excavating and refilling trench for water main, balance January 1, 1896..................................... | $1,688 85 | $1,688 85 | | |
| Item 12½. Refunding certain overpaid and paid-in-error water bills, balance January 1, 1896....... | 772 64 | 772 64 | | |
| | $2,461 49 | $2,461 49 | | |

## *Appropriations and Expenditures*—Continued.

### *Summary.*

| Appropriated, December 28, 1895. | | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|---|
| APPROPRIATIONS. | | | | | |
| Current expenses........... | $1,313,554 00 | | | | |
| Extensions.................... | 319,000 00 | | | | |
| Available balances from 1895........ .................. | 599,117 15 | | | | |
| | | $2,231,671 15 | | | |
| EXPENDITURES. | | | | | |
| Current expenses....... .. | $1,305,234 91 | | | | |
| For extensions.............. | 517.914 49 | | | | |
| For refunds.................. | 2,461 49 | | | | |
| | | .................. | $1,825,610 89 | | |
| Amount merging.............................. | | .................. | .................. | $13,785 84 | |
| Amount not merging......................... | | .................. | .................. | .................. | $392,274 42 |

# RECEIPTS FROM THE OPERATIONS OF THE BUREAU OF WATER.

*As Reported by the Receiver of Taxes.*

| 1896. | Water Rents. By Schedule. On Existing Connections. Current. a | Water Rents. By Schedule. On Existing Connections. b Delinquent. | Water Rents. By Schedule. c On New Connections. | Water Rents. d By Meter, Current and Delinquent. | Penalties. e Current. | Penalties. e Delinquent. | Frontage Charges. f Paid to Receiver of Taxes. | Frontage Charges. f Collected by City Solicitor. | g Fees for Searches. | Charges for Ferrules on new connections. | Miscellaneous. See pages 463, 464. | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | ...... | $2,766 75 | $3,758 50 | $29,778 50 | ...... | $312 48 | $10,654 54 | The City Solicitor's collections are reported but once annually. | 433 50 | $190 00 | 12 17 | $47,906 44 |
| February | $200,659 02 | 1,470 00 | 5,685 21 | 5,161 53 | ...... | 220 50 | 8,966 57 | | 442 75 | 126 00 | 17 73 | 222,749 31 |
| March | 207,271 01 | 960 00 | 5,583 51 | 654 23 | ...... | 143 88 | 7,926 71 | | 477 50 | 224 0 | 872 76 | 224,113 60 |
| April | 340,845 79 | 1,052 50 | 7,674 55 | 20,303 00 | ...... | 157 73 | 5,120 48 | | 554 75 | 535 00 | 188 92 | 376,432 72 |
| May | 1,326,441 14 | 5,630 00 | 8,809 85 | 15,080 79 | ...... | 375 19 | 9,529 07 | | 538 25 | 1,063 00 | ...... | 1,367,467 29 |
| June | 62,310 39 | 855 50 | 5,056 67 | 667 83 | $3,048 83 | 127 88 | 9,087 28 | | 529 50 | 1,055 00 | 172 79 | 82,911 67 |
| July | 32,833 90 | 3,662 50 | 3,808 00 | 23,544 35 | 1,608 15 | 549 42 | 9,535 42 | | 460 00 | 400 00 | 719 03 | 77,120 77 |
| August | 85,121 75 | 540 00 | 2,988 47 | 3,002 51 | 4,249 81 | 81 01 | 12,421 79 | | 371 00 | 1,165 00 | 48 25 | 109,989 59 |
| September | 36,536 15 | 398 00 | 2,678 25 | 333 85 | 5,177 52 | 58 50 | 12,687 72 | | 410 75 | 633 00 | 1,411 05 | 60,324 79 |
| October | 72,950 50 | 439 50 | 3,068 95 | 24,278 79 | 10,892 99 | 65 49 | 13,765 34 | | 531 50 | 708 00 | 97 24 | 126,798 30 |
| November | 32,319 00 | 547 00 | 2,715 82 | 5,386 43 | 4,841 21 | 82 06 | 16,674 96 | | 395 25 | 1,058 00 | 719 07 | 64,738 80 |
| December | 44,395 30 | 811 00 | 3,018 95 | 3,055 84 | 6,599 47 | 121 44 | 15,232 81 | 43,806 52 | 488 75 | 433 00 | 616 90 | 118,579 98 |
| Totals for 1896 | $2,441,683 95 | $19,132 75 | $54,846 73 | $131,247 65 | $36,417 98 | $2,295 58 | $131,602 69 | $43,806 52 | $5,633 50 | $7,590 00 | $4,875 91 | $2,879,133 26 |
| Totals for 1895 | $2,367,057 60 | 28,920 75 | 48,612 92 | 109,579 95 | 37,498 56 | 4,171 49 | 161,285 14 | 46,994 07 | 5,539 25 | 7,410 00 | h 12,787 44 | 2,829,857 17 |
| Increases | $74,626 35 | ...... | $6,233 81 | $21,667 70 | ...... | ...... | ...... | ...... | $94 25 | $180 00 | ...... | $49,276 09 |
| Decreases | ...... | $9,788 00 | ...... | ...... | $1,080 58 | $1,875 91 | $29,682 45 | $3,187 55 | ...... | ...... | $7,911 53 | ...... |

NOTES.

a "Current." Water rents by schedule rates for the year 1896, from January 1 to December 31, inclusive. These are due in advance, but the books are not open for payment until the first Monday in February. Hence, such rents do not appear under January. Certain institutions, classed by Councils as "Charitable," are charged only 15 per cent. of the schedule and meter rates.

b "Delinquent." Water rents by schedule rates for years prior to 1896.

c "On new connections." Schedule rents on new connections cover, in most cases, only a fraction of the year, and the consumer is charged for that fraction only. Thus, for a connection made on December 11, or 20 days before the expiration of the year, the rent charged would be but $\frac{20}{365}$ of the schedule rate for the entire year. Hence, these rents on new connections were formerly called "fractional rents."

d "By Meter." The meter rate is 30 cents per 1,000 cubic feet, or, say 4 cents per 1,000 gallons. See "Charitable," at end of note a. The minimum meter charge for any given ferrule is one-half the minimum schedule charge on a ferrule of the same size. Bills for meter rents are rendered quarterly, except in cases where the amount, at the end of each quarter, is less than the proportionate fraction of the annual minimum meter charge. Unpaid meter rents are reported by the Receiver of Taxes twice in each year, and the delinquents are thereupon notified that unless payment is made within five days the water will be shut off.

e "Penalties." On June 1st, 5 per cent. penalty is charged on unpaid schedule rents, and on September 1st an additional penalty of 10 per cent. is charged on rents still unpaid. If these penalties are paid on or before December 31, they are classed as "current." If paid after that date they are classed as "delinquent." Hence, those here appearing as "delinquent" were charged in the preceding year.

f "Frontage Charges." In order to reimburse the City for the cost of laying service mains (mains to which attachments for the supply of properties may be made) in any street, the owners of property fronting upon such street are assessed at the rate of one dollar per foot front on each side. For four months following date of serving of notice these frontage charges are payable to the Receiver of Taxes. Upon the expiration of the four months the bills are sent to the City Solicitor for lien and collection.

g "Fees for Searches." Fees (25 cents each) for certificates issued relative to municipal claims for pipe frontage and water rents.

h "Miscellaneous." Under this heading, until April, 1895, inclusive, were included payments to the City in reimbursement for cost of repairing streets after the laying of water-pipe. This, in 1895, amounted to $1,111.00.

Since April, 1895, such payments have been included, by the Receiver of Taxes, in the receipts from the operations of the Bureau of Highways.

The following table shows the receipts from the operations of this Bureau during several recent years, together with the estimates of requirements, the amounts rendered available by appropriations, etc., and the amounts expended :

| YEAR. | Receipts. | Estimates. | Available Appropriations etc. | Expended. |
|---|---|---|---|---|
| 1890 | $2,381,037 70 | $1,658,653 00 | $1,371,028 11 | $933,864 29 |
| 1891 | 2,500,762 73 | 2,000,000 00 | 1,880,683 48 | 1,530,294 04 |
| 1892 | 2,634,456 02 | 1,500,000 00 | 2,476,628 37 | 1,372,457 31 |
| 1893 | 2,674,275 24 | 2,871,800 00 | 3,813,973 92 | 2,593,390 81 |
| 1894 | 2,759,630 59 | 4,230,564 00 | 3,888,326 05 | 2,912,856 04 |
| 1895 | 2,829,857 17 | 4,335,366 00 | 2,616,077 32 | 1,897,225 20 |
| 1896 | 2,879,133 26 | 4,385,604 00 | 2 231,671 15 | 1 825,610 89 |
| 1897 | ........ | 4,948,379 00 | ........ | ........ |

Appropriation for 1897 ........ $1,119,654 00
Balance from 1896 ........ 392,274 42

*Requirements and Appropriations.*

The following table makes comparison between the requirements of this Bureau for the year 1897 and the amounts appropriated :

*Statement showing the Estimates of the Bureau for the Year 1897 and the Amounts Appropriated by City Councils.*

| Item. | | Estimates. | Appropriations. |
|---|---|---|---|
| 1 | Salaries | $313,629 00 | $303,354 00 |
| 2 | General supplies | 350,000 00 | 200,000 00 |
| 3 | Repairs to machinery | 100,000 00 | 50,000 00 |
| 4 | Repairs to buildings, grounds and reservoirs | 125,000 00 | 75,000 00 |
| 5 | Repairs to distribution | 200,000 00 | 100,000 00 |
| 6 | Material and labor at City shop | 90,000 00 | 50,000 00 |
| 7 | General, incidental and contingent expenses | 17,000 00 | 16,300 00 |
| 8 | Service mains | 300,000 00 | 210,000 00 |
| 9 | Service pipes and meters | 100,000 00 | 10,000 00 |
| 10 | Emergencies | 25,000 00 | 5,000 00 |
| 11 | Extensions and improvements* | 3,327,750 00 | 100,000 00† |
| | Total | 4,948,379 00 | 1,119,654 00 |

* See itemized list below. † For repairs and improvements of reservoirs.

# ESTIMATES FOR EXTENSIONS AND IMPROVEMENTS.

## *Pumping Stations.*

| | | |
|---|---|---|
| **Fairmount:** | | |
| Alterations in forebay and entrance channel | $15,000 | |
| Repairs to dam | $10,000 | |
| Colonnade over roof of western pump house and repairs to roof | 20,000 | |
| | | $45,000 |
| **Spring Garden:** | | |
| Filling in forebay | $25,000 | |
| New storage yard | 20,000 | |
| New coal shed | 15,000 | |
| | | $60,000 |
| **Queen Lane:** | | |
| Coal shed and tunnel | | $35,000 |
| **Belmont:** | | |
| Five new boilers | $25,000 | |
| Extensions to boiler and engine house and new stack (lowest bid) | 17,700 | |
| | | $42,700 |
| **Roxborough:** | | |
| Six boilers | $30,000 | |
| One 10-million gallon triple-expansion pump | 75,000 | |
| Intake | 10,000 | |
| Engine and boiler house | 50,000 | |
| Chimney | 12,000 | |
| Coal shed | 15,000 | |
| | | $192,000 |
| **Belmont High-Service:** | | |
| New 3-million gallon pump | $10,000 | |
| Coal shed or oil plant | 2,000 | |
| | | $12,000 |
| **Roxborough High-Service:** | | |
| New 5-million gallon pump | $15,000 | |
| Coal shed or oil plant | 2,000 | |
| | | $17,000 |
| **Frankford:** | | |
| New 15-million gallon pump | | $60,000 |
| **Wentz Farm, New High-Service Station:** | | |
| Three boilers | $15,000 | |
| Two 3-million gallon pumps | 20,000 | |
| One stand-pipe | 12,000 | |
| Engine and boiler house | 20,000 | |
| | | $67,000 |
| Pumping Stations, total | | $530,700 |

*Reservoirs.*

| | | |
|---|---|---|
| Belmont: New basin | $200,000 | |
| Wentz Farm: New basin | 300,000 | |
| | | $500,000 |
| Filter plant | | 250,000 |
| Meter testing plant | | 6,000 |
| Lowering Frankford main to correspond with revised street grade | | 12,000 |
| Reservoirs, total | | $768,000 |
| Pumping Stations and Reservoirs, total | | $1,298,700 |

*Pumping and Supply Mains.*

| | |
|---|---|
| 36-inch supply main from Twenty-ninth and Cumberland to Nineteenth and Poplar streets | $144,000 |
| 30-inch supply main from Nineteenth and Poplar streets to Nineteenth street and Fairmount avenue | 12,000 |
| 48-inch supply main from Twenty-second and Huntingdon streets to Broad and Dauphin streets | 113,000 |
| 20-inch supply main from Broad and Dauphin streets to Ninth and Dauphin streets | 10,000 |
| 20-inch supply main from Broad street and Montgomery avenue to Sixth street and Montgomery avenue. | 14,400 |
| 30-inch supply main from Eleventh street and Girard avenue to Front and Jefferson streets | 55,000 |
| 30-inch supply main from Eleventh street and Girard avenue to Eleventh and Green streets | 22,500 |
| 20-inch supply main from Eleventh and Green streets to Eleventh and Vine streets | 8,000 |
| 16-inch supply main from Broad and Brown streets to Sixth and Brown streets | 11,500 |
| 16-inch supply main from Broad and Green streets to Sixth and Green streets | 11,500 |
| 36-inch pumping main from Shawmont Works to Ann street and Shawmont avenue | 38,000 |
| 20-inch supply main, Front street from Lehigh avenue to Tioga street | 17,500 |
| 20-inch supply main, Twenty-second street from Federal street to Snyder avenue | 17,400 |
| 48-inch supply main, Nicetown lane from Thirty-second street to Germantown avenue | 120,000 |
| 20-inch supply main from Sixty-third street and Lansdowne avenue to Overbrook | 21,500 |

| | |
|---|---|
| 48-inch pumping main from Queen Lane Works to Queen Lane Reservoir | 88,000 |
| 48-inch supply main, East Park Reservoir, to supply between Vine and South streets and Delaware and Schuylkill rivers | 345,000 |
| 30-inch supply main from Broad and South streets to Broad street and Washington avenue | 18,000 |
| 36-inch supply main from Fairmount Reservoir to Broad and South streets | 154,000 |
| 20-inch supply main, Frankford and Foulkrod streets, to Bridesburg | 40,000 |
| 16-inch supply main, Allegheny avenue, from Kensington avenue to Richmond street | 17,000 |
| 20-inch suply main, Richmond street from Wheatsheaf lane to Bridge street | 22,000 |
| 20-inch supply main, Richmond street from Allegheny avenue to Tioga street | 8,750 |
| 30-inch supply main from George's Hill Reservoir to Thirty-eighth street and Lancaster avenue | 150,000 |
| 48-inch supply main from Wentz Farm Reservoir to Front street and Lehigh avenue | 450,000 |
| 20-inch supply main from Wentz Farm Reservoir to Lawndale, Fox Chase and Bustleton | 120,000 |
| Pumping and supply mains, total | $2,029,050 |
| Extensions and improvements, total | $3,327,750 |

### *Rainfall and Stream Flow.*

As shown in the report of Mr. Codman on hydrographic work, and in the table below, the total rainfall of 1896, in the Schuylkill Valley, was 42.58 inches, which is about equal to the average and 6.80 inches greater than that of 1895.

The stream flow, also, shows a considerable increase over the phenomenally small one of 1895.

*Rainfall and Stream Flow, 1895-1896.*

| Water Shed. | Rainfall, 1895. | Rainfall, 1896. | Total Annual Stream Flow, 1895. Gallons. | Total Annual Stream Flow, 1896. Gallons. | Increase. Gallons. |
|---|---|---|---|---|---|
| Schuylkill river....... | 35.78 | 42.58 | 368,306,402,874 | 477,667,243,250 | 119,360,840,376 |
| Perkiomen creek..... | 38.68 | 47.16 | 41,480,960,000 | 45,237,394,000 | 3,756,434,000 |
| Neshaminy creek..... | 36.29 | 42.96 | 39,186,539,000 | 41,056,948,000 | 1,870,409,000 |
| Tohickon creek........ | 38.35 | 46.44 | 33,002,629,000 | 35,276,641,000 | 2,273,412,000 |

*Average Daily Flow in Gallons per Square Mile of Water Shed.*

| | Perkiomen. | Neshaminy. | Tohickon. |
|---|---|---|---|
| 1883 to 1896—Oct. 1 to Sept. 30........... | 1,133,000 | 1,100,000 | 1,374,000 |
| May 1 to November 30, 1895............... | 250,000 | 243,000 | 197,000 |
| September, 1895................................. | 98,000 | 30,000 | 31,000 |
| October 1, 1895, to September 30, 1896.. | 680,000 | 702,000 | 797,000 |
| Oct. 1, 1895, to Feb. 1, 1896—April 1 to Oct. 1, 1896.................................... | 410,000 | 307,000 | 388,000 |
| August, 1896....................................... | 170,000 | 114,000 | 104,000 |
| January 1 to December 30, 1896........... | 815,000 | 800,000 | 945,000 |

*Minimum Flow of Schuylkill.*

At the meeting of the Engineer's Club of Philadelphia, held September 19, 1896, Mr. Edwin F. Smith, Superintendent and Engineer of Canal Division, Philadelphia and Reading Railroad Company, presented a paper entitled "The Water Supply of Philadelphia: Considered with reference to the Minimum Flow of the Schuylkill River." In this paper was embodied a valuable table, giving, amongst other data, the annual rainfall and the minimum flow of the Schuylkill at Fairmount for the past twenty-eight (28) years.

I present the table, herewith, adding to it the corresponding data for the year 1896.

# MINIMUM FLOW OF THE SCHUYLKILL RIVER THROUGH FAIRMOUNT POOL, PHILADELPHIA, 1869–1896,

*Compared with the Average Daily Pumpage during the Month of Greatest Consumption.*

| Year. | Yearly Rainfall. Inches. | Period of Low Water during the Year. | Duration in Days. | Number of Days on which no water flowed over Fairmount Dam. | Minimum Flow. Gallons per 24 Hours. | Minimum Flow. Cubic feet per Second per Sq. Mile. | Minimum Flow. Month of Minimum Flow. | Average daily pumpage from the Schuylkill during the m'nth of maximum consumption, gals. per 24 hours. | Month of Maximum Pumpage. | Pumpage from Schuylkill during month of maximum consumption, in percentage of minimum flow available for the City's use.* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1869 | 46.13 | July 8th to September 25th........... | 80 | No Record. | 320,000,000 | 0.261 | September.... | 37,615,023 | July......... | 20.90 per cent. |
| 1870 | 45.18 | ............................................. | ........ | " | 332,000,000 | 0.270 | September.... | 40,050,109 | July......... | 22.25 " |
| 1871 | 45.03 | August 10th to August 25th.......... | 16 | " | 421,000,000 | 0.342 | August........ | 38,179,756 | August...... | 21.21 " |
| 1872 | 43.27 | July 13th to August 17th................ | 36 | " | 305,000,000 | 0.248 | July............ | 37,799,553 | August...... | 21.00 " |
| 1873 | 53.96 | ............................................. | ........ | A few days. | 465,000,000 | 0.378 | July............ | 41,781,303 | July......... | 23.21 " |
| 1874 | 41.25 | April 26th to November 23d........... | 211 | " | 245,458,000 | 0.200 | September..... | 50,288,780 | July......... | 27.94 " |
| 1875 | 44.09 | July 12th to August 2d.................. | 22 | " | 300,000,000 | 0.244 | July............ | 44,648,021 | June......... | 24.80 " |
| 1876 | 45.50 | August 3d to September 16th......... | 45 | 91 | 267,000,000 | 0.217 | August......... | 49,506,238 | July......... | 27.50 " |
| 1877 | 42.51 | August 3d to September 7th........... | 36 | 200 | 408,000,000 | 0.332 | August......... | 48,634,779 | August...... | 27.02 " |
| 1878 | 38.41 | August 30th to October 23d........... | 55 | 234 | 220,000,000 | 0.179 | 9-7 to 10-21 ... | 52,299,916 | July.......... | 29.06 " |
| 1879 | 35.94 | September 22d to November 28th.... | 66 | 276 | 223,000,000 | 0.181 | October....... | 52,923,907 | August...... | 29.40 " |
| 1880 | 35.61 | August 19th to November 11th........ | 85 | 220 | 200,000,000 | 0.163 | October........ | 55,187,096 | July.......... | 30.66 " |
| 1881 | 37.94 | August 16th to November 19th....... | 96 | 265 | 167,000,000 | 0.136 | September.... | 61,399,245 | August. .... | 34.11 " |
| 1882 | 41.20 | August 5th to October 23d.............. | 80 | 195 | 288,000,000 | 0.231 | August......... | 69,567,708 | July......... | 38.65 " |

## MINIMUM FLOW OF THE SCHUYLKILL RIVER, ETC.—Continued.

| Year. | Yearly Rainfall. Inches. | Period of Low Water during the Year. | Duration in Days. | Number of Days on which no water flowed over Fairmount Dam. | Minimum Flow. Gallons per 24 Hours. | Minimum Flow. Cubic feet per Second per Sq. Mile. | Minimum Flow. Month of Minimum Flow. | Average daily pumpage from the Schuylkill during the m'nth of maximum consumption, gals per 24 hours. | Month of Maximum Pumpage. | Pumpage from Schuylkill during month of maximum consumption, in percentage of minimum flow available for the City's use.* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1883 | 41.69 | August 14th to September 10th | 28 | 231 | 265,500,000 | 0.216 | August | 73,003,154 | July | 40.56 per cent. |
| 1884 | 46.58 | September 4th to October 30th | 56 | 227 | 282,000,000 | 0.229 | September | 67,311,473 | August | 37.40 " |
| 1885 | 38.32 | June 23d to August 2d<br>August 20th to October 30th | 113 | 251 | 230,500,000 | 0.188 | July | 70,919,117 | July | 39.40 " |
| 1886 | 42.54 | August 18th to October 25th | 68 | 221 | 253,000,000 | 0.206 | October | 80,774,181 | July | 44.87 " |
| 1887 | 40.98 | September 19th to December 10th | 83 | 252 | 347,500,000 | 0.283 | November | 96,004,901 | July | 53.34 " |
| 1888 | 43.79 | July 3d to August 20th | 49 | 226 | 321,000,000 | 0.261 | July | 103,434,548 | August | 57.46 " |
| 1889 | 56.05 | September 28th to October 12th | 15 | 97 | 556,000,000 | 0.452 | September | 119,166,413 | September | 66.20 " |
| 1890 | 44.63 | August 3d to August 17th | 15 | 194 | 520,000,000 | 0.423 | August | 150,176,770 | September | 83.43 " |
| 1891 | 46.97 | May 22d to July 3d<br>September 25th to October 19th | 68 | 253 | 455,000,000 | 0.370 | June | 159,012,432 | September | 88.34 " |
| 1892 | 38.29 | July 7th to July 29th<br>August 9th to November 10th | 116 | 226 | 219,600,000 | 0.179 | October | 167,283,589 | June | 91.00 " |
| 1893 | 43.91 | June 15th to November 24th | 143 | 278 | 258,000,000 | 0.210 | August | 186,210,903 | June | 103.45 " |
| 1894 | 49.69 | July 10th to September 8th | 61 | 241 | 256,000,000 | 0.208 | August | 202,886,263 | October | 112.71 " |
| 1895 | 34.70 | June 11th to June 27th<br>July 12th to November 5th | 134 | 265 | 185,000,000 | 0.150 | October | 215,501,882 | September | 119.72 " |
| 1896 | 40.01 | August 8th to September 5th | 29 | 301 | 194,000,000 | 0.158 | September | 241,139,190 | August | 133.96 " |

* The minimum flow available for the City's use is assumed to be 180 million gallons per day,

The annual rainfalls given in the table are found by averaging those of six stations, namely, those at Hamburg, Reading, Lebanon, Pottstown, the mouth of the Perkiomen creek and the U. S. Signal Station at Philadelphia.

The minimum flow for 1874 was found by measuring the water used for power by the mills at Manayunk and adding to it the lockage at Manayunk outlet lock and the leakage at Flat Rock dam, outlet lock, mill forebays and canal, making a liberal allowance for leakage through the mill forebays. The small flow of Wissahickon creek, which had been very low that year, was neglected.

The flow for 1875 was obtained by comparison of the stage of the river (as indicated by measurements, made three times daily, of the height of water on Flat Rock dam) and by comparison of the run of the mills.

The figures for 1878, 1879, 1880 and 1881 were ascertained in the same manner and by comparison of the water used for power by the Fairmount Water Works.

The figures for 1892, 1895 and 1896, were deduced from the results of weir measurement of the flow from Pawling's dam, below the mouth of the Perkiomen, making the necessary increase for the greater area of the watershed above Fairmount and a deduction for water taken from the stream between Pawling's and Fairmount.

The figures for 1893 and 1894 were calculated from daily measurements of the height of water on the dams of the Schuylkill Navigation Co.

The minimum flow, for years not specified in the foregoing, was calculated from the quantity of water pumped by the Fairmount Water Works (assuming that 17½ gallons passed through the turbines in order to raise one gallon to the reservoir), from the lockage at Fairmount, the leakage of locks and dam, and the changes in level in the pool. We have hitherto proceeded upon the assumption that 30 gallons are required for this purpose. We have, as yet, no means for ascertaining what figure should be taken for this purpose, but Mr. Smith finds that the quantities obtained by using 17½ gallons correspond closely with the results obtained by weir measurement and by measurement at Flat Rock and at the Manayunk mills.

Furthermore, the figures thus obtained, when reduced to the form of cubic feet per second per square mile, correspond well with those obtained from other streams in this vicinity.

Mr. Smith also states, in his paper, that "The minimum "flow of various streams east of the Allegheny Mountains "has been ascertained by measurement to be about 0.15 "cubic feet per second per square mile of drainage area, "and it falls below that figure only at long intervals. The "ordinary low-season flow of the same stream may safely "be taken as 0.24 cubic feet per second per square mile. "The former figure, applied to the watershed of the Schuyl- "kill river above Fairmount dam, gives a minimum flow "of 185,000,000 gallons per day in periods of extreme "drought, and the latter figure gives an ordinary low- "season flow of nearly 300,000,000 gallons per day.

"The absolute minimum flow of the river, 167,000,000 "gallons per twenty-four hours, occurred in 1881, with an "annual rainfall of 37.94 inches in that year, 35.61 in "1880, and 35.94 in 1879. These are unusual conditions and very rarely prevail."

From Mr. Smith's table it appears that during the month of maximum consumption, our average daily pumpage from the Schuylkill exceeded the minimum daily flow in 1893 by 3.45 per cent; in 1894 by 12.71 per cent.; in 1895 by 19.72 per cent., and in 1896 by 34 per cent., but as the *average* pumpage is here compared with the *minimum* flow, these percentages do not properly represent the relation between the month's pumpage and the month's flow.

### *Average Flow of the Schuylkill.*

Mr. Codman, in his computations of the average daily flow of the Schuylkill (Appendix E) by which he obtains, for 1895, about 1,000,000,000 gallons per day, and, for 1896, 1,308,677,378 gallons per day, assumes that 30 gallons are required for water power at Fairmount to lift one into the reservoir.

Substituting 17½ gallons, the quantity assumed by Mr. Smith, the average daily flow would be reduced to 776,-620,000 gallons for 1895, and to 993,630,000 gallons for 1896.

### *Flood of February 6th.*

As stated by Mr. Codman in Appendix E, the flood of February 6, 1896, was the greatest which has occurred since our hydrographic surveys were begun, 13 years ago, the water reaching a depth of 78 inches above the top of the flashboards.

### *Fairmount Pool.*

We have scrupulously observed the rule, established during 1895, to run the turbines in summer only when water was actually wasting over the flashboards of Fairmount Dam.

We have, however, been frequently compelled, by our necessities, to draw the water in the river, by steam pumpage, below the boating level now fixed by the Philadelphia and Reading Railway, as lessee of the Schuylkill Navigation Company.

### *Low Water.*

On September 2, the water in the Schuylkill was drawn down to 4 inches below the legal comb of the dam.

In April, Martin Gallagher, captain of a canal boat on the Schuylkill Navigation, brought suit against the City for detention of his boat by reason of low water in the pools from which the City draws its supply. The damages claimed were about $140, and the Court awarded a verdict to the plaintiff, reducing the amount of the damages, however, one-half.

### *Fairmount Dam.*

Beyond the existence of inconsiderable leaks, which were stopped, as before, with grass and planking, when the extreme low water of September permitted, the dam at Fairmount has shown no need of immediate repairs.

### *Flat Rock Dam.*

Flat Rock Dam, which, in my report for 1895, I reported as having already given out in places, remains in service, notwithstanding heavy floods, but I respectfully renew my suggestion, made at that time, "that negotiations be opened with the company, looking to the repair or reconstruction of the dam."

## PUMPING STATIONS.

### *Cost of Pumping.*

Although the cost of pumping 1,000,000 gallons 100 feet high, at Spring Garden Station, in 1896, shows an increase of 11 cents, or about 3.17 per cent. over that for 1895, the average of all of our stations shows a decrease of 26 cents, or 7.10 per cent. This is owing chiefly to the very great reduction in the cost of pumping at the new Queen Lane tSation. Here, in 1895, owing to the fact that the station was then, for the first time, put in operation, but little water was pumped and a relatively large amount of coal consumed; the cost per 100,000,000 foot gallons reaching, in that year, $31.72, whereas, in 1896, thanks to the operation of the new high-duty Southwark engines, the cost per 100,000,000 million foot gallons was reduced to $2.88. The addition of proper arrangements for fuel supply would of course still further reduce the cost of pumpage.

## *Cost of raising 1,000,000 gallons 100 feet during 1895 and 1896.*

| | 1895. | 1896. | Increase. | Decrease. |
|---|---|---|---|---|
| Fairmount | $1 71 | $1 29 | ........ | $0 42 |
| Spring Garden | 3 47 | 3 58 | $0 11 | ........ |
| Belmont | 3 99 | 3 63 | ........ | 36 |
| Belmont High Service | 71 11 | 41 38 | ........ | 29 73 |
| Queen Lane | 31 72 | 2 88 | ........ | 28 84 |
| Roxborough | 3 34 | 3 13 | 21 | ........ |
| Roxborough High Service | 11 99 | 8 31 | ........ | 3 68 |
| Mt. Airy High Service | 8 54 | 10 66 | 2 12 | ........ |
| Chestnut Hill High Service | 61 00 | 109 22 | 48 22 | ........ |
| Frankford | 5 09 | 4 26 | ........ | 83 |
| Average | $3 69 | $3 43 | ........ | $0 26 |

Average for 1894, $3.48.

## *Annual Pumpage, 1895-1896.*

| | 1895 | 1896 | Increase. |
|---|---|---|---|
| From Schuylkill | 73,106,159,093 | 81,133,313,005 | 8,027,153,912 |
| From Delaware | 4,712,854,517 | 5,095,047,954 | 382,193,437 |
| Total | 77,819,013,610 | 86,228,360,959 | 8,409,347,349 |
| Auxiliary | 956,835,491 | 1,465,281,570 | 508,446,076 |
| Total annual pumpage | 78,775,849,104 | 87,693,642,529 | 8,917,793,425 |

## *Monthly Record of Pumpage during 1896.*

| MONTH. | Water Power. Gallons. | Steam Power. Gallons. | Totals. Gallons. | Average per day. Gallons. |
|---|---|---|---|---|
| January | 808,597,289 | 5,946,632,258 | 6,755,229,547 | 217,910,630 |
| February | 947,546,477 | 5,449,511,880 | 6,397,058,357 | 220,558,219 |
| March | 1,045,559,183 | 5,655,431,729 | 6,700,990,912 | 216,160,997 |
| April | 1,141,932,545 | 5,633,623,589 | 6,775,556,054 | 225,851,868 |
| May | 722,822,886 | 6,748,716,030 | 7,471,538,916 | 241,017,384 |
| June | 617,485,771 | 6,569,359,824 | 7,186,845,595 | 239,561,519 |
| July | 601,783,437 | 7,116,521,472 | 7,718,304,909 | 248,977,577 |
| August | 310,370,756 | 7,794,967,625 | 8,105,338,381 | 261,462,528 |
| September | 186,964,038 | 7,602,237,409 | 7,789,201,447 | 259,640,048 |
| October | 634,278,228 | 7,275,039,425 | 7,909,317,653 | 255,139,279 |
| November | 948,960,690 | 6,453,947,577 | 7,402,908,267 | 246,763,608 |
| December | 993,544,828 | 6,487,807,663 | 7,481,352,491 | 241,333,951 |
| Totals | 8,959,846,128 | 78,733,796,401 | 87,693,642,529 | 239,600,116 |

# DAILY PUMPAGE.

*Table Showing the Nominal, Maximum, Minimum and Average Daily Pumpage for 1895 and 1896.*

| Name of Station. | Nominal. | | Maximum. | | Minimum. | | Average. | |
|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 |
| Fairmount | 33,290,000 | 33,290,000 | 48,407,523 | 41,963,032 | 434,960 | 850,850 | 20,786,830 | 24,480,454 |
| Spring Garden | 170,000,000 | 170,000,000 | 175,530,140 | 170,998,740 | 48,847,790 | 29,800,000 | 138,915,593 | 127,587,557 |
| Belmont | 38,000,000 | 38,000,000 | 31,756,020 | 32,886,592 | 11,528,125 | 10,872,340 | 23,116,379 | 25,797,572 |
| Queen Lane | 80,000,000 | 80,000,000 | ........ | 42,119,150 | ........ | 1,644,000 | ........ | 26,343,698 |
| R xborough | 24,500,000 | 24,500,000 | 22,839,930 | 23,418,140 | 6,948,240 | 6,288,770 | 17,029,941 | 17,441,755 |
| Total from Schuylkill | 345,790,000 | 345,790,000 | 278,533,613 | 311,385,654 | 67,759,115 | 49,455,960 | 199,848,743 | 221,651,036 |
| Increase | ........ | ........ | ........ | 32,852,041 | ........ | ........ | ........ | 21,802,293 |
| Frankford | 35,000,000 | 35,000,000 | 18,493,575 | 21,661,923 | 3,244,220 | 3,920,730 | 12,911,930 | 13,923,625 |
| Total from Delaware | 35,000,000 | 35,000,000 | 18,493,575 | 21,661,923 | 3,244,220 | 3,920,730 | 12,911,930 | 13,923,625 |
| Increase | ........ | ........ | ........ | 3,168,348 | ........ | 676,510 | ........ | 1,011,695 |
| Total from Delaware and Schuylkill | 380,790,000 | 380,790,000 | 297,027,188 | 333,047,577 | 71,003,335 | 53,376,690 | 212,760,673 | 235,574,661 |
| Increase | ........ | ........ | ........ | 36,020,389 | ........ | ........ | ........ | 22,813,988 |

*Nominal, Maximum, Minimum and Average Daily Pumpage for 1895 and 1896*—Continued.

| Name of Station. | Nominal. | | Maximum. | | Minimum. | | Average. | |
|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 |
| Belmont High Service | 2,500,000 | 2,500,000 | 499,290 | 576,720 | 48,060 | 106,800 | 160,319 | 268,418 |
| Roxborough High Service | 5,000,000 | 5,000,000 | 2,769,920 | 2,566,080 | 50,400 | 356,400 | 865,322 | 2,163,626 |
| Mt. Airy High Service | 3,000,000 | 3,000,000 | 2,175,000 | 2,220,000 | 1,057,500 | 995,000 | 1,595,825 | 1,574,462 |
| Chestnut Hill High Service | 750,000 | 750,000 | 757,680 | 885,600 | 29,520 | 63,960 | 82,824 | 52,549 |
| Total High Service | 11,250,000 | 11,250,000 | 6,201,890 | 6,248,400 | 1,185,480 | 1,522,160 | 2,704,290 | 4,014,498 |
| Increase | | | | 46,510 | | 436,620 | | 1,310,208 |
| Total daily | 392,040,000 | 392,040,000 | 303,429,078 | 359,295,977 | 72,188,815 | 54,898,790 | 215,824,244 | 239,589,159 |
| Increase | | | | 55,866,899 | | | | 23,764,915 |

*Volume and Cost of Pumpage, etc., for the years 1886 to 1896, inclusive.*

| Year. | Number of gallons pumped to reservoirs. | Number of gallons pumped 100 feet high. | Cost per million gallons pumped 100 feet high. | Gallons pumped per capita per day. | Estimated Population. |
|---|---|---|---|---|---|
| 1886 | 26,658,966,5 9 | 46,255,361,203 | $4 13 | 80 | 975,000 |
| 1887 | 32,426,779,765 | 51,289,948,331 | 3 99 | 89 | 995,000 |
| 1888 | 37,088,760,428 | 59,483,831,199 | 4 49 | 100 | 1,020,000 |
| 1889 | 42,518,919,781 | 69,034,118,434 | 3 87 | 110 | 1,050,000 |
| 1890 | 51,698,508,099 | 84,501,451,686 | 3 05 | 131 | *1,046,000 |
| 1891 | 55,665,648,000 | 93,490,106,725 | 2 99 | 140 | 1,071,672 |
| 1892 | 59,787,584,178 | 102,443,373,631 | 2 68 | 143 | †1,142,650 |
| 1893 | 65,352,736,978 | 110,590,708,479 | 3 22 | 150 | 1,190,493 |
| 1894 | 72,073,724,238 | 121,199,588,387 | 3 48 | 159 | 1,238,112 |
| 1895 | 78,775,849,104 | 132,040,954,195 | 3 69 | 162 | 1,329,957 |
| 1896 | 87,693,642,529 | 161,776,711,713 | 3 43 | 168 | 1,421,802 |

* United States Census. † City Census.

## *Tests of Pumping Engines.*

On April 10-11, one of the two vertical triple-expansion high-duty pumping engines built by the Holly Manufacturing Co., at Spring Garden Pumping Station, was tested by Mr. D. A. Decrow, expert for the builders, and Prof. H. W. Spangler, of the University of Pennsylvania, expert for the City.

During September, one of the four 20,000,000 gallon vertical triple-expansion high-duty Southwark engines at Queen Lane Station was subjected to a 30 days fuel duty test by Mr. John E. Codman, Chief Draughtsman of this Bureau, and, inasmuch as the results of this test were satisfactory neither to the City nor to the contractors, a 24-hour heat-unit duty test, as provided in the specifications, was made November 27-28, under the auspices of Professor

Spangler, for the City, Mr. Edward T. Child, for the builders, and Mr. John Birkinbine, selected by the other two experts.

The results of these tests are found in Appendix H. They show a substantial compliance with the requirements of the specifications.

*Fairmount Pumping Station.*

The turbine wheels at Fairmount are, year by year, losing in usefulness as the steam pumpage from the river increases, for this already leaves, as a general rule, insufficient water for the operation of the turbines except in times of flood, and the quality of the water is then such as to render it desirable to restrict the pumpage as much as possible.

The foul condition of the Schuylikll river below Fairmount Dam, mentioned in my report for 1895, continued, during last summer, not only unabated, but, if anything, aggravated by the natural increase in the quantities of filth discharged into the river.

*Spring Garden Pumping Station.*

The break in the pumping main at Spring Garden Station, on July 1, followed, five days later, by a break in a supply main near Thirty-third and Oxford streets, both breaks bringing great quantities of earth and gravel to the doors of the Spring Garden Pumping Station, demonstrated very forcibly the efficiency of the simple expedient adopted by Mr. Hand, General Superintendent, of constructing low walls or dams in front of most of the openings in the walls of the older or upper house at Spring Garden Station.

In previous experiences of this kind, the pump-wells at the station have been more or less completely filled up with the rubbish brought down by the escaping water, and the operations of the pumps stopped until the pump-wells could be freed of these accumulations. On the two occasions mentioned, however, thanks to the presence of the dams referred to, no trouble worth mentioning was experienced beyond the accumulation of rubbish in the grounds surrounding the station.

The introduction of new dynamos and engines for the electric lighting of Spring Garden Station constitutes a marked improvement in a minor but important matter. The dynamos and engines formerly used at that station are now doing good service at the Queen Lane Works.

### *Queen Lane Pumping Station.*

It is hoped that the unsatisfactory action of the Queen Lane pumps, which appears to be due to the presence of air carried to them by the suction mains, may be obviated by means of a modification in the air chambers, which will shortly be applied experimentally, and that it may thus be rendered unnecessary to resort to the costly expedient of altering the suction mains or replacing them with brick or masonry conduits.

For some time after the pumps were put in operation, it was found impossible to keep a sufficient supply of air in the air chambers on the force main, and, as a consequence, the column of water in that main was subjected to such pulsations as produced serious strain on the joints of the main.

Arrangements were at once made with the builders for a compressor for forcing air into the air chambers on the force main and since this was done no further trouble has been experienced.

The grounds surrounding the station are still in unsightly condition, but it is proposed to put them in proper shape early in the coming season. Plans for this work have already been submitted by General Thayer, Chief Engineer and Superintendent of Fairmount Park.

*Frankford Pumping Station.*

Mr. Hand, General Superintendent, in his report, Appendix B, calls attention to the fact that the Southwark Engine, No. 3, at Frankford Station, originally designed as a 15,000,000 gallon compound engine and put in operation as such on August 1, 1894, is still in the hands of the builders, having been run at intervals only, while the builders have been endeavoring to perfect a hydraulic attachment for the direct operation of the pump valves.

Mr. Hand recommends that the contractors be now required to deliver to the City an engine which can be accepted in accordance with the provisions of the original specifications and contract; and, unless the builders can demonstrate the probability of an early and satisfactory completion of their efforts to improve the valve motion, I shall be reluctantly compelled to endorse Mr. Hand's suggestion.

The long delay of which Mr. Hand very justly complains, has been submitted to in the hope of realizing the promise held out by the builders that the capacity of the pump would be increased, by the proposed changes, from 15 to 22 million gallons per day, and, if this can be accomplished, it will certainly be a most desirable consummation. On the other hand, it is not right that the City should be longer delayed in obtaining possession of this pumping engine, which is needed for the supply of its district.

## RESERVOIRS.

*Total Contents of Reservoirs in Millions of Gallons.*
*1895–1896.*

| | 1895. | | 1896. | | Increase. |
|---|---|---|---|---|---|
| Nominal | Dec. 31st | 1,418 | Dec. 31st | 1,418 | |
| Maximum | Dec. 31st | 980 | July 25th | 1,033 | 53 |
| Minimum | Aug. 31st | 608 | Feb. 9th | 612 | 4 |

### *Fairmount Reservoir.*

Under the direction of Mr. Hand, General Superintendent, a very important and much needed improvement has been made at Fairmount Reservoir, in the repair of the inner lining of the main banks and of most of the division banks. These formerly presented a most unsightly collection of linings of many different kinds and mostly in quite dilapidated condition. They have now been given a handsome concrete finish, and the earthen banks themselves have been thoroughly repaired.

### *Queen Lane Reservoir.*

The improvements carried out in Queen Lane Reservoir during the latter part of 1895, comprising the construction of a concrete footing wall under the toe of the inner slope around the entire circumference of the south basin, and the sealing, with asphalt, of joints and cracks in the concrete slope and floor linings in both basins, resulted in a diminution of about 50 per cent. in the leakage from the basins. This partial asphalt treatment of the slopes also perfectly accomplished its purpose of preventing the further washing out of the clay lining from behind the concrete slabs by the infiltration of rain or other water through the joints between them.

It became apparent, however, during the warm weather of the early part of 1896, that the asphalt thus added, remaining exposed to the extremes of heat and cold of our climate, could hardly be counted upon to remain in good and efficient condition, and the excellent results from the construction of the concrete footing wall in the south basin made it evidently desirable to improve the north basin in the same way.

A contract was accordingly entered into with the Alcatraz Paving Co. of Pennsylvania, for the construction of a concrete footing wall in the north basin, and this work was begun on September 21 and completed on November 6.

As stated in my report for 1895, referring to the south basin, " The clay taken out in excavating the trench was, "in accordance with the recommendation of the report, "spread upon the floor of the south basin, in order that "any water percolating through that floor might carry "particles of this clay with it, and thus gradually close "any pores which afforded them passage."

This treatment, although the clay obtained from the trench sufficed to cover only about two-thirds of the floor, brought about a materal diminution in the leakage through the floor in the south basin.

The effect of the concrete footing wall, placed under the toe of the inner slope of the south basin in 1895, in forcing the bottom leakage down to a lower level, was quite marked prior to the commencement of the thorough relining. Previous to the construction of the footing wall, the leakage which appeared in the pipe-trench on Thirty-second street, south of the reservoir, had oozed from the walls as well as from the bottom of the trench, but after the construction of the footing wall it appeared only on the floor of the trench, besides appearing later and under greater heads than before.

*Asphalt Lining.*

The following specifications for the relining of Queen Lane Reservoir were prepared during 1895 :

1st. A lining of melted asphalt.

2d. A double lining of melted asphalt, with burlap between the two coats.

3d. A three-inch lining of asphalt concrete.

4th. A water-tight lining, the method of treatment to be submitted by the bidder.

Among the propositions submitted by bidders was one from the Vulcanite Paving Company for 2 inches of asphalt concrete on the floor and two coats of melted asphalt, with burlap between them, on the slopes, the slope lining to be covered with a single coating of hard brick laid flat and dry. This proposition was accepted, and on July 24 and October 30, contracts were executed for the relining of the south and north basins, respectively.

The estimated quantities and the prices bid are as follows :

| | North Basin. | | | South Basin. | | | Total. | |
|---|---|---|---|---|---|---|---|---|
| | Sq. yds. | Price. | Cost. | Sq. yds. | Price. | Cost. | Sq. yds. | Cost. |
| Slopes.... | 28,260 | $1 40 | $39,564 00 | 27,682 | $1 40 | $38,754 80 | 55,942 | $78,318 80 |
| Floor..... | 91,418 | 1 15 | 105,130 70 | 77,743 | 1 15 | 89,404 45 | 169,161 | 194,535 15 |
| | 119,678 | ......... | $144,694 70 | 105,425 | ......... | $128,159 25 | 225,103 | $272,853 95 |

The specifications will be found in abstract in Appendix J.

The contractors erected, at the foot of the outer slope near the east end of the division bank, an elaborate apparatus for the preparation of asphalt concrete, including the heating of the stone, the melting of the asphalt and the mixing of the two. The ingredients, on leaving the mixer, were received in iron barrows and hauled to the mouth of a vertical iron shaft which emptied into carts traveling upon the floors of the basins.

The triangular prism of asphalt and sand, with which the corner between the slope concrete and the upper edge of the finish to the new concrete footing wall was filled out in 1895, was found quite dilapidated, especially where it had been exposed to continued sunshine. It was removed, in order to secure a square bearing for the footing course of the brick work on the slopes, and the finish of the concrete footing wall also cut down to such an extent as to afford a full and square footing for the brick work.

In order to proceed with the application of the asphalt concrete to the floor, under the new contract, it was of course necessary to remove the clay which had been taken from the footing-wall trench and spread over a part of the floor. It was accordingly deposited upon the outer bank on the south side of the reservoir, where it has since been utilized in reconstructing the outer slopes.

As in our earlier practice, we adhered strictly to the rule of treating all concrete surfaces with a priming coat of asphalt dissolved in benzine, before applying the melted asphalt or asphalt concrete, and the priming coat was always allowed to dry thoroughly before either of the other coats was added to it.

*Reconstruction of Slopes. Retaining Wall.*

In the report made by Mr. Rudolph Hering, Major C. W. Raymond and myself, August 5, 1895, and printed in Appendix H, to my report for 1895, we recommended, in order to prevent washing and sliding of the exterior slopes, that their inclinations be diminished to a slope of two horizontal to one vertical, extending the base of the embankment over a portion of the sidewalk where it is practicable, and elsewhere resorting to a retaining wall.

The greater portion of this work has been done, under contract with Mr. Michael McManus, (for specifications, see Appendix J), who has, during the year, constructed all of the wall with the exception of that near the stairways at the east and west ends of the division bank, and has also carried out the flattening of the slopes, leaving them over-filled for dressing and sodding after the opening of spring.

When finished, the slope will be 2 to 1 on all portions of the bank exceeding 10 feet in height, except a portion of the south slope, where the steepest slope will remain, as now, about 1.60 to 1, and where, owing to the presence of the concourse, the bank, as constructed, is several times its normal thickness. Here, also, the height is very considerable, so that the expenditure for giving a 2 to 1 slope seemed to be greater than would be justified by the benefit secured.

The retaining wall is built of stone from Mr. McManus's quarry on Rittenhouse street, Germantown, and it will go far toward improving the appearance of the structure as a whole.

The specification (Appendix J) called for a coping of 4-inch North River blue stone, which has long been standard in the Bureau; but, in view of the desirability of improving the appearance of the reservoir, it was afterward decided to adopt a coping more nearly in harmony with the appearance of this handsome wall.

Specifications (Appendix J) were accordingly drawn for a dressed stone coping, and bids were opened November 27. The contract for the coping has not yet been awarded.

## *Drain.*

A drain, to surround the entire reservoir for the purpose of carrying off any subterranean leakage, was recommended in the report of Mr. Hering, Major Raymond and myself, and a specification for it (Appendix J) was prepared, but the drain has not yet been constructed, and no contract for it has been awarded, although bids for the work were received and opened March 26, the advisability of constructing the drain not having been fully determined upon.

*Grouting of Brickwork on Slopes.*

For a similar reason, no contract has been awarded for grouting the surface of the brickwork in either basin. Bids for this work were opened November 27.

*Brick Lining on Slopes.*

The bricks used in lining the south basin were hard vitrified shale bricks made from the new red shale or sandstone at the works of Messrs. McAvoy & Son, near Perkiomen Junction, and, by reason of their great hardness, density and weight, they form a most satisfactory lining.

Unfortunately, the contractors found it impracticable to obtain a supply of these bricks sufficient for the lining of the north basin during last season, and submitted, in lieu of them, a very excellent pressed clay brick, made by Messrs. Murtha & Earley, in Philadelphia.

After careful comparison of the two kinds of brick, and after visiting both brickyards and examining the processes of manufacture, I accepted, in accordance with your instructions, the clay bricks, and the north basin was, accordingly, lined with them. These came, chiefly, from the yard of Messrs. Murtha & Earley; but a few bricks, of still finer quality, from the Philadelphia yard of Messrs. McAvoy, were used.

The specifications provide that, in advance of the brick lining of slopes, the asphalt already laid should be treated with an additional application of the priming coat, consisting of liquid asphalt dissolved in benzine. This was intended to soften the asphalt sufficiently to create a bond between it and the bricks laid upon it. The treatment worked satisfactorily in the south basin, where it was applied during the warm weather, but failed to give satisfactory cohesion in the north basin, where the work was done during cooler weather, and where the lighter and more porous clay brick was used.

The contractors, after some investigation, submitted a Russian liquid asphalt, which, after satisfactory reports from Dr. Samuel P. Sadtler, Chemist, was allowed to be used in place of the priming coat. It has given very satisfactory results.

### *Completion of South Basin.*

Early in September the workof relining the south basin of Queen Lane Reservoir was completed, and on September 10 the water was turned into that basin.

### *Stoppage of Work in North Basin.*

Early in September the work of relining the south basin owing to the approach of winter. The slope work had been completed, but about one-third of the floor remained to be covered. The contractors carefully protected the exposed edges of the finished floor work with a heavy coat of melted asphalt, and on December 15 water was turned into that basin.

### *Leakage under Division Bank during Repairs.*

In June, after the south basin at Queen Lane Reservoir had been emptied for repairs, and while there were from 15 to 17 feet in the north basin, it was discovered that a little water was finding its way from the latter under the division bank, and beginning to appear on the concrete floor of the south basin, not only close to the division bank, but also, to some extent, as far as the stop-house. Most of this was near the east side of the reservoir.

The depth in the north basin was therefore diminished, and these evidences of leakage disappeared.

As already stated, however, the floor lining of asphalt concrete in the north basin had not been finished, when winter set in and water was turned into the basin We have, therefore, maintained the south basin at a depth greater than that in the north basin; for leakage from the north basin, under the division bank, would now attack the asphalt concrete floor lining of the south basin from below.

*Results of Repairs.*

The greatest depth carried in either basin prior to 1897, was about 17 feet, but on January 21st of the current year, the depths had reached 23 feet 2 inches and 20 feet 8 inches in the south and north basins respectively, with little, if any, greater indications of leakage in the neighborhood than when the basins were empty. As the basins, however, were in constant use, it was of course impossible to determine the existence or the extent of leakage by means of observations of the water surface in the basins.

Our practice is to pump into the south basin and to draw off from the north basin. All the water drawn must, therefore, flow through the pass pipes from the south to the north basin. All possible use is thus made of the existing facilities for sedimentation.

*Utilization of Reservoirs.*

During the repairs of each basin at Queen Lane Reservoir, a considerable depth of water was kept in the other basin, and this was utilized, as described in detail in the report of Mr. Fuller, Assistant in charge of Distribution, for the relief of the larger portion of the direct pumpage district, which, by this means, was restricted to that portion of the City bounded by Broad, Jefferson and Callowhill streets and the Schuylkill river.

It was not, however, practicable to refrain entirely from direct pumpage during seasons of turbid water, until after the close of the year.

Then, when the depth had reached its maximum (23 and 21 feet respectively), the river became greatly fouled by mud, and afterwards by anthracite coal dust brought down by heavy rains, and the experiment was tried of entirely stopping direct pumpage and supplying the whole of the "direct pumpage district," from Queen Lane Reservoir, the pumpage into the reservoir from Queen Lane Station being also discontinued. Pumpage into East Park Reservoir was also greatly reduced. This was the first time during my administration, that the conditions have warranted such use of the reservoirs.

The result was a supply of relatively clear water to the district and a very rapid drawing down of the reservoir.

The same experience was repeated during the current month, beginning with 19 feet 3 inches and 17 feet 4 inches in the south and north basins respectively, on the 6th instant. Not having had time to restore the depth before the second visitation of turbid water was upon us, we were compelled to resort again to pumping before the river had cleared.

In order to be able to restore the desired depth of water in the reservoir, after thus drawing it down for the supply of the district during the seasons of turbid water, we have resorted to the expedient of running three of the pumps, instead of two, keeping them, for the present, somewhat below their full capacity. Thus far, the experiment has resulted in no damage to the pumping main.

### *Suit for Recovery of Retained Percentage.*

On December 12 this suit was decided in favor of the contractors, with interest, $14,339.15. The City Solicitor filed application for a new trial, but this was refused.

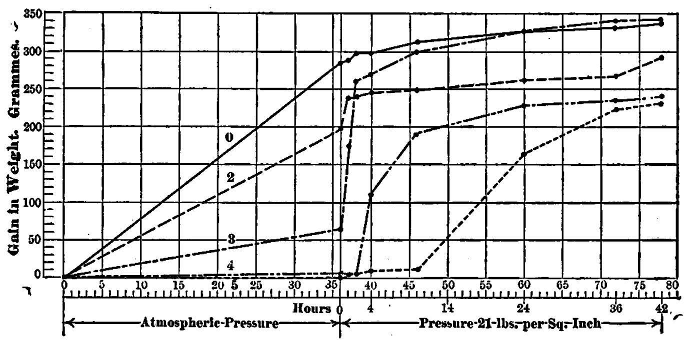
*Experiments with Asphalt.*

In connection with the application of asphalt in relining the Queen Lane and Roxborough Reservoirs, experiments were instituted with a view to ascertaining the power of asphalt to resist the percolation of water. The exigencies of the service prevented any very elaborate preparations for the purpose, and the experiments were therefore necessarily somewhat crude.

The first experiment was made with five single bricks. one of which was left untreated and the other four treated with two, three, four and five coats, respectively, of Bermudez asphalt, applied by dipping the bricks into melted asphalt and allowing each coat to cool before the next was applied.

The bricks were then placed in water, first under the natural atmospheric pressure, and afterward under a pressure of 21 pounds to the square inch, which corresponds to a head of 48.44 feet of water, or more than 18 feet greater than that intended for Queen Lane Reservoir.

The results, shown in the accompanying diagram, indi-



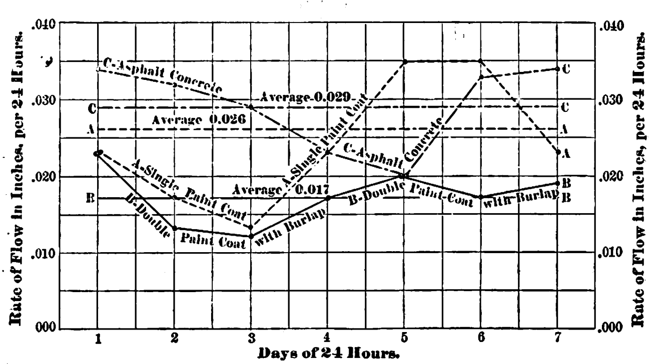

Absorption of water by bricks coated with pure asphalt.
Each curve is marked with the number of coats.

cated, as was expected, that the rate of absorption through the asphalt coating was, in general, inversely proportional to the number of coats, particularly under atmospheric pressure. Under a pressure of 21 pounds per square inch some irregularity appeared, the brick with three coats absorbing water more rapidly than that with two coats. At the end of 75 hours the brick with three coats had absorbed as much water as the uncoated brick, nearly 350 grammes, while the other three had absorbed between 260 and 280 grammes.

In the case of the brick treated with three coats, the rate of leakage during the first two hours, under 21 pounds pressure was, 1.26 inches per day, but that of the other specimens was very considerably less than this.

These results were so widely at variance with what we had previously been able to learn respecting the behavior of asphalt, and so startling, in view of the intended use of that material for relining the reservoir, that it was thought advisable to make tests under conditions more nearly resembling those obtaining in the reservoirs.

We accordingly experimented with three cement concrete slabs, treated with preparations of Bermudez asphalt.




Percolation through asphaltic linings on cement concrete slabs

These slabs had been submitted by the Pennsylvania Asphalt Paving Co., as samples, accompanying their bids on the relining of reservoirs. They were subjected to a pressure of 13 pounds per square inch, corresponding to a depth of 30 feet.

The results of these tests are shown in the accompanying diagram, from which it will be seen that the greatest rate of leakage through these specimens was 0.035 inch per day and the minimum 0.0104 inch per day, with an average of about 0.025 inch per day.

That the results of the experiments with the concrete blocks are the more reliable, is indicated by our subsequent experiments already described, with the asphalt lining of the Queen Lane Reservoir itself.

In order to conduct further experiments upon the behavior of different linings of concrete and asphalt, an apparatus for the purpose has been fitted up at the Spring Garden Pumping Station.

*New Roxborough Reservoir.*

In 1895, the following specifications for the relining of the new Roxborough reservoir were prepared :

1st. A lining of melted asphalt.

2d. A double lining of melted asphalt, with burlap between the two coats.

3d. A water-tight lining, the method of treatment to be submitted by the bidder.

Among the propositions received under the third of these specifications, was one from the Alcatraz Paving Co. of Pennsylvania, for 1½ inches of asphalt concrete on the slopes and floor, and under this proposition the company was authorized to begin work in the north basin. The quantities, together with the corresponding pro rata costs under the lump sum bid, are as follows :

*Lump sum bid $138,031.46 approximately $1.28½ per sq. yd.*

| | North Basin. | | South Basin. | | Total. | |
|---|---|---|---|---|---|---|
| | Sq. yds. | Cost. | Sq. yds. | Cost. | Sq. yds. | Cost. |
| Slopes.................. | 15,745 | $20,240 14 | 15,800 | $20,310 84 | 31,545 | $40,550 98 |
| Floor............ ..... | 36,729 | 47,214 99 | 39,102 | 50,265 49 | 75,831 | 97,480 48 |
| | 52,474 | $67,455 13 | 54,902 | $70,576 33 | 107,376 | $138,031 46 |

In the fall of 1896, the company erected an elaborate plant for the preparation of asphalt concrete, near the east side of the north basin, and, before the work was stopped by the winter, had laid about 260 square yards upon the floor.

The contractors began operations by taking bricks out of the existing lining at short intervals, for the purpose of securing a sufficient bond between their proposed asphalt concrete lining and the brick-work of the slopes.

An examination of the openings thus made developed the fact that, under the brick-work, the clay puddle lining had, in many places, been washed out to a serious extent. Accordingly, as stated in Mr. Hand's report, the spaces thus left under the brick lining were thoroughly grouted.

Water was turned into the basin on December 22, and by January 16th of the present year had reached a depth of 11 feet, but at this depth leakage, to about the same extent as had hitherto occurred, appeared in the meadow northwest of the basin. We, therefore, refrained from further increase of the depth.

### *Distribution.*

In commenting upon the unfortunate effects of the lack of appropriations for extensions and improvements, I have already referred to the pressing necessity for the improvement of our distribution system.

### *Venturi Meter.*

Under the charge of Mr. A. J. Fuller, Assistant in Charge of Distribution, careful experiments have been made with a view to determining the reliability of the Venturi Meter, reference to which, as a means of measuring the flow in large pipes, was made in my report for 1895. Detailed accounts are given in Mr. Fuller's report,

Appendix C, as also in Appendix K, which contains a report by Professor H. W. Spangler, of the University of Pennsylvania, on experiments made by him and by his students upon the 48-inch Venturi at Wentz Farm Reservoir, in connection with the measuring weir established at that place.

The Venturi Meter, in itself, is, by reason of its simplicity and accuracy, a most valuable instrument for the measurement of flow in such cases. The principal difficulty experienced by us in connection with it has arisen from the complicated registering apparatus by which the indications of the meter are recorded. It is hoped that the substitution of mechanical for electrical driving machinery for the registering apparatus may be found to obviate much of the trouble.

*Pitot Tube.*

Owing to difficulties in obtaining satisfactory indications from the Pitot Tube, but little progress has been made in our investigations with that instrument. They will, however, be continued, and we shall seek to overcome the difficulties encountered ; for, if it can be made to give reliable results, it will form a valuable addition to our means for the measurement of flow.

*Machine for Tapping Large Mains Under Pressure.*

The use of the tapping machines by which connections may be made with large mains full of water and under pressure, without stopping the flow, has been fully justified by the results, the service through the full main being continued and the consumers supplied from it while the connection is being made.

*Extension of Supply to Lawndale, Fox Chase, etc.*

On February 6th I visited the Wentz Farm Reservoir with Messrs. Hand and Fuller, in order to ascertain what arrangements had best be made for a supply to Lawndale, which lies just north of the reservoir.

As stated in Mr. Fuller's report, a 20-inch supply main and a 12-inch service main have since been laid in Oxford pike from the reservoir for this purpose, but the head obtained from the reservoir is insufficient for a satisfactory supply. This will be much improved by the operation of the intended high-service pumping station at the reservoir.

On November 19, the Water Committee of Councils reported favorably, with recommendation for reference to the Finance Committee, an ordinance ordering the construction of a high-service pumping station near Wentz Farm Reservoir, for the supply of Fox Chase, Bustleton, and other places in the northeast section of the City.

*Comparison of Conditions Relating to the Distribution. 1895–1896. Mains.*

| | | 1895. | 1896. | Increase. | Decrease. |
|---|---|---|---|---|---|
| New Work. | Service mains, 3 to 16 inch | 169,534 | 158,496 | ............... | 11,038 |
| | Supply mains, 12 to 48 inch | 9,022 | 20,395 | 11,373 | |
| | Pumping mains, 20 to 48 inch | 4,792 | 1,151 | ............... | 3,641 |
| | Connections and miscellaneous work | 25,947 | 16,797 | ............... | 9,150 |
| | Totals in feet | 209,295 | 196,839 | 11,373 | 23,829 |
| Repairs. | Relaid, 4 to 48 inch | 31,063 | 71,189 | 40,126 | |
| | Miscellaneous repairs, 4 to 48 inch | 8,706 | 5,864 | ............... | 2,842 |
| | Taken up, 2 to 48 inch | 23,959 | 60,586 | 36,627 | |
| | Lowered, raised, shifted, 4 to 30 inch | 7,779 | 6,759 | ............... | 1,020 |
| | Totals in feet | 71,507 | 144,398 | 76,753 | 3,862 |
| Pipe cut off and abandoned, 3 to 16 inch | | 10,091 | 14,172 | 4,081 | |

*Pipe Laid by Property Owners under Ordinance of Councils dated June 19, 1890.*

| | 1895. | 1896. | Increase. | Decrease. |
|---|---|---|---|---|
| 6-inch pipe | 12,550 | 7,842 | .................. | 4,708 |
| 8-inch pipe | 2,169 | .................. | .................. | 2,169 |
| Totals in feet | 14,719 | 7,842 | .................. | 6,877 |

*Work Performed in Connection with Construction of Electric Railway.*

| | 1895. | 1896. | Increase. | Decrease. |
|---|---|---|---|---|
| Pipe laid | 17,503 | 5,998 | .................. | 11,505 |
| Fire hydrants | 119 | 11 | .................. | 108 |
| Service connection | 1,649 | 84 | .................. | 1,565 |

*Meters.*

| | 1895. | 1896. | Increase. | Decrease. |
|---|---|---|---|---|
| Meters in use | 1,253 | 1,330 | 77 | |

*Number of Dwellings and of Principal Appliances for the use of City Water.*

| | 1895. | 1896. | Increase. | Decrease. |
|---|---|---|---|---|
| Dwellings wlth water | 205,213 | 211,722 | 6,509 | |
| Dwellings without water | 12,579 | 12,559 | .................. | 20 |
| Water closets | 155,199 | 170,039 | 14,840 | |
| Baths | 138,650 | 145.840 | 7,190 | |
| Wash paves | 77,552 | 81,098 | 3,546 | |
| Basins and sinks | 74,497 | 78,681 | 4,184 | |
| Urinals | 4,564 | 4,686 | 122 | |

*Sewage from House of Correction, and Water Supply for County Prison.*

On September 5, I visited, with Mr. Hand, General Superintendent, the House of Correction and the County Prison, near Holmesburg, in order to form an idea as to the extent of sewage pollution due to the former and as to the advisability of supplying the latter with water from the City's mains.

Taking a boat at the Frankford Pumping Station, we rowed up the Delaware and the Pennypack creek to the House of Correction, examining the sewage outfall and the general conditions there, and then proceeded to the County Prison, where we examined the existing arrangements.

As a result of this visit I arrived at the conclusion that the sewage of the House of Correction, as we observed it, was insignificant in quantity relatively to the volume of other sewage discharged into Pennypack creek, and that, so far as the City's interests were concerned, it mattered little whether a supply of water were furnished to the County Prison by this Bureau or a supply taken from the works of the Holmesburg Water Company in accordance with a proposition made to the prison authorities by that company.

To supply City water to the prison would involve the laying of a main a little over two miles in length from our pumping main at Robbins street, at a cost estimated at $15,000 for a 10-inch pipe, and the cost of this would approximately offset the higher rates necessarily charged by the Water Company.

On September 8th, I visted the prison, in company with a Committee of Councils, for the purpose of further studying the matter.

On September 10 the Water Committee decided in favor of laying a main to supply the prison, but this action was afterward reversed by Councils and a contract was entered into with the Holmesburg Water Company for a supply of water in accordance with its proposition.

*Electrolysis.*

I am glad to be able to report that, as in previous years, no well established case of injury to our water pipes by reason of electrolysis has come to our notice, thanks to the efficient regulations of the Electrical Bureau.

*Second District Yard.*

In Mr. Fuller's report you will find reference to a proposition to increase the area occupied by the Second District yard at 918 Cherry street, by the purchase of adjacent properties. This enlargement of the facilities of the Second District is greatly needed, and I trust that means may be found for bringing it about.

*Consumption and Waste.*

The fact that our average daily pumpage has already, for several years, exceeded the minimum daily flow of the Schuylkill, must, I think, soon compel serious attention, on the part of Councils, to the question of the general introduction of meters, by which, it is safe to say, our consumption could, by the mere elimination of reckless waste, be reduced one-half. Such extension in the use of meters, however, will require an improvement in our means for testing them. Indeed, such need has been a very pressing matter for some years past, and, even if we are to proceed upon the small and insufficient scale which we have for some time followed, we should at once be provided with a proper and suitably equipped building for the testing of meters.

The average daily per capita consumption in 1896 increased from 160 to 172.2 gallons per head per day, and even much higher rates have been observed in certain cases by means of the Deacon Waste Water Meter.

*Proposed Ordinance Extending the Use of Meters.*

In Appendix L, I submit a sugested form of ordinance looking to an extension of the use of meters.

The existing ordinances prevent the introduction of meters into manufacturing establishments unless with the consent of the owners, and no provision is made for their introduction into residences.

In the proposed ordinance, the Director of the Department of Public Works is instructed to place meters upon all manufacturing establishments and upon other connections using large quantities of water, and, with the consent of the owners, upon private residences.

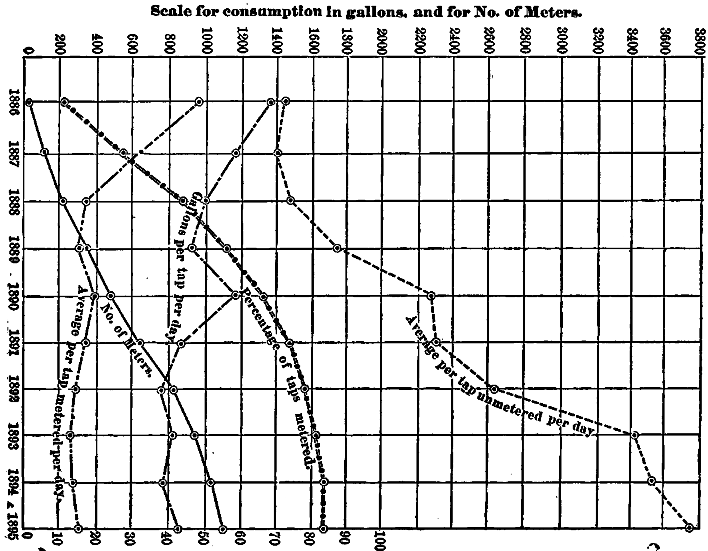
It is probable that private residences consume at least 90 per cent. of all the water pumped by the City, and the use of the meter in them is therefore far more important than in manufacturing establishments. It is believed that if the use of the meter in residences, with the consent of the owner, is permitted by Councils, it will soon be discovered that any careful resident can save money by having his water supply measured and charged by meter rather than by schedule rates.

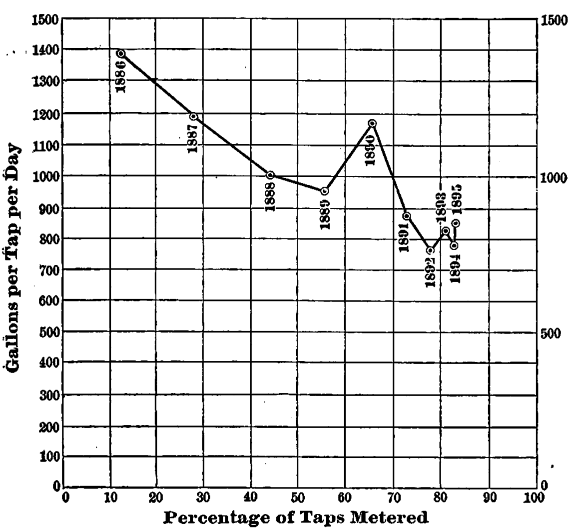
Under schedule rates it is of course necessary to charge the provident and conscientious taker with more water than he uses, in order to reimburse the City for waste on the part of the careless and unscrupulous.

So long as the meter rate is kept, as now, approximately, such as to charge the water at cost, objections to the use of meters can come only from those who seek to get from the City more than they pay for.

*Efficiency of Meters in Reducing Waste.*

The effect of the use of meters in reducing the waste of water is well shown in the accompanying table, giving the experience of the water company supplying the City of Lexington, Kentucky. The results are shown graphically in the accompanying diagram.



*Effect of Use of Meters on the Consumption of Water, Lexington, Ky., 1886–1895.*

| Year. | No. of Taps Metered. | No. of Taps Unmetered. | Total No. of Taps. | Percentage of Taps Metered. | Annual Consumption in Gallons. | Gallons per Tap per Day. |
|---|---|---|---|---|---|---|
| 1886 | 33 | 238 | 271 | 12 | 137,445,250 | 1,389 |
| 1887 | 103 | 264 | 367 | 28 | 159,438,385 | 1,190 |
| 1888 | 209 | 271 | 480 | 44 | 175,208,473 | 1,000 |
| 1889 | 344 | 267 | 611 | 56 | 211,128,133 | 947 |
| 1890 | 486 | 254 | 740 | 66 | 284,791,285 | 1,165 |
| 1891 | 659 | 239 | 898 | 73 | 288,159,700 | 874 |
| 1892 | 829 | 230 | 1,059 | 78 | 301,871,618 | 762 |
| 1893 | 942 | 216 | 1,158 | 81 | 343,540,576 | 814 |
| 1894 | 1,025 | 217 | 1,242 | 83 | 347,994,840 | 787 |
| 1895 | 1,100 | 223 | 1,323 | 83 | 410,664,795 | 850 |

### *Construction and Repair Shop.*

I respectfully endorse the recommendation of Mr. James H. Dean, Superintendent of the Construction and Repair Shop, that a wagon entrance to the rear of the shop be constructed.

It is also very desirable that the gravel mound on the rear of the lot be graded down and carted away, and a fence constructed on that side of the lot, in order to put a stop to depredations and to the use of the lot by disorderly persons.

## QUALITY OF SUPPLY.

### *The City's Typhoid Conditions.*

In "Engineering News," of March 19, the following statement appeared, under the heading, "The Proposed Experiments on the Filtration of the Philadelphia Water Supply."

" Many a person throughout the country remembers the 'Philadelphia fever,' contracted by himself or some relative or friend during the Centennial. * * * Since 1876, as before, Philadelphians have suffered with typhoid, and hundreds of deaths have been caused by the disease. * * * * The death roll from typhoid, caused by impure water, has reached a length that calls for a change."

Believing that this statement might act injuriously and unjustly to the interests of this City, I addressed the editor of "Engineering News" as follows, and my remarks were printed in the issue of that journal of March 26th:

"While each of these statements is in itself literally and

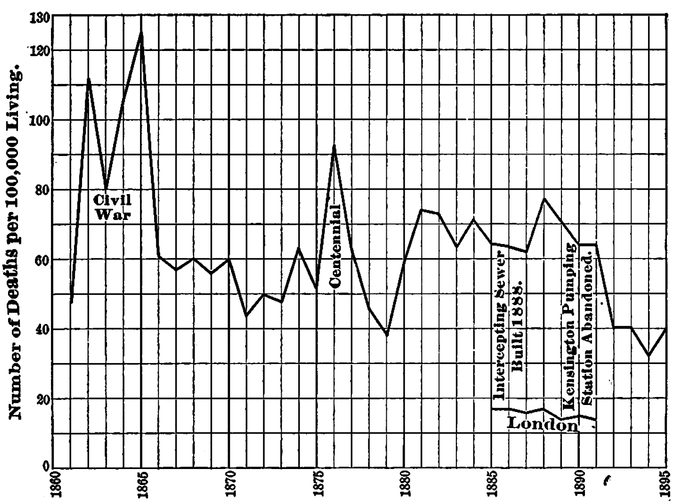



Fig. 1.—Typhoid Fever Mortality per 100,000 of Living Population, in Philadelphia, 1861 to 1895, Inclusive.

strictly true, they tend, when taken together, to convey the erroneuos impression that the conditions obtaining in 1876 have continued unabated, or even intensified, ever since.

"To show that this is far from being the case, I submit herewith, a diagram, Fig. 1, compiled in this Bureau from the reports of our Board of Health, and showing, for each year from 1861 to 1895, inclusive, the number of typhoid deaths for each 100,000 inhabitants.

"As you will see, the Centennial year of 1876, like the four years of the civil war, marked an altogether exceptional state of affairs.

"In both cases our actual population was swelled by a very large influx of non-residents, who do not figure in the divisor used in obtaining the quotients plotted in the

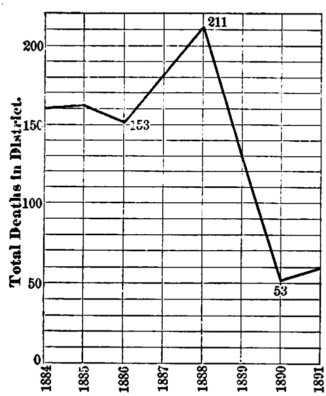



Fig. 2.—Typhoid Fever Mortality in the District supplied, before and after Abandoning the Delaware Pumping Station.

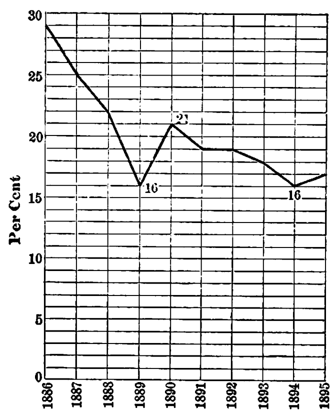



Fig 3.—Percentage of Typhoid Cases Proving Fatal in Philadelphia from 1886 to 1895, inclusive.

diagram. It is needless to point out that the condition of those who were thus added to our numbers during the war was highly favorable to the development of an abnormally high typhoid rate; and this was also the case, though perhaps to a less degree, during the Centennial. Our visitors, as well as our citizens, by reason of the fatigue incident to arduous sight-seeing, rendered themselves an easy prey to zymotic disease; overcrowding was the rule, even in private dwellings, to say nothing of the hundreds of hotels and boarding-houses improvised for the occasion. The summer was an exceptionally hot one, and it is alleged that, in spite of the vigilance of our health authorities, gross violations of sanitary laws occurred within the exhibition grounds themselves.

"Under these circumstances it is not strange that in 1876 there were 92 typhoid deaths per 100,000 of fixed population, a very much higher number than has been reached at any time since the war, and 35 higher than the average (58) of all the years since 1865, including 1876 itself.

"In the discussion upon the ordinance making an appropriation for a filter plant, it was stated, upon the floor of Councils, that the records of the Board of Health showed a continuous decrease in the typhoid death rate, and that this improvement progressed in the face of a steady deterioration in the quality of our water supply.

"The diagram, Fig. 1, shows that, except in the last four years, the typhoid death rate has increased rather than diminished, the average for 1880-91 being distinctly higher than that for 1866-79, and the latter, in turn, distinctly higher than that for 1861.

"During the last four years, however, the rate has been much less than at any other time during the 35 years embraced in the diagram, and these years have followed certain notable steps taken for the improvement of our water supply. I refer particularly to the completion of the intercepting sewer, in 1888, by which a very large amount of pollution was diverted from Fairmount pool, and to the final abandonment, in 1890, of the use of the old "Delaware" pumping station.

"In his report for 1889, my predecessor, Mr. John L. Ogden, referring to the measures taken for the protection of the Schuylkill supply, enumerates sewers, slaughter houses, dwellings, omnibus and car stables, hotels, rolling mills, breweries, gas works, water closets, dye-houses, paper mills, an oil refinery, the House of Refuge and Girard College, all of which polluted the lowest or Fairmount pool. By the establishment of Fairmount Park and the construction of sewers, all of this filth had been removed or turned into the river below Fairmount dam, at a cost of over $7,000,000.

"The completion of this intercepting sewer, in 1888, and the final abandonment of the old Delaware pumping station, in 1890, are indicated in Fig. 1. The Delaware station was in a densely populated district and its intake drew from the river immediately below the mouth of the large Gunner's Run or Aramingo sewer. Its abandonment was marked by an immediate and notable decrease of typhoid mortality in the district supplied by it, as shown by Fig. 2, which is plotted from figures given by Dr. Henry Leffmann, of this City, in the Proceedings of the Engineers' Club of Philadelphia, for January, 1893. It may well be credited with an important share in the striking improvement shown in Fig. 1 between 1891 and 1892.

"It must be remembered, also, that while no municipal filter has been erected, the pollution of the Schuylkill water by anthracite coal dust, a feature which I find first referred to in the report of Mr. Ogden for 1888, has forced our citizens, and more particularly our keepers of hotels and restaurants, to a very general use of domestic and larger filters. It is altogether probable that, by thus forcing filtration, the "black water" of the last few years has been a blessing in disguise, improving the quality of much of the water used for drinking, and thus contributing, as might have been expected, to the lowering of the typhoid death rate.

"Another cause of the improvement shown in Fig. 1 may be found in the increased ability of our physicians to deal with typhoid cases. I submit, herewith, in Fig. 3, a diagram compiled from data furnished me by Dr. Wm. H. Ford, President of our Board of Health, and showing a nearly continuous decrease in the ratio between the number of typhoid deaths and the number of typhoid cases from 1886 to 1895. The returns of cases are admittedly defective, but the ratio of defect is probably a constant quantity, and the record may therefore be safely taken as a means of comparison.

"For the purpose of comparison I have drawn, upon Fig. 1, a diagram showing the numbers of deaths from "fever," including typhoid, per 100,000 persons living, in London, from 1885 to 1891, taken from the evidence of Thomas Orme Dudfield, M. D., Vice President (and Past President) of the Society of Medical Officers of Health, and for twenty-one years Medical Officer of Health for Kensington, before the Royal Commission on Metropolitan Water Supply.

"A comparison of this diagram with that for Philadelphia, shows that the need of filtration is sufficiently evident without any exaggeration of our city's typhoid mortality."

### *Effects of Insufficiency of Aeration.*

Complaints were recently received from West Philadelphia and from the Twenty-fifth Ward, Port Richmond, of an unpleasant smell and taste in the water furnished to those districts. Samples of the water were immediately taken in each case, at the intake, at the reservoir and from several taps in the district, and submitted, for examination, to Mr. W. C. Robinson, Jr., Chemist of the Bureau of Health. He found the trouble due to the presence, on the rivers and reservoirs, of ice, which prevented sufficient aeration and thus caused the death and decay of vegetable organisms existing in the water.

### *Coal Dust Pollution.*

Early in January a heavy flood, extending through the greater portion of the Schuylkill Valley, brought down the river immense quantities of the coal dust which accumulates in its bed and in those of the tributary streams, from the use of water in the washeries, by which the culm heaps are worked for the extraction of the small marketable sizes, and in many of the breakers. The water supplied to the City was thereby rendered utterly unfit for drinking and indeed for most other purposes.

In June, I visited the Schuylikll coal regions in company with Mr. J. W. Catharine, Assistant City Solicitor, the late Mr. Amasa Ely, of this office, and Captain A. C. Huckey, whose familiarity with the region enabled him to act as guide.

We spent two days in the region, examining the Panther Creek Valley, the valley of the Schuylkill between Tamaqua and Pottsville, and the vicinity of Minersville, visiting many breakers and washeries, and obtaining facts as to the means taken or neglected for preventing the introduction of the coal dust into the streams.

Reports of this and of two subsequent visits are contained in Appendix M.

As a result of this visit the City Solicitor filed a bill in equity against certain mine owners, restraining them from carrying on their operations in such a way as to cause further pollution of the stream.

At this writing the water is again very deeply colored with coal dust.

### *Filtration.*

The filtration problem is apparently no nearer a solution than at the date of my last report. At that time I urged the appropriation of $250,000 for a practical filtering plant of such capacity as to supply with filtered water some district of limited size, in order that the filtered water might not, as in a merely experimental station, be allowed to run to waste or return to the river unutilized. I am happy to say that my suggestion received your cordial endorsement.

Eearly in the year an ordinance making such an appropriation, was introduced to the City Councils, and I urged its passage before the Water and Finance Committees, stating, with your approval, that such station would be composed of a number of filtering appliances of different kinds, to be selected by disinterested experts, in order that these might be tested side by side and in actual operation, while the efficacy of filtration in general would be shown by the effect of the experiment upon the health of the district supplied.

The ordinance was reported favorably by the Water and Finance Committees but, on March 19, it failed of the necessary two-thirds vote in Common Council, although, on the day preceding, it had received the endorsement of the Franklin Institute.

A proposition from the Pennsylvania Sanitation Company (see Appendix G), to place, over each of our reservoirs, filter beds carried upon steel structures, after the manner of the sewage filtration plant recently installed at Reading, Pa., and appropriating $3,000,000 for the purpose, was introduced into Councils June 11, and was favorably reported by the Water Committee on October 8, with a recommendation that it be referred to the Finance Committee.

On May 20, the Water Committee reported favorably an ordinance, introduced by Mr. J. Emory Byram, appropriating $250,000 for filtration.

I consider it of the utmost importance that such a beginning as that contemplated in the defeated ordinance should at once be made, in order that we may determine to what extent we may properly utilize the waters of the Delaware River, which flows past our doors in volume more than four times as great as that of the Schuylkill.

If it can be shown that this water can be rendered perfectly satisfactory by means of filtration, we may disregard the numerous and costly schemes, for supply from distant sources, which, from time to time, present themselves to the consideration of Councils.

Recognizing the necessity of improving, as rapidly as possible, the quality of our entire supply, I am nevertheless equally impressed with the importance of making haste slowly, and in no way can this be done better than by the immediate installation of such a plant as is contemplated in the ordinance appropriating $250,000 for the purpose.

Notwithstanding that the experience of other cities furnishes good reason to believe that filtration will give us excellent and perfectly satisfactory water from both rivers, yet the best treatment for any given case must be determined by a careful study of the conditions of that case, and, preferably, by an actual experiment with them upon a relatively small scale.

Whatever we may first do in the matter of filtration must of necessity be experimental, and every expert in water works matters in general, and in filtration in particular, will recognize that it is better to begin with a $250,000 experiment than with a $3,000,000 experiment.

It is therefore all the more urgent that no time should be lost in inaugurating the proposed initial station.

An Ordinance authorizing a loan of $3,000,000 for the purpose of filtration, received the signature of the Mayor, December 9, but is inoperative pending a decision on the question of the power of the City to borrow this money.

For the intelligent application of these funds, when raised, it is of the first importance that we should proceed as early as possible with the installation of a filtration plant of moderate size.

*Report by Mr. Allen Hazen.*

During the summer, Mr. Allen Hazen, of Boston, who is generally recognized as one of the leading authorities in matters connected with filtration, studied our water supply system with a view to making a report to the "Woman's Health Protective Association," upon the subject.

His report, entitled "A Practical Plan for Sand Filtration in Philadelphia," was presented to the Association on September 1, and by the Association to his Honor, the Mayor, on September 18. This report is printed in Appendix N, herewith. In it, Mr. Hazen suggests the construction of sand filter plants on the Delaware below Torresdale, a smaller one just above our so-called Frankford Pumping Station, and other small beds near the new Roxborough and Queen Lane Reservoirs, and on the site of the proposed Cambria Reservoir in the vicinity of Twenty-eighth and Clearfield streets, together with one near the Belmont Reservoir for the filtration of the West Philadelphia supply.

Mr. Hazen, assuming that the City must soon awaken to the folly of its present waste of water and put a stop to it by introducing meters, estimates, for a maximum consumption of 195,000,000 gallons per day, in connection with the existing pumping stations, that the cost of the sand filtration plants necessary would be $3,391,000, with, of course, a provisional increase in the cost "in case the "City is unwilling to bring itself to a reasonable use of "water, and insists on wasting water as at present."

*Estimate of Cost.*

In response to a request from Councils, transmitted by you in April last, I have been in correspondence with many municipalities and corporations employing filtration, with a view to arriving at a satisfactory approximation to the cost of filtering our supply.

While this method is simpler than designing a system of filtration for the City (a task for which, indeed, we have at present no proper facilities) and probably at least as reliable, it is one consuming much time and correspondence and other labor, and involving, after all, considerable uncertainty.

Comparing the most reliable of the data procured, I find that the cost of installation varied, roughly speaking, between $9,000 and $14,000 (exclusive of land) per million gallons of daily capacity, with an average of, say, $12,000, and the cost of operation (exclusive of interest) between $1.50 and $4.00 per million gallons filtered, with an average of about $2.50. In my deductions respecting cost of construction of sand filters, I have assumed a rate of 2.5 million gallons per acre per day.

Mr. Hazen's estimate for the Woman's Health Protective Association, reduced to a basis of 2.5 million gallons per acre per day, makes the cost of sand filters about $19,400 (exclusive of land), per million gallons of daily capacity, and the cost of operation, exclusive of interest and sinking fund, $4.24 per million gallons.

In connection with the experiments made under his care at Providence, R. I., in 1893, Mr. Edmund B. Weston estimates the cost of construction of mechanical filters at from $13,260 to $16,350 per million gallons of daily capacity, and the cost of operation, exclusive of interest, etc., at $4.52 per million gallons.

Assuming the cost of installation at $15,000 per million gallons of daily capacity, and the expense of operation at $3.00 per million gallons, we have the following roughly approximate figures, exclusive of cost of land and of interest.

| Consumption in Millions of Gallons per Day. | Cost of Construction. | Annual Expense of Operation. |
|---|---|---|
| 1896, actual........................................ 235 | $3,525,000 | $257,325 |
| 1896, if metered, say........................ 120 | 1,800,000 | 131,400 |
| 1910, at present rate of increase..... 450 | 6,750,000 | 492,750 |
| 1910, if metered ............... .......... 230 | 3,450,000 | 251,850 |

### *Visits to Filtration Plants.*

During the year I visited the sand filter plant at Lawrence, Mass., the Sellers Plant at Wilmington, Delaware, the Morison-Jewill plants at Wilkesbarre, Pa., Lexington, Ky., and Royers Ford, Pa.; the Warren plant, at Warren, Ohio; the filter crib (not yet in use), at Allegheny, Pa., and the sewage filtration plant at Reading, Pa.

In June last, I witnessed the very elaborate and extensive filtration experiments which were then being conducted at Louisville, Ky. These were completed some months ago, but, owing, as I understand, to further investigations now being conducted by Mr. G. W. Fuller, of Boston, who was in charge of the Louisville experiments, the results have not yet been made public. Unfortunately, the filters which contributed most of the results in this investigation, namely, the Morison-Jewill, the Warren, and the Western, are of nearly similar types.

On October 20, I visited Reading, Pa., with members of the Water Committee of Councils, under the auspices of Mr. John J. Deery, President of the Pennsylvania Sanitation Co., and inspected the sewage filtration plant constructed there by the company.

### *Experiments with Sedimentation.*

Early in the year, while the filtration ordinance was under discussion in Councils, during which it had been urged that sedimentation would do, for the water, all that was necessary, I cut off, from pumpage and from distribution, the smallest basin in East Park Reservoir, and took samples from it from day to day, submitting them, for bacteriological and chemical analysis, to Dr. A. C. Abbott, of the University of Pennsylvania.

Dr. Abbott submitted the following report of his investigation of the nine samples submitted to him:

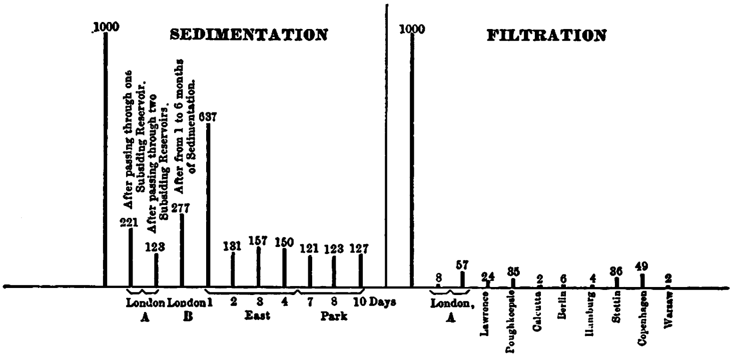
*Chemical and Bacteriological conditions of Water from the South Section of the East Park Reservoir.*

| No. of Sample. | Day and Hour when Collected. | | No. of Bacteria per C. C. | Parts per Million. | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Nitrogen as | | |
| | March. | Hour. | | Total Solids. | Oxidizable Organic matter | Chlorine. | Nitrates. | Free $N. H._3$ | Alb. $N. H._3$ |
| 1 | 6 | 5 P. M. | 3340 | 201.00 | 2,696 | 5,500 | 0.2234 | 0.074 | 0.322 |
| 2 | 7 | 9.30 A. M. | 2127 | 152.00 | 3,088 | 5,500 | 0.2234 | 0.084 | 0.230 |
| 3 | 8 | 9.30 A. M. | 436 | 131.00 | 2,745 | 5,500 | 0.2234 | 0.08875 | 0.251 |
| 4 | 9 | 10.30 A. M. | 525 | 136.00 | 2,941 | 5,500 | 0.2234 | 0.1000 | 0.3025 |
| 5 | 10 | 10.30 A. M. | 490 | 150.00 | 2,549 | 5,500 | 0.2234 | 0.09375 | 0.2568 |
| 6 | 11 | 10.00 A. M. | 403 | 147.00 | 2,647 | 5,500 | 0.2234 | 0.0981 | 0.2537 |
| 7 | 13 | 4.00 P. M. | 403 | 146.00 | 3,0000 | 5,800 | 0.2234 | Lost | Lost. |
| 8 | 14 | 10.00 A. M. | 412 | 140.00 | 3,0434 | 5,500 | 0.2234 | 0.1043 | 0.2287 |
| 9 | 16 | 11.00 A. M. | 427 | ........... | 2,3180 | 5,500 | 0.2234 | 0.1356 | 0.1850 |

The bacteriological results of this examination are shown graphically in the accompanying diagram, where they are compared with the effects of filtration in several American and European cities, showing that while sedimentation produced, during the first two or three days, a notable diminution in the number of bacteria in the water, the improvement then ceased, and was, after all, inconsiderable in comparison with the almost perfect sterilization produced by careful filtration.

Dr. Abbott comments as follows upon the results of his examinations of these samples :

" Each sample deposited a considerable amount of




"brownish sediment on standing. Microscopic examina-"tion of this revealed the presence of algae, diatomes, para-"meciae, bacteria and vegetable debris, besides mineral matters.

" The capacity of each sample was quite marked, and "there was little perceptible improvement, the last samples "being practically identical to the first in this respect.

"Another marked feature of each sample was observed "in the chemical analyses. In the distillations for both "free and potential ammonia these bodies were given off "in such a way as to indicate the presence of urea or some "other analogous organic body, following very closely the "phenomenon observed by Dr. Smart, U. S. Army, in the "distillation of waters polluted with urea.

" No systematic determination of organic matter by in-"cineration was made, but from a rough estimate it was "found to be approximately 33 per cent. of the total solids."

Referring to the last three samples, Dr. Abbott says :

" The amount of sediment in these three samples is "somewhat less than in the first six samples submitted "for analysis, though the water of each sample shows con-"siderable opacity, being never clear even after standing "undisturbed for several days. The continuous evolution "of ammonia on distillation was again observed in these "samples as in the earlier ones."

### *Further Investigation Needed.*

In order to obtain further light upon this subject, I wish to inaugurate a similar set of experiments upon one of the basins of Fairmount Reservoir, continuing them through a much greater leagth of time, perhaps for a year or more, and under varying seasonal conditions.

Additional assistance has been provided for the bacteriological laboratory of the Bureau of Health, and that branch of the investigation might therefore shortly be taken up; but it is most desirable that the chemical examination should proceed at the same time, and to this end it is necessary that assistants should be provided for Mr. Robinson, the Chemist of the Bureau.

With proper aid of this kind at our disposal, very valuable investigations of our supplies might be made and our present ignorance respecting them in great measure dispelled.

It is, for instance, highly desirable that experiments should be made, similar to those carried on by Professor Erastus G. Smith, on the Mississippi River water at Davenport, Iowa, and described by him in his paper presented to the Convention of the American Water Works Association, at Indianapolis, in May last, under the title of "The Seasonal Fluctuations of Running Streams."

### *Accommodations in City Hall.*

In acordance with advices received from the Commissioners to Erect the Public Buildings, designs were made in this Bureau for furniture, etc., in Rooms Nos. 177, 178, 178a, 181, 183, 185, 187, and 191, on the ground floor of the City Hall, for those of our offices to which the public requires easy access, and for Rooms Nos. 701, 702, 704, 706, 780, 784, 788, 790, 792, 793, 794, 795, and 796, and the room in the corner tower, on the seventh floor, for the remaining officers and employees of the Bureau.

At the time of submitting my report for 1895, we had in view, for this latter purpose, two large rooms and the intervening hall in the ninth story of the western pavilion, but, owing to the absence of elevator facilities and to certain other objectionable features which developed as we proceeded with the study of the arrangement of the rooms, those on the seventh floor were selected in preference.

Owing to changes in the arrangements of the Board of Revision of Taxes and of the Bureau of Gas, it was afterward decided by the Commission that the latter Bureau should be given the rooms which had been assigned to this Bureau on the ground floor, and rooms Nos. 562, 562a, 564, 566, 568, 568a, 580, 580a, 582, 584, 586, and 588 on the fifth floor were placed at our disposal.

We have therefore prepared, and submitted to Mr. W. Bleddyn Powell, Architect of the Commission, drawings showing the desired arrangement of furniture, etc., in the latter rooms.

The architect has reported to the Building Commission that the furniture specified by us for the rooms in the seventh floor will cost over $200,000.

What manner of furniture it is proposed to furnish us, to bring the cost to any such figure, I am at a loss to conjecture. The Bureau, of course, asks for only such facilities as will enable it to do its work to the best advantage and with reasonable comfort, and a very liberal estimate, based on high class wooden furniture, makes the cost scarcely $25,000.

*Visits to Water Works, etc.*

In May and June last, I attended the Convention of the American Water Works Association at Indianapolis, at which many valuable papers were read and much information gathered, and visited the water works of that city and of St. Louis, Louisville, Lexington, Ky., Cincinnati, and Pittsburg. An acount of this visit was transmitted to you shortly afterward.

On October 28, by the courtesy of Mr. Edwin F. Smith, Superintendent and Chief Engineer Canal Division, Philadelphia and Reading Railway, I had the pleasure of making a trip with him, in the company's steam tug, from Reading to Port Clinton.

In October, I visited New York, for the purpose of examining, by the courtesy of Mr. A. Fteley, Chief Engineer, Aqueduct Commission, some of the prominent features of the water supply of that city, the works of which, however, are scattered over so wide a territory that but a small portion of them could be examined within the two days which I was able to devote to this purpose. On the first day I visited the distributing reservoir in Central Park, the large gate house at 135th street, the high-service station at High Bridge and the large Jerome Park reservoir, then under construction and still far from completion. On the second day I visited the handsome masonry dam, 135 feet high, recently constructed on the Titicus River near Purdy's Station, and the work on the enormous Cornell or new Croton Dam, which will impound the waters of the main stream a few miles above its mouth.

This dam will be higher than any other existing dam in the world, and the reservoir produced by it will impound 32,000 million gallons of water. The cost of the dam, alone, is estimated at $3,650,000.

This lake will entirely submerge the old Croton Dam, built in connection with the original Croton aqueduct in 1840.

By means of Cornell Dam, together with the smaller dams upon the tributary streams, the entire yield of the Croton watershed, with the exception of the small portion below the new Cornell Dam, will be taken for the supply of New York City, and yet it seems probable that the works will hardly be completed before complaints of insufficiency are heard.

During October, Mr. F. L. Hand, General Superintendent, and Mr. John E. Codman, Chief Draughtsman, made, at my request, a trip to Chicago, and to several other western cities which I had visited during the summer, in order to inform themselves as to matters connected with the water supplies of those cities.

### *Means of Communication Between Stations.*

Travel between our works on the Roxborough and Chestnut Hill ridges, respectively, continues to be much impeded by the absence of a high-level bridge across the upper Wissahickon, the need of which was pointed out in my report for 1895.

As stated in the report of Mr. Hand, General Superintendent, an important beginning has been made in the work of improving our telephone lines. The necessity for such improvement was pointed out in my report for 1895. Communication between our main office and most of our pumping stations, reservoirs, district offices, etc., is now carried on with comparative ease and with almost entire freedom from the annoyance hitherto experienced from induction due to the proximity of electric light wires and trolley feeders, and I trust that the substitution of proper instruments for some of those now in use will make the service entirely satisfactory.

In this connection the Bureau is indebted to the kind offices of Chief David R. Walker, of the Electrical Bureau, Department of Public Safety, who designed the laying out of the new system, which involves the use of several of the City's underground cables. Two of the employees of the Electrical Bureau were transferred to our pay-roll for the purpose of running the new wires.

*Abbreviation of Report.*

In obedience to the wishes of Councils I have made renewed efforts to reduce the bulk of the annual report.

In the report for 1895, the tables of new fire hydrants and of renewals of fire hydrants, which had previously accompanied the report of the Assistant in Charge of Distribution, and which occupied 130 pages of the report of 1894, were omitted, but the table of service and supply pipes was transmitted as before, because these pipes, unlike the fire hydrants, are of course under ground, and it is therefore desirable to keep a permanent record of their laying. This could be accomplished in no way so satisfactorily as by putting them in print.

It seems, however, unnecessary to burden the report with them, inasmuch as they are of little or no interest to most of the persons to whom the report is sent. I therefore transmit them with the request that they be printed separately and that a small edition of them be bound for the use of this Bureau. These tables occupied about 70 pages in the report for 1895. The recapitulations of pipe-laying by districts are submitted with the report, as heretofore and it is believed that, to most readers of the report, they will answer every useful purpose.

A considerable economy is effected by the omission of the three diagrams representing the stream flows of the Perkiomen, Neshaminy and Tohickon, respectively, which, being printed in three colors, were necessarily expensive.

A number of minor abbreviations in the report have also been made.

### *Additional Errata in Report for 1895.*

I regret to have to report the following additional errata in my report for 1895.

Fig. 1, Appendix H, was reduced, photographically, one-half, for presentation in the report. Hence for "1 inch=200" read "1 inch=400 feet."

In the table, p. 78, of rainfall and stream-flow in 1894-5, the quantities for the Schuylkill are given (as stated) in gallons, while those for the Perkiomen, Neshaminy and Tohickon are given in cubic feet, although the headings read "gallons." Hence the following corrections should be made :

| | Total Annual Stream Flow, 1894. Gallons. | Total Annual Stream Flow, 1895. Gallons. | Decrease. Gallons. |
|---|---|---|---|
| Perkiomen | 63,464,307,000 | 41,480,690,000 | 21,983,347,000 |
| Neshaminy | 62,695,502,000 | 39,186,539,000 | 23,508,963,000 |
| Tohickon | 55,203,406,000 | 33,002,629,000 | 22,200,777,000 |

The following appendixes accompany this report :

A. Report of Chief Clerk.

B. Report of General Superintendent.

C. Report of Assistant in Charge of Distribution.

D. Report of Superintendent of Construction and Repair Shop.

E. Report of Assistant in Charge of Hydrographic Work.

F. Report of Chief Draughtsman.

G. Propositions respecting Future Water Supply.

H. Reports of Tests of Pumping Engines.

J. Specifications for the Repair of Queen Lane and Roxborough Reservoirs.

K. Report of Prof. H. W. Spangler on Experiments with Venturi Meter at Wentz Farm.

L. Proposed Ordinance for the Extension of the Use of Water Meters.

M. Reports on Pollution of the River by Anthracite Coal Dust.

N. Report of Mr. Allen Hazen to the Woman's Health Protective Association, on a Practical Plan for Sand Filtration in Philadelphia.

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I desire to renew my acknowledgments to yourself, and to the Chairman and members of the Water Committee, for aid and encouragement in the performance of my duties.

I remain, sir,

Very respectfully yours,

JOHN C. TRAUTWINE, Jr.,

*Chief of Bureau.*

## *List of Miscellaneous Receipts for the Year 1896.*

| | | | |
|---|---|---|---|
| Jan. 21 | Delaware Market Co | Repairing fire hydrant | $5 98 |
| 22 | George Anderson | Repairing pipe | 6 19 |
| Feb. 4 | Maginnis Bros | Watching main | 3 50 |
| 10 | D. McMahon | Relaying main | 14 23 |
| Mar. 3 | Dooley Bros | Repairing main | 25 48 |
| 3 | Dooley Bros | Shut off | 1 00 |
| 3 | Dooley Bros | Shut off | 2 75 |
| 20 | Mills Bridge Co | Cutting out stop | 800 10 |
| 25 | D. McMahon | Repairing main | 11 25 |
| 28 | Samuel Smeeton | Fire hydrant | 32 18 |
| April 1 | John Hevener | Rent of Farm No. 3 | 78 50 |
| 8 | Quaker City Croquet Club | Rent of ground | 10 00 |
| 18 | Joseph Perna & Co | Repairing main | 24 77 |
| 18 | Joseph Perna & Co | Repairing main | 12 22 |
| 18 | Joseph Perna & Co | Repairing main | 30 19 |
| 18 | Joseph Perna & Co | Repairing main | 11 64 |
| 24 | Richard Hey | Stop for meter | 4 60 |
| 29 | Philadelphia Brewing Co | Repairing pipe | 17 00 |
| June 9 | David France | Repairing main | 33 57 |
| 18 | Bureau of Water | Overdrawn warrant | 8 00 |
| 20 | John Bonhage | Repairing main | 8 05 |
| 27 | B. Monaghan | Repairing main | 11 50 |
| 27 | B. Monaghan | Raising pipe | 11 67 |
| 29 | H. M. Harris | Rent of Farm No. 1 | 100 00 |
| July 1 | Terminal Market Co | Examination for leak | 12 30 |
| 11 | Franklin Sugar Refinery | Cutting off pipe | 20 14 |
| 11 | Franklin Sugar Refinery | Removing stop | 8 01 |
| 11 | Franklin Sugar Refinery | Cutting off pipe | 8 64 |
| 21 | Union Traction Co | Fire hydrant | 158 04 |
| 21 | Union Traction Co | Fire hydrant | 164 73 |
| 21 | Union Traction Co | Fire hydrant | 86 56 |
| 21 | M. McManus | Repairing main | 13 80 |
| 22 | Pennsylvania R. R. Co | Repairing fire hydrant | 5 63 |
| 24 | Henry Snyder | Rent of saloon at Fairmount | 200 00 |

## *Miscellaneous Receipts for the Year 1896*—Continued.

| | | | |
|---|---|---|---|
| 29 | Bureau of Water | Shortage on water rent, May 29, 1896 | 5 00 |
| 29 | Enterprise Manufacturing Co | Lowering main | 36 18 |
| Aug. 6 | Bureau of Water | Overdrawn warrant | 48 25 |
| Sept. 1 | Robert Higgins | Repairing pipe | 6 10 |
| 1 | Robert Higgins | Shut off to redrive ferrule | 3 00 |
| 3 | Franklin Sugar Refinery, | Fire hydrant | 10 30 |
| 3 | Union Traction Co | Shifting stop | 19 02 |
| 17 | Union Traction Co | Repairing fire hydrant | 5 36 |
| 17 | Union Traction Co | Searching for leak | 15 26 |
| 28 | Girard Iron and Metal Co | Scrap iron | 1,352 01 |
| Oct. 12 | Harkness & Co | Sale of horses | 36 00 |
| 16 | Union Traction Co | Fire hydrant | 5 36 |
| 16 | Union Traction Co | Shifting stop | 46 48 |
| 19 | James H Louchiem | Repairing fire hydrant | 9 40 |
| Nov. 4 | D. P. S. Nichols | Sale of horses | 30 00 |
| 5 | John Hevener | Rent of Farm No. 3 | 78 50 |
| 16 | Wallace & Jones | Repairing pipe | 12 01 |
| 16 | Wallace & Jones | Repairing pipe | 14 06 |
| 16 | Wallace & Jones | Shut off to redrive ferrule | 4 25 |
| 16 | Wallace Jones | Shut off to redrive ferrule | 2 75 |
| 16 | Charles T. Moore | Stone | 44 00 |
| 18 | Allison Manufacturing Co | Repairing joint | 1 70 |
| 19 | A. D. McNeil | Repairing main | 13 76 |
| 21 | Union Traction Co | Fire hydrant | 11 11 |
| 23 | Franklin Sugar Refinery | Relaying pipe | 496 34 |
| 30 | George F. Payne & Co | Cutting off connection | 10 59 |
| Dec. 5 | Philadelphia Inquirer | Fire hydrant | 19 56 |
| 9 | Franklin Engineering Co | Material at bridge | 232 74 |
| 11 | George W. Ruch | Repairing supply connection | 8 79 |
| 12 | Wallace & Jones | Shut off | 8 63 |
| 12 | Wallace & Jones | Shut off | 2 50 |
| 28 | Standard Telephone Co | Recaulking joint | 4 50 |
| 29 | Valentine Skipton | Empty oil barrels | 140 00 |
| 30 | Henry Snyder | Rent of saloon | 200 00 |
| | Total | | 4,875 91 |

# APPENDIX A.

# REPORT OF CHIEF CLERK.

BUREAU OF WATER.

*Philadelphia, February 5, 1897.*

MR. JOHN C. TRAUTWINE, JR.,
Chief of Bureau of Water.

DEAR SIR:—I have the honor to transmit herewith, detailed statement of the expenditures of the Bureau for the year 1896.

Yours truly,

J. T. HICKMAN,
*Chief Clerk.*

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|
| An Ordinance to make an appropriation to the Bureau of Water, approved Dec. 28, 1895.........$928,154 00 | | | | |
| Bal. from books of 1895..... 599,117 15 | | | | |
| Increased by additional appropriations.................. 704,400 00 | | | | |
| Net appropriation.............................. | $2,231,671 15 | | | |
| Item 1. Salaries.................$302,154 00 | | | | |
| Diminished by transfer..... 14,000 00 | | | | |
| Net appropriation to Item.................. | 288,154 00 | | | |
| For Salary of Chief of Bureau........... | 6,000 00 | 6,000 00 | | |
| Chief clerk.................. | 2,000 00 | 2,000 00 | | |
| Assistant clerk............ | 1,200 00 | 1,200 00 | | |
| Correspondence clerk... | 900 00 | 900 00 | | |
| Time clerk .................. | 1,000 00 | 1,000 00 | | |
| Messenger.................. | 720 00 | 720 00 | | |
| Draughtsmen ............... | 4,700 00 | 4,700 00 | | |
| General superintend't.. | 3,500 00 | 3,500 00 | | |
| Clerks to general superintendent.................. | 2,000 00 | 2,000 00 | | |
| Assistants to Chief........ | 3,600 00 | 3,600 00 | | |
| Pipe inspector and clerk | 2,200 00 | 2,200 00 | | |
| Search clerks............... | 2,200 00 | 2,200 00 | | |
| Assistant clerks........... | 2,750 00 | 2,750 00 | | |
| Chief inspector........... | 1,200 00 | 1,200 00 | | |
| Inspectors.................... | 19,000 00 | 19,000 00 | | |
| Permit clerks............... | 2,300 00 | 2,300 00 | | |
| Purveyors.................... | 9,200 00 | 9,200 00 | | |
| Clerks to purveyors...... | 4,800 00 | 4,800 00 | | |
| Assistant clerks to purveyors...................... | 4,500 00 | 4,500 00 | | |
| Hydrant inspectors...... | 7,050 00 | 7,050 00 | | |
| General foremen.......... | 6,634 00 | 6,634 00 | | |
| Foremen of repairs .... | 3,900 00 | 3,900 00 | | |
| Superintend't of shop.. | 1,500 00 | 1,500 00 | | |
| Clerk to superintend't of shop. .................. | 900 00 | 900 00 | | |
| Watchmen (offices and yards)...................... | 6,075 00 | 6,075 00 | | |
| Storekeepers................ | 1,400 00 | 1,400 00 | | |
| Foreman machinist...... | 1,500 00 | 1,500 00 | | |
| Foreman bricklayer..... | 1,100 00 | 1,100 00 | | |
| Foreman carpenter...... | 1,000 00 | 1,000 00 | | |
| Foreman stonemason... | 900 00 | 900 00 | | |
| Foreman painter.......... | 900 00 | 900 00 | | |
| Foreman rigger............ | 900 00 | 900 00 | | |
| Foreman laborer......... | 840 00 | 840 00 | | |
| Janitor, Main Office..... | 720 00 | 720 00 | | |
| Lineman...................... | 1,000 00 | 1,000 00 | | |
| Telephone operators.... | 1,100 00 | 1,100 00 | | |
| Electrician .................. | 1,200 00 | 1,200 00 | | |
| General storekeeper..... | 1,000 00 | 1,000 00 | | |
| Yard keeper, Fourth District................... | 915 00 | 915 00 | | |
| SALARIES AT PUMPING STATIONS. | | | | |
| Fairmount, engineers, oilers, etc....... | 14,310 00 | 14 128 98 | | |
| Spring Garden, engineers, oilers, etc.. | 79,300 00 | 75,628 09 | | |
| Belmont, engineers, oilers, etc.......... | 19,800 00 | 24,004 53 | | |
| Belmont Auxiliary, engineers, oilers, etc................................................ | 4,750 00 | | | |

*Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|
| Item 1—Continued. | | | | |
| Queen Lane, engineers, oilers, etc...... | $26,400 00 | $18,513 61 | | |
| Roxborough, engineers, oilers, etc..... | 17,270 00 | | | |
| Roxborough Auxiliary, engineers, oilers, etc...... | 4,750 00 | 21,599 51 | | |
| Mt. Airy, engineers, oilers, etc........... | 3,070 00 | 3,070 00 | | |
| Chestnut Hill, engineers, oilers, etc .. | 1,500 00 | 1,500 00 | | |
| Frankford, engineers, oilers, etc........ | 16,700 00 | 16,510 28 | | |
| Total....................................... | | $287,707 94 | $446 06 | |
| Item 2. For general supplies, including fuel and small stores. $150,000 00 | | | | |
| Increased by additional appropriation.............. 150,000 00 | | | | |
| Net appropriation to item.......... | 300,000 00 | | | |
| Deficiencies 1895: | | | | |
| Paints.............................. $2 80 | | | | |
| Lime.................................. 8 80 | | | | |
| Hauling coal....................... 58 80 | | | | |
| Coal..................................113 40 | ................. | $183 80 | | |
| Cement... ........................................ | ................. | 124 75 | | |
| Chandlery........................................ | ................. | 1,920 31 | | |
| COAL FOR OFFICES AND SHOP. | | | | |
| 1 ton nut.............................. $5 22 | | | | |
| 1 ton bituminous.................. 6 00 | | | | |
| 2 tons bituminons, at $3.39.... 6 78 | | | | |
| 2 tons stove, at $5.00............. 10 00 | | | | |
| 3 tons bituminous, at $4.00.... 12 00 | | | | |
| 4 tons bituminous, at $4.50.... 18 00 | | | | |
| 4 tons stove, at $5.42............. 21 68 | | | | |
| 5 tons stove, at $6.50............. 32 50 | | | | |
| 9 tons stove, at $5.10............. 45 90 | | | | |
| 12 tons nut, at $4.74................ 56 88 | | | | |
| 19 tons bituminous, at $3.35.... 56 95 | | | | |
| 16 tons stove, at $5.20............. 83 20 | | | | |
| 50.1 tons bituminous, at $3.33.. 166 78 | | | | |
| 41 tons stove, at $4.73............ 193 93 | | | | |
| 304.9 tons pea, at $2.89............ 883 12 | ..... ............. | 1,598 94 | | |
| COAL FOR STATIONS. | | | | |
| 125 tons egg, Fairmount, at $4.39................................. $548 75 | | | | |
| 141.01 tons pea, Chestnut Hill, at $3.00.................... 420 15 | | | | |
| 217.06 tons buck, Belmont, at $1.95............................. 423 74 | | | | |
| 1,406.10 tons buck, Mt. Airy, at $2.75............................. 3,845 89 | | | | |
| 7,705.07 tons buck, Frankford, at $2.03.....................15,641 87 | | | | |
| 9,551.10 tons pea, Queen Lane, at $3.00....... ......................28,654 50 | | | | |
| 17,843.04 tons pea, Belmont, at $2.69..............................47,998 23 | | | | |
| 18,630.13 tons pea, Roxborough, at $2.71......................50,489 09 | | | | |

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|
| **Item 2—Continued.** | | | | |
| 31,390.08 tons buck, Spring Garden, at $1.97 ............ 61,839 08 | | | | |
| 27,014.06 tons pea, Spring Garden, at $2.71 ............ 73,597 18 | | | | |
| | ............ | $283,458 48 | | |
| Coke ............ | ............ | 647 00 | | |
| Grease ............ | ............ | 180 83 | | |
| Grease Cups ............ | ............ | 42 00 | | |
| Hauling ashes ............ | ............ | 73 19 | | |
| Hauling coal, 948½ tons, at 30c ............ | ............ | 284 57 | | |
| Ice ............ | ............ | 1,014 94 | | |
| **Oil.** | | | | |
| 54 gallons Arctic, at 15c ............ $8 10 | | | | |
| 105 gallons black, at 9c ............ 9 45 | | | | |
| 149 gallons Electric, at 18c ............ 26 82 | | | | |
| 420 gallons gasoline, at 11½c ............ 48 37 | | | | |
| 300½ gallons cylinder, at 28c ............ 84 14 | | | | |
| 108 gallons castor, at 88c ............ 95 04 | | | | |
| 4,779 gals. headlight, at 9¾c ............ 465 99 | | | | |
| 983⅓ gallons lard, at 54c ............ 531 09 | | | | |
| 13,391 gallons engine, at 19c ............ 2,544 62 | | | | |
| 1,231½ gals. cylinder, at 23c ............ 2,832 39 | | | | |
| | ............ | 6,646 01 | | |
| Oil cans ............ | ............ | 1 25 | | |
| Paints ............ | ............ | 1,089 20 | | |
| Tallow, 2,205 lbs ............ | ............ | 132 30 | | |
| Wood ............ | ............ | 48 00 | | |
| Total ............ | ............ | $297,445 72 | 2,554 28 | |
| **Item 3.** For repairs to machinery, including the conveyance of workmen incident thereto ............ $50,925 13 | | | | |
| Increased by additional appropriation and transfers 40,000 00 | | | | |
| Net appropriation to item ............ | $90,925 13 | | | |
| Deficiencies of 1895: | | | | |
| Hardware ............ $11 25 | | | | |
| Tube cleaners ............ 28 00 | | | | |
| Fire brick ............ 46 40 | | | | |
| Repairs to Dynamo ............ 50 00 | | | | |
| Chandlery ............ 57 00 | | | | |
| Gum goods ............ 60 19 | | | | |
| Iron fittings ............ 263 65 | | | | |
| Brass fittings ............ 320 88 | | | | |
| | ............ | $837 37 | | |
| Brass fittings ............ | ............ | 737 49 | | |
| Chain hoist ............ | ............ | 71 00 | | |
| Chandlery ............ | ............ | 1,091 69 | | |
| Coal cars ............ | ............ | 500 00 | | |
| Donkey pump ............ | ............ | 503 00 | | |
| Electric plant, Spring Garden ............ | ............ | 4,500 00 | | |
| Electric supplies ............ | ............ | 75 00 | | |
| Fire brick ............ | ............ | 460 80 | | |
| Fire clay ............ | ............ | 9 60 | | |
| Forged shafts ............ | ............ | 518 10 | | |
| Gum goods ............ | ............ | 726 60 | | |
| Gum valves ............ | ............ | 2,822 04 | | |
| Hardware ............ | ............ | 726 65 | | |

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|---|
| Item 3—Continued. | | | | | |
| Hauling | | | $2,000 00 | | |
| Iron (bar) | | | 375 62 | | |
| Iron castings | | | 647 50 | | |
| Iron fittings | | | 932 22 | | |
| Jet heads | | | 84 00 | | |
| Lumber | | | 992 02 | | |
| Packing | | | 687 93 | | |
| Repairs to boilers: | | | | | |
| Frankford | $6 00 | | | | |
| City shop | 6 50 | | | | |
| Fairmount | 659 32 | | | | |
| Spring Garden | 1,920 63 | | | | |
| Belmont | 2,933 58 | | | | |
| Queen Lane | 5,105 35 | | | | |
| Roxborough | 826 86 | | | | |
| | | | $11,458 24 | | |
| Repairs to engines: | | | | | |
| Spring Garden | $82 95 | | | | |
| Belmont | 573 00 | | | | |
| Roxborough | 1,317 96 | | | | |
| | | | 1,973 91 | | |
| Repairs to grate | | | 9 00 | | |
| Repairs to jack | | | 10 00 | | |
| Repairs to pipe covering: | | | | | |
| Roxborough | $42 50 | | | | |
| Fairmount | 59 60 | | | | |
| Belmont | 97 85 | | | | |
| Spring Garden | 536 00 | | | | |
| Queen Lane | 1,184 60 | | | | |
| | | | 1,920 55 | | |
| Separators | | | 600 00 | | |
| Steel steam pipe | | | 940 13 | | |
| Solution | | | 341 25 | | |
| Transportation | | | 2,213 20 | | |
| Water columns | | | 37 16 | | |
| Wages: | | | | | |
| Bricklayers | $12,905 03 | | | | |
| Carpenters | 2,094 03 | | | | |
| Laborers | 1,531 06 | | | | |
| Machinists | 23,153 03 | | | | |
| Stone masons | 11,032 27 | | | | |
| | | | 50,715 42 | | |
| Total | | | $89,077 49 | $1,847 64 | |
| Item 4. For maintenance and repairs to buildings, grounds, and reservoirs | $50,000 00 | | | | |
| Increased by additional appropriations and transfer | 51,000 00 | | | | |
| Net appropriation to item | | $101,000 00 | | | |
| Deficiencies of 1895: | | | | | |
| Hardware | $9 38 | | | | |
| Plants | 24 25 | | | | |
| Stone | 33 75 | | | | |
| Electric supplies | 43 72 | | | | |
| Harness and repairs | 52 25 | | | | |
| Repairs to dynamo | 110 00 | | | | |
| Forage | 140 81 | | | | |
| Ice | 174 54 | | | | |
| Furnishing | 245 80 | | | | |
| | | | 834 50 | | |

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | Amount appropria'd. | Amount expended. | Amount merging | Amount not merging |
|---|---|---|---|---|
| **Item 4—Continued.** | | | | |
| Asphalt | | $41 88 | | |
| Barrows | | 199 32 | | |
| Belting | | 74 58 | | |
| Belgian blocks | | 1,245 00 | | |
| Brushes | | 177 90 | | |
| Bricks and lime | | 1,815 97 | | |
| Cement | | 4,399 90 | | |
| Chandlery | | 1,101 17 | | |
| Coping stone | | 509 50 | | |
| Curbing stone | | 487 30 | | |
| Device for watering horses | | 150 00 | | |
| Disinfectant | | 84 00 | | |
| Disinfectant rental | | 128 25 | | |
| Dredging | | 90 00 | | |
| Electric Supplies | | 3,254 08 | | |
| Fire clay | | 20 00 | | |
| Freight | | 33 07 | | |
| Forage | | 1,986 05 | | |
| Furnishing light | | 1,031 69 | | |
| Glass (window) | | 115 50 | | |
| Gum goods | | 964 26 | | |
| Hardware | | 1,643 31 | | |
| Hauling | | 945 22 | | |
| Harness and repairs | | 91 67 | | |
| Horse | | 119 00 | | |
| Horseshoeing | | 224 30 | | |
| Iron (bar) | | 135 42 | | |
| Iron pipe (wrought) | | 60 84 | | |
| Lumber | | 3,987 43 | | |
| Packing | | 48 72 | | |
| Paper hanging | | 168 01 | | |
| Paints | | 178 57 | | |
| Plants | | 20 50 | | |
| Professional services V. S. | | 38 00 | | |
| Repairs to range $13 00 | | | | |
| Repairs to siding 41 85 | | | | |
| Repairs to wagons 122 05 | | | | |
| Repairs to electric plant 182 50 | | | | |
| Repairs to roofs 2,128 20 | | | | |
| | | 2,487 60 | | |
| Sand | | 356 34 | | |
| Services of diver | | 70 00 | | |
| Services of lineman | | 336 83 | | |
| Stable supplies | | 31 30 | | |
| Stone | | 680 39 | | |
| Telephone rental and calls | | 1,308 75 | | |
| Tin | | 251 25 | | |
| Welsbach light | | 26 10 | | |
| Window shades | | 35 50 | | |
| Wages: | | | | |
| Stone masons $119 50 | | | | |
| Horses, carts and drivers 3,037 00 | | | | |
| Painters 5,628 00 | | | | |
| Engineer corps 6,791 19 | | | | |
| Helpers 11,915 69 | | | | |
| Carpenters 11,372 42 | | | | |
| Laborers 29,159 08 | | | | |
| | | 68,022 88 | | |
| Total | | $100,006 85 | $993 15 | |

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|
| Item 5. For repairs and improvement of the distribution, including the purchase of material in connection therewith and expenses incident thereto.......................... $100,000 00 | | | | |
| Increased by additional appropriation................ 79,900 00 | | | | |
| Net appropriation to item.................. | $179,900 00 | | | |
| Deficiencies of 1895: | | | | |
| Iron fittings...................... $59 79 | | | | |
| Shop castings..................... 74 37 | | | | |
| | .................... | $134 16 | | |
| Brass fittings.............................. | .................... | 158 45 | | |
| Bricks and lime.............................. | .................... | 736 13 | | |
| Cement.............................. | .................... | 1,200 00 | | |
| Chandlery.............................. | .................... | 998 21 | | |
| Forage.............................. | .................... | 1,001 66 | | |
| Gum goods.............................. | .................... | 753 54 | | |
| Hardware.............................. | .................... | 1,561 60 | | |
| Harness & repairs.............................. | .................... | 57 15 | | |
| Hauling.............................. | .................... | 997 10 | | |
| Horse shoeing.............................. | .................... | 6 00 | | |
| Iron Fittings.............................. | .................... | 480 80 | | |
| Iron pipe: | | | | |
| 128 6-in., 46,097 lbs. at .909 c., $419 02 | | | | |
| 2,797 6-in., 1,015,096 lbs. at .930 c...................... 9,440 16 | | | | |
| | .................... | 9,859 18 | | |
| Iron special castings: | | | | |
| 106,150 lbs. at $1.75......... $1,857 64 | | | | |
| 251,052 lbs. at 1.65......... 4,142 36 | | | | |
| | .................... | 6,000 00 | | |
| Lead (pig), 31,007 lbs. at $3.22½.... | .................... | 1,000 00 | | |
| Lumber.............................. | .................... | 3,000 00 | | |
| Paper hanging.............................. | .................... | 20 00 | | |
| Plastering.............................. | .................... | 28 47 | | |
| Plumbing.............................. | .................... | 79 19 | | |
| Professional services, V. S,........... | .................... | 12 00 | | |
| Services of diver.............................. | .................... | 120 00 | | |
| Shop castings: | | | | |
| 7,683 lbs., at 1.44c........ $110 60 | | | | |
| 21,731 lbs., at 1.39c........ 302 06 | | | | |
| 94,880 lbs., at 1c........... 948 80 | | | | |
| 24,004 lbs., at 1.49c........ 1,102 65 | | | | |
| 82,967 lbs., at 1.58½c..... 1,315 03 | | | | |
| | .................... | 3,779 14 | | |
| Stable supplies.............................. | .................... | 7 46 | | |
| Stone.............................. | .................... | 9 00 | | |
| Stop watch and repairs.............................. | .................... | 33 50 | | |
| Tapping machine.............................. | .................... | 3,224 50 | | |
| Transportation.............................. | .................... | 756 00 | | |
| Tin.............................. | .................... | 77 50 | | |
| Traveling expenses.............................. | .................... | 276 26 | | |
| Valves.............................. | .................... | 28 00 | | |
| Wages: | | | | |
| Improvement............... $8,767 50 | | | | |
| First District............... 12,130 91 | | | | |
| Second District............ 15,726 65 | | | | |
| Third District.............. 38,841 12 | | | | |
| Fourth District............ 29,225 48 | | | | |
| Fifth District............... 18,069 74 | | | | |
| Sixth District............... 19,198 32 | | | | |
| | .................... | 141,959 72 | | |
| Total.............................. | .................... | $178,454 72 | $1,445 28 | |

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|---|
| Item 6. For supplies, including fuel and labor, at the City Construction and Repair Shop............ | $50,000 00 | | | | |
| Increased by additional appropriation................ | 23,200 00 | | | | |
| | $73,200 00 | | | | |
| Diminished by transfer..... | 3,000 00 | | | | |
| Net appropriation to item................ | | $70,200 00 | | | |
| Deficiencies of 1895: | | | | | |
| Hauling ashes.................... | $5 00 | | | | |
| Hardware.......................... | 13 88 | | | | |
| Iron fittings........................ | 17 17 | | | | |
| Lead coating ...................... | 41 10 | | | | |
| Iron (bar).......................... | 83 99 | | | | |
| | | ................. | $161 14 | | |
| Belting.............................................. | | ................. | 55 55 | | |
| Brass castings, etc: | | | | | |
| 103 lbs. Babbit metal, at 12c.............................. | $12 36 | | | | |
| 14,292 lbs. lead coating, at .04c.............................. | 571 68 | | | | |
| 3,166 lbs. expansion metal, at .24½c...................... | 775 67 | | | | |
| 11,809½ lbs. ajax metal, at .22c......................... | 2,598 09 | | | | |
| 33,197½ lbs. yellow brass, at .09c.......................... | 2,987 74 | | | | |
| | $6,945 54 | | | | |
| Cr. | | | | | |
| 1,800 lbs. scrap copper, at 7⅝ c. | 137 25 | | | | |
| 8,000 lbs. brass turnings, at 4 c. | 320 00 | | | | |
| 11,100 lbs. scrap brass, at 6⅛ c... | 679 87 | | | | |
| | $1,137 12 | ................. | 5,808 42 | | |
| Brass Fittings.......................................... | | ................. | 154 00 | | |
| Chandlery.............................................. | | ................. | 599 71 | | |
| Corporation cocks: | | | | | |
| 300 ½-in., at 34 c............. | $102 00 | | | | |
| 625 ⅝-in., at 38 c............. | 237 50 | | | | |
| | | ................. | 339 50 | | |
| Gum goods.............................................. | | ................. | 3,169 85 | | |
| Hardware, bolts and nuts.............................. | | ................. | 3,027 30 | | |
| Horse shoeing.......................................... | | ................. | 25 50 | | |
| Iron (bar)............................................... | | ................. | 2,077 15 | | |
| Lead, 31,008 lbs. at 3.22½ c............................. | | ................. | 1,000 00 | | |
| Lumber.................................................. | | ................. | 3,000 00 | | |
| Packing................................................. | | ................. | 37 70 | | |
| Professional services, V. S.............................. | | ................. | 3 00 | | |
| Shop castings: | | | | | |
| 362,687 lbs. at 1.44 c......... | $5,222 70 | | | | |
| 522,535 lbs. at 1.58½ c.... | 8,282 18 | | | | |
| | | ................. | 13,504 88 | | |
| Special castings ........................................ | | ................. | 318 63 | | |
| Tin....................................................... | | ................. | 184 25 | | |
| Transportation.......................................... | | ................. | 21 50 | | |
| Wages.................................................... | | ................. | 35,581 19 | | |
| Total.............................................. | | ................. | $69,069 27 | $1,130 73 | |

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|
| Item 7. For general, incidental, and contingent expenses, including keep of horse for Chief of Bureau, general superintendent, and assistant, each $400.................$15,000 00 | | | | |
| Increased by additional appropriation.................... 2,800 00 | | | | |
| Net appropriation to item.................. | $17,800 00 | | | |
| Deficiencies of 1895: | | | | |
| Inking pads.................... $4 50 | | | | |
| Care of clocks.................... 10 00 | | | | |
| Lamps.............................. 16 50 | | | | |
| Incidentals.......................... 30 55 | | | | |
| Stationery........................ 352 49 | ................ | 414 04 | | |
| Advertising...... ........................... | ................ | 239 10 | | |
| Analysis of water............................ | ................ | 110 00 | | |
| Bottles .............................................. | ................ | 21 00 | | |
| Care of clocks.......................... | ................ | 20 00 | | |
| Carriage hire................................. | ................ | 26 75 | | |
| Clocks and repairs............................ | ................ | 17 00 | | |
| Daily papers.................................... | ................ | 27 82 | | |
| Desks and chairs............................ | ................ | 271 35 | | |
| Engineer supplies............................ | ................ | 128 38 | | |
| Gauges and repairs.......................... | ................ | 35 96 | | |
| Ground rent (918 Cherry street)........ | ................ | 26 66 | | |
| Incidentals........................................ | ................ | 851 65 | | |
| Incidentals, Hydrographic Corps...... | ................ | 252 55 | | |
| Inspectors' badges............................ | ................ | 15 00 | | |
| Insurance.......................................... | ................ | 242 00 | | |
| Keep of horses................................ | ................ | 799 97 | | |
| Lamps................................................ | ................ | 83 30 | | |
| Maps.................................................. | ................ | 708 60 | | |
| Packing and chandlery.................... | ................ | 173 12 | | |
| Photograph supplies........................ | ................ | 132 45 | | |
| Repairs to chairs.............................. | ................ | 65 50 | | |
| Services of typewriter...................... | ................ | 674 75 | | |
| Stationery.......................................... | ................ | 8,009 89 | | |
| Stencils ............................................ | ................ | 16 40 | | |
| Subscriptions (periodicals).............. | ................ | 15 00 | | |
| Telegraph and messenger service....... | ................ | 68 58 | | |
| Telephone calls.................................. | ................ | 2 10 | | |
| Text books........................................ | ................ | 108 26 | | |
| Transportation.................................. | ................ | 87 00 | | |
| Typewriter supplies.......................... | ................ | 53 68 | | |
| Washing towels................................ | ................ | 90 75 | | |
| Wages, Hydrographic Corps.............. | ................ | 1,560 00 | | |
| Writing duplicates............................ | ................ | 2,109 41 | | |
| Total ........................................ | ................ | $17,458 02 | $341 98 | |
| Item 8. For the purchase of material and cost of labor in connection with the laying of service mains and expenses incident thereto, $204,000 00 | | | | |
| Increased by additional appropriation .................... 55,500 00 | | | | |
| Net appropriation to item.................. | $259,500 00 | | | |

10

*Detailed Expenditures of the Bureau for 1896.*

| General appropriation. | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|
| Item 8—Continued. | | | | |
| Deficiencies of 1895: | | | | |
| Bricks .......... $16 50 | | | | |
| Professional services V. S... 28 75 | | | | |
| Gum goods .......... 44 71 | | | | |
| Repairs to wagons .......... 90 25 | | | | |
| Burlap bags .......... 91 50 | .......... | 271 71 | | |
| Brass castings, 13,229½ lbs., at 11.85c.. | .......... | 1,567 42 | | |
| Brass fittings .......... | .......... | 2,102 96 | | |
| Cement .......... | .......... | 2,894 55 | | |
| Chandlery .......... | .......... | 1,022 41 | | |
| Corporation Cocks: | | | | |
| 6,726 ½-inch, at 34c.. . . 2,286 84 | | | | |
| 575 ⅝-inch, at 38c.......... 218 50 | | | | |
| 250 ¾-inch, at 50.40c. .... 126 0 | | | | |
| 100 1 inch, at 77c.......... 77 00 | | | | |
| 25 1½-inch, at $1.3950.... 34 87 | | | | |
| 25 2-inch, at $2.0880...... 52 20 | .......... | 2,795 41 | | |
| Dynamite .......... | .......... | 351 80 | | |
| Device for watering horses .......... | .......... | 280 00 | | |
| Freight .......... | .......... | 13 00 | | |
| Forage .......... | .......... | 1,923 60 | | |
| Gum goods .......... | .......... | 1,205 48 | | |
| Hardware .......... | .......... | 424 51 | | |
| Harness and repairs .......... | .......... | 248 50 | | |
| Hauling .......... | .......... | 4,994 57 | | |
| Horses, 2, at $119.00 .......... | .......... | 238 00 | | |
| Horseshoeing .......... | .......... | 620 12 | | |
| Iron bar .......... | .......... | 628 87 | | |
| Iron pipe: | | | | |
| 7,872 6-inch, 2,879,067 lbs., at .909c.......... $26,079 75 | | | | |
| 200 8-inch, 95,604 lbs., at .920c.......... 879 55 | | | | |
| 200 10-inch, 137,418 lbs., at .909c.......... 1,249 13 | | | | |
| 500 12-inch, 453,855 lbs., at .909c.......... 4,125 53 | | | | |
| 700 16-inch, 942,835 lbs., at .895c.......... 8,438 37 | | | | |
| 590 20-inch, 1,082,588 lbs., at .895c.......... 9,689 16 | | | | |
| 2 48-inch, 13,063 lbs., at .95c.......... 124 10 | .......... | 50,585 59 | | |
| Iron specials: | | | | |
| 446,091 lbs., at .175c...... $7,806 62 | | | | |
| 712,100 lbs., at .165c...... 11,749 66 | .......... | 19,556 28 | | |
| Lead (pig) 217,055 lbs., at 3.22½c.......... | .......... | 7,000 00 | | |
| Lumber .......... | .......... | 4,034 50 | | |
| Machine work. 418¾ hours, at 60c..... | .......... | 251 25 | | |
| Packing .......... | .......... | 9 58 | | |
| Paints.. .......... | .......... | 16 46 | | |
| Pasturing horses .......... | .......... | 33 00 | | |
| Professional services V S.......... | .......... | 180 10 | | |
| Repairs to wagons .......... | .......... | 401 85 | | |
| Rent of shop, Fifth District .......... | .......... | 100 00 | | |
| Stable supplies .......... | .......... | 136 71 | | |
| Stop valves: | | | | |
| 47 6-in. x 6-in., 3-way, at $44.......... $2,068 00 | | | | |
| 5 8-in. x 6-in., 3-way, at $48.......... 240 00 | | | | |

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|---|
| Item 8—Continued. | | | | | |
| 4 12-in. x 6-in., 3-way, at $68 | $272 00 | | | | |
| 26 6-in. x 6-in., 4-way, at $67 | 1,742 00 | | | | |
| 7 8-in. x 6-in., 4-way, at $75 | 525 00 | | | | |
| 21 10-in. x 6-in., 4-way, at $87 | 1,827 00 | | | | |
| 13 12-in. x 6-in., 4-way, at $102 | 1,326 00 | | | | |
| | | ........ | $8,000 00 | | |
| Travelling expenses | | ........ | 1,585 65 | | |
| Venturi meters: | | | | | |
| 1 12-in | $595 00 | | | | |
| 1 25-in | 913 75 | | | | |
| 1 48-in | 2,337 50 | | | | |
| | | ........ | 3,846 25 | | |
| Wages: | | | | | |
| Improvement | $4,823 63 | | | | |
| First District | 11,345 89 | | | | |
| Second District | 18,195 47 | | | | |
| Third District | 33,073 67 | | | | |
| Fourth District | 32,340 44 | | | | |
| Fifth District | 14,118 51 | | | | |
| Sixth District | 24,889 58 | | | | |
| | | ........ | 138,787 19 | | |
| Total | | ........ | $256,107 43 | $3,392 57 | |
| Item 9. For service pipes and meters | | $10,000 00 | | | |
| Brass fittings | | ........ | $778 73 | | |
| Corporation cocks, 2,800 ½-in., at 34 c. | | ........ | 952 00 | | |
| Hauling | | ........ | 5 00 | | |
| Iron fittings | | ........ | 269 39 | | |
| Lead pipe, 6,500 lbs., at 3.89 c. | | ........ | 252 85 | | |
| Meters: | | | | | |
| 6 1½-in., at $30 | $180 00 | | | | |
| 6 2-in., at $45 | 270 00 | | | | |
| 9 3-in., at $85 | 765 00 | | | | |
| 12 4-in., at $175 | 2,100 00 | | | | |
| | $3,315 00 | | | | |
| Less hauling | 7 00 | | | | |
| | | ........ | 3,308 00 | | |
| Wages | | ........ | 4,217 50 | | |
| Total | | ........ | $9,783 47 | $216 53 | |
| Item 10. For the purchase of telephones and new switch board | | $1,000 00 | $124 00 | $876 00 | |
| Item 10a. Extensions. | | | | | |
| Balance January 1, 1896 | | $273,812 86 | | | |
| Boilers | | ........ | $16,939 96 | | |
| Engine house | | ........ | 212 50 | | |
| Excavating pipe trench | | ........ | 1,080 48 | | |
| Pumping engines | | ........ | 171,102 80 | | |
| Services of experts | | ........ | 589 00 | | |
| Total | | ........ | $189,924 74 | $175 82 | $83,712 30 |

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|---|
| Item 10½. For repairs and improvement of reservoirs. | | | | | |
| Balance January 1, 1896... | $156,169 49 | | | | |
| Increased by additional appropriation.............. | 350,000 00 | | | | |
| | $506,169 49 | | | | |
| Diminished by transfer... | 31,000 00 | | | | |
| Net appropriation........................... | | $475,169 49 | | | |
| Analysis of Water.............................. | | .................... | $50 00 | | |
| Cement.............................................. | | .................... | 298 35 | | |
| Freight.............................................. | | .................... | 57 29 | | |
| Concrete wall, north basin, Queen Lane: | | | | | |
| 23 cu. yds. slope removed, at $1.25......... | $28 75 | | | | |
| 25 bbls. cement and labor grouting.......... | 100 00 | | | | |
| 1,708 sq. yds. floor removed, at 10c............ | 170 80 | | | | |
| 2,042 cu. yds. excavation, at 75c............... | 1,531 50 | | | | |
| 2,340 cu. yds. concrete wall, at $7.50............. | 17,550 00 | | | | |
| | | .................... | 19,381 05 | | |
| Relining south basin, Queen Lane: | | | | | |
| 26,979 sq yds. slope, at $1 40........................ | $37,770 60 | | | | |
| 77,705 sq yds. floor, at $1.15......................... | 89,360 75 | | | | |
| | | .................... | 127,131 35 | | |
| Relining north basin, Queen Lane: | | | | | |
| 18,062 sq. yds. floor, at $1.15........................ | $20,771 30 | | | | |
| 28,004 sq. yds. slope, at $1.40........................ | 39,205 60 | | | | |
| | $59,976 90 | | | | |
| Less 20 per cent............ | 11,995 38 | | | | |
| | | .................... | 47,981 52 | | |
| Retaining wall Queen Lane: | | | | | |
| 5,239 cu. yds. excavation, at 22c.. ........... | $1,152 58 | | | | |
| 36,294 cq. yds. earth filling, at 57c................ | 20,687 58 | | | | |
| 6,55 cu. yds. masonry, at $4.97..................... | 32,588 29 | | | | |
| | $54,428 45 | | | | |
| Less 20 per cent............ | 10,885 69 | | | | |
| | | .................... | 43,542 76 | | |
| Sand.................................................. | | .................... | 800 00 | | |
| Services of diver.................................. | | .................... | 170 00 | | |
| Stone.................................................. | | .................... | 1,080 23 | | |
| Testing material................................... | | .................... | 194 00 | | |
| Tools.................................................. | | .................... | 87 50 | | |
| Wages: | | | | | |
| Engineer corps............ | $6,536 82 | | | | |
| Buildings, grounds and reservoirs.................. | 42 028 27 | | | | |
| | | .................... | 48,565 09 | | |
| Total........................................ | | .................... | $289,339 14 | .................... | $185,830 35 |

## *Detailed Expenditures of the Bureau for 1896.*

| General Appropriation. | | Amount appropria'd. | Amount expended. | Amount merging. | Amount not merging |
|---|---|---|---|---|---|
| Item 11. For the construction and completion of Queen Lane Reservoir, balance January 1st, 1896 | | $122,731 77 | ........ | ........ | $122,731 77 |
| Item 11½. For new mains, balance January 1st, 1896 | | $39,016 41 | | | |
| Deficiencies for 1895: | | | | | |
| Coping | $1,009 00 | | | | |
| Iron pipe | 2,633 17 | ........ | $3,642 17 | | |
| Excavating pipe trenches: | | | | | |
| 7,478 cubic yards earth, at .21c | $1,570 38 | | | | |
| 1,746 cubic yards earth, at .63c | 1,099 98 | | | | |
| 1,854 cubic yards rock, at .47c | 871 38 | | | | |
| 928 cubic yards rock, at .97c | 900 16 | | | | |
| Retained percentage | 117 48 | ........ | 4,559 38 | | |
| Iron pipe: | | | | | |
| 4,034 6-in., 1,487,717 lbs., at .930c | $13,829 67 | | | | |
| 94 12-in., 87,121 lbs., at .909c | 791 93 | ........ | 14,621 60 | | |
| Lead (pig), 77,520 lbs., at .3.22½ | | ........ | 2,500 00 | | |
| Lumber | | ........ | 1,000 00 | | |
| Machine work: | | | | | |
| 55 hours, at .50c | $27 50 | | | | |
| 232 hours, at .60c | 139 20 | ........ | 166 70 | | |
| Special castings: | | | | | |
| 72,052 lbs., at 3⅛c | $2,126 62 | | | | |
| 118,815 lbs., at 2.3c | 2,735 28 | ........ | 4,861 90 | | |
| Stop valves: | | | | | |
| 5 12-in. x 6-in., 4-way, at $102 | $510 00 | | | | |
| 22 6-in. x 6-in., 4-way, at $67 | 1,474 00 | ........ | 1,984 00 | | |
| Wages: | | | | | |
| Fourth District | $4,614 86 | | | | |
| Sixth District | 700 00 | ........ | 5,314 86 | | |
| Total | | ........ | $38,650 61 | $365 80 | |
| Item 12. For refunding to Joseph J. Martin for excavating and refilling a twelve (12) inch trench for water mains in Thirtieth street, from Spring Garden street to the Zoological Garden. Balance January 1, 1896 | | $1,688 85 | $1,688 85 | | |
| Item 13. For refunding certain paid-in-error and over-paid water bills. Balance January 1, 1896 | | 772 64 | 772 64 | | |

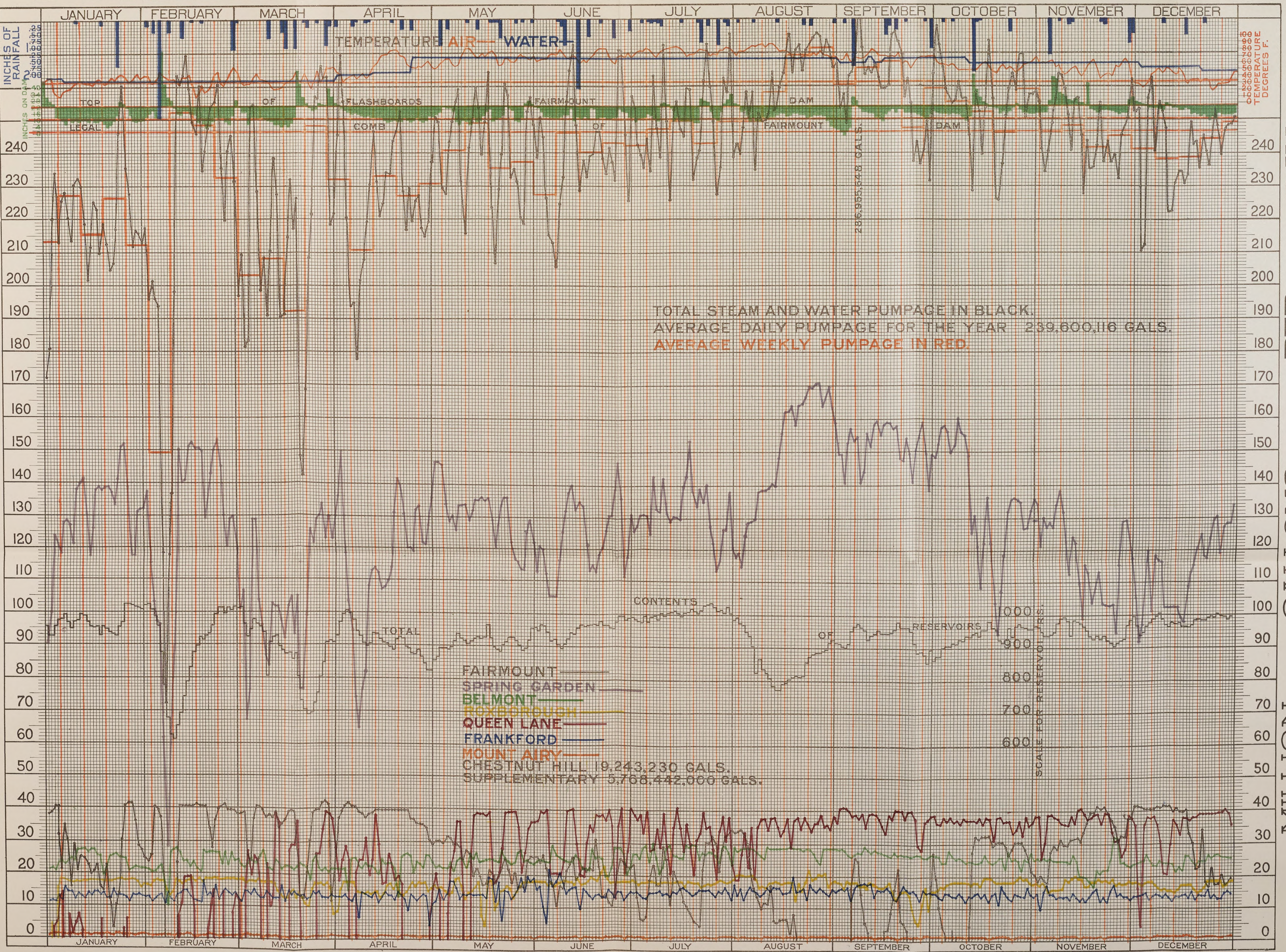
## *Detailed Expenditures of the Bureau for 1896.*

### RECAPITULATION.

GENERAL APPROPRIATION.

| | | | |
|---|---|---|---|
| Balance from books of 1895 | $599,117 15 | | |
| Special appropriations | 704,400 00 | | |
| | | $1,303,517 15 | |
| Annual appropriation | ................ | 928,154 00 | |
| | | | $2,231,671 15 |
| Expended for refunds | 2,461 49 | | |
| Expended for deficiencies | 6,478 89 | | |
| Expended for maintenance | 1,302,398 19 | | |
| Expended for extensions | 514,272 32 | | |
| | | 1,825,610 89 | |
| Amount merging | $13,785 84 | | |
| Amount not merging | 392,274 42 | | |
| | | 406,060 26 | |
| | | | $2,231,671 15 |

# PUMPAGE DIAGRAM FOR THE YEAR 1896.



# APPENDIX B.

## REPORT

OF THE

# GENERAL SUPERINTENDENT

OF

Work during 1896, on Buildings, Grounds and Reservoirs, and on Boilers and Machinery at the Pumping Stations.

OFFICE OF THE GENERAL SUPERINTENDENT.

BUREAU OF WATER.

*Philadelphia, January 15, 1897.*

MR. JOHN C. TRAUTWINE, JR.,
Chief of Bureau of Water.

DEAR SIR:—I have the honor to submit the following report of work performed under my direction during the year 1896.

The engines and boilers at the several pumping stations have been kept in good running order, and greatly needed minor repairs have been made to a number of the reservoirs in addition to the relining of Queen Lane Reservoir.

Two new engines, of the type and capacity of the Nos. 1 and 2 referred to in my report for 1895, have been completed at Queen Lane Pumping Station. They are designated as Nos. 3 and 4.

The following table shows the annual, and the maximum and average daily pumpage and the daily pumpage per capita for 1896, as compared with that for 1895 :

*Comparison of Pumpage for 1895 and 1896.*

| | 1895. Gallons. | 1896. Gallons. | Increase. Gallons. |
|---|---|---|---|
| Annual pumpage: | | | |
| From rivers | 77,819,013,610 | 86,228,360,959 | 8,409,347,349 |
| High service | 956,835,494 | 1,465,281,570 | 508,446,076 |
| Total | 78,775,849,104 | 87,693,642.529 | 8,917,793,425 |
| Maximum daily pumpage: | | | |
| From rivers | 254,032,747 | 282,661,868 | 28,629,121 |
| High service | 4,805,780 | 4,293,780 | Dec. 512,000 |
| Total | 258,838,527 | 286,955,648 | 28,117,121 |
| Average daily pumpage: | | | |
| From rivers | 213,202,777 | 235,596,614 | 22,393,837 |
| High service | 2,621,467 | 4,003,502 | 1,382,035 |
| Total | 215,824,244 | 239,600,116 | 23,775,872 |
| Average daily pumpage: | | | |
| From rivers, per capita | 160.3 | 172.2 | 11.9 |

The following is a summary of the work done at the several stations and reservoirs :

## *Fairmount.*

Advantage was taken of an opportunity presented during the summer, while the water in the Schuylkill river was at a low level, to make all the repairs necessary to the wheels and pumps at this station. The dam was inspected, and, as far as possible, the leaks in it were stopped.

The basins were repaired, and also, much improved, by removing the old and dilapidated linings of the inner slopes, consisting of bricks on edge and flat coping stone, cobbles and wood. The vertical walls were rebuilt, and a concrete coping, 10 inches thick and 19½ inches wide, was constructed, from which a concrete slope, 8 inches thick, extended to the top of the bank. The banks back of the inner slopes were all rebuilt and thoroughly rammed with gravel and clay, in many places a fill of from five to six feet being required to bring them to a level. This work was continued around the whole of the outside banks and around the inside banks with the exception of those of No. 1 basin. On the low division banks the coping was renewed and the banks straightened and put in readiness to receive the cement concrete covering.

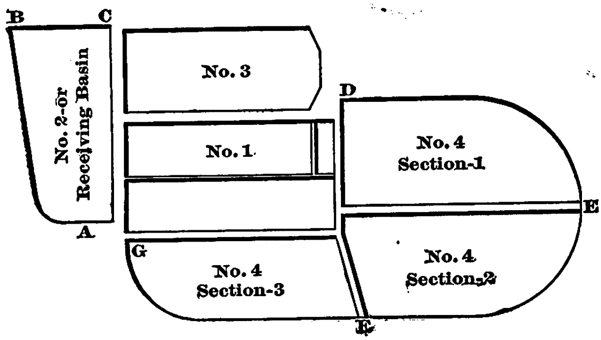
The quantities are as follows :

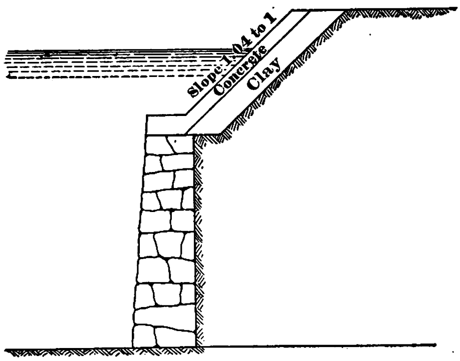
| | |
|---|---|
| Finished slope | 2,958 lineal feet. |
| Cement coping | 3,792 lineal feet. |
| Wall finished and ready for cement coping | 670 lineal feet. |

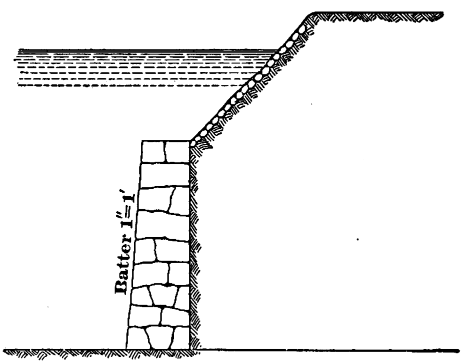
The old fence around the basin was removed and replaced by a new one.

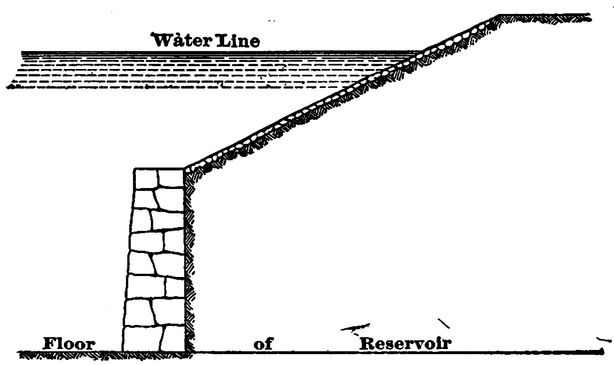
Much of the improvement contemplated at the beginning of the work still remains to be done.

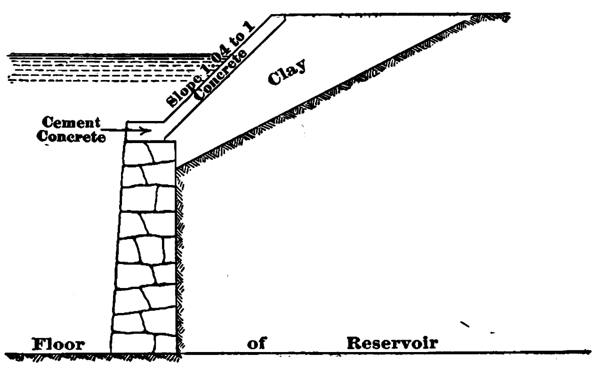
The roof over Nos. 7, 8 and 9 wheels is still in the same condition as that stated in my report for 1895, and I would again suggest that this matter be given immediate attention, in order that the machinery may be protected from the water which percolates through the roof. It is still necessary for this portion of the works to be closed to the public.


B
C
No. 2-or
Receiving Basin
A
No. 3
No. 1
D
No. 4
Section-1
E
G
No. 4
Section-3
No. 4
Section-2
F


Slope 1.04 to 1
Concrete
Clay


Batter 1"=1'


Water Line
Floor
of
Reservoir


Slope 1.04 to 1
Concrete
Clay
Cement
Concrete
Floor
of
Reservoir

*Spring Garden Pumping Station.*

The engines and boilers at this station were kept running, during the summer months, to their full capacity, and almost without intermission.

During the early part of the year, and, also, after the heavy pumpage of the summer was over, opportunities were found in which to make much needed repairs to engines and pumps Nos. 6, 10 and 11.

On No. 6 all the receiving and delivery valves were renewed and a new bucket plunger put in.

On No. 10 all steam valves and seats were refaced and properly scraped, the pistons adjusted, the plungers turned true and new diaphragms placed in the pumps.

An entire new valve sytem was put in the bottom of both pumps of No. 11 Gaskill engine, thus doing away with the majority of the small "Troy" valves which were liable to become choked with pebbles, etc., carried up by the water from the forebay, as they were only 1¼ inches in diameter, with a ¼-inch lift. They were replaced by 5-inch valves, with ⅝-inch lift. The plungers of this engine were also trued up, and new sleeves put in the diaphragms. At this writing, the pump has been started, and the action of the valves proves to be entirely satisfactory.

No. 5 (Southwark) engine has twice been robbed during the year to supply parts of engines at other stations, which had broken. This method was resorted to only in cases where the services of the engines so repaired were needed continuously.

On the first occasion the connecting rod and strap of No. 5 engine was removed and taken to Roxborough station to replace a strap which had broken on No. 1 engine at that station, both engines being of similar make and design. On the second occasion a plunger was taken from it to supply No. 4 Worthington engine at Belmont Station. In both cases the disabled engines were again put in operation within a few days, whereas, to have renewed the broken parts would have required some weeks of waiting and the consequent loss of the services of the engines during that time. No. 5 engine is now running at one-half of its regular capacity.

The duty tests of Nos. 2 and 3 triple-expansion Holly engines were made as follows : No. 3, April 10-11, twenty-four hours, and No. 2, April 15, four hours.

A new electric light plant was installed at this station in July. The plant consists of 40 two Kilo-watt multipolar compound-wound Siemens-Halske generators, of 600 lights each, driven by two 12 x 12-inch Ames direct-coupled high-speed engines, together with an oak Madrepora finish switch-board, containing two 400 Ampere dynamo switches, twenty-five 75 Ampere circuit switches, two Weston illuminating dial volt meters, Station B, and two Weston illuminating Ampere meters, Station B.

The engines and dynamos are in operation and are giving entire satisfaction.

On July 6 the 48-inch pumping main No. 11, at Spring Garden Station, broke near the east side of the Reading Railroad. The escaping flood washed away the bank on that side of the road and carried many hundreds of cubic yards of gravel and sand down to and around the Spring Garden works and into the forebay.

The precaution taken, however, after the breaks of last year, of building diverting walls at all doors, windows and other openings in the buildings at this station, prevented the debris from filling the engine pits, most of it banking around the buildings and finding its way into the forebay.

On July 11, a 48-inch supply main broke near Thirty-third and Oxford streets. The discharge from the pipe rushed through Snyder's woods, into the Park, to the Pennsylvania Railroad tracks and along these tracks to a point where they cross those of the Reading Railroad, and thence to the Spring Garden Pumping Station, causing a flood equal to that of the 6th, five days before.

In neither case was the quantity of dirt washed into the pump wells such as to prevent the starting of the pumps.

*Belmont Pumping Station.*

The engines and boilers at these works are in good running order, but the station is in the same condition as that stated in my report of last year.

No. 4 engine is still running as a low-duty engine, owing to inadequate boiler capacity, and it is still protected by only a rude structure of boards.

Efforts should be made at once to have additional boilers, with an engine house, boiler house and stack, built at this station in order to properly meet the rapidly growing needs of West Philadelphia.

In this connection I desire to again call your attention to the fact that there is no connection between the supply mains on the east and west sides of the Schuylkill river, and, were it not for the fact that the plunger of No. 5 engine at Spring Garden station answers for No. 4 at Belmont, all of West Philadelphia would have been, since November 25, 1896, on a short supply of water, as the plunger of No. 5 is still unfinished.

This is a deplorable state of affairs and it should not be allowed to continue.

*Queen Lane Pumping Station.*

The erection of engines Nos. 3 and 4 at this station has been completed. No. 3 was put in operation on May 20, and No. 4 on May 28.

After May 28 all the engines at this station were run at intervals, and, as a rule, two at a time.

Considerable difficulty was experienced with all of these engines, owing to the breaking of the pedestal bolts on the main shaft bearings. The bolts were designed and made too light. This defect, together with the pedestal caps being in two castings instead of in one, caused the breaking of the bolts. The contractors claim that this is owing, partly, at least, to the presence of air admitted into the suction pipes by leakage, or liberated from the water within them, by reason of their location, and I am of opinion that they are justified in their claim, although the air chambers on the suction mains have been connected with the condensers of the pumps, in the hope of carrying off this air. The remedy first adopted was to drill out the hole and replace the broken bolts with others of a larger size, but, in nearly every case, the new bolts were as short-lived as the old ones. Finally, two extra bolts were put in each pedestal, and the caps were made in one piece. Since these changes were made, no bolts have broken.

There have been frequent stoppages, for adjustment and for other reasons, of all the engines. The following is a statement of the number of days' service of each of the engines during the year :

| | |
|---|---|
| No. 1 | 172 days. |
| No. 2 | 162 days. |
| No. 3 | 85 days. |
| No. 4 | 71 days. |

The specifications for the engines called for a duty trial of thirty consecutive days, under the direction of the Chief of the Bureau, assisted by regular employees thereof, during which time the engines should perform an average duty of 110 million foot-pounds.

This test was made from September 1 to 30, both inclusive, and, falling short of the required duty, was unsatisfactory to both the Chief of the Bureau and the contractors, and the 24-hour heat-unit test referred to in paragraph 32 of the specifications was called for. In this test the City appointed, as its expert, Professor H. W. Spangler, the contractors named Mr. Edward T. Child as theirs, and these two experts selected, as the third, Mr. John Birkinbine.

The test of No. 2 engine was begun at noon on November 27 and finished at noon on the following day, November 28.

This test proving satisfactory as to duty and capacity, it was deemed necessary to test only one of the remaining engines. Engine No. 4 was selected, and, on December 11, a test of four hours' duration was made.

While the tests of both these engines proved quite satisfactory as to duty and capacity, the engines themselves have not, from the first, performed in a satisfactory manner. As already stated, this appears to be due to the presence of air. A modification is now being made in one of the suction air chambers, and it is hoped that this will remedy the difficulty. If so, it will be applied to the other three. If not, it will be necessary to change the grade of the suction mains, so that the water may flow through them by gravity to the pumps, instead of being raised through the mains by the pumps, as at present.

The buildings at this station have been wired for electric lighting, and the two engines and dynamos which were removed from Spring Garden and placed here on foundations prepared for them, are now giving satisfactory service.

Queen Lane is still supplied with coal hauled from the Wissahickon Station, at a cost of 29 cents per ton in excess of the price paid at Spring Garden and other stations.

During the year 13,881 tons were used. The extra cost of 29 cents per ton, with the additional expense of $1.75 per day for a period of 374 days, for the services of a man to handle the coal, makes the total cost, in excess of the amount which would be necessary if proper facilities for delivery were provided, $4,871.24.

This increase in cost is for the running of two engines only. When the third and fourth engines are running regularly this amount will, of course, be greatly increased.

The hauling of ashes from this station will, also, increase its running expenses unless some means are soon provided for removing them by rail. I would therefore recommend that the proposed coal shed be built, or other means provided for a proper and economical fuel supply.

The Committee on Plans and Improvements of the Park Commission visited this station on October 16 and conferred with me in regard to the improvement of the surrounding grounds. At their request I consulted with the Commission's landscape gardener, and I have since received, from General Russell Thayer, Chief Engineer and Superintendent of the Park, a plan showing the improvement desired. It is hoped that, when the weather becomes favorable, means may be provided for carrying out this needed improvement.

*Roxborough Station.*

No. 1 (Southwark) engine at this station has required a considerable amount of repairs and close attention.

On June 12 the strap on the connecting rod broke at the bell crank, necessitating the dismantling of No. 5 (Southwark) engine at Spring Garden station (as before mentioned in this report) in order to secure a connecting rod to replace it. The piston rod, also, pulled out of the low pressure piston. The bed-plate on the river-side of the engine was found to be badly cracked, and it is now held together by a four-inch bolt running through the bed-plate. A new plunger was put in on the same side and difficulty has been experienced in preventing the joint between the pump and the suction chamber from leaking. On each of these occasions the engine was disconnected and one side only put in operation.

Engines Nos. 2 and 3 are in good condition, but the pressure required to force the water into the new basin is much greater than that for which the pumps were designed. The utmost care, therefore, is, of necessity, exercised in the running of these engines.

The boilers, which are in good condition, are run at their full capacity.

There should be put in, at this station, at an early date, an additional pump and boilers, with the necessary engine and boiler houses for their accommodation, and stack and intake, for, while one of the smaller engines remains idle the greater part of the time, it is for the reason that the boiler capacity is sufficient only for the large engines and one of the smaller ones. As all the water for the supply of Manayunk, Germantown, Chestnut Hill and Roxborough is pumped from this station, it is a question of a short time only when it will become unable to meet the demands upon it.

During the summer the road leading from the railroad station to the engine house was graded, curbed and paved with Belgian blocks; and suitable drainage, to carry the wash of the road to below the intake of the pumps, was provided. Before this provision was made, the wash of the road, during heavy rains, was carried into the river and drawn in by the pumps, scouring the plungers and rods.

### *Frankford Pumping Station.*

Engines Nos. 1 and 2, as well as the boilers at this station, are in good condition, and require very little outlay for repairs, notwithstanding the fact that the engines have been in active service during the greater part of the year, and that they have now been in service for 20 and 13 years, respectively.

Engine No. 3, 15 million gallon, compound, which was contracted for in July, 1892, by the Southwark Foundry and Machine Company, was erected by that company, and, on August 1, 1894, was put in operation. Since that time it has been in the hands of the builders, and it has been run at intervals only, most of the builders' time being spent on the hydraulic attachment for operating the pump valves. The engine is in much the same condition as that stated in my reports for 1894 and 1895. During the past year it has run on an average only 2.4 hours per day, and has pumped, on an average, 1,600,000 gallons per day, by plunger displacement.

As it is now more than four years since the engine was contracted for, and over two years since it was started, the contractors should, in my judgment, be required to deliver to the City an engine which could be accepted, in accordance with the provisions of the original specification and contract.

### *Roxborough and Belmont High-service.*

At the high-service works at Roxborough and Belmont, the engines, which are compelled to run night and day, have been kept in operation without repairs of any kind.

With the exception of the time required to repair broken mains, the engine at Roxborough High-service Station has not been stopped during the year.

The engine at Belmont can be stopped for a few hours only, during the night.

In my report for 1895, I recommended that supplementary, or relief, engines should be installed at each of these stations, and, as no action has been taken in the matter, I again urge the necessity of relieving these over-worked pumps.

### *Roxborough Reservoir.*

The north section of this reservoir was emptied, and the work of repairing the brick slope lining was begun, on April 27. The bottom of the slopes, where bulging or settlement had taken place, was cut out and repaired, and clay, to a depth of ½ inch, was spread over the bottom, after which water was again let in. When it had reached a depth of 10 feet, evidences of leakage became apparent, and the water was again drawn off and preparations made to cover the bottom and sides of the basin with asphalt.

The preliminary work, which consisted of cutting holes, about three feet apart, in the brick slope lining, showed that the bank had settled away from the brick-work. As the cavities thus formed required filling up, a force of men was put to work, with instructions to fill in every hole with small broken stone as long as it would run or could be rammed. Cement grout was then poured in until the cavity was thoroughly filled, and in this manner the bricks were pervented from following the settlement of the clay. A small portion of the bottom of the basin was covered with asphalt concrete, as the beginning of the work of relining the entire basin under contract, and, in order to prevent a repetition of the washing of the clay from under the bricks, all cracks on top of the banks were sealed with asphalt. Water was again turned in on December 22.

Shortly after the north section was emptied for the repair of its brick lining, evidences of leaks around the pass-pipe through the division bank became visible. The south section was therefore drawn off, and the bank cut into, to a depth of 8 feet. The clay was taken out and replaced with concrete, and grout was poured around the pipes and allowed time to set.

This treatment proved successful and the pass-pipes are now perfectly tight.

The contractor for relining the north basin with asphalt concrete has a thoroughly equipped plant prepared for the resumption of work at as early a date as the weather will permit.

*Mount Airy Reservoir.*

In September, the small section of this basin was emptied, and mud to a depth of 4½ feet was found in the bottom. Appliances for removing the mud were taken to the basin, the section was thoroughly cleaned and necessary repairs made. The entire slope on the southeast side was renewed and the other slopes were repaired. When this work was completed, water was let in and the larger section was emptied and cleaned. Repairs were also made to the slopes and floor of this section.

Complaints having been made, by residents in the vicinity, of offensive and unwholesome odors from the mud taken out, I visited the work with Dr. J. Howard Taylor, Medical Inspector of the Board of Health, who reported that the mud offered no menace to health, but suggested the propriety of sprinkling lime upon it, and this was done.

*Wentz Farm Reservoir.*

The water in this reservoir was drawn down, and the east slope, from the top of the ten-foot line, was renewed. The slope below the ten-foot line was found to be in good condition. The greater part of the fence around the top of the basin was also renewed.

A weir, 70 feet in length, 12 feet in width, and 4 feet 3 inches in depth was built around the overflow at the northeast corner. The weir was built for the purpose of testing the No. 3 Southwark engine at the Frankford works. The engine in question not being ready for test, the weir was used for testing the Venturi meter, which was placed in the 48-inch main near the reservoir.

The weir is still in position and ready for use at any time it may be needed.

### *Chestnut Hill Reservoir.*

A serious leak was discovered in the bank between the Chestnut Hill basin and the stone quarry on the northwest side. The bank at this point was cut down until rock was reached, within a short distance from the bottom of the basin. A concrete wall was then built to a point above the water level, and the basin is now water-tight until the water reaches a depth of 7 feet.

The pumps at this station have done very little service since the starting of the high-service pump at Roxborough.

The station is greatly in need of repairs, and, if it is to be continued as a pumping station, will require a thorough overhauling.

### *Lehigh Avenue Reservoir.*

Very little was required to be done at this reservoir except to keep the grass on the banks mowed down, and to make some minor repairs to the inside slope.

The following table shows the amount expended on minor repairs and improvements to reservoirs :

*Expenditures.*

| | Wages. | Material. | Total. |
|---|---|---|---|
| Fairmount | $16,189 10 | $7,019 28 | $23,208 38 |
| Queen Lane, chiefly wages | | | 1,159 65 |
| Roxborough, new | 8,664 00 | 2,090 22 | 10,754 22 |
| Mt. Airy | 2,446 05 | 541 15 | 2,987 20 |
| Chestnut Hill | 380 00 | 303 91 | 683 91 |
| Wentz Farm | 3,265 72 | 441 17 | 3,706 89 |
| Lehigh avenue | 217 13 | 53 75 | 270 88 |
| Totals | | | $42,771 13 |

*Improvement of the Telephone Service.*

The telephone service of the Bureau has been greatly improved by the equipment of new lines, the first and most important of which embraces the following-named stations : Fairmount, Spring Garden, Storehouse, Belmont Works and Belmont Auxiliary.

The second line, which is now run from the Electrical Bureau to Queen Lane pumping station and reservoir, will ultimately connect the main office with that pumping station and reservoir. From the Queen Lane works it extends to Roxborough district, thence to the station, thence to the Auxiliary works and to the new reservoir.

The equipment of these new lines has been in charge of employees of the Electrical Bureau, under the supervision of the Chief of that Bureau, Mr. David R. Walker.

The result has been an almost complete elimination of the induction, which, hitherto, has so seriously interfered with the working of the line, and it is hoped that by placing new and improved telephone instruments in the several stations and in the main office of the Bureau, our telephone service will be made to compare favorably with that of other City departments.

The lines leading to the remaining stations will receive early attention.

Respectfully submitted.

F. L. HAND,
*General Superintendent.*

Total Capacity 38,000,000 gallons per day.

# BELMONT PUMPING STATION.

No. 1 Worthington Duplex. Capacity 5,000,000 gallons per day.
No. 2 Worthington Duplex. Capacity 5,000,000 gallons per day.
No. 3 Worthington Duplex. Capacity 8,000,000 gallons der day.
No. 4 Worthington Duplex. Capacity 20,000,000 gallons per day.

| 1896. | Running Time of each Engine in hours. | | | | Gallons Pumped by each Engine. | | | | Total pumpage of each month. | Average pumpage per day. | Coal. | | Percentage of Ashes. | Oils. | | Mean water pressure and mean suction lift in pounds per sq. inch. | | | | Gallons raised 100 ft. per pound of coal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Cylinder. | Engine. | | | | | |
| | No. 1. | No. 2. | No. 3. | No. 4. | No. 1. | No. 2. | No. 3. | No. 4. | Gallons. | Gallons. | Tons. | Lbs. | | Qts. | Qts. | No. 1 | No. 2 | No. 3 | No. 4 | |
| January........... | 48 | ........... | 500 | 704 | 12,274,200 | ................. | 195,693,663 | 566,021,047 | 773,988,910 | 24,967,384 | 1,517 | 62 | 25 | 301 | 117 | 88 | ...... | 88 | 90 | 507.7 |
| February.......... | 37 | ........... | 476 | 642 | 8,630,400 | ................. | 187,165,810 | 519,127,470 | 714,923,680 | 24,652,540 | 1,423 | 790 | 25 | 276 | 114 | 88 | ...... | 88 | 90 | 500.4 |
| March.............. | 106 | 197 | 162 | 730 | 23,401,500 | 51,723,680 | 63,726,575 | 596,816,905 | 735,668,660 | 23,731,247 | 1,468 | 1,745 | 25 | 299 | 122 | 88 | 88 | 88 | 90 | 499.0 |
| April............... | ¾ | 569 | ........... | 674 | 138,000 | 153,936,896 | ................. | 552,492,686 | 706,567,582 | 23,552,252 | 1,375 | 1,545 | 25 | 278 | 110 | 88 | 88 | ...... | 90 | 511.7 |
| May................. | 59 | 277 | 285 | 680 | 13,329,000 | 76,853,076 | 109,595,845 | 580,906,120 | 780,684,041 | 25,183,356 | 1,440 | 85 | 25 | 291 | 115 | 88 | 88 | 88 | 90 | 524.2 |
| June................ | 70 | 194 | 389 | 645 | 16,709,700 | 52,090,262 | 153,152,815 | 549,847,796 | 771,800,573 | 25,726,685 | 1,473 | 1,500 | 25 | 298 | 119 | 88 | 88 | 88 | 90 | 521.8 |
| July................ | 103 | 251 | 728 | 636 | 25,588,300 | 64,375,864 | 225,476,595 | 551,229,872 | 866,670,631 | 27,957,117 | 1,742 | 105 | 25 | 338 | 124 | 88 | 88 | 88 | 90 | 495.9 |
| August............ | 47 | 39 | 727 | 605 | 12,592,500 | 13,313,976 | 283,488,177 | 592,937,650 | 902,332,303 | 29,107,493 | 1,736 | 1,840 | 25 | 485 | 122 | 88 | 88 | 88 | 90 | 678.1 |
| September... ..... | 5 | 5 | 564 | 714 | 1,579,200 | 1,474,200 | 218,508,791 | 621,927,650 | 843,489,841 | 28,116,328 | 1,693 | 1,840 | 25 | 480 | 120 | 88 | 88 | 88 | 90 | 496.2 |
| October ........... | 35 | 42 | 482 | 706 | 9,219,900 | 11,540,208 | 186,621,038 | 601,119,130 | 808,500,276 | 26,080,654 | 1,695 | 1,000 | 25 | 496 | 124 | 88 | 88 | 88 | 90 | 480.4 |
| November........ | 143 | 212 | 446 | 552 | 37,514 500 | 57,662,008 | 174,156,177 | 472,089,000 | 741,421,685 | 24,714,056 | 1,611 | 1,510 | 25 | 420 | 115 | 88 | 88 | 88 | 90 | 458.3 |
| December........ | 11 | 118 | 367 | 732 | 2,685,500 | 30,251,200 | 135,757,160 | 616,989,297 | 785,663,157 | 25,343,972 | 1,733 | 1,695 | 25 | 496 | 124 | 88 | 88 | 88 | 90 | 451.5 |
| Totals and averages. | 664 | 1,904 | 5,126 | 7,020 | 163,662,700 | 513,221,370 | 1,933,343,646 | 6,821,483,623 | 9,431,711,339 | 25,797,572 | 18,912 | 277 | 25 | 4,458 | 1,426 | 88 | 88 | 88 | 90 | 496.9 |

Total capacity, 80,000,000 gallons per day.

# QUEEN LANE PUMPING STATION.

No. 1—Vertical Triple Expansion, 20,000,000 gallons per day.
No. 2—Vertical Triple Expansion, 20,000,000 gallons per day.
No. 3—Vertical Triple Expansion, 20,000,000 gallons per day.
No. 4—Vertical Triple Expansion, 20,000,000 gallons per day.

| 1896. | Running Time of each Engine in Hours. | | | | Gallons Pumped by each Engine. | | | | Total Pumpage of each Month. | Average Pumpage per Day. |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1. | No. 2. | No. 3. | No. 4. | No. 1. | No. 2. | No. 3. | No. 4. | Gallons. | Gallons. |
| January | 58 | 33 | ........ | ........ | 49,557,300 | 27,637,850 | ........ | ........ | 77,195,150 | 2,490,166 |
| February | 41 | 150 | ........ | ........ | 34,544,700 | 124,541,700 | ........ | ........ | 159,086,400 | 5,485,737 |
| March | 390 | 346 | ........ | ........ | 319,423,850 | 281,853,050 | ........ | ........ | 601,276,900 | 19,396,029 |
| April | 286 | 312 | ........ | ........ | 231,300,150 | 253,264,095 | ........ | ........ | 484,564,245 | 16,152,141 |
| May | 623 | 235 | 136 | 87 | 512,452,350 | 187,690,905 | 110,171,000 | 58,242,600 | 868,556,855 | 28,017,963 |
| June | 448 | 353 | 327 | 16 | 377,430,650 | 300,828,400 | 270,328,550 | 11,429,750 | 960,017,350 | 32,000,578 |
| July | 659 | 422 | 130 | ........ | 557,116,800 | 346,606,350 | 105,834,900 | ........ | 1,009,558,050 | 32,566,388 |
| August | 432 | 426 | 117 | 313 | 347,529,900 | 342,257,150 | 92,918,300 | 257,798,750 | 1,040,504,100 | 33,564,648 |
| September | ........ | 713 | 331 | 343 | ........ | 614,708,050 | 250,517,850 | 277,313,900 | 1,142,539,800 | 38,084,660 |
| October | 574 | 141 | 471 | 234 | 464,925,550 | 114,363,000 | 374,640,350 | 189,674 900 | 1,143,603,800 | 36,890,445 |
| November | 348 | 330 | 334 | 323 | 285,580,000 | 270,154,750 | 270,993,150 | 263,264,150 | 1,089,992,050 | 36,333,068 |
| December | 271 | 440 | 211 | 393 | 214,826,900 | 355,353,450 | 173,208,200 | 321,395,400 | 1,064,898,950 | 34,351,579 |
| Totals and averages | 4,130 | 3,901 | 2,057 | 1,709 | 3,394,688,150 | 3,219,373,750 | 1,648,612,300 | 1,379,119,450 | 9,641,793,650 | 26,343,698 |

| 1896. | Coal. | | Percentage of Ashes. | Oils. | | Mean Water Pressure and Suction Lift in Pounds per Sq. Inch. | | | | Gallons raised 100 feet per Pound of Coal. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tons. | Lbs. | | Cylinder. Qts. | Engine. Qts. | No. 1. | No. 2. | No. 3. | No. 4. | |
| January | 296 | 560 | .25 | 156 | 552 | 100 | 100 | ........ | ........ | 290.8 |
| February | 366 | 1.460 | .25 | 222 | 824 | 100 | 100 | ........ | ........ | 484.3 |
| March | 1,042 | 1,120 | .25 | 766 | 2,848 | 100 | 100 | ........ | ........ | 647.9 |
| April | 832 | 1,120 | .25 | 588 | 2,122 | 100 | 100 | ........ | ........ | 649.5 |
| May | 1,225 | 1,600 | .25 | 442 | 1,685 | 100 | 100 | 100 | 100 | 790.8 |
| June | 1,369 | 640 | .25 | 577 | 2,344 | 100 | 100 | 100 | 100 | 749.8 |
| July | 1,193 | 1,280 | .25 | 516 | 1,961 | 100 | 100 | 100 | ........ | 944.0 |
| August | 1,300 | 800 | .25 | 524 | 1,844 | 100 | 100 | 100 | 100 | 893.1 |
| September | 1,465 | 1,800 | .25 | 959 | 3,109 | ........ | 100 | 100 | 100 | 868.1 |
| October | 1,614 | 1,440 | .25 | 939 | 2,600 | 100 | 100 | 100 | 100 | 790.4 |
| November | 1,578 | 2,080 | .25 | 936 | 2,681 | 100 | 100 | 100 | 100 | 770.0 |
| December | 1,600 | 1,600 | .25 | 925 | 3,082 | 100 | 100 | 100 | 100 | 742.4 |
| Totals and averages | 13,886 | 2,060 | .25 | 7,550 | 25,652 | 100 | 100 | 100 | 100 | 774.5 |

Jonval Turbine—Double-acting Horizontal Plunge Pumps. Total Capacity 33,000,000 gallons per day.

# FAIRMOUNT PUMPING STATION.

Capacity No. 1—2,000,000 gallons per day.
Capacity Nos. 3, 4, 5—5,300,000 gallons per day.
Capacity Nos. 7, 8, 9—5,100,000 gallons per day.

| 1896. | Running Time of each Turbine in Hours. | | | | | | |
|---|---|---|---|---|---|---|---|
| | No. 1. | No. 3. | No. 4. | No. 5. | No. 7. | No. 8. | No. 9. |
| January | 264 | 698 | 686 | 351 | 308 | 475 | 259 |
| February | 539 | 596 | 595 | 489 | 545 | 579 | 570 |
| March | 524 | 632 | 630 | 585 | 626 | 629 | 652 |
| April | 565 | 718 | 718 | 718 | 717 | 674 | 716 |
| May | ........ | 744 | 708 | 532 | 197 | 12 | 584 |
| June | ........ | 720 | 687 | 344 | ........ | 143 | 444 |
| July | 203 | 731 | 469 | ........ | 248 | 410 | 433 |
| August | 114 | 229 | 319 | ........ | 207 | 260 | 170 |
| September | 79 | ........ | 285 | 75 | 121 | 125 | 106 |
| October | 229 | ........ | 500 | 512 | 450 | 498 | 480 |
| November | 340 | 336 | 657 | 581 | 523 | 664 | 683 |
| December | 551 | 735 | 734 | 469 | 475 | 601 | 495 |
| Totals and Averages. | 3,408 | 6,139 | 6,937 | 4,656 | 4,417 | 5,070 | 5,592 |

| 1896. | Gallons Pumped by each Turbine. | | | | | | | Total Pumpage of each Month. | Average Pumpage per Day. | Oils. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Castor. | Engine. |
| | No. 1. | No. 3. | No. 4. | No. 5. | No. 7. | No. 8. | No. 9. | Gallons. | Gallons. | Qts. | Qts. |
| January | 26,345,244 | 191,460,290 | 184,136,880 | 94,476,325 | 80,201,625 | 126,529,050 | 105,447,875 | 808,597,289 | 25,987,009 | 42 | 178 |
| February | 53,502,592 | 163,959,260 | 164,158,836 | 141,272,989 | 133,242,525 | 146,599,050 | 144,811,225 | 947,546,477 | 32,674,016 | 29 | 191 |
| March | 54,499,914 | 177,679,500 | 178,438,433 | 164,096,636 | 147,249,250 | 161,267,650 | 162,327,800 | 1,045,559,183 | 32,727,715 | 46 | 206 |
| April | 59,068,416 | 197,269,744 | 190,553,559 | 197,461,877 | 158,253,250 | 163,618,125 | 175,707,575 | 1,141,932,545 | 38,064,418 | 23 | 215 |
| May | ................ | 198,186,430 | 189,447,869 | 152,461,447 | 43,595,975 | 2,028,425 | 137,102,740 | 722,822,886 | 23,316,867 | 47 | 173 |
| June | ................ | 191,179,909 | 188,068,251 | 93,030,261 | ................ | 34,436,325 | 110,780,025 | 617,485,771 | 20,582,859 | 15 | 149 |
| July | 19,990,016 | 189,176,726 | 127,229,546 | ................ | 58,243,900 | 99.678,424 | 107,464,825 | 601,783,437 | 19,412,368 | 40 | 178 |
| August | 11,429,888 | 62,107,303 | 86,875,665 | ................ | 41,220,725 | 64,900,950 | 43,836,225 | 310,370,756 | 10,019,959 | 8 | 100 |
| September | 8,190,720 | ................ | 70,991,386 | 22,479,282 | 27,259,700 | 30,344,600 | 27,698,350 | 186,964,038 | 6,232,134 | 17 | 72 |
| October | 22,189,624 | ................ | 129,493,960 | 131,395,249 | 103,133,120 | 126,997,625 | 121,068,650 | 634,278,228 | 20,460,588 | 15 | 166 |
| November | 34,946,320 | 95,483,240 | 184,394,822 | 155,728,888 | 128,509,325 | 172,065,600 | 177,832,495 | 948,960,690 | 31,632,023 | 49 | 105 |
| December | 56,980,320 | 205,592,033 | 206,954,026 | 130,778,999 | 112,415,850 | 154,225,075 | 126,597,525 | 993,514,828 | 32,049,838 | 17 | 208 |
| Totals and Averages. | 347,143,054 | 1,674,085,435 | 1,901,743,232 | 1,283,180,953 | 1,028,327,245 | 1,284,690,899 | 1,440,675,310 | 8,959,846,128 | 24,480,454 | 348 | 1,941 |

Total Capacity 80,000,000 gallons per day.

# OLD SPRING GARDEN STATION.

No. 5.—Vertical Compound. Capacity 20,000,000 gallons per day.
No. 6.—Simson Rotary Compound. Capacity 10,000,000 gallons per day.
No. 7.—Marine Rotary Compound. Capacity 20,000,000 gallons per day.
No. 8.—Worthington Duplex. Capacity 10,000,000 gallons per day.
No. 11.—Gaskill Compound. Capacity 20,000,000 gallons per day.

| 1896. | Running Time of each Engine in Hours. | | | | | Gallons Pumped by Each Engine. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. 5. | No. 6. | No. 7. | No. 8. | No. 11. | No. 5. | No. 6. | No. 7. | No. 8. | No. 11. |
| January | 511 | 571 | 662 | 248 | .......... | 457,994,000 | 243,285,000 | 542,919,600 | 125,118,000 | .......... |
| February | 449 | 655 | 657 | 654 | .......... | 398,898,000 | 272,580,000 | 530,926,100 | 329,677,600 | .......... |
| March | 123 | 409 | 573 | 718 | .......... | 107,509,900 | 174,766,548 | 460,907,300 | 361,664,800 | .......... |
| April | 665 | 198 | 517 | 720 | .......... | 586,552,760 | 82,950,000 | 422,245,900 | 361,664,800 | .......... |
| May | 742 | 628 | 579 | 743 | .......... | 651,309,300 | 261,870,000 | 465,587,300 | 362,880,000 | .......... |
| June | 513 | 277 | 256 | 719 | 200 | 349,459,050 | 117,285,000 | 198,453,000 | 374,976,000 | .......... |
| July | 431 | 116 | 702 | 744 | 364 | 278,830,200 | 53,550,000 | 530,477,900 | 362,880,000 | 88,019,550 |
| August | 687 | 550 | 744 | 719 | 664 | 598,869,900 | 227,140,100 | 570,002,500 | 374,724,000 | 263,776,000 |
| Septemb'r | 671 | .......... | 720 | 716 | 601 | 621,170,750 | .......... | 527,664,210 | 360,108,000 | 477,184,000 |
| October | 265 | .......... | 743 | 688 | 730 | 210,919,000 | .......... | 508 403,100 | 362,000,700 | 442,504,000 |
| November | 516 | .......... | 720 | 720 | 468 | 362,878,400 | .......... | 530,096,100 | 374,220,000 | 556,304,000 |
| December | 271 | .......... | 699 | 744 | 509 | 123,039,200 | .......... | 520,53 ,500 | 360,785,000 | 357,656,000 |
| Totals and averages. | 5,844 | 3,404 | 7,572 | 8,133 | 3,536 | 4,747,430,460 | 1,433,426,648 | 5,808,217,510 | 4,123,758,100 | 2,568,115,550 |

| 1896. | Total Pumpage of each Month. | Average Pumpage per Day. | Coal. | | Percentage of Ashes. | Oils. Cylinder. | Oils. Engine. | Mean Water Pressure and Mean Suction Lift in Pounds per Square Inch. | | | | | Gallons Raised 100 Feet per Pound of Coal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gallons. | Gallons. | Tons. | Lbs. | | Qts. | Qts. | No. 5. | No. 6. | No. 7. | No. 8. | No. 11. | |
| January | 1,369,316,600 | 44,171,503 | 2,000 | 466 | .25 | 514 | 513 | 50 | 50 | 63 | 63 | ......... | 471.2 |
| February | 1,532,081,700 | 52,830,403 | 2,153 | 1,280 | .25 | 547 | 514 | 50 | 50 | 53 | 63 | ......... | 469.0 |
| March | 1,104,848,518 | 35,640,274 | 1,826 | 1,760 | .25 | 376 | 333 | 50 | 50 | 53 | 69 | ......... | 411.2 |
| April | 1,454,628,600 | 48,487,620 | 2,042 | 1,930 | .25 | 517 | 422 | 50 | 50 | 53 | 63 | ......... | 490.3 |
| May | 1,753,742,600 | 56,572,341 | 2,471 | 632 | .25 | 524 | 524 | 58 | 58 | 53 | 62 | ......... | 488.5 |
| June | 1,116,096,600 | 37,203,220 | 1,617 | 2,227 | .25 | 437 | 429 | 53 | 50 | 53 | 66 | 50 | 474.8 |
| July | 1,501,358,100 | 48,430,932 | 2,180 | 320 | .25 | 604 | 604 | 55 | 50 | 55 | 67 | 50 | 474.2 |
| August | 2,233,304,500 | 72,042,080 | 2,849 | 1,944 | .25 | 620 | 620 | 55 | 55 | 59 | 59 | 55 | 539.6 |
| Septemb'r | 1,953,339,750 | 65,111,325 | 2,619 | 1,440 | .25 | 600 | 600 | 55 | ......... | 55 | 60 | 50 | 512.9 |
| October | 1,649,846,100 | 53,220,844 | 2,319 | 804 | .25 | 585 | 545 | 60 | ......... | 60 | 62 | 60 | 489.6 |
| November | 1,611,415,500 | 53,713,850 | 2,223 | 1,272 | .25 | 662 | 448 | 60 | ......... | 60 | 68 | 60 | 497.6 |
| December | 1,400,969,700 | 45,192,572 | 2,159 | 1,400 | .25 | 739 | 460 | 50 | ......... | 50 | 68 | 50 | 446.5 |
| Totals and averages. | 18,680,948,268 | 51,040,842 | 26,464 | 2,035 | .25 | 6,725 | 6,011 | 55 | 54 | 55 | 66 | 62 | 485.9 |

Total Capacity—2,500,000 Gallons per day.

# BELMONT AUXILIARY STATION.

No. 1—Worthington Duplex—Capacity, 2,000,000 gallons per day.
No. 2—Snow.—Capacity, 500,000 gallons per day.

| 1896. | Running Time of each Engine in Hours. | | Gallons Pumped by each Engine. | | Total Pumpage per Month. | Average Pumpage per Day. | Coal. | | Per Centage of Ashes. | Oils. | | Mean Water Pressure. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Cylinder. | Engine. | | |
| | No. 1. | No. 2. | No. 1. | No. 2. | Gallons. | Gallons. | Tons. | Lbs. | | Qts. | Qts. | No. 1. | No. 2. |
| January | 130 | ......... | 5,562,080 | ......... | 5,562,080 | 179,421 | 36 | 860 | 25 | 31 | 8 | 61 | |
| February | 123 | ......... | 5,510,880 | ......... | 5,510,880 | 190,030 | 32 | 571 | 25 | 29 | 14 | 61 | |
| March | 134 | ......... | 5,745,840 | ......... | 5,745,840 | 185,349 | 35 | 1,428 | 25 | 31 | 15 | 62 | |
| April | 144 | ......... | 6,155,680 | ......... | 6,155,680 | 205,189 | 31 | 210 | 25 | 30 | 7 | 61 | |
| May | 191 | ......... | 8,191,030 | ......... | 8,191,030 | 264,226 | 31 | 523 | 25 | 31 | 7 | 60 | |
| June | 223 | ......... | 9,865,650 | ......... | 9,865,650 | 328,850 | 30 | 240 | 25 | 31 | 7 | 59 | |
| July | 224 | ......... | 9,569,230 | ......... | 9,569,230 | 308,684 | 34 | 707 | 25 | 31 | 7 | 59 | |
| August | 278 | 84 | 12,041,400 | 1,246,660 | 13,288,060 | 428,647 | 41 | 855 | 25 | 31 | 8 | 60 | 57 |
| September | 231 | 3 | 10,488,970 | 37,125 | 10,526,095 | 350,203 | 35 | 460 | 25 | 30 | 8 | 60 | 55 |
| October | 205 | 1 | 8,840,330 | 14,850 | 8,855,180 | 285,650 | 27 | 1,395 | 25 | 31 | 8 | 62 | 55 |
| November | 162 | 3 | 6,920,640 | 44,450 | 6,935,190 | 232,173 | 27 | 1,735 | 25 | 30 | 7 | 60 | 61 |
| December | 164 | ......... | 7,006,080 | ......... | 7,006,080 | 226,002 | 31 | 245 | 25 | 31 | 8 | 62 | |
| Totals and averages | 2,209 | 93 | 95,897,910 | 1,343,085 | 97,240,995 | 268,418 | 394 | 269 | 25 | 367 | 104 | 60 | 57 |

Total Capacity—24,500,000 gal-lons per day.

# ROXBOROUGH PUMPING STATION.

No. 1—Vertical Compound.—Capacity, 12,000,000 gallons per day.
No. 2—Worthington Duplex.—Capacity, 5,000,000 gallons per day.
No 3—Worthington Duplex.—Capacity, 7,500,000 gallons per day.

| 1896. | Running Time of each Engine in Hours. | | | Gallons Pumped by each Engine. | | | Total Pumpage of each Month. | Average Pumpage per Day. | Coal. | | Percentage of Ashes. | Oil. | | Mean Water Pressure and Mean Suction Lift in Pounds. | | | Gallons Raised 100 feet per Pound of Coal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Cylinder. | Engine. | | | | |
| | No. 1. | No. 2. | No. 8. | No. 1. | No. 2. | No. 3. | Gallons. | Gallons. | Tons. | Lbs. | | Qts. | Qts. | No. 1. | No. 2. | No. 3. | |
| January | 690 | 667 | 22 | 362,180,240 | 162,364,900 | 7,282,920 | 531,828,060 | 17,155,743 | 1,655 | 2,040 | .25 | 652 | 541 | 160 | 160 | 160 | 558.6 |
| February | 626 | 676 | 141 | 324,086,900 | 161,388,540 | 43,940,010 | 529,415,450 | 18,255,705 | 1,593 | 280 | .25 | 445 | 495 | 160 | 160 | 160 | 577.9 |
| March | 638 | 534 | 93 | 347,020,320 | 117,507,350 | 29,236,790 | 493,764,460 | 15,927,835 | 1,503 | 320 | .25 | 365 | 500 | 160 | 160 | 160 | 571.3 |
| April | 657 | 538 | 53 | 352,128,720 | 113,280,000 | 19,700,500 | 485,109,220 | 16,170,307 | 1,470 | 1,200 | .25 | 406 | 546 | 160 | 160 | 160 | 568.9 |
| May | 638 | 554 | 119 | 326,070,720 | 124,469,350 | 36,377.610 | 486,917,680 | 15,707,021 | 1,418 | 1,880 | .25 | 577 | 641 | 160 | 160 | 160 | 596.8 |
| June | 689 | 674 | 149 | 365,593,740 | 156,51[illegible],250 | 46,151,190 | 568,257,180 | 18,941,906 | 1,638 | 2,120 | .25 | 443 | 646 | 160 | 160 | 160 | 603.0 |
| July | 717 | 698 | 69 | 386,680,080 | 167,170,600 | 22,272,030 | 576,122,770 | 18,584,605 | 1,723 | 1,920 | .25 | 448 | 821 | 160 | 160 | 160 | 582.7 |
| August | 697 | 436 | 313 | 374,325,020 | 107,208,900 | 104,698,140 | 586,232,060 | 18,910.711 | 1,722 | 1,440 | .25 | 504 | 915 | 160 | 160 | 160 | 591.5 |
| September | 600 | 526 | 52 | 325,668,050 | 126,165,600 | 16,871,550 | 468,705.200 | 15,623,506 | 1,446 | 1,680 | .25 | 388 | 673 | 160 | 160 | 160 | 563.4 |
| October | 727 | 653 | 186 | 358,695,840 | 155,576,400 | 60,145,740 | 574,417,980 | 18,529,612 | 1,730 | 1,280 | .25 | 505 | 88[illegible] | 160 | 160 | 160 | 577.3 |
| November | 658 | 662 | 398 | 264,424,200 | 158.137,150 | 125,548,170 | 548,9[illegible]9,520 | 18,296,987 | 1,833 | 1,280 | .25 | 498 | 827 | 160 | 160 | 160 | 545.0 |
| December | 720 | 566 | 47 | 383,943,280 | 185,319,450 | 14,730,240 | 533,992,970 | 17,225,579 | 1,789 | ......... | .25 | 439 | 829 | 160 | 160 | 160 | 521.6 |
| Totals and averages | 8,057 | 8,184 | 1,642 | 4,170,827,110 | 1,685,900,490 | 526,954,950 | 6,383,682,550 | 17,441.755 | 19,528 | 2,000 | .25 | 5,670 | 8,314 | 160 | 160 | 160 | 558.6 |

Total Capacity—5,250,000 gallons per day.

## ROXBOROUGH AUXILIARY STATION.

No. 1—Worthington Duplex.—Capacity, 5,000,000 gallons per day.
No. 2—Knowles.—Capacity, 250,000 gallons per day.

| 1890. | Running Time of each Engine in Hours. | | Gallons Pumped by each Engine. | | Total pumpage of each Month. | Average Pumping per Day. | Coal. | | Percentage of Ashes. | Oil. | | Mean Water Pressure. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Cylinder. | Engine. | |
| | No. 1. | No. 2. | No. 1. | No. 2. | Gallons. | Gallons. | Tons. | Lbs. | | Qts. | Qts. | |
| January | 648 | ........ | 63,604,035 | ........ | 63,604,035 | 2,051,743 | 74 | 758 | .25 | 134 | 15 | 56 |
| February | 575 | ........ | 52,132,410 | ........ | 52,132,410 | 1,797,669 | 68 | 1,027 | .25 | 123 | 12 | 56 |
| March | 648 | ........ | 56,734,425 | ........ | 56,734,425 | 1,830,142 | 75 | 1,957 | .25 | 139 | 14 | 56 |
| April | 693 | ........ | 63,884,700 | ........ | 63,884,700 | 2,129,490 | 79 | 190 | .25 | 150 | 15 | 56 |
| May | 744 | ........ | 66,290,000 | ........ | 66,290,000 | 2,138,387 | 86 | 362 | .25 | 155 | 16 | 56 |
| June | 688 | ........ | 63,706,500 | ........ | 63,706,500 | 2,123,550 | 82 | 1,735 | .25 | 150 | 30 | 56 |
| July | 743 | ........ | 68,239,700 | ........ | 68,239,700 | 2,201,280 | 92 | 730 | .25 | 155 | 31 | 56 |
| August | 744 | ........ | 72,919,440 | ........ | 72,919,440 | 2,352,240 | 101 | 18 | .25 | 151 | 31 | 56 |
| September | 720 | ........ | 70,567,200 | ........ | 70,567,200 | 2,352,240 | 96 | 1,670 | .25 | 120 | 15 | 56 |
| October | 744 | ........ | 72,821,430 | ........ | 72,821,430 | 2,349,078 | 99 | 1,850 | .25 | 124 | 8 | 56 |
| November | 720 | ........ | 70,567,200 | ........ | 70,567,200 | 2,352,240 | 88 | 200 | .25 | 120 | 15 | 56 |
| December | 717 | ........ | 70,420,185 | ........ | 70,420,185 | 2,273,554 | 102 | 1,880 | .25 | 122 | 8 | 56 |
| Totals and averages | 8,384 | ........ | 791,887,225 | ........ | 791,887,225 | 2,163,626 | 1,047 | 1,177 | .25 | 1,643 | 210 | 56 |

Total Capacity 3,000,000 gallons per day.

# MOUNT AIRY PUMPING STATION.

No. 1—Davidson Rotary. Capacity 1,000,000 gallons per day.
No. 2—Davidson Rotary. Capacity 1,000,000 gallons per day.
No. 3—Knowles. Capacity 1,000,000 gallons per day.

| 1896. | Running Time of each Engine in Hours. | | Gallons Pumped by each Engine. | | Total Pumpage per day. | Av. Pumpage per day. | Coal. | | Percentage of Ashes. | Oils. Cyl'r | Oils. Engine | Mean Water pressure and mean suct'n lift in lbs. per sq. in. | | Gallons Raised 100 feet per pound of coal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 1. | No 2. | No. 1. | No. 2. | Gallons. | Gallons. | Tons. | Lbs. | | Qts. | Qts. | No. 1. | No. 2. | |
| January | 744 | 412 | 32,727,500 | 16,360,000 | 49,087,500 | 1,583,467 | 128 | 780 | .25 | 38 | 38 | 60 | 60 | 202.2 |
| February | 695 | 374 | 32,671,500 | 12,942,250 | 45,613,750 | 1,572,887 | 130 | 300 | .25 | 29 | 29 | 60 | 60 | 216.8 |
| March | 744 | 369 | 32,968,750 | 14,728,750 | 47,697,500 | 1,538,629 | 117 | 1,920 | .25 | 34 | 34 | 60 | 60 | 254.1 |
| April | 708 | 323 | 31,398,250 | 12,991,250 | 44,389,500 | 1,479,650 | 105 | 1,300 | .25 | 30 | 30 | 60 | 60 | 260.1 |
| May | 744 | 331 | 33,737,000 | 14,273,750 | 48,010,750 | 1,548,733 | 110 | 600 | .25 | 31 | 31 | 60 | 60 | 269.4 |
| June | 720 | 354 | 32,978,750 | 15,608,750 | 48,587,500 | 1,619,583 | 111 | 1,860 | .25 | 30 | 30 | 60 | 60 | 268.8 |
| July | 744 | 346 | 33,793,000 | 14,465,000 | 48,258,000 | 1,556,709 | 103 | 1,280 | .25 | 31 | 31 | 60 | 60 | 288.2 |
| August | 744 | 409 | 35,168,750 | 18,083,750 | 53,252,500 | 1,787,822 | 116 | 160 | .25 | 31 | 31 | 60 | 60 | 283.8 |
| September | 720 | 349 | 34,306,250 | 15,611,250 | 49,917,500 | 1,663,916 | 180 | 680 | .25 | 30 | 30 | 60 | 60 | 261.0 |
| October | 744 | 353 | 34,537,600 | 15,425,000 | 49,962,600 | 1,611,696 | 124 | 240 | .25 | 31 | 31 | 60 | 60 | 250.5 |
| November | 719 | 365 | 32,958,750 | 11,433,750 | 44,392,500 | 1,479,750 | 117 | 920 | .25 | 30 | 30 | 60 | 60 | 234.0 |
| December | 744 | 311 | 33,532,500 | 13,451,250 | 46,983,750 | 1,515,601 | 122 | 720 | .25 | 31 | 31 | 60 | 60 | 237.6 |
| Totals and averages | 8,770 | 4,296 | 400,778,600 | 175,374,750 | 576,153,350 | 1,574,462 | 1,463 | 1,800 | .25 | 376 | 376 | 60 | 60 | 243.5 |

Total Capacity, 750,000 gallons per day.

# CHESTNUT HILL STATION.

No. 2—Knowles—Capacity, 250,000 gallons per day.
No. 3—Worthington Duplex—Capacity, 500,000 gallons per day.

| 1896. | Running time of each Engine in hours. | | Gallons Pumped by each Engine. | | Total Pumpage of each Month. | Average Pumpage per day. | Coal. | | Percentage of Ashes. | Oils. | | Mean Water Pressure and Mean Suction Lift in pounds per sq. in. | | Gallons raised 100 feet per pound of Coal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Cylinder. | Engine. | | | |
| | No. 2. | No. 3. | No. 2. | No. 3. | Gallons. | Gallons. | Tons. | Lbs. | | Qts. | Qts. | No. 2. | No. 3. | |
| January | 101 | ........ | 3,553,700 | ........ | 3,553,700 | 114,635 | 17 | 1,540 | .25 | 10 | ........ | 53 | ........ | 110.3 |
| February | 137 | ........ | 4,813,900 | ........ | 4,813,900 | 165,996 | 17 | 843 | .25 | 13 | ........ | 53 | ........ | 151.3 |
| March | 91 | ........ | 3,328,380 | ........ | 3,328,380 | 107,367 | 15 | 2,155 | .25 | 9 | ........ | 53 | ........ | 113.6 |
| April | 6 | ........ | 221,400 | ........ | 221,400 | 7,380 | 11 | 649 | .25 | 1 | ........ | 53 | ........ | 10.7 |
| May | 21 | ........ | 664,200 | ........ | 664,20 | 21,425 | 12 | 1,736 | .25 | 3 | ........ | 53 | ........ | 28.7 |
| June | 45 | ........ | 1,377,570 | ........ | 1,377,570 | 45,919 | 12 | 1,651 | .25 | 5 | ........ | 53 | ........ | 59.0 |
| July | 22 | ........ | 836,400 | ........ | 836,400 | 26,980 | 12 | 2,140 | .25 | 3 | ........ | 53 | ........ | 35.2 |
| August | 43 | ........ | 1,574,400 | ........ | 1,574,400 | 50,787 | 14 | 744 | .25 | 7 | ........ | 53 | ........ | 60.0 |
| September | 11 | ........ | 422,960 | ........ | 422,960 | 14,432 | 11 | 480 | .25 | 2 | ........ | 53 | ........ | 20.5 |
| October | 5 | ........ | 196,800 | ........ | 196,800 | 6,348 | 10 | 1,960 | .25 | 1 | ........ | 53 | ........ | 9.8 |
| November | 35 | ........ | 1,377,600 | ........ | 1 377,600 | 45,920 | 11 | 1,800 | .25 | ........ | 5 | 53 | ........ | 63.7 |
| December | 24 | ........ | 865,920 | ........ | 865,920 | 27,932 | 11 | 884 | .25 | 3 | ........ | 53 | ........ | 41.5 |
| Total and Average | 541 | ........ | 19,233,230 | ........ | 19,233,230 | 52,549 | 160 | 902 | .25 | 57 | 5 | 53 | ........ | 65.5 |

# FRANKFORD PUMPING STATION.

Total Capacity—35,000,000 Gallons per day.

No. 1.—Marine Compound Rotary—Capacity, 10,000,000 Gallons per day.
No. 2.—Corliss Compound Rotary—Capacity, 10,000,000, Gallons per day.
No. 3—.Vertical Compound Rotary—Capacity, 15,000,000 Gallons per day.

| 1896. | Running Time of each Engine in Hours. | | | Gallons Pumped by each Engine. | | | Total Pumpage each Month. | Average Pumpage per Day. | Coal. | | Percentage of Ashes. | Oils. | | Mean Water Pressure & Mean Suction Lift in Pounds per Sq. In. | | | Gallons Raised 100 ft. per Pounds of Coal. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Cylinder. | Engine. | | | | |
| | No. 1. | No. 2. | No. 3. | No. 1. | No. 2. | No. 3. | Gallons. | Gallons. | Tons. | Lbs. | | Qts. | Qts. | No. 1. | No. 2. | No. 3. | |
| January | 720 | 416 | 8 | 251,653,761 | 151,932,722 | 5,110,300 | 408,696,783 | 13,183,767 | 617 | 1,901 | 25 | 371 | 495 | 69 | 68 | 67 | 510.2 |
| February | 630 | 427 | ........ | 224,955,592 | 158,806,670 | ........ | 383,761,670 | 13,233,161 | 598 | 1,471 | 25 | 344 | 455 | 68 | 68 | ...... | 494.5 |
| March | 684 | 457 | ........ | 243,266,983 | 173,534,891 | ........ | 416,801,879 | 13,145,221 | 642 | 1,159 | 25 | 361 | 485 | 68 | 68 | ...... | 501.1 |
| April | 483 | 4 3 | 47 | 180,497,325 | 155,463,877 | 29,155,307 | 365,116,509 | 12,170,550 | 506 | 335 | 25 | 334 | 440 | 68 | 72 | 67 | 556.5 |
| May | 704 | 552 | 18 | 271,958,654 | 166,586,464 | 12,214,736 | 450,759,854 | 14,540,640 | 640 | 1,640 | 25 | 289 | 595 | 69 | 67 | 65 | 542.7 |
| June | 618 | 301 | 190 | 229,463,013 | 83,452,148 | 117,805,879 | 430,721,040 | 14,357,368 | 604 | 1,566 | 25 | 342 | 611 | 67 | 71 | 67 | 623.3 |
| July | 655 | 380 | 92 | 242,741,910 | 142,320,800 | 62,966,648 | 448,029,358 | 14,452,559 | 633 | 1,586 | 25 | 548 | 759 | 68 | 70 | 69 | 543.9 |
| August | 728 | 346 | 99 | 268,250,730 | 126,646,491 | 75,666,251 | 470,563,472 | 15,179,466 | 695 | 1,676 | 25 | 693 | 894 | 67 | 73 | 68 | 521.7 |
| September | 710 | 589 | 2 | 256,862,003 | 200,669,107 | 1,682,687 | 459,213,797 | 15,307,126 | 682 | 280 | 25 | 617 | 770 | 68 | 69 | 75 | 519.3 |
| October | 689 | 346 | 94 | 246,034,570 | 126,485,855 | 158,762,784 | 431,283,209 | 13,912,361 | 667 | 2,169 | 25 | 587 | 779 | 68 | 76 | 73 | 498.0 |
| November | 617 | 236 | 147 | 219,083,460 | 83,076,510 | 105,842,222 | 408,002,192 | 13,600,073 | 634 | 411 | 25 | 534 | 807 | 67 | 70 | 76 | 496.3 |
| December | 727 | 135 | 181 | 253,408,650 | 51,224,994 | 117,464,547 | 422,098,191 | 13,616,070 | 675 | 1,062 | 25 | 510 | 825 | 68 | 69 | 74 | 497.9 |
| Totals and averages | 7,965 | 4,598 | 838 | 2,888,176,656 | 1,519,199,937 | 687,671,361 | 5,095,047,954 | 13,923,625 | 7,509 | 1,816 | 25 | 5,565 | 7,915 | 68 | 70 | 70 | 517.7 |

# CURRENT EXPENSES AND WORK OF THE PUMPING STATIONS FOR THE YEAR 1896.

| Stations. | Pay of Employees at the Stations. | Coal. | | | Lubricating Oils. | | Lighting Oils. | | Repairs to Boilers and Machinery. | Small Stores. | Total Expenses. | Total Gallons Pumped. | Lift in Feet Including Suction and Friction. | Gallons Pumped 100 Feet High, Suction and Friction Included. | Cost of Raising One Million Gallons One Hundred Feet. | Percentage of Work Done at Each Station. | Height of Surface of Basin Above Pumps in Feet. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tons. | Price Per Ton. | Cost. | Gallons. | Cost. | Oils. | Electricity. | | | | | | | | | |
| Fairmount | $7,540 00 | ........ | ........ | ........ | 572 | $213 61 | $19 00 | ........ | $3,635 27 | $192 50 | $11,600 38 | 8,959,846,128 | 100.0 | 8,959,846,128 | $1 29 | 5.40 | 90.00<br>115.00<br>120.00 |
| Spring Garden | 66,135 32 | 62,824 | Buck.. $1 97<br>Pea.... 2 71 | $152,623 28 | 8,775 | 1,883 05 | 41 00 | $1,556 90 | 35,202 13 | 862 35 | 258,304 03 | 46,697,046,108 | 154.2 | 72,008,845,098 | 3 58 | 44.40 | 102.00<br>179.00<br>*215.00 |
| Belmont | 18,188 53 | 18,912 | Pea.... 2 69 | 50,873 28 | 1,471 | 324 05 | 19 20 | 432 66 | 6,493 22 | 219 00 | 76,549 94 | 9,431,711,339 | 223.2 | 21,052,579,708 | 3 63 | 14.00 | 198.08 |
| Belmont Auxiliary | 3,400 00 | 394 | Pea.... 2 69 | 1,059 86 | 118 | 26 10 | 1 20 | ........ | 815 10 | 68 00 | 5,380 26 | 97,240,995 | 134.6 | 130,886,379 | 41 38 | .10 | †160.00 |
| Queen Lane | 16,931 11 | 13,887 | Pea.... 3 00 | 41,661 00 | 8,300 | 1,652 77 | 40 25 | 817 90 | 7,987 15 | 396 00 | 69,486 18 | 9,641,793,650 | 250.0 | 24,104,484,125 | 2 88 | 14.30 | 231.00 |
| Roxborough | 15,232 51 | 19,529 | Pea.... 2 71 | 52,923 59 | 3,496 | 710 92 | 16 00 | 442 91 | 8,349 62 | 220 00 | 77,895 55 | 6,383,682,550 | 389.6 | 24,870,827,214 | 3 13 | 15.30 | 319.00<br>366.00 |
| Roxborough Auxiliary | 3,648 14 | 1,047 | Pea.... 3 01 | 3,151 47 | 463 | 104 41 | 13 85 | ........ | 1,532 27 | 53 00 | 8,503 14 | 791,887,225 | 129.3 | 1,023,910,181 | 8 31 | 60. | ‡140.00 |
| Mount Airy | 3,403 00 | 1,464 | Buck.. 2 75 | 4,026 00 | 188 | 39 48 | 9 10 | ........ | 983 12 | 47 60 | 8,508 30 | 576,153,350 | 138.6 | 798,548,543 | 10 66 | .50 | §128.00 |
| Chestnut Hill | 1,500 00 | 160 | Pea.... 3 00 | 480 00 | 15 | 3 42 | 10 30 | ........ | 498 18 | 20 25 | 2,512 15 | 19,233,230 | 122.4 | 23,541,473 | 109 22 | .10 | 128.00 |
| Frankford | 12,877 28 | 7,600 | Buck.. 2 03 | 15,428 00 | 3,370 | 695 94 | 12 85 | 366 80 | 7,963 15 | 221 00 | 37,565 02 | 5,095,047,954 | 172.8 | 8,803,242,864 | 4 26 | 5.30 | 108.53 |
| Totals and averages deducted from totals | $148,855 89 | 125,817 | $2 56 | $322,226 48 | 26,768 | $5,653 75 | $192 75 | $3,617 17 | $78,459 21 | $2,299 70 | $556,304 95 | 87,693,642,529 | 181.4 | 161,776,711,713 | $3 43 | 100.00 | |

* Spring Garden to Queen Lane. † Repumpage from Belmont. ‡ Repumpage from Roxborough. § Repumpage from Mt. Airy.

# TOTAL GALLONS PUMPED DURING 1896.

| 1896. | Fairmount. | Spring Garden. | Belmont. | Queen Lane. | Roxborough. | Chestnut Hill. | Frankford. | Consumption. | Supplementary Pumpage. | | | | Total Pumpage. | Average per day. | Percentage of Pumpage. | Maximum Gallons for one day. | Minimum Gallons for one day. | Total Steam Pumpage. | Total Water Pumpage. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Bel. Auxiliary. | Rox. Auxiliary. | Mount Airy. | Total. | | | | | | | |
| January | 808,597,289 | 4,033,116,040 | 773,988,910 | 77,195,150 | 531,828,060 | 3,553,700 | 408,696,783 | 6,636,975,933 | 5,562,080 | 63,604,035 | 49,087,500 | 118,253,615 | 6,755,229,547 | 217,910,630 | 7.70 | 260,408,202 | 171,951,498 | 5,946,632,258 | 808,597,289 |
| February | 947,546,477 | 3,554,253,740 | 714,923,680 | 159,086,400 | 529,415,450 | 4,813,900 | 383,761,670 | 6,293,801,317 | 5,510,880 | 52,132,410 | 45,613,750 | 103,257,040 | 6,397,058,357 | 220,558,219 | 7.20 | 269,831,609 | 72,143,883 | 5,449,511,880 | 947,546,477 |
| March | 1,045,559,183 | 3,294,413,685 | 735,668,660 | 601,276,900 | 493,764,460 | 3,328,380 | 416,801,879 | 6,590,813,147 | 5,745,840 | 56,734,425 | 47,697,500 | 110,177,765 | 6,700,990,912 | 216,160,997 | 7.65 | 266,120,304 | 142,272,601 | 5,655,431,729 | 1,045,559,183 |
| April | 1,141 932,545 | 3,477,614,673 | 706,567,582 | 484,564,245 | 485,109,220 | 221,400 | 365,116,509 | 6,661,126,174 | 6,155,680 | 63,884,700 | 44,389,500 | 114,429,880 | 6,775,556,054 | 225,851,868 | 7.73 | 269,580,329 | 177,222,744 | 5,633,623,509 | 1,141,932,545 |
| May | 722,822,886 | 4,038,641,620 | 780,684,041 | 868,556,855 | 486,917,680 | 664,200 | 450,759,854 | 7,349,047,136 | 8,191,030 | 66,290 000 | 48,010,750 | 122,491,780 | 7,471,538,916 | 241,017,334 | 8.52 | 264,316,839 | 206,714,150 | 6,748,716,030 | 722,822,886 |
| June | 617,485,771 | 3,715,026,461 | 771,800,573 | 960,017,350 | 568,257,180 | 1,377,570 | 430,721,040 | 7,064,685,945 | 9,865,650 | 63,706,500 | 48,587,500 | 122,159,650 | 7,186,845,595 | 239,561,519 | 8.21 | 272,627,496 | 205,157,179 | 6,569,359,824 | 617,485,771 |
| July | 601,783,437 | 4,089,237,333 | 866,670,631 | 1,009,558,050 | 576,122,770 | 836,400 | 448,029,358 | 7,592,237,979 | 9,569,230 | 68,239,700 | 48,258,000 | 126,066,930 | 7,718,304,909 | 248,977,577 | 8.82 | 275,727,468 | 225,796,506 | 7,116,521,472 | 601,783,437 |
| August | 310,370,756 | 4,654,301,290 | 902,332,303 | 1,040,504,100 | 586,232,060 | 1,574,400 | 470,563,472 | 7,965,878,381 | 13,288,060 | 72,919,440 | 53,252,500 | 139,460,000 | 8,105,338,381 | 261,462,528 | 9.25 | 275,808,008 | 234,697,575 | 7,794,967,625 | 310,370,756 |
| September | 186,964,038 | 4,556,845,016 | 843,489,841 | 1,142,539,800 | 4[illegible]8,705,200 | 422,960 | 459,213,797 | 7,658,190,652 | 10,526,095 | 70,567,200 | 49,917,500 | 131,010,795 | 7,789,201,447 | 259,640,048 | 8.90 | 286,955,648 | 231,354,695 | 7,602,237,409 | 186,964,038 |
| October | 634,278,228 | 4,185,398,150 | 808,500,276 | 1,143,603,800 | 574,417,980 | 196,800 | 431,283,209 | 7,777,678,443 | 8,855,180 | 72,821,430 | 49,962,600 | 131,639,210 | 7,909,317,653 | 255,139,279 | 9.02 | 278,303,479 | 226,032,515 | 7,275,039,425 | 634,278,228 |
| November | 948,960,690 | 3,542,319,640 | 741,421,685 | 1,089,992,050 | 548 909,520 | 1,377,600 | 408,002,192 | 7,280,983,377 | 6,965,190 | 70,567,200 | 44,392,500 | 121,924,890 | 7,402,908,267 | 246,763,608 | 8.45 | 263,705,166 | 227,667,919 | 6,453,917,577 | 948,960,690 |
| December | 993,544,828 | 3,555,878.460 | 785,663.157 | 1,064,898,950 | 533,992,970 | 865,920 | 422,098,191 | 7,356.942,476 | 7,006,080 | 70,420,185 | 46,983,750 | 124,410,015 | 7,481,352,491 | 241,333,951 | 8.55 | 262,839,288 | 210,972.273 | 6,487,807,663 | 993,544,828 |
| Totals | 8,959,846,128 | 46,697,046,108 | 9,431,711,339 | 9,641,793,650 | 6,383,682,550 | 19,233,230 | 5,095,047,954 | 86,228,360,959 | 97,240,995 | 791,887,225 | 576,153,350 | 1,465,281,570 | 87,693,642,529 | 239,600,116 | 100.00 | ........ | ........ | 78,733,796,401 | 8,959,846,128 |
| Increase over 1895 | 1,872,652,917 | ........ | 994,232,814 | 9,510,657,702 | 167,753,763 | ........ | 382,193,437 | 8,409,347,349 | 38,724,379 | 476,014,597 | ........ | 508,446,076 | 8,917,793,425 | 23,775,872 | ........ | 28,117,121 | ........ | 7,545,140,508 | 1,372,652,917 |
| Decrease from 1895 | ........ | 4,007,145,734 | ........ | ........ | ........ | 10,997,550 | ........ | ........ | ........ | ........ | 6,322,900 | ........ | ........ | ........ | ........ | ........ | 61,772,836 | ........ | ........ |

# DESCRIPTION OF PUMPING MACHINERY OF THE BUREAU OF WATER, PHILADELPHIA, 1896.

## STEAM ENGINES AND PUMPS.

| Pumping Station. | Designated Number of Engine or Turbine. | Types of Engines. | Designated Capacity—Million Gallons per Day. | High Pressure Cylinder: Number of Cylinders. | Bore (inches). | Stroke (feet). | Number of revolutions. | Speed (feet per minute). | Diameter of Rod (inches). | Int. Pressure Cylinder: Number of Cylinders. | Bore (inches). | Stroke (feet). | Number of Revolutions. | Speed (feet per minute). | Diameter of Rod (inches). |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spring Garden: (Old Station) | 5 | Southwark Foundry Quarter-Crank Fly Wheel Pump | 20 | 2 | 44 | 4 | 16 2/3 | 133 1/3 | 8 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 6 | Simpson Compound Rotary | 10 | 1 | 36 | 5.2 | 11 | 133 2/3 | 4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 7 | Marine Compound Rotary | 20 | 1 | 45 | 6 | 17 | 204 | 8 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | Worthington Duplex | 10 | 2 | 38 | 4 | 12 1/2 | 100 | 4 1/2 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 11 | Gaskill Compound | 20 | 2 | 33 | 4 | 17 1/2 | 140 | 4 1/2 | ...... | ...... | ...... | ...... | ...... | ...... |
| (New Station) | 2 | Holly Ver. Triple Expansion | 30 | 1 | 36 | 5 | 20 | 200 | 7 1/2 | 1 | 62 1/2 | 5 | 20 | 200 | 7 1/2 |
| | 3 | Holly Ver. Triple Expansion | 30 | 1 | 36 | 5 | 20 | 200 | 7 1/2 | 1 | 62 1/2 | 5 | 20 | 200 | 7 1/2 |
| | 9 | Worthington Duplex | 15 | 2 | 38 | 4 | 12 1/2 | 100 | 4 1/2 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 10 | Worthington Duplex | 15 | 2 | 38 | 4 | 12 1/2 | 100 | 4 1/2 | ...... | ...... | ...... | ...... | ...... | ...... |
| Belmont | 1 | Worthington Duplex | 5 | 2 | 29 | 4 | 12 | 96 | 4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 2 | Worthington Duplex | 5 | 2 | 29 | 4 | 12 | 96 | 4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 3 | Worthington Duplex | 8 | 2 | 33 3/4 | 4 | 12 | 96 | 4 1/2 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 4 | Worthington Duplex | 20 | 2 | 41 | 4 | 16 1/4 | 180 | 7 | ...... | ...... | ...... | ...... | ...... | ...... |
| Belmont Auxiliary | 1 | Worthington Duplex | 2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 2 | Snow | 1/2 | 2 | 12 | 1 | 35 | ...... | 1 1/2 | | | | | | |
| Queen Lane Station | 1 | Southwark Foundry Vert. Triple Expansion | 20 | 1 | 37 | 4.5 | 22 | 198 | 5 1/4 | 1 | 62 | 4.5 | 21.84 | 198 | 5 1/4 |
| | 2 | Southwark Foundry Vert. Triple Expansion | 20 | 1 | 37 | 4.5 | 22 | 198 | 5 1/4 | 1 | 62 | 4.5 | 21.84 | 198 | 5 1/4 |
| | 3 | Southwark Foundry Vert. Triple Expansion | 20 | 1 | 37 | 4.5 | 22 | 198 | 5 1/4 | 1 | 62 | 4.5 | 21.84 | 198 | 5 1/4 |
| | 4 | Southwark Foundry Vert. Triple Expansion | 20 | 1 | 37 | 4.5 | 22 | 193 | 5 1/4 | 1 | 62 | 4.5 | 21.84 | 198 | 5 1/4 |
| Roxborough | 1 | Southwark Foundry Quarter-Crank Fly Wheel Pump | 12 | 2 | 44 | 4 | 15 1/2 | 124 | 8 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 2 | Worthington Duplex | 5 | 2 | 36 | 4 | 12 | 96 | 4 1/2 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 3 | Worthington Duplex | 7 1/2 | 2 | 38 | 4 | 12 1/2 | 100 | 4 1/2 | ...... | ...... | ...... | ...... | ...... | ...... |
| Roxborough Auxiliary | 1 | Worthington Duplex | 6 | 2 | 21 | 4 | 12 | 96 | 3 1/2 | ...... | ...... | ...... | ...... | ...... | ...... |
| Mount Airy | 1 | Davidson Pump | 1 | 1 | 20 | 1 2/3 | 60 | 200 | 2 1/4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 2 | Davidson Pump | 1 | 1 | 20 | 1 2/3 | 60 | 200 | 2 1/4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 3 | Knowles' Pump | 1 | 1 | 24 | 2 | 20 | 80 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Chestnut Hill | 1 | Knowles' Pump | 1/4 | 1 | 24 | 1 3/4 | 11 | 38.5 | 3 5/8 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 2 | Worthington Duplex | 1/2 | 2 | 14 | 7/8 | ...... | ...... | 1 3/4 | ...... | ...... | ...... | ...... | ...... | ...... |
| Frankford | 1 | Marine Compound Rotary | 10 | 1 | 40 | 5 | 21 | 210 | 6 3/4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 2 | Corliss Compound Rotary | 10 | 1 | 28 | 3 | 37 | 222 | 3 15/16 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 3 | Southwark Foundry Quarter-Crank Compound Pump | 15 | 1 | 44 | 3 1/3 | 24 | 168 | {2 rods 5} | ...... | ...... | ...... | ...... | ...... | ...... |
| Fairmount: (New House) | 1 | Turbine Wheels | 2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 3 | ...... | 5 1/3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 4 | ...... | 5 1/3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 5 | ...... | 5 1/3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| (Old House) | 7 | ...... | 5 1/10 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | ...... | 5 1/10 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | ...... | 5 1/10 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |

| Pumping Station. | Designated Number | Low Pressure Cylinder: Number of Cylinders. | Bore (inches). | Stroke (feet). | Number of Revolutions. | Speed (feet per minute). | Diameter of Rod (inches). | Air Pumps: Number of Air Pumps. | Bore (inches). | Stroke (feet). | Number of Revolutions. | Diameter of Rod (inches). | Type—Single [S] or Double [D]. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spring Garden (Old Station) | 5 | 2 | 88 | 4 | 16 2/3 | 133 1/3 | 8 | 4 | 24 | 2 | 16 2/3 | ...... | S. |
| | 6 | 1 | 57 | 8 | 11 | 176 | 5 | 1 | 30 | 4 | 11 | ...... | S. |
| | 7 | 1 | 80 | 6 | 17 | 204 | 8 | 1 | 40 | 3 | 17 | ...... | S. |
| | 8 | 2 | 66 3/16 | 4 | 12 1/2 | 100 | {2 rods 4} | {2 2} | {29 3/4 27} | 2 | 12 1/2 | ...... | S. |
| | 11 | 2 | 66 | 4 | 17 1/2 | 140 | 5 | 2 | 24 | 2 1/4 | 17 1/2 | ...... | S. |
| (New Station) | 2 | 1 | 92 | 5 | 20 | 200 | 8 | 1 | 26 | 5 | 20 | ...... | S. |
| | 3 | 1 | 92 | 5 | 20 | 200 | 8 | 1 | 26 | 5 | 20 | ...... | S. |
| | 9 | 2 | 66 | 4 | 12 1/2 | 100 | {2 rods 4} | {2 2} | {29 1/2 27} | 2 | 12 1/2 | ...... | S. |
| | 10 | 2 | 66 | 4 | 12 1/2 | 100 | {2 rods} | {2 2} | {29 3/4 27} | 2 | 12 1/3 | ...... | S. |
| Belmont | 1 | 2 | 50 1/4 | 4 | 12 | 96 | 4 | {2 2} | ...... | 2 | 12 | ...... | S. |
| | 2 | 2 | 50 1/2 | 4 | 12 | 96 | 4 | {2 2} | ...... | 2 | 12 | ...... | S. |
| | 3 | 2 | 58 1/4 | 4 | 12 | 96 | 4 1/2 | {2 2} | {29 3/4 29 3/4} | 2 | 12 | ...... | S. |
| | 4 | 2 | 82 | 4 | 16 1/4 | 130 | {2 rods 5} | 2 | ...... | ...... | ...... | ...... | ...... |
| Belmont Auxiliary | 1 | 2 | ...... | 2.6 | | | | | | | | | |
| | 2 | | | | | | | | | | | | |
| Queen Lane Station | 1 | 1 | 96 | 5.4 | 22 | 198 | 5 1/4 | 1 | 28 | 3 | ...... | 2 3/4 | T. |
| | 2 | 1 | 96 | 5.4 | 22 | 198 | 5 1/4 | 1 | 28 | 3 | ...... | 2 3/4 | T. |
| | 3 | 1 | 96 | 5.4 | 22 | 198 | 5 1/4 | 1 | 28 | 3 | ...... | 2 3/4 | T. |
| | 4 | 1 | 96 | 5.4 | 22 | 198 | 5 1/4 | 1 | 28 | 3 | ...... | 2 3/4 | T. |
| Roxborough | 1 | 2 | 88 | 4 | 15 1/2 | 124 | 8 | 2 | 24 | ...... | ...... | ...... | S. |
| | 2 | 2 | 58 | 4 | 12 | 96 | 4 1/2 | {2 2} | {29 3/4 29 3/4} | {2 2} | 12 | ...... | S. |
| | 3 | 2 | 66 | 4 | 12 1/2 | 100 | 2 of 4 | {2 2} | {29 3/4 27} | {2 2} | 12 1/2 | ...... | S. |
| Roxborough Auxiliary | 1 | 2 | 36 | 4 | 12 | 96 | 3 1/2 | 4 | 18 | 1,59 | 12 | ...... | S. |
| Mount Airy | 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Chestnut Hill | 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 2 | 2 | 10 | 10 1/4 | ...... | ...... | 1 3/4 | ...... | ...... | ...... | ...... | ...... | ...... |
| Frankford | 1 | 1 | 69 | 5 | 21 | 210 | 6 3/4 | 1 | 24 | 2 1/2 | 21 | 3 3/4 | S. |
| | 2 | 1 | 56 | 3 | 37 | 222 | 4 15/16 | 1 | 30 | 1 1/6 | 37 | {Trunk 6} | S. |
| | 3 | 1 | 88 | 3 1/2 | 24 | 168 | {2 rods 5} | 1 | 28 | 1 3/4 | 24 | ...... | S. |
| Fairmount: (New House) | 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 5 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| (Old House) | 7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |

| Pumping Station. | Designated Number | Forcing Pumps: Type—Single [S], Double [D], Bucket [B], Plunger [P]. | Number of Pumps. | Bore (inches). | Area (square inches), A. | Stroke (feet). | Number of single strokes per minute. | Diameter of Pump Rod (inches). | Displacement per stroke, Theoretical. (Gallons.) | Displacement per stroke, Actual. (Gallons.) | Diameter Suction Pipe (inches). |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Spring Garden (Old Station) | 5 | {D. P.} | 2 | 36 1/2 | 1,021 | 4 | 66 2/3 | 8 | 212 1/6 | 208 | 2 x 36 |
| | 6 | {R. P.} | 2 | {B. 28 1/2 P. 20 1/8} | {638 818} | 8 | 22 | ...... | 112 5/8 | 125 | None.... |
| | 7 | {D. P.} | 2 | 30 | 707 | 6 | 34 | 8 | 218 1/2 | 207 1/2 | {2 of 30} |
| | 8 | {D. P.} | 2 | 30 | 707 | 4 | 25 | 4 1/2 | 147 1/2 | 140 | 30 |
| | 11 | P. | 2 | 36 | 1,017.9 | 4 | 35 | 6 | 208 1/2 | 200 | 36 |
| (New Station) | 2 | D. Plunger. | 3 | 20 | 706. | 5 | 40 | 6 | 539.8 | ...... | 48 |
| | 3 | D. Plunger. | 3 | 30 | 706.8 | 5 | 40 | 6 | 539.8 | ...... | 48 |
| | 9 | {D. P.} | 2 | 37 | 1,075 | 4 | 25 | 5 | 221 1/4 | 2 0 1/4 | 36 |
| | 10 | {D. P.} | 2 | 37 | 1,075 | 4 | 25 | 5 | 221 1/4 | 210 1/4 | 36 |
| Belmont | 1 | {D. P.} | 2 | 22 13/16 | 382 | 4 | 24 | 4 | 78 | 75 | 30 |
| | 2 | {D. P.} | 2 | 22 1/2 | 397 | 4 | 24 | 4 | 81 1/4 | 78 | 30 |
| | 3 | {D. P.} | 2 | 28 | 615 | 4 | 24 | 4 1/2 | 126 1/2 | 121 1/4 | 30 |
| | 4 | {D. P.} | 2 | 36 1/2 | 1,025 | 4 | 65 | 6 15/16 | 221 1/2 | 215 | 36 |
| Belmont Auxiliary | 1 | | | | | | | | | | |
| | 2 | | | | | | | | | | |
| Queen Lane Station | 1 | {D. P.} | 3 | 34 1/2 | 934.8 | 5.4 | 22 | 5 | 655.5 | ...... | 48 |
| | 2 | {D. P.} | 3 | 34 1/2 | 934.8 | 5.4 | 22 | 5 | 655.5 | ...... | 48 |
| | 3 | {D. P.} | 3 | 34 1/2 | 934.8 | 5.4 | 22 | 5 | 655.5 | ...... | 48 |
| | 4 | {D. P. C.} | 3 | 34 1/2 | 934.8 | 5.4 | 22 | 5 | 655.5 | ...... | 48 |
| Roxborough | 1 | {D. P.} | 2 | 29 | 635 | 4 | 31 | 8 | 137 1/2 | 133 1/2 | 27 |
| | 2 | {D. P.} | 2 | 22 | 380 | 4 | 24 | 4 1/2 | 77 1/2 | 73 3/4 | 30 |
| | 3 | {D. P.} | 2 | 26 | 531 | 4 | 25 | 5 | 108 | 102 3/4 | 30 |
| Roxborough Auxiliary | 1 | {D. P.} | 2 | 24 | 452 | 4 | 21 | 3 1/2 | 93 1/2 | 89 1/4 | 30 |
| Mount Airy | 1 | {D. Piston} | 1 | 10 | 78.5 | 1 2/3 | 120 | 2 1/4 | 6 5/8 | 6 1/4 | 12 |
| | 2 | {D. Piston} | 1 | 10 | 78.5 | 1 2/3 | 120 | 2 1/4 | 6 5/8 | 6 1/4 | 12 |
| | 3 | Piston | ...... | ...... | ...... | 2 | 40 | 3 15/16 | ...... | 25 | 42 |
| Chestnut Hill | 1 | Piston | 1 | 18 | 254.5 | 1 3/4 | 22 | 3 3/8 | 26 | 25 | 10 |
| | 2 | ...... | ...... | ...... | ...... | ...... | ...... | 1 3/4 | 6.9 | 6.5 | ...... |
| Frankford | 1 | {D. P.} | 2 | 21 | 346 | 5 | 42 | 6 3/4 | 85 1/4 | 81 3/4 | {2 of 20} |
| | 2 | {D. P.} | 2 | 20 | 314 | 3 | 74 | 3 11/16 | 48 | 45 3/4 | 30 |
| | 3 | {D. P.} | 2 | 28 | 615 | 3 1/2 | 96 | 5 1/2 | 109 3/4 | ...... | 42 |
| Fairmount: (New House) | 1 | Piston | 2 | 16 | 201 | 6 | 24 | 3 5/8 | 61 [illegible] | 61 1/20 | 18 |
| | 3 | Piston | 2 | 22 3/8 | 394.3 | 6 | 16 | 5 | 119 13/16 | 115 3/8 | 22 1/2 |
| | 4 | Piston | 2 | 22 | 380.1 | 6 | 16 | 5 | 115 5/8 | 115 5/8 | 22 1/2 |
| | 5 | Piston | 2 | 22 | 380.1 | 6 | 16 | 5 | 115 5/8 | 115 5/8 | 22 1/2 |
| (Old House) | 7 | Piston | 2 | 18 11/16 | 274.3 | 6 | 22 | 4 | 83 1/2 | 80 97/100 | 20 |
| | 8 | Piston | 2 | 18 5/8 | 272.4 | 6 | 22 | 4 | 82 9/10 | 80 97/100 | 20 |
| | 9 | Piston | 2 | 18 11/16 | 274.3 | 6 | 22 | 4 | 83 1/2 | 80 97/100 | 20 |

| Pumping Station. | Designated Number | Diameter Discharge Pipe (inches). | Number of Suction Valves (on each end). | Lift of Suction Valves (inches). | Area of Suction Valves (square inches). | Number of Discharge Valves. | Lift of Discharge Valves (inches). | Total area, B (square inches). | Relative speed of Water, A, B (through valves). | Speed (feet per second) through Valves. | Mean Pressure on Pumps at Pressure Gauge (pounds per square inch). | Corresponding Head (feet). | Lift (feet) from Surface of Water to Centre of Gauge. | Total Lift (feet). |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spring Garden (Old Station) | 5 | 48 | 78 | 1/2 | 554 | 78 | 1/2 | 554 | 1.81 | 4.05 | 110 | 250 | ...... | ...... |
| | 6 | 36 | 16 | 1 1/2 | 424 | Check.. | ...... | ...... | 1.50 | 4.4 | 45 | 104.6 | 22 | 126.6 |
| | 7 | 48 | 18 | 1 | 631 | 18 | 1 | 631 | 1-12 | 3.8 | {66 45} | {153.5 104.6} | 20 | {173.5 124.6} |
| | 8 | 30 | 8 | 1 | 280 1/2 | 8 | 1 | 280 1/2 | 2.50 | 4.2 | {86 45} | {200 104.6} | 16.5 | {216.6 121.2} |
| | 11 | 36 | 306 | 5/16 | 414 | 288 | 5/16 | 390 | 2.61 | 6.09 | 71 | 163.9 | 25 | 188.9 |
| (New Station) | 2 | 30 | 8 | 1 | 218 | 72 | 1/2 | 546 | 1.29 | 4.22 | | | | |
| | 3 | 30 | 8 | 1 | 248 | 72 | 1/2 | 546 | 1.29 | 4.22 | | | | |
| | 9 | 36 | 12 | 1 | 300 3/4 | 12 | 1 | 300 3/4 | 3.58 | 5.97 | {66 45} | {153.5 104.6} | 16.4 | {169.9 121} |
| | 10 | 36 | 12 | 1 | 300 3/4 | 12 | 1 | 300 3/4 | 3.58 | 5.97 | {86 45} | {200 104.6} | 16.4 | {216.4 121} |
| Belmont | 1 | 30 | 8 | 1 | ...... | 8 | 1 | ...... | ...... | ...... | 88 | 204.6 | 14.6 | 219.2 |
| | 2 | 30 | 8 | 1 | ...... | 8 | 1 | ...... | ...... | ...... | 88 | 204.6 | 14.6 | 219.2 |
| | 3 | 30 | 8 | 1 | 248 | 8 | 1 | 248 | 2.47 | 3.96 | 88 | 204.6 | 14.6 | 219.2 |
| | 4 | 36 | 36 | 1/2 | 302 | 36 | 1/2 | 302 | | | | | | |
| Belmont Auxiliary | 1 | | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | | |
| Queen Lane Station | 1 | 48 | 89 | 1/2 | 801.5 | 89 | 1/2 | 801 | 1.16 | 3.6 | 100 | 231 | 32 | 246 |
| | 2 | 48 | 89 | 1/2 | 801.5 | 89 | 1/2 | 801 | 1.16 | 3.6 | 100 | 231 | 32 | 246 |
| | 3 | 48 | 89 | 1/2 | 801.5 | 89 | 1/2 | 801 | 1.16 | 3.6 | 100 | 231 | 32 | 246 |
| | 4 | 48 | 89 | 1/2 | 801.5 | 89 | 1/2 | 801 | 1.16 | 3.6 | 100 | 231 | 32 | 246 |
| Roxborough | 1 | 36 | 60 | 1/2 | 465 | 60 | 1/2 | 465 | ...... | 2.6 | | | | |
| | 2 | 30 | 8 | 1 | ...... | 8 | 1 | ...... | ...... | ...... | ...... | ...... | 21 | 365.4 |
| | 3 | 30 | 8 | 1 | 280 | 8 | 1 | 280 | 2.50 | 4.2 | 148 | 344 | 21.4 | 365.4 |
| Roxborough Auxiliary | 1 | 48 | 72 | 1/2 | 546 | 8 | 1 | 248 | 1.82 | 2.91 | 52 | 121 | 14.5 | 135.5 |
| Mount Airy | 1 | 10 | 6 | 5/8 | 87 | 6 | 5/8 | 87 | 0.90 | 3.00 | 60 | 140 | | |
| | 2 | 10 | 6 | 5/8 | 87 | 6 | 5/8 | 87 | 0.90 | 3.00 | 60 | 140 | | |
| | 3 | 40 | 2 | ...... | ...... | 2 | ...... | ...... | ...... | ...... | 36 | 83.7 | | |
| Chestnut Hill | 1 | 8 | 2 | 5/8 | 34 | 2 | ...... | 34 | 7.4 | 4.74 | 56 | 123.2 | | |
| | 2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 53 | 123.2 | | |
| Frankford | 1 | 30 | 10 | 1 | 350 5/8 | 10 | 1 | 350 5/8 | 9.98 | 3.45 | 73 | 170 | 17.4 | 187.5 |
| | 2 | 30 | 12 | 3/4 | 420 3/4 | 12 | 3/4 | 420 3/4 | 0.75 | 2.77 | 73 | 172 | 15.4 | 187.5 |
| | 3 | 40 | 1 | ...... | 290 | 1 | ...... | 290 | 2.12 | .47 | | | | |
| Fairmount: (New House) | 1 | 16 | 2 | ...... | 240 | 2 | ...... | 240 | 0.88 | 2.11 | | | | |
| | 3 | 36 | 6 | ...... | 528 | 1 | 2 | 441 | 0.90 | 1.44 | | | | |
| | 4 | 36 | 6 | ...... | 528 | 1 | 2 | 441 | 0.86 | 1.37 | 56 | 130 | ...... | 130 |
| | 5 | 36 | 6 | ...... | 528 | 1 | 2 | 441 | 0.86 | 1.37 | 56 | 130 | ...... | 130 |
| (Old House) | 7 | 30 | 1 | 2 | 264 | 1 | 2 | 264 | 1.04 | 2.29 | 56 | 130 | ...... | 130 |
| | 8 | 30 | 1 | 2 | 264 | 1 | 2 | 264 | 1.04 | 2.29 | 56 | 130 | ...... | 130 |
| | 9 | 30 | 1 | 2 | 264 | 1 | 2 | 264 | 1.04 | 2.29 | 56 | 130 | ...... | 130 |

## STEAM BOILERS.

| Pumping Station. | Type of Boilers. | Number of Boilers. | Diameter of Shell (inches). | Length of Shell (feet). | Thickness of Shell (inches). | Number of Flues. | Diameter of Flues (inches). | Thickness of Flues (inches). | Length of Flues (feet). | Number of Tubes. | Length of Tubes (feet). | Diameter of Tubes (inches). | Diameter of Steam Drum (inches). | Length of Steam Drum (feet). | Length of Grate (feet). | Area of Grate (square feet). | Area of Heating Surface (square feet). | Estimated Horse-power, at 10 square feet for Shell and Fire Flues, 15 square feet for Tubes and 12 square feet for Drums. | Height of Stack (feet). | Section of Stack (square feet). |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spring Garden | Marine, Steel | 24 | 138 | 10 5/6 | {1 1/8, 15/16, 9/16} | Fo 2 | x corr 43 | uga 3/8 | ted. 8 | 188 | 8 | 3 | 42 | 12 1/2 | 6 1/6 | 42 | 1,551 | 113 | 100 | 49 |
| | Furnace Flue, Tubular | 10 | 102 | 20 | 5/8 | 2 | 37 | 3/8 | 8 | 90 | 10 | 4 | ...... | ...... | 6 1/6 | 42 | 1,116 | 100 | 150 | 27 |
| Belmont | Tubular | 7 | 72 | 12 | 1/2 | ...... | ...... | ...... | ...... | 92 | 12 | 4 | 48 | 14 | 5 1/2 | 86 | 1,371 | 95.9 | 100 | 25 |
| | Furnace Flue, Tubular | 5 | 102 | 20 | 5/8 | 2 | 42 | 3/8 | 8 | 90 | 10 | 4 | ...... | ...... | 6 1/6 | 42 | 1,116 | 100 | 100 | 25 |
| Belmont Aux | Furnace Flue | 4 | 102 | 20 | 5/8 | 2 | 42 | 3/8 | 7 1/2 | 90 | 10 | 4 | ...... | ...... | 6 1/6 | 42 | 1,116 | 80 | 125 | 20 |
| Queen Lane | Furnace Flue, Tubular | 24 | 102 | 20 | 5/8 | 2 | 42 | 3/8 | 8 | 90 | 10 | 4 | ...... | ...... | 6 1/6 | 42 | 1,116 | 100 | 202 | 113 |
| Roxborough | Tubular | 3 | 72 | 15 | 3/8 | ...... | ...... | ...... | ...... | 67 | 15 | 4 | {1 dome 36} | 4 | 5 | 33 3/4 | 1,215 | 87 | 100 | 20 1/4 |
| | Marine | 6 | {oval 11 1/2, 9 1/2} | 9 5/6 | 9/16 | 2 | 37 1/2 | 3/8 | 7 | 138 | 7 | 3 | 42 | 11 1/2 | 6 1/6 | 37 1/2 | ...... | ...... | 100 | 28 |
| | Furnace Flue, Tubular | 4 | 102 | 20 | 3/8 | 2 | 42 | 5/8 | 7 1/2 | 90 | 10 | 4 | ...... | ...... | 6 1/7 | 42 | 1,116 | 80 | 100 | 25 |
| New Roxborough Aux | Furnace Flue | 4 | 102 | 20 | 5/8 | 2 | 42 | 3/8 | 7 1/2 | 90 | 10 | 4 | ...... | ...... | 6 1/6 | 42 | 1,116 | 80 | 125 | 20 |
| Mount Airy | Tubular | 3 | 48 | 10 | 5/16 | ...... | ...... | ...... | ...... | 48 | 10 | 3 | {1 dome ......} | ...... | 4 | 16 2/3 | 475 | 33 | 50 | 7 9/16 |
| | Scotch Boiler | 1 | 6 | 10 | 5/8 | 1 | 36 | 3/8 | 74 | 38 | 7.6 | 3 | ...... | ...... | 5 | 1 | 293 | 25 | 50 | 1 1/2 |
| | | | Connecte | d by 1 | drum | in | the | flue | and 1 | on top | | | | | | | | | | |
| Chestnut Hill | Cylinder | 2 | 30 | 30 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 30 | 7 1/2 | 5 | 13 3/4 | 175 | 16 1/2 | | |
| | Tubular | 1 | 48 | 14 | 5/16 | ...... | ...... | ...... | ...... | 44 | 14 | 3 | 24 | 21 | 5 | 22 1/2 | ...... | 44 | | |
| Frankford | Marine, Steel | 12 | 138 | 10 5/6 | {15/16, 3/4} | Fo 2 | x corr 43 | uga 3/8 | ted. 8 | 188 | 8 | 3 | 42 | 12 1/2 | ...... | 42 | 1,551 | 113 | {150 100} | {38 33} |

# APPENDIX C.

## REPORT

OF

## Assistant in Charge of Distribution.

BUREAU OF WATER.

*Philadelphia, January 13, 1897.*

MR. JOHN C. TRAUTWINE, JR.,
Chief of Bureau of Water.

DEAR SIR:—I have the honor to submit the following report, for the year 1896, on work done in connection with the Distribution System.

During the past year but little addition has been made to the supply and pumping mains, but the lack of the usual extensions in this respect has been less severely felt than it would have been if the Queen Lane pumping station and reservoir had not been in continuous operation. These works have greatly relieved the demands upon several districts which formerly contributed to the supply of what is now the Queen Lane system of distribution, and owing to this relief, the pumpage throughout the year has been equal to the demand. The height of the water in the older reservoirs has been maintained at nearly the maximum levels, and the supply, in consequence, has been generally better than for a number of years past.

The particular localities where an improvement in the water supply has been made during the past year, are, with few exceptions, entirely in connection with the new Queen Lane system.

*Queen Lane Supply.*

On the 4th of January, 1896, the 48-inch supply main (No. 1) was filled from Queen Lane reservoir to Thirty-third and Master streets, for the purpose of supplying the district hitherto served by direct pumpage from the Spring Garden Station. The full supply was turned on by 6.30 P. M., and all the engines, that previously supplied this district, were shut down or used for pumping to East Park reservoir.

The pressure at the Fourth District office increased from 23 to 38 pounds, but at 10.30 P. M. it fell to 10 pounds, which, upon investigation, was found to be caused by slush ice, which choked the gratings at the outlet from the reservoir. The ice was removed and the supply continued until 1 P. M. next day, when the main broke and the water from the reservoir was then shut off. The repairs to the main were completed on January 11, and water was let in, this time without supplying the district, for the purpose of testing the main, and it so remained until the 15th of January, when the pipe again broke. The repairs were made and water turned in on January 21, 1896, since which time the main has remained intact.

On the 29th of January the Queen Lane water was let into a portion of the Tioga district, increasing the pressure there from 21 to 31 pounds. On February 3d this district was extended, with good results, so as to include the area bounded by Sixteenth and Twenty-second streets, Westmoreland street and Pulaski and Hunting Park avenues.

On February 25, Nos. 1 and 2 of the forty-eight inch mains from the Queen Lane Reservoir to Twenty-ninth and Cumberland streets, were put into service to supply all of that portion of the direct pumpage district east of Seventeenth street and as far south as Berks street, thence west to Twenty-second street, to Columbia avenue, to Twenty-sixth street, to Jefferson street, to Pennsylvania Railroad.

On February 27, the supply from Queen Lane reservoir was extended from the 48-inch main (No. 1) in Thirty-third street through the 12-inch main in Ridge avenue to Indian Queen Lane. Previous to this time, Ridge avenue, from Thirty-third street to Indian Queen lane, was supplied from Roxborough, and there were many complaints from the higher levels of the Twenty-first Ward, of scarcity of water. The pressures now are ample and there is no cause for complaint.

The daily consumption of water from the Queen Lane reservoir, at this date, was about 12,000,000 gallons.

On March 13th the district was extended southward to Jefferson street, and eastward to Ninth street.

The daily consumption in the new section was 17,000,000 gallons, making a total daily supply of about 29,000,000 gallons for the entire district supplied from the Queen Lane Reservoir.

This extension gave great relief, particularly in the neighborhood of Broad and Berks streets, and indicated that when the second pumping main between the pumping station and the reservoir, and the mains which comprise the Queen Lane distribution system, are laid, satisfactory pressure from the reservoir can be maintained throughout what has heretofore been the "direct pumpage district."

The Queen Lane system was also extended to the territory above Lehigh avenue, between Germantown avenue and Sixth street, and as far north as Cambria street, and as a result the supply of this district has been greatly improved. By thus reducing the draught on the 30-inch supply main in Sixth street, which formerly supplied this section, a corresponding improvement was made east of Sixth street. This supply, however, is still by no means what it should be, and it is highly necessary to improve it further in order to give this section a better domestic supply, as well as a much needed and efficient fire service.

There is also urgent need of additional supply mains for the Twelfth, Thirteenth and Fourteenth Wards, where the supply is deficient for both domestic and fire purposes. The same may be said of the old City, between Vine and South streets, and to some extent of the territory below South streets, and of West Philadelphia and Chestnut Hill.

### *Mains.*

A 20-inch supply main was laid in Germantown avenue to connect the dead end, north of Allen's lane, with the one south of Abington street. This main is intended to supply the high level in the northeastern part of Germantown, and will be used for this purpose during the coming summer.

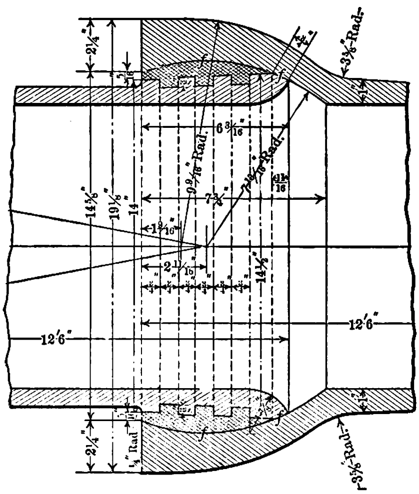
A 12-inch service main and a 20-inch supply main were laid in Oxford pike (Old Second street), from Wentz Farm reservoir grounds to 43 feet northeast of Levick street, for the purpose of supplying Lawndale. These mains are eventually to be continued to Fox Chase and Bustleton, but the relatively low head obtained from the Wentz Farm reservoir is inadequate for either domestic or fire purposes, and a supplementary pumping station and stand pipe are needed to meet the requirements of this section.

The 48-inch supply main from Queen Lane reservoir to Broad and Dauphin streets was extended 5,143 feet, making the total length now laid 11,682 feet; 5,500 feet more will be necessary to complete the line.

The four twenty-million gallon engines at the Queen Lane works have been connected to No. 1 pumping main, and the arrangement is such that any one or two of the engines can pump through this main to the reservoir. No. 2 main, when laid, will be connected in the same manner, and it will then be possible to use all four of the pumps simultaneously. It is important that this main should be laid as soon as possible, as it is needed not only to supply the direct pumpage district, but also as an additional reliance in case of accident.

Connection has been made, in front of the Shawmont works, north of the Reading Railroad, between the 20-inch and 30-inch pumping mains, to pump with No. 3 engine through the 20-inch main, while No. 1, the new 12,000,000 gallons Southwark engine pumps through the 30-inch main. Having but two mains for three engines, it is necessary for one of the pumps to remain idle. An additional main for No. 1 is therefore highly necessary, not only for use in case either of the present mains should break, but also for economy of fuel, and for prevention of wear and tear to machinery due to friction when pumping at a high velocity through such small mains.

An old draw bridge which crossed Frankford creek at Bridge street has been removed, and abutments for a new bridge have been constructed by the Bureau of Surveys. This necessitated the removal of the 12-inch submerged pipe laid in 1886, and the laying of a new main above the line of the new structure. Before removing the old pipe, two lines of 6-inch wrought iron pipe were laid, for temporary use, below the bridge. After the construction of the abutments and the turntable for the new bridge, a 12-inch flexible-joint pipe was laid on the up-stream side, passing through a 20-inch sleeve at low water line in the north abutment, and along the west side of the south abutment. The method of laying was to draw the pipe across the stream by means of a windlass, as each length was added on the opposite side. The pipes were of the bead and bell pattern, the bells being spherical and turned true on the inside. The joint, designed in this Bureau, is shown in the accompanying figure. The bead ends of the pipe were cast with three grooves on the outer circumference that lay within the bells when the pipes were joined together. The joints were cast in the usual manner except with the addition of about 3 per cent. of bismuth to prevent the shrinkage of the lead joints when cooling.




The intake at the Queen Lane pumping station has been completed, and the two 48-inch suction pipes for Nos. 3 and 4 engines, have been laid. In my report for 1895, I stated, in reference to suction mains Nos. 1 and 2, that "owing to defective caulking the leakage was excessive, "and it became necessary to uncover the pipes in order "to have them repaired." Notwithstanding the care taken to make the joints perfectly tight, the results are found to be unsatisfactory, as there is evidently more or less leakage of air into the pipes, and this it is apparently impossible to prevent. The leakage, however, is not as great as it was previous to the recaulking. A special effort was made to have the joints on No. 4 secure, and it was tested by the following method: a gum ring, $\frac{1}{8}$-inch thick and 18 inches wide, was placed over a joint within the pipe, and expanded at the outer edges with steel expansion bands, to make the ring air-tight at each end. A vacuum pump was attached to a tube opening into the gum ring directly over the point where the bead end of the pipe abuts against the seat of the bell of the adjoining pipe. The air between the gum ring and the pipe was then exhausted, and if a vacuum of from 15 to 20 inches could be obtained and held for a considerable time, the joint was considered to be tight; otherwise it was uncovered from the outside and re-caulked and tested until the vacuum held steadily. Each joint was examined in this manner and yet upon testing the whole line the highest vacuum which could be obtained was 17 inches, which fell, in twenty-four hours, to 5 inches.

### *Purveyor's Districts.*

The water distribution throughout the City is divided into several systems, the boundaries of which are determined, in a great measure, by the relative elevation of the reservoirs from which they are supplied.

To facilitate the care and maintenance of these systems, aggregating 1,212 miles of pipes, 10,624 "five hydrants," 20,500 "stop valves," and fully 500,000 "appliances," for using water, the entire City is divided into six districts, each district being in charge of a "purveyor."

The duties of the purveyors cover every detail relating to the construction, repair and management of the work in their respective districts.

The present arrangement of the districts is as follows. They include, practically, the same area as when they were established, in 1867, and include the following wards :

| Districts. | Wards. | Area. Square Miles. | Population. |
|---|---|---|---|
| First................ | 1st, 2d, 3d, 4th, 26th, 30th and 36th..... | 14,371 | 260,621 |
| Second.............. | 5th, 6th, 7th, 8th, 9th, 10th, 24th, 27th and 34th.................................... | 23,680 | 257,164 |
| Third.............. | 11th, 12th, 16th, 17th, 18th, 19th, 23d, 25th, 31st, part of 33d and 35th...... | 53,282 | 354,064 |
| Fourth............. | 13th, 14th, 15th, 20th, part of 28th, 29th, 32d and 37th....................... | 7,522 | 346,6)0 |
| Fifth................ | 21st and part of 28th......................... | 8,629 | 36,867 |
| Sixth................ | 22d, part of 28th and 33d.................. | 21,904 | 69,335 |
| Total......... | ........................................................ | 129,388 | 1,324,741 |

In regard to the Second District, I stated, in my report of 1895, as follows :

"A suitable meter shop is urgently needed. At present "the office and repair shop for this branch of the service "is at 918 Cherry street, which is also the headquarters "for the Second Purveyor's District. The apparatus for "testing the meters is at Spring Garden Pumping Station, "three miles distant, and various materials are stored at "the South street yard, equally inaccessible from the office. "This conditon of affairs is annoying as well as expensive, "and I would earnestly recommend that a meter shop be "constructed at Fairmount, on the site of the one destroy-"ed by fire May 23, 1892, as this location is the most "central and the conveniences for obtaining water and the "conditions necessary for properly testing meters are better "than elsewhere."

In this connection it may be further said that the work pertaining to the Second Purveyor's District is greatly hindered by the overcrowded condition of the yard, etc., and not only should the meter force, now quartered there, be withdrawn, but an addition should be made to property now occupied. Such an addition could now be made to good advantage by the purchase of properties Nos. 922 and 924

Cherry street, which have been offered for sale to the Bureau. A yard entrance and exit could then be provided, and the confusion and delay consequent upon the massing of wagons in the present limited quarters could thus be avoided. It is especially urgent that the storage facilities of this district should be increased, inasmuch as we shall soon be deprived of the South street yard, the ground having been donated by the City to the University of Pennsylvania.

Storage yards are needed also in the Third, Fourth, Fifth and Sixth Districts, and they should be provided immediately, while suitable sites are yet available for the purpose.

### *Reading Subway.*

A conference was held on August 26, with George S. Webster, Chief Engineer of the Bureau of Surveys, to consider the alterations which would be made necessary by the construction of the Pennsylvania Avenue Subway.

At this meeting it was decided that all pipes crossing Pennsylvania avenue, between and including those in Thirteenth and Twenty-second streets should be deflected so as to pass below the tracks of the subway, and that all pipes west of Twenty-second street should pass over the tunnel to be constructed at this end of the line.

To facilitate the construction of the subway it has been decided to lower immediately all pipes which are eventually to pass below the tracks, and to support the balance upon trestles. This work is progressing and we hope to have it accomplished during the early part of the current year.

### *Machines for Tapping Large Mains.*

The five tapping machines purchased last year have been frequently used for making connections to mains in localities where turning off the water would have seriously affected the operations of numerous industrial establishments. The machines were used also for tapping supply mains which otherwise would have had to be emptied, seriously interfering with the supply of large districts.

The desirability of being able to make connections while the mains are under pressure has been fully demonstrated, and additional machines for making 30, 36 and 48-inch connections should be purchased.

The following is a list of connections made with these machines during 1896 :

| | Inches. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size of main | 12 | 6 | 20 | 6 | 10 | 12 | 30 | 48 | 30 | 30 | 20 | 30 | 36 | 48 | 30 | Total. |
| Size of tap | 3 | 4 | 4 | 6 | 6 | 6 | 6 | 6 | 8 | 10 | 12 | 12 | 12 | 12 | 16 | |
| District. | Number. | | | | | | | | | | | | | | | |
| Second | 1 | 3 | ..... | 6 | 1 | 1 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 12 |
| Third | ..... | ..... | 1 | ..... | ..... | ..... | 5 | ..... | 1 | 2 | 1 | 2 | 1 | ..... | 2 | 15 |
| Fourth | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2 | ..... | 2 |
| Fifth | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 2 |
| Total | 1 | 3 | 1 | 6 | 1 | 1 | 5 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 31 |

## *Water-waste.*

An examination was made with the Deacon waste-water meter in Forty-second street, between Westminster avenue and Mantua avenue, and in Pennsgrove street, between Forty-second and Forty-third streets, in order to ascertain the quantity of water used and wasted. The results show a daily consumption of 244 gallons per capita; of these, 244 gallons, 179 were wasted.

The following comparative table of appliances, etc., affecting this inspection, is submitted in order to show that in this instance the consumption per capita was relatively greater in the smaller houses. These results are in line with inspections previously made in other localities, and indicate that any effective system for the restriction of the waste of water must include all consumers.

| | Forty-second street. | Pennsgrove street. |
|---|---|---|
| Number of houses | 39 | 46 |
| Stories | 3 | 2 |
| Population | 179 | 186 |
| Total consumption (per house, 24 hours) | 960 gallons | 1,124 gallons |
| Total consumption (per capita) | 209 " | 278 " |
| Wasted (per capita) | 163 " | 194 " |
| Quantity used (per capita) | 46 " | 84 " |
| Appliances. | | |
| Hydrants | 39 | 46 |
| Screw nozzles | 15 | |
| Sinks in kitchens | 39 | 46 |
| Wash paves | 39 | 4 |
| Wash tubs | 3 | |
| Water closets | 78 | 51 |
| Baths | 39 | 46 |
| Basins | 39 | 3 |
| Hydrants leaking | | 1 |
| Basins leaking | 2 | |
| Water closets leaking | 6 | 3 |
| Water closets, constant flow | 14 | 8 |

## *Meters.*

The destruction of our meter records by fire, in 1892, when valuable data relative to tests and to the merits of meters were lost, necessitates a repetition of most of our work in this direction. Accordingly, a series of tests of mechanical meters have been begun. They are unfinished as yet, but will be continued and completed during the present year.

For the purpose of making such tests, meters were kindly loaned the Bureau by the following named manufacturers:

| Manufacturer. | Style of Meter. | Size in Inches. | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ½ | ¾ | 1 | 1½ | 2 | 3 | 4 | 6 | |
| National Meter Company, 298 Broadway, N. Y. | Nash | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 |
| | Crown | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 |
| | Empire | 1 | 1 | 1 | ...... | ...... | ...... | ...... | ...... | 3 |
| | Gem | ...... | ...... | ...... | ...... | 1 | 1 | 1 | 1 | 4 |
| Union Meter Company, Worcester, Mass. | Union | 1 | 1 | 1 | 1 | 1 | 1 | 1 | ...... | 7 |
| Hersey Meter Company, S. Boston, Mass. | Torrent | ...... | ...... | ...... | ...... | ...... | 1 | ...... | ...... | 1 |
| | Hersay | ...... | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7 |
| Neptune Meter Company, 253 Broadway, N. Y. | Trident | ...... | 1 | 1 | ...... | 1 | ...... | ...... | ...... | 3 |
| Thompson Meter Company 79 Washington st., Brooklyn, N. Y. | Thompson | ...... | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7 |
| | Lambert | ...... | ...... | ...... | ...... | 1 | 1 | ...... | ...... | 2 |
| Totals | | 4 | 7 | 7 | 5 | 8 | 8 | 6 | 5 | 50 |

The initial tests, to ascertain the accuracy of the registration, have been completed, and a trial for durability is now in progress.

A comparison of these meters with those of the Venturi class is also being made, and for this purpose the supply of Chestnut Hill is first discharged through a 12-inch Venturi meter and then through a number of the mechanical meters. For a similar purpose a 20-inch Venturi meter is connected to the supply main leading from the old Roxborough reservoir to Manayunk.

This work has not yet continued sufficiently long to determine fully the relative merits of the two classes of meters.

Such tests can, of course, show only the relation between the Venturi reading and that of the group of mechanical meters, taken as a unit, and can throw no light upon the performance of the individual mechanical meters.

A 48-inch Venturi meter has been placed on the Frankford pumping main, discharging at the reservoir over a weir.

The discharge indicated by the registering apparatus of this Venturi meter and that deduced from measurements of the difference between the head in the main and that in the throat of the Venturi, as indicated by the column of mercury in a U tube, were compared with that shown by the depth on a measuring weir, erected over the reservoir. The results of five such comparisons are given below:

| | Discharge, Gallons Per 24 Hours. | Error of Venturi Meter as Compared with Weir, Per Cent. |
|---|---|---|
| Weir | 11,066,115 | |
| Venturi Meter: | | |
| By register | 10,577,563 | −4.41 |
| By mercury column | 11,354,353 | +2.60 |
| Weir | 13,839,269 | |
| Venturi Meter: | | |
| By register | 13,575 590 | −1.91 |
| By mercury column | 14,088,083 | +1.79 |
| Weir | 15,707,533 | |
| Venturi Meter: | | |
| By register | 15,569,770 | −0.88 |
| By mercury column | 16,046,826 | +2.16 |
| Weir | 18,107,895 | |
| Venturi Meter: | | |
| By register | 18,111,773 | −0.02 |
| By mercury column | 18,595,292 | +2.69 |
| Weir | 20,468,834 | |
| Venturi Meter: | | |
| By register | 20,475,943 | +0.03 |
| By mercury column | 21,018,704 | +2.68 |

The registering apparatus, used in these tests, was driven by electricity, but experience shows that the electric register does not always record correctly, and it is believed that a more eligible registration will be obtained from a mechanically driven register, which has been installed in its place, and which will be tested as soon as possible. The clock work of this register is actuated by a weight.

During the past year 72 additional meters were set, making a total of 1,320 now in service. This number forcibly represents the meagre proportions of our meter service, and the effect of such a limited use of the meter may be as fully represented by the extent of our daily average consumption, 239.6 million gallons, which is greatly in excess of the supply of any city where any pretence is made to restrict the waste of water.

The consumption, per capita, which, in 1896, reached 172.2 gallons per day, is exceeded by that of but few large cities, and is very much greater than that of either New York or Boston.

### *Mains.*

The following is a statement of mains laid, relaid, taken up, etc.:

#### *New Work.*

| | |
|---|---|
| Service mains laid | 158,496 feet |
| Supply mains laid | 20,395 feet |
| Pumping mains laid | 1,151 feet |
| Connections, etc | 16,797 feet |
| Total | 196,839 feet |

#### *Repairs.*

| | | |
|---|---|---|
| Mains relaid | 71,189 feet | |
| Repairs and connections | 5,864 feet | |
| Total | | 77,053 feet |
| Old pipes taken up | 60,586 feet | |
| Pipes lowered, raised and shifted | 6,759 feet | |
| Total | | 67,345 feet |
| Total | | 144,398 feet |

### *Abandoned.*

| | |
|---|---|
| Three-inch | 1,737 feet |
| Four-inch | 8,612 feet |
| Six-inch | 951 feet |
| Twelve-inch | 621 feet |
| Total | 14,172 |

The total quantity of pipe handled for all purposes throughout the year was 341,237 feet, weighing 18,562,636 pounds.

The total quatity of new pipe laid was 196,839 feet, or 37.28 miles, making, in addition to that previously laid, 1,212.1 miles now in use.

### *Fire Hydrants.*

| | |
|---|---|
| New style fire hydrants in new locations | 732 |
| Old style fire hydrants in new locations | 1 |
| New style fire hydrants in place of old style | 384 |
| Old style fire hydrants in place of others of the old style | 6 |
| Total | 1,123 |

| | |
|---|---|
| New style fire hydrants taken out | 54 |
| Old style fire hydrants taken out | 93 |
| Total | 147 |

The total number of new style fire hydrants added to the distribution system was 586, and the total number in use December 31, 1896, was 10,624, of which, 1,230 are of the old style, and 9,394, or 88.4 per cent. are of the new pattern.

### *Drills for Attachment.*

The following new attachments were made to the mains:

| | | |
|---|---|---|
| ½-inch | 7,030; area of openings | 1,380 square inches |
| ⅝-inch | 542; area of openings | 163 square inches |
| ¾-inch | 98; area of openings | 43 square inches |
| 1-inch | 98; area of openings | 77 square inches |
| 1½-inch | 32; area of openings | 57 square inches |
| 2-inch | 45; area of openings | 141 square inches |
| 3-inch | 2; area of openings | 14 square inches |
| 4-inch | 11; area of openings | 138 square inches |
| 6-inch | 2; area of openings | 57 square inches |
| Total | 7,860; area of openings | 2,070 square inches |

The following attachments, including the ferrules, service pipes and curb stops were put in from the street mains to the curbs, by employees of this Bureau, in order to provide for possible future services without breaking of street pavements :

| | |
|---|---|
| ½-inch | 2,272 |
| ⅝-inch | 109 |
| 1-inch | 1 |
| Total | 2,382 |

Captain Theodore S. S. Baker, Chief Pipe Inspector, reports that with the aid of two assistants, he has inspected cast iron water pipes and special castings at the following named foundries :

Donaldson Iron Co., Emaus, Pa.
Reading Foundry Co., Reading, Pa.
Gray's Ferry Foundry and Boiler Co., Philadelphia.

The quantity of castings inspected, rejected, cancelled, and accepted, including a large number for private parties to whom the Director of the Department of Public Works gave permission to purchase and lay pipes, subject to such inspection, are shown in the following table :

*Schedule of Pipe and Special Castings Inspected, Rejected and Accepted during the Year 1896.*

| | Manufacturer. | Size—Inches. Pipe. | Size—Inches. Special Castings. | Ordered. | Inspected. | Rejected. | Cancelled. | Accepted. |
|---|---|---|---|---|---|---|---|---|
| Bureau of Water. | Donaldson Iron Company, Emaus, Pa........ | 6 | ............... | 14,800 | 17,715 | 2,915 | ......... | 14,800 |
| | | 8 | ............... | 200 | 286 | 86 | ........ | 200 |
| | | 10 | ............... | 200 | 213 | 13 | ......... | 200 |
| | | 12 | ............... | 625 | 683 | 58 | ......... | 625 |
| | | 16 | ............... | 607 | 720 | 113 | ......... | 607 |
| | | 20 | ............... | 600 | 647 | 47 | ......... | 600 |
| | Reading Foundry Co., Ltd., Reading, Pa....... | ...... | 3 to 18 | 5,882 | 6,878 | 838 | 158 | 5,724 |
| | | ...... | 20 to 48 | 400 | 455 | 43 | 24 | 388 |
| | Total ........................ | ...... | ............... | 23,314 | 27,597 | 4,113 | 182 | 23,144 |
| *Private. | Donaldson Iron Company, Emaus, Pa........ | 4 | ............... | 30 | 33 | 3 | ......... | 30 |
| | | 6 | ............... | 169 | 171 | 2 | ......... | 169 |
| | Reading Foundry Co., Ltd., Reading, Pa.......... | ...... | 3 to 18 | 3 | 3 | ............ | ......... | 3 |
| | Total ........................ | ...... | ............... | 202 | 207 | 5 | ......... | 202 |
| | Grand Total.................... | ...... | ............... | 23,516 | 27,804 | 4,118 | 182 | 23,346 |

*Pipe inspected for builders and property owners under ordinance of Councils dated June 19, 1890.

Tabulations of work performed and expenditures made are submitted herewith.

Yours very respectfully,

ALLEN J. FULLER,

*Assistant in Charge of Distributian.*

# SERVICE AND SUPPLY MAINS LAID DURING 1896.

## First District.

*Comprising the First, Second, Third, Fourth, Twenty-sixth, Thirtieth and Thirty-sixth Wards.*

| Purposes for which used. | | Size in Inches. 3 | 4 | 6 | 8 | 10 | 12 | 16 | Total in feet and pounds. |
|---|---|---|---|---|---|---|---|---|---|
| New pipe or feet added. | Service mains | | | 11,282 | 1,383 | | 1,655 | | 14,320 |
| | Supply mains | | | | | | | 5,005 | 5,005 |
| | Supply main connections | | | | | 146 | | 10 | 156 |
| | Fire hydrant connections | | | 719 | | | | | 719 |
| | Total { Feet | | | 12,001 | 1,383 | 146 | 1,655 | 5,015 | 20,200 |
| | Total { Pounds | | | 396,033 | 58,086 | 8,030 | 119,160 | 551,650 | 1,132,959 |
| Pipe used but adding nothing to feet in ground. | Pipe relaid | | | 17,873 | 1,281 | | 1,632 | | 20,786 |
| | Repairs general | | | 489 | 3 | 8 | 4 | | 504 |
| | Pipe taken up | 1,025 | 18,156 | 856 | | | | | 20,037 |
| | Total { Feet | 1,025 | 18,156 | 19,218 | 1,284 | 8 | 1,636 | | 41,327 |
| | Total { Pounds | 15,375 | 344,964 | 634,194 | 53,928 | 440 | 117,792 | | 1,166,693 |
| Total handled... | Feet | 1,025 | 18,156 | 31,219 | 2,667 | 154 | 3,291 | 5,015 | 61,527 |
| | Pounds | 15,375 | 344,964 | 1,030,227 | 112,014 | 8,470 | 236,952 | 571,650 | 2,299,652 |
| Pipe cut off and abandoned | | 459 | 211 | 72 | | | | | 742 |

## SECOND DISTRICT,

*Comprising the Fifth, Sixth, Seventh, Eighth, Ninth, Tenth, Twenty-fourth, Twenty-seventh and Thirty-fourth Wards.*

| | Purposes for which used. | Size in Inches. 2 | 3 | 4 | 6 | 8 | 10 | 12 | 16 | 20 | 30 | 36 | Total in feet and pounds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New pipe or feet added. | Service mains | | | | 25,096 | 7,250 | 4,163 | 2,701 | | | | | 39,210 |
| | Supply mains | | | | | | | | | 48 | | | 48 |
| | Service main connections | | | | | 40 | | | | | | | 40 |
| | Supply main connections | | | | | | | | | 144 | | | 144 |
| | Meter inspection connections | | | | 16 | | | | | | | | 16 |
| | Service supply connections | | | 302 | | | | | | | | | 302 |
| | Fire hydrant connections | | | | 2,375 | | | | | | | | 2,375 |
| | Fire connection (private) | | 8 | 60 | 11 | | | | | | | | 79 |
| | Supply connection (private) | | 61 | 103 | 180 | | | | | | | | 344 |
| | Motor connections (private) | | 24 | | 25 | | | | | | | | 49 |
| | Drains | 11 | | | 664 | | | | | | | 5 | 680 |
| | Total { Feet | 11 | 93 | 465 | 28,367 | 7,290 | 4,163 | 2,701 | | 192 | | 5 | 43,287 |
| | Total { Pounds | 110 | 1,395 | 8,835 | 936,111 | 306,180 | 228,965 | 194,472 | | 30,528 | | 2,110 | 1,708,706 |
| Pipe used but adding nothing to feet in ground. | Pipe relaid | | | | 11,640 | | 1,787 | 423 | | | 26 | | 13,876 |
| | Repairs general | | 4 | 31 | 584 | 86 | 63 | 37 | | 13 | | | 818 |
| | Pipe taken up | 138 | 8,824 | 2,286 | 462 | | | 1,699 | 45 | 22 | | | 13,476 |
| | Pipe raised | | | | | | | | | 144 | | 340 | 484 |
| | Pipe shifted | | | | 173 | | | | | | | | 173 |
| | Total { Feet | 138 | 8,828 | 2,317 | 12,859 | 86 | 1,850 | 2,159 | 45 | 179 | 26 | 340 | 28,827 |
| | Total { Pounds | 1,380 | 132,420 | 44,023 | 424,347 | 3,612 | 101,750 | 155,448 | 4,950 | 28,461 | 8,632 | 143,480 | 1,048,503 |
| Total handled | Feet | 149 | 8,921 | 2,782 | 41,226 | 7,376 | 6,013 | 4,860 | 45 | 371 | 26 | 345 | 72,114 |
| Total handled | Pounds | 1,490 | 133,815 | 52,858 | 1,360,458 | 309,792 | 330,715 | 349,920 | 4,950 | 58,989 | 8,632 | 145,590 | 2,757,209 |
| Pipe cut off and abandoned | | | 1,815 | 636 | 266 | | | 621 | | | | | 3,338 |

# THIRD DISTRICT.

*Comprising the Elevenih, Twelfth, Sixteenth, Seventeenth, Eighteenth Nineteenth, Twenty-third, Twenty-fifth, Thirty-fifth and part of Thirty-third Wards.*

| Purposes for which used. | | Sizes in Inches. | | | | | | | | | | Total in feet and pounds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3 | 4 | 6 | 8 | 10 | 12 | 16 | 20 | 30 | 48 | |
| New pipe or feet added. | Service mains | ........ | ........ | 24.049 | 1,124 | 3,731 | 5,085 | 2,647 | ........ | ........ | ........ | 36,636 |
| | Supply mains | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 1,560 | ........ | ........ | 1,560 |
| | Service main connections | ........ | ........ | 35 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 35 |
| | Pumping main donnections | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 14 | ........ | 14 |
| | Bye-pass connections | ........ | ........ | ........ | 18 | 75 | 98 | 37 | ........ | ........ | ........ | 228 |
| | Service supply connections | ........ | 262 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 262 |
| | Fire hydrant connections | ........ | ........ | 2,694 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 2,694 |
| | Fire connections (private) | ........ | 34 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 34 |
| | Supply conneciions (private) | 14 | 40 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 54 |
| | Total { Feet | 14 | 336 | 26,778 | 1,142 | 3,806 | 5,183 | 2,684 | 1,560 | 14 | ........ | 41,517 |
| | Total { Pounds | 210 | 6,[illegible]84 | 883,674 | 47,964 | 209,330 | 373,176 | 295,240 | 248,040 | 4,648 | ........ | 2,068,666 |
| Pipe used but adding nothing to feet in ground. | Pipe relaid | ........ | ........ | 11,009 | ........ | ........ | 5,720 | ........ | ........ | ........ | ........ | 16,729 |
| | Repairs general | ........ | 9 | 2,347 | 12 | 111 | 17 | ........ | ........ | 23 | 94 | 2,613 |
| | Pipe taken up | 1,106 | 12,422 | 916 | 93 | 602 | 204 | ........ | ........ | ........ | ........ | 15,343 |
| | Pipe lowered | 56 | 12 | 1.089 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 1,157 |
| | Pipe raised | ........ | ........ | 2,168 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 2,168 |
| | Total { Feet | 1,162 | 12,443 | 17,529 | 105 | 713 | 5,941 | ........ | ........ | 23 | 94 | 38,010 |
| | Total { Pounds | 17,430 | 236,417 | 578,457 | 4,410 | 39,215 | 427,752 | ........ | ........ | 7,636 | 54,990 | 1,366,307 |
| Total handled { Feet | | 1,176 | 12,779 | 44,307 | 1,247 | 4,519 | 11,124 | 2,684 | 1,560 | 37 | 94 | 79,527 |
| Total handled { Pounds | | 17,640 | 24[illegible],801 | 1,462,131 | 52,374 | 248,545 | 800,928 | 295,240 | 248,040 | 12,284 | 54,990 | 3,434,973 |
| Pipe cut off and abandoned | | 420 | 1,120 | 179 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 1,719 |

## Fourth District.

*Comprising the Thirteenth, Fourteenth, Fifteenth, Twentieth, Twenty-ninth, Thirty-second, and part of the Twenty-eighth Wards.*

| | Purposes for which used. | Size in Inches: 3 | 4 | 6 | 8 | 10 | 12 | 20 | 36 | 48 | Total in feet and pounds. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| New pipe or feet added. | Service mains | ........ | ........ | 17,124 | 1,843 | 9,555 | 1,584 | ........ | ........ | ........ | 30,106 |
| | Supply mains | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 4,587 | 4,587 |
| | Service main connections | ........ | ........ | 120 | ........ | ........ | ........ | ........ | ........ | ........ | 120 |
| | Supply main connections | ........ | ........ | 20 | ........ | 223 | 74 | ........ | ........ | ........ | 317 |
| | Meter inspection connection | ........ | ........ | 40 | ........ | ........ | ........ | ........ | ........ | ........ | 40 |
| | Service supply connections | ........ | 759 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 759 |
| | Fire hydrant connections | ........ | ........ | 1,252 | ........ | ........ | ........ | ........ | ........ | ........ | 1,252 |
| | Fire connection (private) | ........ | ........ | 68 | ........ | ........ | ........ | ........ | ........ | ........ | 68 |
| | Snpply connection (private) | 366 | 30 | 312 | ........ | ........ | ........ | ........ | ........ | ........ | 708 |
| | Drains | ........ | ........ | 51 | ........ | ........ | ........ | ........ | ........ | ........ | 51 |
| | Total { Feet | 366 | 789 | 18,987 | 1,843 | 9,778 | 1,658 | ........ | ........ | 4,587 | 38,008 |
| | Total { Pounds | 5,490 | 14,991 | 626,571 | 77,406 | 537,790 | 119,3[illegible]6 | ........ | ........ | 2,683,395 | 4,065,0[illegible]9 |
| Pipe used, but adding nothing to feet in ground. | Pipe relaid | ........ | ........ | 10,367 | ........ | 356 | ........ | ........ | ........ | ........ | 10,723 |
| | Repairs general | 3 | 4 | 608 | 4 | 39 | 9 | 6 | 12 | 28 | 713 |
| | Pipe taken up | 392 | 9,787 | 358 | ........ | 36 | ........ | ........ | ........ | ........ | 10,573 |
| | Total { Feet | 395 | 9,791 | 11,333 | 4 | 431 | 9 | 6 | 12 | 28 | 22,009 |
| | Total { Pounds | 5,925 | 186,029 | 373,989 | 168 | 23,705 | 648 | 954 | 5,064 | 16,380 | 612,862 |
| Total handled | { Feet | 761 | 10,580 | 30,320 | 1,847 | 10,209 | 1,667 | 6 | 12 | 4,615 | 60,017 |
| | { Pounds | 11,415 | 201,020 | 1,000,560 | 77,574 | 561,495 | 120,024 | 954 | 5,064 | 2,699,775 | 4,677,881 |
| Pipe cut off and abandoned | | ........ | 34 | 244 | ........ | ........ | ........ | ........ | ........ | ........ | 278 |

# Fifth District.

*Comprising the Twenty-first and part of the Thirty-eighth Wards.*

| | Purposes for which used. | Size in Inches. 2 | 3 | 4 | 6 | 12 | 16 | 20 | 30 | 36 | 48 | Total in feet and pounds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New pipe or feet added. | Service mains | | | | 3,243 | 45 | | | | | | 3,288 |
| | Supply mains | | | | | | | | | | 641 | 641 |
| | Pumping mains | | | | | | | | | 528 | 623 | 1,151 |
| | Supply main connections | | | | 17 | | | | | | | 17 |
| | Pumping main connections | | | | | | | 28 | 15 | | 274 | 317 |
| | Bye-pass connections | | | | 36 | | | | | | | 36 |
| | Meter inspection connections | | | | | | 158 | 104 | | | | 262 |
| | Fire hydrant conneciions | | | | 180 | | | | | | | 180 |
| | Fire connections (private) | | | | 15 | | | | | | | 15 |
| | Supply connections (private) | | | | 111 | | | | | | | 111 |
| | Motor connections (private) | | 13 | | | | | | | | | 13 |
| | Drains | 306 | | 90 | 651 | 117 | | | | | | 1,164 |
| | Total Feet | 306 | 13 | 90 | 4,253 | 162 | 158 | 132 | 15 | 528 | 1,538 | 7,195 |
| | Total Pounds | 3,060 | 195 | 1,710 | 140,319 | 11,664 | 17,380 | 20,988 | 4,980 | 222,816 | 899,730 | 1,322,872 |
| Pipe used but adding nothing to feet in ground. | Pipe relaid | | | | 55 | | | | | | 360 | 415 |
| | Repairs general | | | 25 | 201 | 26 | | 76 | 43 | | 48 | 419 |
| | Pipe taken up | | | | | | 86 | 23 | | | 360 | 469 |
| | Pipe lowered | | 81 | 253 | 261 | | | | | | | 595 |
| | Pipe raised | | | 104 | | | | | | | | 104 |
| | Pipe shifted | | | | | | | | | | 700 | 700 |
| | Total Feet | | 81 | 382 | 517 | 26 | 86 | 99 | 43 | | 1,468 | 2,702 |
| | Total Pounds | | 1,215 | 7,258 | 17,061 | 1,872 | 9,46 | 15,741 | 14,276 | | 858,780 | 925,663 |
| | Total handled... Feet | 306 | 94 | 472 | 4,770 | 188 | 244 | 2 1 | 58 | 528 | 3,006 | 9,897 |
| | Total handled... Pounds | 3,060 | 1,410 | 8,968 | 157,410 | 13,536 | 26,840 | 36,729 | 19,256 | 222,816 | 1,758,510 | 2,248,535 |
| | Pipe cut off and abandoned | | | 12 | | | | | | | | 12 |

# SIXTH DISTRICT,

*Comprising the Twenty-second, and part of the Thirty-third, Thirty-seventh, and Thirty-eighth Wards.*

| Purposes for which used. | | Size in inches. 3 | 4 | 6 | 8 | 10 | 12 | 20 | 30 | Total in feet and pounds. |
|---|---|---|---|---|---|---|---|---|---|---|
| New pipe or feet added. | Service mains | ........ | ........ | 25,816 | 23 | 22 | 9,075 | ........ | ........ | 34,936 |
| | Supply mains | ........ | ........ | ........ | ........ | ........ | 4,025 | 4,529 | ........ | 8,554 |
| | Service main connections | ........ | ........ | 23 | ........ | ........ | ........ | ........ | ........ | 23 |
| | Supply main connections | ........ | ........ | ........ | ........ | 151 | 113 | ........ | ........ | 264 |
| | Bye-pass connections | ........ | ........ | 71 | ........ | ........ | 68 | ........ | ........ | 139 |
| | Meter inspection connections | ........ | ........ | ........ | ........ | ........ | 92 | ........ | ........ | 92 |
| | Service supply connections | ........ | 636 | ........ | ........ | ........ | ........ | ........ | ........ | 636 |
| | Fire hydrant connections | ........ | ........ | 1,826 | ........ | ........ | ........ | ........ | ........ | 1,826 |
| | Trolley sprinkling connections | ........ | ........ | ........ | ........ | 100 | ........ | ........ | ........ | 100 |
| | Supply connections (private) | 48 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 48 |
| | Motor connections (private) | 14 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 14 |
| | Total { Feet | 62 | 636 | 27,736 | 23 | 273 | 13,373 | 4,529 | ........ | 46,632 |
| | Total { Pounds | 930 | 12,084 | 915,288 | 966 | 15,015 | 962,856 | 720,111 | ........ | 2,627,250 |
| Pipe used but adding nothing to feet in ground. | Pipe relaid | ........ | ........ | 2,186 | 3,148 | 2,927 | 399 | ........ | ........ | 8,660 |
| | Repairs, general | ........ | 20 | 512 | 9 | 91 | 124 | 12 | 29 | 797 |
| | Pipe taken up | ........ | 289 | 345 | ........ | 54 | ........ | ........ | ........ | 688 |
| | Pipe lowered | ........ | 25 | 969 | ........ | ........ | 384 | ........ | ........ | 1,378 |
| | Total { Feet | ........ | 334 | 4,012 | 3,157 | 3,072 | 907 | 12 | 29 | 11,523 |
| | Total { Pounds | ........ | 6,346 | 132,396 | 132,594 | 168,960 | 65,304 | 1,908 | 9,628 | 517,136 |
| Total handled { Feet | | 62 | 970 | 31,748 | 3,180 | 3,345 | 14,280 | 4,541 | 29 | 58,155 |
| Total handled { Pounds | | 930 | 18,430 | 1,047,684 | 133,560 | 183,975 | 1,028,160 | 722,019 | 9,628 | 3,144,386 |
| Pipe cut off and abandoned | | 1,294 | 6,599 | 190 | ........ | ........ | ........ | ........ | ........ | 8,083 |

## *Recapitulation of Work on Water Pipes.*

| | Purposes for which used. | Size in Inches. 2 | 3 | 4 | 6 | 8 | 10 | 12 | 16 | 20 | 30 | 36 | 48 | Total in feet and pounds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New pipe or feet used. | Service mains | ........ | ........ | ........ | 106,610 | 11 623 | 17,471 | 20,145 | 2,647 | ........ | ........ | ........ | ........ | 158,496 |
| | Supply mains | ........ | ........ | ........ | ........ | ........ | ........ | 4,025 | 5,005 | 6,137 | ........ | ........ | 5,228 | 20,395 |
| | Pumping mains | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 528 | 623 | 1,151 |
| | Service main connections | ........ | ........ | ........ | 178 | 40 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 218 |
| | Supply main connections | ........ | ........ | ........ | 37 | ........ | 520 | 187 | 10 | 144 | ........ | ........ | ........ | 898 |
| | Pumping main connections | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 28 | 29 | ........ | 274 | 331 |
| | Bye-pass connections | ........ | ........ | ........ | 107 | 18 | 75 | 166 | 37 | ........ | ........ | ........ | ........ | 403 |
| | Meter inspection connections | ........ | ........ | ........ | 56 | ........ | ........ | 92 | 158 | 104 | ........ | ........ | ........ | 410 |
| | Service supply connections | ........ | ........ | 1,959 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 1,959 |
| | Fire hydrant connections | ........ | ........ | ........ | 9,046 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 9,046 |
| | Fire connections (private) | ........ | 8 | 94 | 94 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 196 |
| | Supply connections (private) | ........ | 489 | 173 | 603 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 1,265 |
| | Motor connections (private) | ........ | 51 | ........ | 25 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 76 |
| | Trolley sprinkling connections | ........ | ........ | ........ | ........ | ........ | 100 | ........ | ........ | ........ | ........ | ........ | ........ | 100 |
| | Drains | 317 | ........ | 90 | 1,366 | ........ | ........ | 117 | ........ | ........ | ........ | 5 | ........ | 1,895 |
| | Total... Feet | 317 | 548 | 2,316 | 118,122 | 11,681 | 18,166 | 24,732 | 7,857 | 6,413 | 29 | 533 | 6,125 | 196,839 |
| | Total... Pounds | 3,170 | 8,220 | 41,004 | 3,898,026 | 490,602 | 999,130 | 1,708,704 | 864,270 | 1,019,667 | 9,628 | 224,926 | 3,583,125 | 12,925,472 |
| Pipe used, but adding nothing to feet in ground. | Pipe relaid | ........ | ........ | ........ | 53,130 | 4,429 | 5,070 | 8,174 | ........ | ........ | 26 | ........ | 360 | 71,189 |
| | Repairs, general | ........ | 7 | 89 | 4,741 | 114 | 312 | 217 | ........ | 107 | 95 | 12 | 170 | 5,864 |
| | Pipe taken up | 138 | 11,347 | 42,910 | 2,937 | 93 | 692 | 1,903 | 131 | 45 | ........ | ........ | 360 | 60,586 |
| | Pipe lowered | ........ | 137 | 290 | 2,319 | ........ | ........ | 384 | ........ | ........ | ........ | ........ | ........ | 3,130 |
| | Pipe raised | ........ | ........ | 104 | 2,168 | ........ | ........ | ........ | ........ | 144 | ........ | 340 | ........ | 2,756 |
| | Pipe shifted | ........ | ........ | ........ | 173 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 700 | 873 |
| | Total... Feet | 138 | 11,491 | 43,423 | 65,468 | 4,636 | 6,074 | 10,678 | 131 | 296 | 121 | 352 | 1,590 | 144,398 |
| | Total... Pounds | 1,380 | 172,365 | 825,037 | 2,160,444 | 194,712 | 334,070 | 768,816 | 14,410 | 47,064 | 40,172 | 148,544 | 930,150 | 5,637,164 |
| Total handled... | Feet | 455 | 12,039 | 45,739 | 183,590 | 16,317 | 24,240 | 35,410 | 7,988 | 6,709 | 150 | 885 | 7,715 | 341,237 |
| | Pounds | 4,550 | 180,585 | 869,041 | 6,058,470 | 685,314 | 1,333,200 | 2,549,520 | 878,680 | 1,066,731 | 49,800 | 373,470 | 4,513,275 | 18,562,636 |
| Pipe cut off and abandoned | | ........ | 3,988 | 8,612 | 951 | ........ | ........ | 621 | ........ | ........ | ........ | ........ | ........ | 14,172 |

## *Recapitulations by Districts.*

| Districts. | | Size in Inches. 2 | 3 | 4 | 6 | 8 | 10 | 12 | 16 | 20 | 30 | 36 | 48 | Feet. | Pounds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New pipe or feet added. | First | ...... | ...... | ...... | 12,001 | 1,383 | 146 | 1,655 | 5,015 | ...... | ...... | ...... | ...... | 20,200 | 1,132,959 |
| | Second | 11 | 93 | 465 | 28,367 | 7,290 | 4,163 | 2,701 | ...... | 192 | ...... | 5 | ...... | 43,287 | 1,708,706 |
| | Third | ...... | 14 | 336 | 26,778 | 1,142 | 3,806 | 5,188 | 2,684 | 1,560 | 14 | ...... | ...... | 41,517 | 2,068,666 |
| | Fourth | ...... | 366 | 789 | 18,987 | 1,843 | 9,778 | 1,658 | ...... | ...... | ...... | ...... | 4,587 | 38,008 | 4,065,019 |
| | Fifth | 306 | 13 | 90 | 4,253 | ...... | ...... | 162 | 158 | 132 | 15 | 528 | 1,538 | 7,195 | 1,322,872 |
| | Sixth | ...... | 62 | 636 | 27,736 | 23 | 273 | 13,373 | ...... | 4,529 | ...... | ...... | ...... | 46,632 | 2,627,250 |
| | Total.... Feet. | 317 | 548 | 2,316 | 118,122 | 11,681 | 18,166 | 24,732 | 7,857 | 6,413 | 29 | 533 | 6,125 | 196,839 | 12,925,472 |
| | Total.... Pounds. | 3,170 | 8,220 | 44,004 | 3,898,026 | 490,602 | 999,130 | 1,780,704 | 864,270 | 1,019,667 | 9,628 | 224,926 | 3,583,125 | | |
| Pipe used but adding nothing to feet in ground. | First | ...... | 1,025 | 18,156 | 19,218 | 1,284 | 8 | 1,636 | ...... | ...... | ...... | ...... | ...... | 41,327 | 1,166,693 |
| | Second | 138 | 8,828 | 2,317 | 12,859 | 86 | 1,850 | 2,159 | 45 | 179 | 26 | 340 | ...... | 28,827 | 1,048,503 |
| | Third | ...... | 1,162 | 12,443 | 17,529 | 105 | 713 | 5,941 | ...... | ...... | 23 | ...... | 94 | 38,010 | 1,366,807 |
| | Fourth | ...... | 395 | 9,791 | 11,333 | 4 | 431 | 9 | ...... | 6 | ...... | 12 | 28 | 22,009 | 612,862 |
| | Fifth | ...... | 81 | 382 | 517 | ...... | ...... | 26 | 86 | 99 | 43 | ...... | 1,468 | 2,702 | 925,663 |
| | Sixth | ...... | ...... | 334 | 4,012 | 3,157 | 3,072 | 907 | ...... | 12 | 29 | ...... | ...... | 11,523 | 517,136 |
| | Total.... Feet. | 138 | 11,491 | 43,423 | 65,468 | 4,636 | 6,074 | 10,678 | 131 | 296 | 121 | 352 | 1,590 | 144,398 | 5,637,164 |
| | Total.... Pounds. | 1,380 | 172,365 | 825,037 | 2,160,444 | 194,712 | 334,070 | 768,816 | 14,410 | 47,064 | 40,172 | 148,544 | 930,150 | | |
| Totai handled... | Feet | 455 | 12,039 | 45,739 | 183,590 | 16,317 | 24,240 | 35,410 | 7,988 | 6,709 | 150 | 885 | 7,715 | 341,237 | 18,562,636 |
| | Pounds | 4,550 | 180,585 | 869,041 | 6,058,470 | 685,314 | 1,333,200 | 2,549,520 | 878,680 | 1,066,731 | 49,800 | 373,470 | 4,513,275 | | |
| Pipe cut off and abandoned | | ...... | 3,988 | 8,612 | 951 | ...... | ...... | 621 | ...... | ...... | ...... | ...... | ...... | 14,172 | |

*Recapitulation of Fire Hydrants, Set, Renewed, and Removed.*

| | Districts. | Style. O. S. | No. 1. | No. 2. | No. 3. | Total. |
|---|---|---|---|---|---|---|
| Set. | First | ........ | 67 | 4 | ........ | 71 |
| | Second | ........ | 155 | 6 | ........ | 161 |
| | Third | 1 | 220 | 12 | ........ | 233 |
| | Fourth | ........ | 104 | 8 | ........ | 112 |
| | Fifth | ........ | 14 | ........ | ........ | 14 |
| | Sixth | ........ | 137 | 4 | 1 | 142 |
| | Total | 1 | 697 | 34 | 1 | 733 |
| Renewed. | First | ........ | 38 | ........ | ........ | 38 |
| | Second | 6 | 68 | 31 | 1 | 106 |
| | Third | ........ | 122 | 13 | ........ | 135 |
| | Fourth | ........ | 1 | 4 | ........ | 5 |
| | Fifth | ........ | 49 | ........ | ........ | 49 |
| | Sixth | ........ | 50 | 7 | ........ | 57 |
| | Total | 6 | 328 | 55 | 1 | 390 |
| | Total new hydrants | ........ | ........ | ........ | ........ | 1,123 |
| Removed. | First | 19 | 3 | 1 | 3 | 26 |
| | Second | 23 | 4 | 6 | 1 | 34 |
| | Third | 42 | 4 | 4 | 11 | 61 |
| | Fourth | 5 | 2 | 6 | 3 | 16 |
| | Fifth | 1 | ........ | ........ | ........ | 1 |
| | Sixth | 3 | 4 | ........ | 2 | 9 |
| | Total | 93 | 17 | 17 | 20 | 147 |
| | Total added during 1896 | ........ | ........ | ........ | ........ | 586 |

# *Fire Hydrants, by Wards.*

| Wards. | Style. | | | | | | Total. |
|---|---|---|---|---|---|---|---|
| | O. S. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | |
| First | 45 | 287 | 156 | 17 | ... | ... | 505 |
| Second | 13 | 96 | 86 | 16 | ... | ... | 211 |
| Third | 12 | 63 | 43 | 6 | ... | ... | 124 |
| Fourth | 5 | 60 | 32 | 14 | ... | ... | 111 |
| Fifth | 27 | 87 | 51 | 12 | ... | 1 | 178 |
| Sixth | 11 | 66 | 44 | 15 | ... | ... | 136 |
| Seventh | 16 | 96 | 82 | 10 | ... | 1 | 205 |
| Eighth | 20 | 90 | 100 | 6 | ... | 1 | 217 |
| Ninth | ... | 114 | 66 | 8 | ... | 2 | 190 |
| Tenth | 1 | 88 | 65 | 3 | ... | 4 | 161 |
| Eleventh | 14 | 57 | 29 | 1 | ... | ... | 101 |
| Twelfth | 8 | 47 | 31 | 6 | ... | ... | 92 |
| Thirteenth | 36 | 44 | 55 | 10 | ... | ... | 145 |
| Fourteenth | ... | 73 | 83 | ... | ... | ... | 156 |
| Fifteenth | 19 | 166 | 170 | 12 | 1 | 2 | 370 |
| Sixteenth | 4 | 59 | 41 | 4 | 1 | ... | 109 |
| Seventeenth | 15 | 73 | 30 | 2 | ... | ... | 120 |
| Eighteenth | 39 | 109 | 62 | 10 | ... | ... | 220 |
| Nineteenth | 49 | 214 | 120 | 9 | ... | ... | 392 |
| Twentieth | 37 | 106 | 123 | 2 | ... | ... | 268 |
| Twenty-first | 120 | 167 | 84 | 5 | ... | ... | 376 |
| Twenty-second | 200 | 542 | 229 | 61 | ... | ... | 1,032 |
| Twenty-third | 40 | 248 | 83 | 1 | ... | ... | 372 |
| Twenty-fourth | 99 | 181 | 127 | 19 | ... | ... | 426 |
| Twenty-fifth | 35 | 345 | 129 | 1 | ... | ... | 510 |
| Twenty-sixth | 18 | 157 | 121 | 15 | ... | ... | 311 |
| Twenty-seventh | 87 | 280 | 126 | 15 | ... | 1 | 509 |
| Twenty-eighth | 38 | 284 | 218 | 40 | ... | ... | 580 |
| Twenty-ninth | 43 | 147 | 166 | 20 | ... | 1 | 377 |
| Thirtieth | 12 | 99 | 111 | 6 | ... | ... | 228 |
| Thirty-first | 10 | 147 | 72 | 8 | ... | ... | 237 |
| Thirty-second | 20 | 96 | 85 | 12 | ... | 1 | 214 |
| Thirty-third | 45 | 291 | 183 | 25 | 1 | ... | 545 |
| Thirty-fourth | 46 | 241 | 69 | 21 | ... | 1 | 378 |
| Thirty-fifth | ... | 54 | 11 | 1 | ... | ... | 66 |
| Thirty-sixth | 35 | 135 | 98 | 31 | ... | ... | 299 |
| Thirty-seventh | 11 | 72 | 64 | 6 | ... | ... | 153 |
| Total | 1,230 | 5,481 | 3,445 | 450 | 3 | 15 | 10,624 |

## *Statement of the Number of Fire Hydrants by Districts and Wards during 1896 and total previous thereto.*

| | First District. | | | | | | | | Second District. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wards. | | | | | | | Total. | Wards. | | | | | | | | | Total. |
| | 1 | 2 | 3 | 4 | 26 | 30 | 36 | | 5 | 6 | 7 | 8 | 9 | 10 | 24 | 27 | 34 | |
| Prior to 1896 | ... | ... | ... | ... | ... | ... | ... | 1,785 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2,240 |
| During 1896 | 37 | 2 | 4 | ... | 9 | 7 | 12 | 71 | 5 | 2 | 10 | 8 | 7 | 14 | 27 | 39 | 49 | 161 |
| Total | ... | ... | ... | ... | ... | ... | ... | 1,856 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2,401 |
| Taken out, 1896 | 13 | 4 | 1 | 1 | 3 | 3 | 1 | 26 | 3 | 2 | 1 | ... | 1 | 1 | 8 | 9 | 9 | 34 |
| Total in City | ... | ... | ... | ... | ... | ... | ... | 1,830 | ... | ... | .. | ... | ... | ... | ... | ... | ... | 2,367 |

| | Third District. | | | | | | | | | | | | | Fourth District. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wards. | | | | | | | | | | | | Total. | Wards. | | | | | | | | Total. |
| | 11 | 12 | 16 | 17 | 18 | 19 | 22 | 23 | 25 | 31 | 33 | 35 | | 13 | 14 | 15 | 20 | 28 | 29 | 32 | 37 | |
| Prior to 1896 | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | 2,493 | ... | ... | ... | ... | ... | ... | ... | ... | 1,886 |
| During 1896 | 10 | 1 | 7 | 5 | 17 | 17 | 11 | 27 | 64 | 16 | 42 | 16 | 233 | 3 | 6 | 14 | 7 | 56 | 13 | 6 | 7 | 112 |
| Total | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | .. | ... | 2,726 | ... | ... | ... | .. | ... | ... | ... | ... | 1,998 |
| Taken out, 1896 | 2 | 1 | 1 | 1 | 5 | 6 | ... | 10 | 18 | 9 | 8 | ... | 61 | 1 | ... | 7 | 2 | 3 | ... | 2 | 1 | 16 |
| Total in City | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2,665 | ... | ... | ... | ... | ... | ... | ... | ... | 1,982 |

| | Fifth District. | | | Sixth District. | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | Wds | | Total. | Wards. | | | | Total. | |
| | 21 | 28 | | 22 | 28 | 33 | 37 | | |
| Prior to 1896 | ... | ... | 430 | ... | ... | ... | ... | 1,204 | 10,038 |
| During 1896 | 10 | 4 | 14 | 104 | 14 | 20 | 4 | 142 | 733 |
| Total | ... | ... | 444 | ... | ... | ... | ... | 1,346 | 10,771 |
| Taken out, 1896 | 1 | ... | 1 | 6 | 1 | 1 | 1 | 9 | 147 |
| Total in City | ... | ... | 443 | ... | ... | ... | ... | 1,337 | 10,624 |

**Number of attachments for fire purposes previously reported** ..................... 445

| | | |
|---|---|---|
| Made during 1896 | First District | ... |
| | Second District | 79 |
| | Third District | 34 |
| | Fourth District | 68 |
| | Fifth District | 15 |
| | Sixth District | ... |

**Total** ..................................................... 641

*Fire Hydrants by Purveyors' Districts.*

| Districts. | Style. | | | | | | Total. |
|---|---|---|---|---|---|---|---|
| | O. S. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | |
| **First** | 138 | 906 | 678 | 108 | ........... | ........... | 1,830 |
| **Second** | 300 | 1,243 | 701 | 112 | ........... | 11 | 2,367 |
| **Third** | 245 | 1,599 | 757 | 62 | 2 | ........... | 2,665 |
| **Fourth** | 177 | 826 | 896 | 78 | 1 | 4 | 1,982 |
| **Fifth** | 124 | 224 | 88 | 7 | ........... | ........... | 443 |
| **Sixth** | 246 | 683 | 325 | 83 | ........... | ........... | 1,337 |
| **Total** | 1,230 | 5,481 | 3,445 | 450 | 3 | 15 | 10,624 |

*Attachments, etc., made by the Purveyors in accordance with Permits issued by the Bureau of Water. Arranged by Districts.*

| DISTRICTS. | NEW ATTACHMENTS. | | | | | | | | | | SHUT OFF BY PERMIT. | | | | | | | WORK DONE BY PERMIT. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SIZE. | | | | | | | | | | | | | | REPAIRS. | | | DRAWN. | | | | | |
| | $\frac{1}{2}$ inch. | $\frac{5}{8}$ inch. | $\frac{3}{4}$ inch. | 1 inch. | $1\frac{1}{2}$ inch. | 2 inch. | 3 inch. | 4 inch. | 6 inch. | Total. | Reamed for larger attachments. | Redriven. | Discontinued. | Transfer. | Not drawn. | Drawn and re-driven. | Total. | Discontinued and abandoned. | Duplicate. | Delinquent. | Leak. | Total. | Driven and re-driven. |
| First | 1,298 | 24 | 12 | 13 | 3 | 2 | ...... | ...... | ...... | 1,352 | ......... | 38 | 31 | ...... | ...... | 49 | 118 | 13 | ...... | 8 | 80 | 101 | 19 |
| Second | 1,406 | 191 | 32 | 31 | 12 | 12 | ...... | ...... | ...... | 1,684 | 54 | 100 | 149 | 2 | 88 | 50 | 393 | 57 | ...... | 2 | 115 | 174 | 632 |
| Third | 1,765 | 27 | 20 | 33 | 8 | 17 | 2 | 11 | ...... | 1,883 | ......... | 91 | 83 | 1 | 33 | 50 | 258 | 46 | 8 | 1 | 148 | 203 | 992 |
| Fourth | 1,330 | 232 | 17 | 11 | 6 | 7 | ...... | ...... | 2 | 1,605 | 27 | 90 | 25 | 2 | 18 | 67 | 229 | 7 | ...... | 3 | 105 | 115 | 511 |
| Fifth | 253 | 7 | 4 | 4 | ...... | 3 | ...... | ...... | ...... | 271 | ......... | ......... | 3 | 2 | ...... | 35 | 40 | 1 | ...... | ...... | ......... | 1 | 40 |
| Sixth | 978 | 61 | 13 | 6 | 3 | 4 | ...... | ...... | ...... | 1,065 | ......... | 30 | 7 | 2 | 8 | 18 | 60 | 10 | ...... | ...... | ......... | 10 | 105 |
| Total | 7,030 | 542 | 98 | 98 | 32 | 45 | 2 | 11 | 2 | 7,860 | 81 | 349 | 298 | 9 | 92 | 269 | 1,098 | 134 | 8 | 14 | 448 | 604 | 2,299 |

*Permits Issued During the year 1896.*

| | |
|---|---|
| Aquaria | 3 |
| Bakeries | 35 |
| Barber shops | 80 |
| Bars | 21 |
| Brick yards | 3 |
| Basins and sinks in dwellings | 3,746 |
| Basins and sinks in offices and stores | 302 |
| Baths in dwellings | 7,480 |
| Baths in hotels, etc | 10 |
| Baths, shower | 91 |
| Bidets | 2 |
| Boats, etc., supply of | 167 |
| Bottling establishments | 19 |
| Building purposes | 552 |
| Carriages and wagons | 142 |
| Cellar drainers | 2 |
| Dwellings, half | 8 |
| Drug stores | 45 |
| Dye houses | 7 |
| Factories | 5 |
| Ferrules, number | 8,732 |
| Fire hydrants, for use of | 170 |
| Fish troughs and stands | 12 |
| Forges | 11 |
| Fountains, counter | 36 |
| Fountains, garden | 7 |
| Green houses | 52 |
| Heating boilers | 31 |
| Hydrants in new buildings | 6,509 |
| Hydraulic elevators | 4 |
| Ice cream saloons | 7 |
| Ice machines | 1 |
| Lawn sprinklers | 4 |
| Laundries | 32 |
| Laboratories | 1 |
| Machines, scouring, rinsing, etc | 30 |
| Milk houses | 35 |
| Motors, beer | 17 |
| Motors, organ | 22 |
| Photograph galleries | 2 |
| Pantry sinks | 264 |
| Pools, swimming | 2 |
| Pools in churches | 3 |

| | |
|---|---|
| Restaurants and eating saloons | 34 |
| Screw nozzles | 72 |
| Slaughter houses | 4 |
| Stables | 109 |
| Stalls in stables | 1,004 |
| Steam boilers, number | 98 |
| Steam boilers, horse power | 1,781 |
| Steam engines, number | 40 |
| Steam engines, horse power | 211 |
| Street sprinklers | 261 |
| Tubs, vats and tanks | 62 |
| Urinals in dwellings | 1 |
| Urinals in stores, offices, etc | 105 |
| Urinal troughs | 35 |
| Wash paves | 4,101 |
| Wash paves for watering horses | 23 |
| Wash tubs, stationary | 2,079 |
| Water closets in dwellings | 14,389 |
| Water closets in stores, etc | 552 |

*Premises Supplied and Appliances in uss.*
*January 1, 1896.*

| | |
|---|---|
| Aquaria | 9 |
| Arsenals | 2 |
| Asylums | 8 |
| Bakeries | 1,390 |
| Barber shops | 1,303 |
| Bars | 1,607 |
| Basins and sinks in dwellings | 53,643 |
| Basins and sinks in offices and stores | 25,038 |
| Baths in dwellings | 144,410 |
| Baths, public | 1,102 |
| Baths, shower | 225 |
| Baths, foot | 103 |
| Beam houses and tanneries | 18 |
| Bidets | 442 |
| Bottling establishments | 599 |
| Brick yards | 21 |
| Brick yards, gangs of men | 92 |
| Breweries | 88 |
| Barrels brewed | 1,996,284 |
| Cars, steam and horse | 1,139 |
| Carriages and wagons | 8,415 |
| Cellar drainers | 10 |

| | |
|---|---|
| Cemeteries ................................................ | 26 |
| Churches ................................................ | 492 |
| Coal yards................................................ | 246 |
| Coloring rooms................................................ | 152 |
| Condensers ................................................ | 13 |
| Depots and railroad staions................................ | 110 |
| Dwellings with water................................ | 211,722 |
| Dwellings without water................................ | 3,087 |
| Dwellings half without water................................ | 9,472 |
| Dyers ................................................ | 678 |
| Drug stores................................................ | 291 |
| Dye houses................................................ | 630 |
| Engines on railroads................................ | 269 |
| Factories, foundries and mills................................ | 1,604 |
| Filters ................................................ | 10 |
| Fire stations................................................ | 42 |
| Fountains, garden................................................ | 31 |
| Fountains, counter................................................ | 466 |
| Forges ................................................ | 1,118 |
| Furnaces ................................................ | 26 |
| Gas works and holders................................ | 6 |
| Glass works................................................ | 14 |
| Greenhouses ................................................ | 914 |
| Grindstones ................................................ | 136 |
| Halls and club houses................................ | 204 |
| Hatters' planks, per set................................ | 16 |
| Hydrants ................................................ | 223,305 |
| Hospitals ................................................ | 41 |
| Hotels ................................................ | 47 |
| Hydraulic elevators................................ | 217 |
| Ice cream saloons................................ | 281 |
| Institutions, charitable................................ | 71 |
| Ice machines................................................ | 136 |
| Laundries ................................................ | 584 |
| Lawn sprinklers................................................ | 262 |
| Laboratories ................................................ | 39 |
| Machines for washing, scouring, etc................................ | 2.530 |
| Marble yards................................................ | 78 |
| Malt houses................................................ | 17 |
| Market houses................................................ | 67 |
| Milk houses................................................ | 409 |
| Mint ................................................ | 1 |
| Motors, beer................................................ | 1,527 |
| Motors, organ................................................ | 170 |
| Photograph galleries................................ | 121 |

| | |
|---|---|
| Photograph galleries, operators | 67 |
| Police stations and patrols | 39 |
| Polishing wheels | 19 |
| Pools, swimming | 19 |
| Pools in churches | 68 |
| Printing establishments | 161 |
| Prisons | 3 |
| Rectifying establishments | 9 |
| Restaurants and oyster saloons | 934 |
| Screw nozzles | 4,533 |
| Shot towers | 1 |
| Slaughter houses | 462 |
| Soap boiling establishments | 17 |
| Stand pipes for watering engines | 26 |
| Stables | 7,245 |
| Stalls in stables | 47,889 |
| Stalls in markets | 6,870 |
| Stalls, fish, and troughs | 79 |
| Steam boilers, number | 2,940 |
| Steam boilers, horse power | 97,987 |
| Steam boilers, heating number | 715 |
| Steam boilers, heating, horse power | 4,583 |
| Steam engines, number | 1,836 |
| Steam engines, horse power | 32,458 |
| Steam saws | 58 |
| Steam presses and hammers | 51 |
| Shops and stores with water | 4,763 |
| Shops without water | 991 |
| School houses | 293 |
| Theatres | 18 |
| Tubs, vats and tanks | 1,835 |
| Turbine wheels | 26 |
| Urinals in dwellings | 172 |
| Urinals in stores, offices, etc | 4,073 |
| Urinal troughs | 441 |
| Vinegar establishments | 8 |
| Wash paves | 81,098 |
| Wash paves for watering horses | 495 |
| Wash tubs, stationary | 19,350 |
| Water closets in dwellings | 145,710 |
| Water closets in stores, etc | 24,329 |
| Wool washers | 79 |

*Service Attachments laid to the Curb (on Streets to be Paved or Repaved) by Bureau of Water.*

| Districts. | Size. | | | Total. |
|---|---|---|---|---|
| | ½-inch. | ⅝-inch. | 1-inch. | |
| First | 165 | ........ | ........ | 165 |
| Second | 497 | 92 | ........ | 589 |
| Third | 663 | 2 | ........ | 665 |
| Fourth | 318 | ........ | 1 | 349 |
| Fffth | 18 | ........ | ........ | 18 |
| Sixth | 581 | 15 | ........ | 596 |
| Total | 2,272 | 109 | 1 | 2,382 |

*Account of New Stops and Check Valves for 1896.*

| District. | Bureau of Water. | | Viney. | | Smith's patent. | Ludlow. | Check Valves. | Total. |
|---|---|---|---|---|---|---|---|---|
| | 2-way. | Butterfly. | 3-way. | 4-way. | | | | |
| First | 112 | ........ | 17 | 9 | ........ | ........ | ........ | 138 |
| Second | 181 | 1 | 5 | 30 | 12 | 1 | ........ | 230 |
| Third | 268 | 2 | 6 | 6 | 10 | ........ | ........ | 292 |
| Fourth | 162 | 4 | 25 | 33 | ........ | ........ | ........ | 224 |
| Fifth | 39 | 5 | ........ | ........ | 6 | ........ | 1 | 51 |
| Sixth | 204 | ........ | ........ | 18 | ........ | ........ | ........ | 222 |
| Total | 966 | 12 | 53 | 96 | 28 | 1 | 1 | 1,15 |

*Repairs to Mains, Stops and Fire Hydrants; also Stops and Fire Hydrants removed during 1896.*

| Districts. | Repairs to Mains. | Stops. | | | Fire Hydrants. | | |
|---|---|---|---|---|---|---|---|
| | | Repaired. | Renewed. | Removed. | Repaired. | Renewed. | Removed. |
| First | 61 | 285 | 35 | 7 | 279 | 38 | 26 |
| Second | 248 | 241 | 26 | 9 | 168 | 106 | 34 |
| Third | 243 | 340 | 264 | 15 | 310 | 135 | 61 |
| Fourth | 389 | 571 | 12 | 7 | 1,744 | 5 | 16 |
| Fifth | 19 | 11 | 6 | 1 | 35 | 49 | 1 |
| Sixth | 59 | 6 | 17 | 2 | 25 | 57 | 9 |
| Total | 1,019 | 1,454 | 360 | 41 | 2,561 | 390 | 147 |

*Location of Check Valves.*

| Street. | Location. | Ward. | Size. |
|---|---|---|---|
| Queen Lane Pumping Station | Southeast side of Engine House | 28 | 48 |

*Total Number of Stop Valves in the City—Arranged by Districts.*

| Pattern. | Size. | Outlets. | District. 1st. | 2d. | 3d. | 4th. | 5th. | 6th. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| Single Gate, Bureau of Water. | 3 | 2 Way. | 1 | 207 | 1 | 9 | 2 | 13 | 233 |
| | 4 | 2 Way. | 100 | 214 | 217 | 162 | 36 | 102 | 831 |
| | 6 | 2 Way. | 3,309 | 3,388 | 3,531 | 3,048 | 528 | 1,761 | 15,565 |
| | 8 | 2 Way. | 116 | 272 | 40 | 64 | 7 | 38 | 537 |
| | 10 | 2 Way. | 134 | 250 | 208 | 270 | 25 | 140 | 1,027 |
| | 12 | 2 Way. | 64 | 323 | 189 | 117 | 39 | 134 | 866 |
| | 16 | 2 Way. | 36 | 38 | 30 | 21 | ......... | 38 | 163 |
| | 18 | 2 Way. | ......... | ......... | 5 | ......... | ......... | 1 | 6 |
| | 20 | 2 Way. | 24 | 39 | 13 | 45 | 11 | 16 | 148 |
| | 30 | 2 Way. | 8 | 10 | 22 | 38 | 10 | 3 | 91 |
| | 36 | 2 Way. | 3 | 4 | 8 | 12 | 6 | ......... | 33 |
| | 48 | 2 Way. | ......... | ......... | 3 | 10 | ......... | ......... | 13 |
| | Totals.......... | | 3,795 | 4,745 | 4,267 | 3,796 | 664 | 2,246 | 19,513 |
| Butterfly, Bureau of Water. | 20 | 2 Way. | ......... | 4 | 2 | 6 | 2 | 2 | 16 |
| | 30 | 2 Way. | 2 | 1 | 1 | 6 | 9 | 1 | 20 |
| | 36 | 2 Way. | ......... | ......... | ......... | 17 | 1 | ......... | 18 |
| | 48 | 2 Way. | ......... | ......... | 1 | 23 | 15 | ......... | 39 |
| | Totals.......... | | 2 | 5 | 4 | 52 | 27 | 3 | 93 |
| Barton. | 6 | 4 Way. | 3 | 2 | 1 | 12 | ......... | ......... | 18 |
| | 8 | 4 Way. | ......... | ......... | ......... | 5 | ......... | ......... | 5 |
| | 6 | 5 Way. | 12 | 32 | ......... | ......... | ......... | ......... | 44 |
| | 6 | 6 Way. | ......... | 7 | ......... | ......... | ......... | ......... | 7 |
| | Totals.......... | | 15 | 41 | 1 | 17 | ......... | ......... | 74 |

*Total Number of Stop Valves, etc.*—Continued.

| Pattern. | Size. | Outlets. | District. 1st. | 2d. | 3d. | 4th. | 5th. | 6th. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| Viney. | 6 | 2 Way. | 7 | ........ | 4 | 3 | ........ | ........ | 14 |
| | 6 | 3 Way. | 56 | 65 | 39 | 227 | 6 | 11 | 404 |
| | 8 | 3 Way. | ........ | 5 | ........ | ........ | ........ | ........ | 5 |
| | 10 | 3 Way. | ........ | ........ | ........ | 3 | ........ | ........ | 3 |
| | 12 | 3 Way. | ........ | 2 | ........ | 3 | ........ | ........ | 5 |
| | 6 | 4 Way. | 20 | 45 | 19 | 108 | ........ | 16 | 208 |
| | 8 | 4 Way. | 1 | 6 | ........ | ........ | ........ | ........ | 7 |
| | 10 | 4 Way. | ........ | 5 | ........ | 14 | ........ | ........ | 19 |
| | 12 | 4 Way. | ........ | ........ | ........ | ........ | ........ | 4 | 4 |
| | 6 | 5 Way. | 26 | 6 | 2 | 29 | ........ | ........ | 63 |
| | Totals.......... | | 110 | 134 | 64 | 387 | 6 | 31 | 732 |
| Smith Patent. | 3 | 2 Way. | ........ | 1 | ........ | ........ | ........ | ........ | 1 |
| | 4 | 2 Way. | ........ | 2 | ........ | ........ | ........ | ........ | 2 |
| | 6 | 2 Way. | ........ | 10 | 7 | ........ | 6 | ........ | 23 |
| | 8 | 2 Way. | ........ | ........ | 1 | ........ | ........ | ........ | 1 |
| | 10 | 2 Way. | ........ | ........ | 2 | ........ | ........ | ........ | 2 |
| | 12 | 2 Way. | ........ | ........ | 4 | ........ | ........ | ........ | 4 |
| | 16 | 2 Way. | ........ | ........ | 2 | ........ | ........ | ........ | 2 |
| | Totals.......... | | ........ | 13 | 16 | ........ | 6 | ........ | 35 |
| Ludlow. | 3 | 2 Way. | ........ | 1 | ........ | ........ | ........ | ........ | 1 |
| Total number of Stops................ | | | 3,922 | 4,939 | 4,352 | 4,252 | 703 | 2,280 | 20,448 |
| Check Valves. | 30 | .............. | ........ | ........ | 1 | ........ | 2 | 2 | 5 |
| Bureau of Water. | 48 | .............. | ........ | ........ | 4 | 4 | 5 | ........ | 13 |
| | Totals.......... | | ........ | ........ | 5 | 4 | 7 | 2 | 18 |

*Number of Valves Raised in the several Districts during the year 1896.*

| Districts. | 5-way Barton. | 3-way Viney. | 4-way Viney. | Single Gate. 3-inch. | Single Gate. 4-inch. | Single Gate. 6-inch. | Single Gate. 10-inch. | Single Gate. 30-inch. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| First | ........ | ........ | 1 | ........ | ........ | 9 | ........ | ........ | 10 |
| Second | 4 | ........ | 4 | 2 | 1 | 3 | ........ | 3 | 17 |
| Third | ........ | 3 | ........ | ........ | 1 | 8 | 1 | ........ | 13 |
| Fourth | ........ | 3 | ........ | ........ | 1 | 10 | ........ | ........ | 14 |
| Total | 4 | 6 | 5 | 2 | 3 | 30 | 1 | 3 | 54 |

## *Number of Complaints and Examinations during 1895 and 1896.*

| Months. | Hydrants. | | Service Pipe. | | Wash Paves. | | Spigots. | | Water-closets | | Horse Troughs | | No. Leaks. | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 | 1895 | 1896 |
| January | 135 | 170 | 120 | 125 | 13 | 10 | 3 | 5 | 9 | 8 | 2 | ........ | 16 | 15 | 298 | 333 |
| February | 224 | 128 | 208 | 172 | 29 | 7 | 7 | 3 | 17 | 6 | 5 | ........ | 30 | 19 | 520 | 335 |
| March | 115 | 113 | 157 | 101 | 8 | 3 | 1 | ........ | 8 | 1 | 3 | 2 | 10 | 17 | 302 | 237 |
| April | 97 | 87 | 99 | 92 | 7 | 2 | ........ | ........ | 8 | 9 | ........ | 1 | 11 | 7 | 222 | 198 |
| May | 113 | 104 | 63 | 84 | ........ | 4 | 5 | ........ | 5 | 10 | 1 | 2 | 13 | 10 | 200 | 214 |
| June | 95 | 89 | 69 | 103 | 2 | 1 | 4 | 4 | 5 | 12 | 1 | ........ | 6 | 14 | 182 | 223 |
| July | 126 | 76 | 78 | 68 | 6 | 3 | 3 | 1 | 12 | 22 | 1 | 1 | 18 | 9 | 244 | 180 |
| August | 66 | 82 | 69 | 90 | 1 | 9 | 2 | 2 | 5 | 16 | ........ | ........ | 11 | 11 | 154 | 210 |
| September | 94 | 86 | 71 | 70 | 3 | 4 | 2 | ........ | 6 | 12 | 3 | ........ | 11 | 9 | 190 | 181 |
| October | 91 | 103 | 63 | 88 | 4 | 5 | 6 | 4 | 1 | 12 | ........ | 1 | 5 | 8 | 170 | 221 |
| November | 98 | 115 | 88 | 65 | 1 | 4 | 2 | 1 | 9 | 9 | 1 | 2 | 9 | 11 | 208 | 207 |
| December | 126 | 107 | 111 | 111 | 6 | 5 | 4 | 3 | 14 | 13 | 1 | ........ | 10 | 15 | 282 | 254 |
| Total | 1,390 | 1,260 | 1,196 | 1,169 | 80 | 57 | 39 | 23 | 99 | 130 | 18 | 9 | 150 | 145 | 2,972 | 2,793 |

## New Meters Set.

| Ward. | Occupant. | Location. | Business. | Date when Set. | Name of Meter. | Size. ½-inch. | ¾-inch. | 1-inch. | 1½-inch. | 2-inch. | 3-inch. | 4-inch. | 6-inch. | Total. | Gallons Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Brock, John | 2108 Dean street | Stair Building Factory. | July 27 | Crown | 1 | | | | | | | | 1 | 750 |
| 1 | Hamilton, R. & Son | 1537–41 Anthony and 709 Tasker st. | Soap Works | March 10 | Crown | | | 1 | | | | | | 1 | 45,756 |
| 4 | Godley, Philip | 722–24 Swanson street | Storage House | June 15 | Nash | 1 | | | | | | | | 1 | 2,925 |
| 5 | Chamber of Commerce. | 131–37 South Second street | Office Building | Dec. 2 | Crown | | 1 | | 1 | | | | | 2 | No water used. |
| 5 | Friends Association | 312–22 Walnut and Walnut place and Willings alley | Office Building | Dec. 12 | Gem | | | | | 1 | | | | 1 | 4,975,163 |
| 5 | Friends Association | 312–22 Walnut and Walnut place and Willings alley | Office Building | Dec. 12 | Crown | 1 | | 2 | | | | | | 3 | |
| 5 | Lutz, J. E. Trustee | 515–19 Lombard street | Shirt Factory | March 30 | Crown | | | | 1 | | | | | 1 | 962,750 |
| 5 | Philadelphia Exchange | N. E. cor. Third and Walnut sts. | Office Building | Feb. 11 | Gem | | | | | 1 | | | | 1 | 135,750 |
| 6 | Est. of A. B. Kirshba'm | 306 Market street | Tailoring | May 18 | Crown | | 1 | | | | | | | 1 | 55,000 |
| 6 | Friends Meeting-house | S. E. cor. Fourth and Arch sts. | Church | March 31 | Crown | | | | | 1 | | | | 1 | 88,442 |
| 6 | Wiley, H. E. | 148 Bread street | Machine Shop | August 27 | Crown | | | | | 1 | | | | 1 | 60,225 |
| 7 | Am. Bap. Pub. Society | N. W. cor. Juniper and Lombard st. | Publication House | Dec. 31 | Gem | | | | | | | 1 | | 1 | No water used. |
| 8 | Am. Acad. of Music | S. W. cor. Broad and Locust sts. | Theatre | Dec. 30 | Gem | | | | | 1 | | | | 1 | No water used. |
| 8 | Hotel Walton | S. E. cor. Broad and Locust sts. | Hotel | April 28 | Crown | | | | 1 | | | | | 1 | 1,269,000 |
| 8 | Wurbarton, B. | 704 Chestnut street | Newspaper Office | July 13 | Crown | | | | | 1 | | | | 1 | 1,2 0,435 |

## *New Meters Set*—Continued.

| Ward. | Occupant. | Location. | Business. | Date when Set. | Name of Meter. | Size. | | | | | | | | Total. | Gallons Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ½-inch. | ¾-inch. | 1-inch. | 1½-inch. | 2-inch. | 3-inch. | 4-inch. | 6-inch. | | |
| 8 | Wagner, J. P | 1 34 Locust street | Laundry | Aug. 28 | Crown | 1 | | | | | | | | 1 | 25,500 |
| 9 | City Trust Safe Deposit and Surety Co. | ·27-29 Chestnut street | Office Building | Dec. 31 | Thomp'n | | | | | | 1 | | | 1 | No water used. |
| 9 | Physicians and Dentist Building Co | 1831-33 Chestnut street | Office Building | Dec. 22 | Gem | | | | | | | 1 | | 1 | No water used. |
| 9 | Reading Terminal Mkt | Arch street, southeast cor. Twelfth | Market House | Dec. 20 | Hervey | | | | 2 | | | | | 2 | No water used. |
| 9 | Reading Terminal Mkt | Arch street, southeast cor. Twelfth | Market House | Dec. 20 | Crown | | | 1 | | | | | | 1 | |
| 9 | Reading Terminal Mkt | Arch street, southeast cor. Twelfth | Market House | Dec. 20 | Gem | | | | | | | 2 | | 2 | |
| 10 | Fidelity Mutual Life Association | West side Broad st., 118 ft. north of Arch | Office Building | Mar. 9 | Crown | | | | | | 1 | | | 1 | 5,905,250 |
| 10 | Shell J | 924 Vine street, southeast cor. Tenth | Hat Factory | Aug. 11 | Crown | | | 2 | | | | | | 2 | 82,950 |
| 11 | Meurer, Charles A | 424-28 St. John street | Morocco Factory | Feb. 11 | Crown | | 1 | | | | | | | 1 | 7,395 |
| 11 | Reeves Charles W | 437-47 St. John street | Furniture Factory | Aug. 14 | Crown | | | | 1 | | | | | 1 | 5,250 |
| 13 | Brown & Bailey | 412 Franklin st., rear on Willow | Paper Box Factory | Aug. 15 | Crown | | | | | 1 | | | | 1 | 459,750 |
| 13 | Fitler, E. H. Estate | 856-64 North Seventh street | Concert Hall | Oct. 29 | Crown | | | 1 | | | | | | 1 | No water used. |
| 14 | Belfield, H. & Co | 435 North Broad st and 1341-47 Noble | Gas Fixtures | Jan. 21 | Crown | | | | 1 | 1 | | | | 2 | 1,422,518 |
| 14 | Huber, John Y | East side Eleventh street, first house south of Ridge avenue | Machine Shop | Aug. 11 | Crown | | | 1 | | | | | | 1 | 118,485 |
| 14 | Park Theatre | Northeast cor. Broad and Fairmount av. | Theatre | June 12 | Crown | | 1 | | | | | | | 1 | 177,750 |

## *New Meters Set*—Continued.

| Ward. | Occupation. | Location. | Business. | Date when Set. | Name of Meter. | Size. ½-inch. | ¾-inch. | 1-inch. | 1½-inch. | 2-inch. | 3-inch. | 4-inch. | 6-inch. | Total. | Gallons Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | Park Theatre | N. E. c. Broad and Fairmount avenue | Theatre | June 26 | Nash | 1 | | | | | | | | 1 | |
| 14 | Phila. Traction Co | N. E. c. Thirteenth and Mt. Vernon sts. | Power house | June 24 | Crown | | | | 1 | | | | | 1 | 174,000 |
| 16 | Collins, A. M., & Co | 1051 N. Third st., N. E. cor. Canal st | Miscellaneous | Nov. 30 | Crown | | 2 | 1 | | | | | | 3 | 481,500 |
| 16 | Jewish Church | 926–28 New Market street | Church | June 17 | Nash | 1 | | | | | | | | 1 | 39,750 |
| 16 | Moland, Wm., & Co | 154 Laurel st., S. E. cor. Rachel st | Packing house | June 18 | Crown | | | | 1 | | | | | 1 | 472,392 |
| 16 | Paxon, J. W., & Co | 1056-60 Beach street | Moulders' supplies | June 17 | Crown | | | | 1 | | | | | 1 | 228,420 |
| 17 | Fretz, J., Estate | 1308–12 Charlotte street | Button factory | Sept. 12 | Gem. | | | | | 1 | | | | 1 | 231,000 |
| 19 | Armour & Co | 20[illegible]1 American st., N. E. cor. Norris st | Packing house | Feb. 29 | Crown | | | | 1 | | | | | 1 | 709,500 |
| 19 | Moore, John | 2336–38 North Front street | Furniture factory | Feb. 12 | Crown | | 1 | | | | | | | 1 | 27,742 |
| 19 | Schadenwald, Henry | N. S. Huntingdon st., from Third to Orianna street | Mill | Dec. 31 | Thomp'n | | | | | | 1 | | | 1 | No water used. |
| 21 | Kling, J | 139 Centre street | Soap works | Oct. 14 | Crown | 1 | | | | | | | | 1 | 7,500 |
| 21 | Leibert & Obert | 158–60 Oak street and rear of 156 | Brewery | May 4 | Gem | | | | | | 1 | | | 1 | 3,441,368 |
| 21 | Leibert & Obert | 173–83 Mulberry street | Brewery | May 5 | Crown | | | 1 | 2 | | | | | 3 | |
| 21 | Metzler Bros | 108–12 Levering street | Laundry | Dec. 24 | Crown | 1 | 2 | | | | | | | 3 | 85,853 |
| 21 | Roshor, Charles F | E. S. Ridge ave., 2d H. N. Paoli ave | Lard factory | June 19 | Crown | 1 | | | | | | | | 1 | 96,413 |

## *New Meters Set*—Continued.

| Ward. | Occupant. | Location. | Business. | Date when Set. | Name of Meter | Size. ½-inch. | ¾-inch. | 1-inch. | 1½-inch. | 2-inch. | 3-inch. | 4-inch. | 6-inch. | Total. | Gallons Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | Roxb'gh Aux. P'p'g Sta | Roxborough | Pumping station | May 19 | Venturi, 20 in. | | | | | | | | | 1 | |
| 22 | Collum, A. G. | N.W. s. Washington la., N.E. of Sullivan | Brickyard | March 20 | Crown | | | | | 1 | | | | 1 | 1,446,660 |
| 22 | Graves, Thomas W. | Rear 4947 Wakefield street | Braid mill | June 18 | Crown | | 1 | | | | | | | 1 | 90,668 |
| 22 | Hains, Est. of J. S. | N.E. s. Chew st. from Hains to Walnut la | Nursery | April 21 | Crown | | | | | 1 | | | | 1 | 152,250 |
| 22 | Chestnut Hill water t'nk | E. s. 25th st. 450 ft. south of Union ave. | Water tank | Jan. 29 | Venturi, 12 in. | | | | | | | | | 1 | |
| 22 | Shaw | Chelton avenue west of Anderson street | Cotton mill | March 19 | Crown | | 1 | | | | | | | 1 | 750 |
| 22 | Young, J. Welch | N.E. s. Wiss. ave., 96 ft. S.E. of Philellena | Florist | April 20 | Crown | | | | | 1 | | | | 1 | 68 |
| 23 | Aramingo Mills Co. | S.E. cor. Unity and Leiper streets | Mill | Dec. 28 | Gem | | | | | | | 1 | | 1 | 8,250 |
| 23 | Diam'nd Mills Emery Co | S. side Oxford street, west of Hedge | Emery factory | Oct. 8 | Crown | | | 1 | | | | | | 1 | 149,400 |
| 23 | Gordon Bros. | N.E. cor. Orthodox and Pierce streets | Mill | Oct. 2 | Crown | | | | 1 | | | | | 1 | 368,340 |
| 23 | Frank'd Co-operative Co | S.W. cor. Orthodox and Horrocks sts. | Mill | Jan. 24 | Crown | | | | | 1 | | | | 1 | 60,000 |
| 23 | Wentz Farm Reservoir | Wentz Farm | Reservoir | June 1 | Venturi, 48 in. | | | | | | | | | 1 | |
| 24 | Bureau of Water, | Forty-second and Pennsgrove streets | | April 13 | Deacon | | | | | | | | 1 | 1 | |
| 24 | West Hope Presb. Ch. | S.W. cor. Preston and Aspen streets | Church | Nov. 5 | Crown | | | | | 1 | | | | 1 | 27,375 |
| 24 | Union Traction Co. | S.W. cor. Forty-first and Haverford sts. | Power house | Dec. 1 | Crown | | | 1 | | | | | | 1 | No water used. |

## *New Meters Set*—Continued.

| Ward. | Occupant. | Location. | Business. | Date when Set. | Name of Meter. | Size. | | | | | | | | Total. | Gallons Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ½ inch. | ¾ inch. | 1 inch. | 1½ inch. | 2 inch. | 3 inch. | 4 inch. | 6 inch. | | |
| 25 | Goldschmid, F. I | Rear 3344 and all 3346 Frankford av | Laboratory | Dec. 22 | Gem | | | | | 1 | | | | 1 | No water used. |
| 25 | Klauder & Bro | Rear 1809 Russell st | Candy factory | June 23 | Crown | | | | | 1 | | | | 1 | 591,000 |
| 25 | Union Traction Co | N. W. c. Richmond st. & Allegheny av | Depot | Dec. 23 | Crown | | | 1 | | | | | | 1 | 1,500 |
| 26 | Dooley, Daniel | S. W. c. Juniper st. & Snyder av | Depot | Jan. 27 | Crown | | | 1 | | | | | | 1 | 259,680 |
| 27 | Brill, J. G. & Sons | 61st & Woodland av | Car Works | May 11 | Crown | | | | | 1 | | | | 1 | 934,815 |
| 27 | Elliott, A. G | W. S. Island rd., S. Woodland av | Soap Works | Aug. 12 | Crown | | | 1 | | | | | | 1 | 450,563 |
| 27 | Ind. Widows & Sing. Wom. Home | 3609–19 Chestnut st | Home | Aug. 12 | Crown | | | | | 1 | | | | 1 | 716,250 |
| 27 | Rirble, J. B | 7014 Woodland av | Umbrella factory | Jan. 28 | Crown | | 1 | | | | | | | 1 | 153,975 |
| 27 | Sharpless, S. J | 3045–17 Chestnut st | Stone yard | Dec. 23 | Crown | | | 1 | | | | | | 1 | No water used. |
| 27 | Students' Hall | N. S. Spruce st., W. of 34th | Hall | Jan. 18 | Gem | | | | | | | 1 | | 1 | 5,016,000 |
| 27 | St. James' Hall Ass'n | 3740–46 Market st | Hall | Dec. 29 | Gem | | | | | 1 | | | | 1 | No water used. |
| 27 | University of Penna | S. W. c. 33rd & Locust sts | Swimming pool | Nov. 23 | Crown | | | | | | | 1 | | 1 | No water used. |
| 27 | Vermont Marble Co | N. E. c. 30th & Walnut sts | Marble works | July 14 | Crown | | 1 | | | | | | | 1 | 378,555 |
| 28 | Elec. Storage Battery Co | S. W. c. 19th & Allegheny av | Electric works | Dec. 26 | Gem | | | | | 1 | | | | 1 | 5,250 |
| 28 | Penna. Asphalt Co | S. E. s. Sedgley av. E. of 19th st | Asphalt works | Aug. 13 | Crown | | | | | 1 | | | | 1 | 89,123 |

## *New Meters Set*—Continued.

| Ward. | Occupant. | Location. | Business. | Date when Set. | Name of Meter. | Size. ½-inch. | ¾-inch. | 1-inch. | 1½-inch. | 2-inch. | 3-inch. | 4-inch. | 6-inch. | 12-inch. | 20-inch. | 48-inch. | Total. | Gallons Consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | People's Amusement Co. | N. E. c. Ridge ave. and Thirty-two-and-one-half street | Carrousel | June 2 | Crown |  | 1 |  |  | 1 |  |  |  |  |  |  | 2 | 235,845 |
| 28 | Union Traction Co. | East side Ridge ave, n. of Huntingdon | Depot | June 22 | Crown |  |  |  | 1 |  |  |  |  |  |  |  | 1 | 35,250 |
| 29 | Schemm, Peter | 908–22 West College avenue | Brewery | July 1 | Crown |  |  |  |  |  | 1 |  |  |  |  |  | 1 | 1,213,500 |
| 31 | Schoenhut, A. & Co. | 2150–52 Adams street | Toy factory | Aug. 19 | Crown |  |  |  | 1 |  |  |  |  |  |  |  | 1 | 629,250 |
| 31 | Schoenhut, A. & Co. | 2218–22 Aramingo street | Toy factory | Aug. 20 | Crown |  |  |  | 1 |  |  |  |  |  |  |  | 1 | 110,190 |
| 31 | Vulcanite Paving Co. | North side Morris, w. of Gunner's Run | Asphalt works | Sept. 2 | Crown | 1 |  |  |  |  |  |  |  |  |  |  | 1 | 102,255 |
| 32 | Bureau of Water | N. W. c. Twenty-eighth and Montgomery avenue |  | Jan. 17 | Deacon |  |  |  |  |  |  |  | 1 |  |  |  | 1 | 6,750 |
| 33 | Kensington Labor Lyceum | 2916–24 North Second street | Hall | Dec. 23 | Crown |  |  | 1 |  |  |  |  |  |  |  |  | 1 | No water used. |
| 33 | Philada. Brewing Co. | S. E. c. Sixth and Clearfield streets | Brewery | Aug. 27 | Crown |  |  |  |  | 1 |  |  |  |  |  |  | 1 | 1,438,250 |
| 33 | Thackara, Geo. T. | East s. Lawrence st., south of Venango | Mill | Aug. 7 | Crown | 1 |  |  |  |  |  |  |  |  |  |  | 1 | 19,500 |
| 34 | Houseman | Rear 5105 Westminster avenue | Packing house | Sept. 9 | Crown |  |  |  |  | 1 |  |  |  |  |  |  | 1 | 984,405 |
| 34 | Voight, F. G. | 4714–16 Westminster avenue | Packing house | April 15 | Gem |  |  |  |  | 1 |  |  |  |  |  |  | 1 | No water used. |
| 36 | Walkins, Geo. & Co. | Reed street, south side, from Thirty-sixth street to Schuylkill ave. | Rubber factory | Aug. 10 | Crown | 1 |  |  |  |  |  |  |  |  |  |  | 1 | 30,750 |
| 37 | People's Pass. R. W. Co. | Dauphin street, S. W. c. Eighth street | Depot | Oct. 28 | Crown | 1 |  |  |  |  |  |  |  |  |  |  | 1 | 2,250 |
| 37 | Union Traction Co. | 2214 North Eleventh street | Depot | Nov. 30 | Crown | 1 |  | 1 |  |  |  |  |  |  |  |  | 2 | 370,605 |
|  | **Totals** |  |  |  |  | 14 | 14 | 18 | 17 | 25 | 5 | 7 | 2 | 1 | 1 | 1 | 105 | 39,175,759 |

## *Miscellaneous Work.*

| Size. | Meters. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Repaired. | | | | Used in Service. | | | | Purchased. | | | | | |
| | Crown. | Gem. | Nash. | Total. | Crown. | Gem. | Nash. | Total. | Venturi. | Gem. | Hersey. | Thompson. | Trident. | Total. |
| ½-inch | 3 | ...... | ...... | 3 | ...... | ...... | 2 | 2 | | | | | | |
| ¾-inch | 16 | ...... | 11 | 27 | 4 | ...... | 1 | 5 | | | | | | |
| 1-inch | 26 | ...... | 3 | 29 | 1 | ...... | ...... | 1 | | | | | | |
| 1½-inch | 17 | ...... | 1 | 18 | ...... | ...... | ...... | ...... | ...... | ...... | 3 | ...... | 3 | 6 |
| 2-inch | 44 | 33 | ...... | 77 | ...... | ...... | ...... | ...... | ...... | 6 | ...... | ...... | ...... | 6 |
| 3-inch | 10 | 39 | ...... | 49 | ...... | 1 | ...... | 1 | ...... | ...... | ...... | 4 | 5 | 9 |
| 4-inch | 16 | 90 | ...... | 106 | ...... | ...... | ...... | ...... | ...... | 12 | ...... | ...... | ...... | 12 |
| 6-inch | 4 | 10 | ...... | 14 | | | | | | | | | | |
| 12-inch | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | ...... | ...... | ...... | ...... | 1 |
| 20-inch | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | ...... | ...... | ...... | ...... | 1 |
| 48-inch | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | ...... | ...... | ...... | ...... | 1 |
| Toeal | 136 | 172 | 15 | 323 | 5 | 1 | 3 | 9 | 3 | 18 | 3 | 4 | 8 | 36 |

| | Examinations. | | | | | Miscellaneous. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Attachments. | Meters. | Leaks. | Short Supply. | Total. | New Boxes. | Boxes Repaired. | Iron Covers. | Fish Traps. | Service Pipes Repaired. | Total. | Statements. |
| Total.... | 1,449 | 1,000 | 53 | 116 | 2,618 | 119 | 7 | 31 | 96 | 1,093 | 1,346 | 24,945 |

## *Meters Tested and Received on Trial.*

| Size. | Tested. | | | | | | | | | | | Received on Trial. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Crown. | Gem. | Nash. | Trident. | Thompson. | Hersey. | Union. | Empire. | Lambert. | Venturi. | Total. | Crown. | Gem. | Nash. | Th mpson. | Hersey. | Trident. | Union. | Empire. | Lambert. | Total. |
| ½-inch | 11 | ...... | 1 | ...... | 1 | 1 | 2 | 1 | ...... | ...... | 17 | 1 | ...... | 1 | 1 | 1 | ...... | 1 | 1 | ...... | 6 |
| ¾-inch | 8 | ...... | 1 | 1 | 1 | 1 | 2 | 1 | ...... | ...... | 15 | 1 | ...... | 1 | 1 | 1 | 1 | 1 | 1 | ...... | 7 |
| 1-inch | 22 | ...... | 2 | 1 | 1 | 1 | 2 | 1 | ...... | ...... | 30 | 1 | ...... | 1 | 1 | 1 | 1 | 1 | 1 | ...... | 7 |
| 1½-inch | 12 | ...... | 1 | 3 | 1 | 4 | 2 | ...... | ...... | ...... | 23 | 1 | ...... | 1 | 1 | 1 | 1 | 1 | ...... | ...... | 6 |
| 2-inch | 13 | 3 | 1 | 1 | 1 | 1 | 2 | ...... | 1 | ...... | 23 | 1 | 1 | 1 | 1 | 1 | ...... | 1 | ...... | 1 | 7 |
| 3-inch | 2 | 1 | 1 | ...... | 5 | 1 | 2 | ...... | 1 | ...... | 13 | 1 | 1 | 1 | 1 | 1 | ...... | 1 | ...... | 1 | 7 |
| 4-inch | 2 | 13 | 1 | ...... | 1 | 1 | 2 | ...... | ...... | ...... | 20 | 1 | 1 | 1 | 1 | 1 | ...... | 1 | ...... | ...... | 6 |
| 6-inch | 1 | 1 | 1 | ...... | 1 | 1 | ...... | ...... | ...... | 1 | 6 | 1 | 1 | 1 | 1 | 1 | ...... | ...... | ...... | ...... | 5 |
| 12-inch | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | 1 | | | | | | | | | | |
| 20-inch | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | 1 | | | | | | | | | | |
| 48-inch | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1 | 1 | | | | | | | | | | |
| Total | 71 | 18 | 9 | 6 | 12 | 11 | 14 | 3 | 2 | 4 | 150 | 8 | 4 | 8 | 8 | 8 | 3 | 7 | 3 | 2 | 51 |

*Attachments made and delivered to Districts during the Year 1896.*

| Districts. | Attachments made and delivered. | Total Feet. | Lead Pipe—Feet. 5/8-inch. | 3/4-inch. | 1-inch. |
|---|---|---|---|---|---|
| First | 183 | 3,353 | 3,353 | | |
| Second | 441 | 8,844 | 6,819 | 2,025 | |
| Third | 659 | 9,878 | 9,830 | ........... | |
| Fourth | 486 | 6,685 | 6,670 | ........... | |
| Fifth | 8 | 118 | 118 | | |
| Sixth | 598 | 10,234 | 9,802 | 432 | |
| Total | 2,375 | 39,112 | 36,592 | 2,457 | |

# DISTRIBUTION EXPENSES

*During the year 1896.*

INCLUDING EXPENSES AT MAIN OFFICE, PURVEYORS' DISTRICTS, AND METER SHOPS.

| Material and Labor. | First District. | Second District | Third District. | Fourth District. | Fifth District. | Sixth District. | Distribut'n. | Meter Shops | Main Office. | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|
| Lead | $663 71 | $2,099 80 | $2,431 65 | $1,464 76 | $1,935 97 | $1,293 45 | ........ | ........ | ........ | $9,889 34 |
| Gasket | 68 32 | 38 03 | 109 65 | 115 54 | 21 86 | 66 96 | ........ | ........ | ........ | 420 36 |
| Coke | 47 45 | 68 50 | 122 30 | 179 40 | 80 50 | 127 20 | ........ | ........ | ........ | 625 35 |
| Wood | ........ | ........ | ........ | ........ | ........ | 48 00 | ........ | ........ | ........ | 48 00 |
| Pipes | ........ | ........ | ........ | ........ | ........ | ........ | 74,942 28 | ........ | ........ | 74,942 28 |
| Breeches pipe | ........ | ........ | ........ | ........ | ........ | ........ | 2,126 62 | ........ | ........ | 2,126 62 |
| Small specials | ........ | ........ | ........ | ........ | ........ | ........ | 16,146 53 | ........ | ........ | 16,146 53 |
| Large specials | ........ | ........ | ........ | ........ | ........ | ........ | 9,728 04 | ........ | ........ | 9,728 04 |
| Frames and covers | ........ | 392 60 | 356 20 | ........ | ........ | 200 00 | ........ | ........ | ........ | 948 80 |
| Viney stops | 1,460 00 | 2,205 00 | 528 00 | 4,033 00 | ........ | 1,758 00 | ........ | ........ | ........ | 9,984 00 |
| Excavating by contract | ........ | ........ | ........ | 1,953 40 | ........ | 1,600 11 | ........ | ........ | ........ | 3,553 51 |
| Hauling, trans. and hotel | 45 00 | 164 25 | 35 00 | 25 00 | 5 00 | 50 00 | 10,424 55 | 386 50 | 15 00 | 11,050 30 |
| Supplies, tools, small stores, etc | 899 90 | 2,179 31 | 1,682 75 | 2,773 02 | 604 02 | 1,145 00 | 1,025 72 | 2,287 69 | 352 27 | 12,949 68 |
| Plumbing, and Plumbers supplies | ........ | ........ | ........ | ........ | ........ | 13 35 | ........ | 497 70 | ........ | 511 05 |
| Meters, etc | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 7,387 25 | ........ | 7,387 25 |
| Repairs to building, etc | 2 50 | 40 25 | 36 75 | 30 75 | 2 68 | 30 88 | ........ | ........ | ........ | 143 81 |
| Brick, stone, lime and cement | 33 45 | 188 45 | 25 95 | 991 48 | 739 40 | 23 65 | ........ | 39 57 | ........ | 2,041 95 |

## *General Summary of Meter Operations for the year 1896.*

| Size of Meters. | In Use January 1, 1896.* | | | | | | | Set During 1896. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Crown. | Gem. | Nash. | Deacon. | Worthington. | Union. | Total. | Crown. | Gem. | Nash. | Deacon. | Venturi. | Thompson. | Hersey. | Total. |
| ½-inch | 24 | | 6 | | | | 30 | 11 | | 3 | | | | | 14 |
| ¾-inch | 222 | | 21 | | | | 243 | 14 | | | | | | | 14 |
| 1-inch | 204 | | 16 | | 1 | | 221 | 18 | | | | | | | 18 |
| 1½-inch | 117 | | 15 | | 2 | 1 | 135 | 15 | | | | | | 2 | 17 |
| 2-inch | 148 | 86 | | | | | 234 | 17 | 8 | | | | | | 25 |
| 3-inch | 61 | 84 | | | | | 145 | 2 | 1 | | | | 2 | | 5 |
| 4-inch | 44 | 169 | | 1 | | | 214 | 1 | 6 | | | | | | 7 |
| 6-inch | 4 | 23 | | 4 | | | 31 | | | | 2 | | | | 2 |
| 12-inch | | | | | | | | | | | | 1 | | | 1 |
| 20-inch | | | | | | | | | | | | 1 | | | 1 |
| 48-inch | | | | | | | | | | | | 1 | | | 1 |
| Totals | 824 | 362 | 58 | 5 | 3 | 1 | 1,253 | 78 | 15 | 3 | 2 | 3 | 2 | 2 | 105 |

| Size of Meters. | Renewed. | | | | | | | | Discontinued | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Taken Out. | | | | Put In. | | | | Taken Out. | | | |
| | Crown. | Gem. | Nash. | Total. | Crown. | Gem. | Nash. | Total. | Crown. | Gem. | Nash. | Total. |
| ½-inch | 1 | | 1 | 2 | 1 | | | 1 | 1 | | | 1 |
| ¾-inch | 6 | | 3 | 9 | 8 | | 1 | 9 | 7 | | 1 | 8 |
| 1-inch | 11 | | 5 | 16 | 14 | | | 14 | 6 | | | 6 |
| 1½-inch | 3 | | 2 | 5 | 4 | | 1 | 5 | 5 | | | 5 |
| 2-inch | 6 | 1 | | 7 | 7 | 1 | | 8 | 4 | | | 4 |
| 3-inch | 1 | 1 | | 2 | | 1 | | 1 | | 1 | | 1 |
| 4-inch | | | | | | 1 | | 1 | | 1 | | 1 |
| 6-inch | | | | | | | | | | | | |
| 12-inch | | | | | | | | | | | | |
| 20-inch | | | | | | | | | | | | |
| 48-inch | | | | | | | | | | | | |
| Totals | 28 | 2 | 11 | 41 | 34 | 3 | 2 | 39 | 23 | 2 | 1 | 26 |

| Size of Meters. | In Use December 31, 1896. | | | | | | | | | | Stock on Hand December 31, 1896. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Crown. | Gem. | Nash. | Deacon. | Worthington. | Union. | Venturi. | Thompson. | Hersey. | Total. | Crown. | Gem. | Nash. | Deacon. | Thompson. | Hersey. | Trident. | Total. | Totals. |
| ½-inch | 34 | | 8 | | | | | | | 42 | 3 | | 3 | | | | | 6 | 48 |
| ¾-inch | 231 | | 18 | | | | | | | 249 | 10 | | 15 | | | | | 25 | 274 |
| 1-inch | 219 | | 11 | | 1 | | | | | 231 | 51 | | 21 | | | | | 72 | 303 |
| 1½-inch | 128 | | 14 | | 2 | 1 | | | 2 | 147 | | | 14 | | | 1 | 3 | 18 | 165 |
| 2-inch | 162 | 94 | | | | | | | | 256 | 5 | 8 | | | | | | 13 | 269 |
| 3-inch | 62 | 84 | | | | | | 2 | | 148 | | 1 | | | 2 | | 5 | 8 | 156 |
| 4-inch | 45 | 175 | | 1 | | | | | | 221 | | 7 | | 1 | | | | 8 | 229 |
| 6-inch | 4 | 23 | | 6 | | | | | | 33 | 1 | 2 | | 4 | | | | 7 | 40 |
| 12-inch | | | | | | | 1 | | | 1 | | | | | | | | | 1 |
| 20-inch | | | | | | | 1 | | | 1 | | | | | | | | | 1 |
| 48-inch | | | | | | | 1 | | | 1 | | | | | | | | | 1 |
| Totals | 885 | 376 | 51 | 7 | 3 | 1 | 3 | 2 | 2 | 1,330 | 70 | 18 | 53 | 5 | 2 | 1 | 8 | 157 | 1,487 |

Note.—One 1-inch Crown; three ½-inch Crown; eight 2-inch Crown, and two 4-inch Crown Meters are dismantled, and do not show in above table.
One 1½-inch Crown Meter was omitted in stock December 31, 1895.

## *Distribution Expenses*—Continued.

| Material and Labor. | First District. | Second District. | Third District. | Fourth District. | Fifth District. | Sixth District. | Distribution. | Meter Shops | Main Office. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| Lumber | $2,404 12 | $648 76 | $1,854 00 | $351 56 | $166 47 | $740 12 | ........ | $362 11 | ........ | $6,527 14 |
| Hay, feed, etc. | 777 89 | 897 32 | 625 21 | 609 45 | 124 48 | 55 88 | ........ | 41 19 | ........ | 3,131 42 |
| Stable supplies | 320 34 | 246 69 | 291 04 | 493 94 | 12 17 | 13 85 | ........ | ........ | ........ | 1,378 03 |
| Stable repairs | 73 54 | 157 15 | 154 60 | 269 75 | 11 65 | 5 20 | ........ | ........ | ........ | 671 89 |
| Stable medicines | 72 00 | 78 10 | 50 00 | 19 28 | ........ | ........ | ........ | ........ | ........ | 219 38 |
| Stable shoeing | 141 25 | 112 00 | 178 75 | 131 00 | 27 00 | 36 00 | ........ | ........ | ........ | 626 00 |
| Supplies, stationery | 280 78 | 175 35 | 419 77 | 345 68 | 28 88 | 115 56 | $312 58 | 411 29 | 1,716 39 | 3,866 28 |
| Wages { Per diem | 23,476 89 | 32,696 36 | 67,390 81 | 62,409 89 | 25,207 23 | 42,288 30 | 3,805 50 | 9,679 00 | 3,232 13 | 270,177 11 |
| Wages { Salary | 4,622 55 | 5,914 44 | 6,764 00 | 1,950 09 | 1,739 00 | 3,212 51 | ........ | ........ | ........ | 24,202 59 |
| Total cost of labor and material on account of distribution | 35,389 69 | 48,302 36 | 83,056 43 | 78,137 99 | 30,706 31 | 52,824 02 | 118,541 82 | 21,122 30 | 5,315 79 | 473,396 71 |
| Building and grounds | ........ | 681 55 | 4,339 61 | 3,647 77 | 6,981 02 | 2,564 60 | ........ | 1,092 00 | ........ | 19,306 55 |
| Fairmount Park Trolley Railway | ........ | *2,388 07 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 2,388 07 |
| Bureau of Survey { Bridge over Frankford creek | ........ | ........ | 184 37 | ........ | ........ | ........ | ........ | ........ | ........ | 184 37 |
| Bureau of Survey { Pennsylvania avenue Subway | ........ | ........ | ........ | 132 12 | ........ | ........ | ........ | ........ | ........ | 132 12 |
| Total labor and material | $35,389 69 | $51,371 98 | $87,580 41 | $81,917 88 | $37,687 33 | $55,388 62 | $118,541 82 | $22,214 30 | $5,315 79 | $495,407 82 |

* Note—$1,778.25 of this amount was paid direct to employees by the contractors.

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*Summary of Work done in Connection with the Distribution, 1896.*

| | Feet. | Pounds. |
|---|---|---|
| New pipe laid during 1896 | 196,839 | 12,925,472 |
| Repairs and Relays during 1896 | 144,398 | 5,637,164 |
| Total | 341,237 | 18,562,636 |
| Pipe in use December 31, 1896 | 6,399,661 | 418,883,161 |
| Repairs and relays to December 31, 1896 | 1,414,434 | 53,822,631 |
| Total | 7,814,095 | 472,705,792 |

| | |
|---|---|
| Additional stops | 1,114 |
| Additional fire hydrants | 586 |
| Fire hydrants in use | 10,624 |
| Meters in use | 1,330 |
| Service attachments | 7,860 |

# APPENDIX D.

## REPORT

OF THE

## Superintendent of the Construction and Repair Shop,

TWELFTH AND REED STREETS.

**For the year 1896.**

*Philadelphia, January 8, 1897.*

MR. JOHN C. TRAUTWINE, JR.,
Chief of Bureau of Water.

DEAR SIR:—The demand on the shop for stop valves and fire hydrants was not as great during the past year as during the two preceding years; supplies of both were kept up without running the shop overtime. One thousand and thirty-nine (1,039) fire hydrants were made during the year, and two hundred and fifty-seven (257) were repaired. One thousand two hundred and fifty-nine (1,259) stop valves were made, ranging from 4 to 48-inch, the latter weighing sixteen thousand (16,000) pounds. Three (3) 20-inch, two (2) 36-inch, three (3) 48-inch rotary stop valves and two (2) 36-inch check valves were also made. Patterns were made for the new style 48-inch rotary stop valve, and one is now in course of construction at the shop. One (1) 16-inch screw cutting lathe, and one (1) 72-inch wood turning lathe were added to the stock of tools.

The fan used for blowing the blacksmith's fires having worn out, a new No. 5 Sturtevant Blower was put in its place. New galvanized blast pipe was placed over head, and connected with the forges, which gives an increased blast to the fires.

Work to the amount of fifteen thousand and ninety-eight (15,098) dollars and fifty-five (55) cents, was done for the different pumping stations and reservoirs.

I recommend that an entrance be made, in the rear of the shop, from Reed street, as it would be a great convenience in the reception of material and delivery of work.

I respectfully submit the following report in detail of the operations of the shop for the year ending December 31, 1896.

Respectfully,

JAMES H. DEAN,

*Superintendent of Shop.*

| MERCHANDISE. | DR. | |
|---|---|---|
| To stock per inventory, January 1, 1896... | $25,561 34 | |
| Bolts and nuts | 1,517 92 | |
| Hardware | 458 42 | |
| Wrought iron | 1,116 61 | |
| Steel | 1,013 80 | |
| Iron castings | 17,980 14 | |
| Brass castings | 7,313 08 | |
| Lead coatings | 612 78 | |
| Lumber | 1,265 54 | |
| Paints and brushes | 124 85 | |
| Oils and tallows | 120 78 | |
| Chandlery | 199 86 | |
| Machinery | 1,047 81 | |
| Miscellaneous | 241 69 | |
| Coal | 1,049 90 | |
| Coke | 41 40 | |
| Gum goods | 761 29 | |
| Brass fittings | 84 57 | |
| Packing | 44 84 | |
| Plug valves | 2,530 00 | |
| Lead | 1,615 57 | |
| Wages | 35,581 19 | |
| | | $100,283 38 |

| MERCHANDISE | CR. | |
|---|---|---|
| First District | $6,962 88 | |
| Second District | 11,219 54 | |
| Third District | 19,810 57 | |
| Fourth District | 11,955 02 | |
| Fifth District | 2,365 29 | |
| Sixth District | 3,881 23 | |
| | | $56,194 53 |
| Spring Garden Works | $7,378 56 | |
| Belmont Works | 1,139 87 | |
| Queen Lane Works | 2,615 76 | |
| Roxborough Works | 1,832 91 | |
| Fairmount Works | 962 06 | |
| Frankford Works | 136 50 | |
| Mount Airy Works | 27 50 | |
| East Park Reservoirs | 596 01 | |
| General buildings and grounds | 409 38 | |
| | | $15,098 55 |

| | | |
|---|---|---|
| Construction and repair shop | $359 31 | |
| | | $359 31 |
| Shop machinery | $1,080 16 | |
| | | $1,080 16 |
| Main office | $103 50 | |
| | | $103 50 |
| Meter department | $229 98 | |
| | | $229 98 |
| Old metals | $1,293 57 | |
| | | $1,293 57 |
| Fixed patterns | $346 75 | |
| | | $346 75 |
| Distribution | $803 00 | |
| | | $803 00 |
| Holmesburg Water Co | $103 00 | |
| | | $103 00 |

## *Inventory January 1, 1897.*

| | |
|---|---|
| Total Cr | $75,612 35 |
| Inventory, January 1, 1897 | 28,582 20 |
| | $104,194 55 |
| Total Dr | 100,283 38 |
| Balance | $3,911 17 |

| | | | |
|---|---|---|---|
| 38 | No. 1 fire hydrants, at $25 | | $950 00 |
| 56 | stop valves | | 2,113 00 |
| | Finished parts of fire hydrants | $1,783 00 | |
| | Finished parts of stop valves | 2,000 00 | |
| | Finished parts of rotary valves | 1,134 00 | |
| | | | $4,917 00 |
| 3 | unfinished 36-inch check valves, at $90 | | 270 00 |
| | Finished and unfinished parts | | 85 00 |
| 53 | old style stop screws | | 406 50 |
| 54 | Viney stop screws, at $2 00 | $108 00 | |
| 14 | Barton stop screws, at $3 50 | 49 00 | |
| 12 | Barton stop bonnets, at $8 00 | 96 00 | |
| | | | 253 00 |
| 294 | new style stop screws | | 1,029 00 |
| 95 | socket screws, at $1 75 | $166 25 | |
| 73 | spindles, at $1 50 | 109 50 | |
| | | | 275 75 |
| 498 | iron bands | | 1,511 25 |
| 41 | stop boxes, at $2 25 | | 92 25 |
| 301 | fire hydrant valves | | 427 50 |
| 90 | Frost valves, at $0 30 | $27 00 | |

| | | | |
|---|---|---|---|
| 250 | fire hose heads, at $1 50 | $375 00 | |
| 630 | wooden plugs, at $0 50 | 315 00 | |
| 123 | iron plugs, at $1.00 | 123 00 | |
| 1,467 | brass plugs, at $0 25 | 366 75 | |
| 21 | cast iron risers, at $2 00 | 42 00 | |
| 36 | pairs cast iron monkey legs, at $1 50. | 54 00 | |
| 35 | pairs wrought iron monkey legs, at $3 50 | 122 50 | |
| 11 | drilling machine spindles, at $6 50 | 71 50 | 1,496 75 |
| 2 | 24-inch furnaces, at $17 00 | $34 00 | |
| 10 | furnace grates, at $5 00 | 50 00 | |
| 24 | stop keys, at $5 25 | 126 00 | |
| 15 | hydrant keys, at $2 25 | 33 75 | |
| 26 | small lead pots, at $1 35 | 35 10 | |
| 7 | medium lead pots, at $1 50 | 10 50 | |
| 13 | large lead pots, at $4 00 | 52 00 | |
| 88 | Tail clamps, at $0 75 | 66 00 | 407 35 |
| 19 | air pump rod straps, at $9 50 | $180 50 | |
| 64 | air pump rod brasses, at $2 25 | 144 00 | |
| 6 | sets of gibs and keys, at $4 25 | 25 50 | |
| 8 | pressure caps, at $2 00 | 16 00 | |
| 55 | ferrule mandrils, at $1 00 | 55 00 | |
| 27 | taper reamers, at $3 50 | 94 50 | |
| 55 | flat drills, at $0 35 | 19 25 | |
| 76 | bursting wedges, at $0 25 | 19 00 | 553 75 |
| 340 | flat chisels, at $0 35 | $119 00 | |
| 128 | cape chisels, at $0 35 | 44 80 | |
| 12 | hand gouges, at $0 40 | 4 80 | |
| 23 | handle gouges, at $0 60 | 13 80 | |
| 134 | hand diamond points, at $0 40 | 53 60 | |
| 76 | handle diamond points, at $0 60 | 45 60 | |
| 44 | pipe cutters, at $0 60 | 26 40 | |
| 14 | drill sockets, at $0 35 | 4 90 | |
| 46 | sets hand caulking tools, at $2 50 | 115 00 | |
| 21 | sets handle caulking tools, at $4 50 | 94 50 | |
| 7 | steel plug wrenches, at $0 50 | 3 50 | 525 90 |
| 76,730 | pounds wrought iron, at $0 01½ | $1,150 95 | |
| 450 | pounds iron forgings, at $0 08 | 36 00 | |
| 16,665 | pounds machinery steel, at $0 02 | 333 30 | |

| | | | |
|---|---|---|---|
| 8,527 | pounds cast steel, at $0 05½ | $468 98 | |
| 994 | pounds tool steel, at $0 15 | 149 10 | |
| 409 | pounds self-hardening steel, at $0 35 | 143 15 | |
| 4,675 | pounds expansion metal, at $0 24½ | 1,145 37 | |
| 3,000 | pounds lead, at $0 03¼ | 975 00 | |
| | | | 4,401 85 |
| 110,704 | pounds stop valve castings, at $0 01 44-100 | $1,594 14 | |
| 227,050 | pounds fire hydrant castings, at $0 0158½ | 3,598 74 | |
| 21,249 | pounds loam castings, at $0 02⅜ | 504 66 | |
| 2,850 | pounds machinery castings at $0 01 49-100 | 42 46 | |
| 8,838 | pounds brass castings, at $0 10½ | 927 99 | |
| 1,221 | pounds Ajax metal, at $0 22 | 268 62 | |
| | | | 6,936 61 |
| | Hardware | $121 87 | |
| | Bolts and nuts | 803 44 | |
| | Oils and tallow | 74 10 | |
| | Paints, oils and brushes | 11 10 | |
| | Chandlery | 30 40 | |
| | Gum goods | 202 96 | |
| | Lumber | 685 87 | |
| | | | 1,929 74 |
| | Total | | $28,582 20 |

## *Articles Manufactured During 1896.*

| | | |
|---|---|---|
| 1,039 | No. 1 fire hydrants, at $25 00 | $25,975 00 |
| 44 | 4-inch stop valves, at $11 00 | 484 00 |
| 997 | 6-inch stop valves, at $12 00 | 11,964 00 |
| 19 | 8-inch stop valves, at $24 00 | 456 00 |
| 85 | 10-inch stop valves, at $31 00 | 2,635 00 |
| 84 | 12-inch stop valves, at $37 00 | 3,108 00 |
| 14 | 16-inch stop valves, at $60 00 | 840 00 |
| 7 | 20-inch stop-valves, at $95 00 | 665 00 |
| 6 | 30-inch stop valves, at $190 00 | 1,140 00 |
| 2 | 36-inch stop valves, at $275 00 | 550 00 |
| 1 | 48-inch stop valve, at $600 00 | 600 00 |
| 3 | 20-inch rotary stop valves, at $265 00 | 795 00 |
| 2 | 36-inch rotary stop valves, at $525 00 | 1,050 00 |
| 3 | 48-inch rotary stop valves, at $665 00 | 1,995 00 |
| 2 | 36-inch check valves, at $275 00 | 550 00 |
| 91 | new style plug casings, at $4 00 | 364 00 |
| 633 | stop boxes, at $2 50 | 1,582 50 |
| 1,464 | wooden plugs, at $0 50 | 732 00 |

| | | |
|---|---|---|
| 1,583 | brass plugs, at $0 25 | $395 75 |
| 266 | fire hoe heads, at $1 50 | 399 00 |
| 73 | 4-inch iron bands, at $0 75 | 54 75 |
| 309 | 6-inch iron bands, at $1 00 | 309 00 |
| 139 | 8-inch iron bands, at $3 50 | 486 50 |
| 69 | 12-inch iron bands, at $5 00 | 345 00 |
| 3 | 16-inch iron bands, at $7 50 | 22 50 |
| 16 | 20-inch iron bands, at $9 50 | 152 00 |
| 11 | 30-inch iron bands, at $15 00 | 165 00 |
| 4 | 36-inch iron bands, at $16 50 | 66 00 |
| 10 | 48-inch iron bands, at $20 00 | 200 00 |
| 93 | stop valve keys, at $5 25 | 488 25 |
| | Total | $58,569 25 |

## *Articles Delivered to Purveyor's Districts, etc.*

| | | |
|---|---|---|
| Wedge stop valves | | 1,285 |
| Rotary stop valves | | 6 |
| Check valves | | 2 |
| Fire hydrants | | 1,045 |
| Fire hydrant casings | | 91 |
| Plugs, wood | 1,379 | |
| Iron | 150 | |
| Brass | 1,109 | |
| | | 2,638 |
| Stop boxes | | 564 |
| Risers | | 331 |
| Iron bands | | 286 |
| Stop screws | | 99 |

# APPENDIX E.

## Report of Assistant in Charge of Hydrographic Work.

BUREAU OF WATER.

*Philadelphia, January 2, 1897.*

MR. JOHN C. TRAUTWINE, JR.,

Chief of Bureau.

DEAR SIR:—The following report on Hydrographic Work and data collected during the year 1896, in connection with the investigations for a future water supply is respectfully submitted.

Rainfall observations at twenty-two stations, three of which are provided with automatic rain gauges, have been continued, completing fourteen years continuous records of data relating to precipitation.

Steam-flow observations by the automatic stream gauges on the Perkiomen, Neshaminy and Tohickon streams have also been continued, completing thirteen years continuous records.

The amount of rainfall for the year ending September 30, 1896, on the area comprising the watershed of the three streams was 45.14 inches, being 3.62 inches less than the average for the past thirteen years, and 2.43 inches more than the amount for 1895.

The amount of rainfall for the year ending September

30, 1896, for seventeen stations situated in the counties of Philadelphia, Bucks, Montgomery, Berks and Chester, covering an area including the watersheds of the streams, but considerably larger, was 43.28 inches, being .85 inches less than the average annual rainfall for the past fourteen years, and 5.68 inches more than the rainfall of 1895.

From December 31, 1895, to January 1, 1897, the amount of rainfall over the same area was 42.58 inches, 3.64 less than the preceding fourteen years.

The greatest monthly rainfall during the year, on the three watersheds, 7.49 inches, occurred in July, and the least, 1.13 inches in January.

There was a deficiency in the rainfall in the months of January, April and August. The remaining months show nearly an average rainfall from those months.

A rain storm of some severity occurred on the morning of the 6th of February. The total fall of rain was about 4½ inches in 20 hours. This was preceded by a snow storm on the 3d inst., amounting to about 0.5 inch of rain. The ground at the time was frozen and nearly all this water found its way into the water courses, producing great freshets on all the small streams in Eastern Pennsylvania. The Schuylkill rose 7 feet 7 inches in 20 hours. The Perkiomen rose 15 feet 4 inches in 15 hours, the Neshaminy rose 20 feet 5 inches in 14 hours, and the Tohickon rose 13 feet 11 inches in 12 hours. This was the highest freshet on any of the streams since observations were begun thirteen years ago.

The automatic gauge on the Perkiomen was about one foot above the highest point reached by the water and was not injured in any way. This gauge was carried away by the freshet of May, 1894, and was afterward replaced and raised vertically about five feet above the former level.

The automatic gauges on the Neshaminy and Tohickon were carried away and the observers were directed to keep up the observations on temporary gauges until the automatic gauges could be replaced. The heavy parts of the gauges were found in the channels of the creeks after the high water had passed. The missing parts were replaced and some repairs made to them at the machine shop of the Bureau. The carpenter work was rebuilt and the gauges were in operation again before the first of April.

The total precipitation registered by the automatic gauge at Thirty-second and Spruce streets, for the year ending December 31, 1896, was 35.11 inches. This is collected at a point 13 feet above the ground. The total amount registered by the ground gauge was 36.98 inches, 2.41 inches more than in 1895.

The automatic gauge recorded fifteen storms in which the rate exceeded 0.25 inch per hour, and one hundred and sixteen days on which 0.01 inch or more of rain fell.

Four heavy rainfalls occurred during the year, on February 6, June 14, September 5 and September 30. The greatest amount recorded in a single storm was on February 6, when 3.74 inches fell in 15 hours and 10 minutes. The maximum fall was 0.75 in 60 minutes. The greatest amount for a short period of time occurred on September 5, when 0.75 inch fell in 15 minutes, or at the rate of 3.00 inches per hour. The amount of rain recorded at stations outside of the City exceeded that recorded by the U. S. Weather Bureau by from 10 to 30 per cent. The greatest amount recorded was 51.74 inches at Seisholtzville.

The automatic gauge at Spring Mount (or Frederick) recorded seventeen storms in which the rate exceeded 0.25 inch per hour. The greatest amount in a single storm was on February 6, when 3.88 inches fell in 21 hours and 10 minutes. The maximum fall was at the rate of 0.96 inch per hour.

The greatest amount for a short period of time was on

July 3, when 1.30 inches fell in 40 minutes, or at the rate of 1.95 inches per hour.

The automatic guage at the Forks of the Neshaminy recorded sixteen storms in which the rate exceeded 0.25 inch per hour. The greatest amount recorded in a single storm was on February 6, when 5.25 inches fell in 19 hours and 50 minutes. The maximum fall in this storm was at the rate of 1.11 inches per hour.

The greatest amount recorded for a short period of time occurred on September 17, when 1.08 inches fell in 28 minutes, or at the rate of 2.31 inches per hour.

The following tables, compiled as in previous years, accompany this report.

I. Monthly precipitation on sundry water sheds.

| | | |
|---|---|---|
| II. | Rain storms exceeding $\frac{1}{4}$ inch per hour. | Philadelphia. |
| III. | | Forks of Neshaminy. |
| IV. | | Frederick, Perkiomen Valley. |

V. Inches of rainfall flowing in Perkiomen, Neshaminy and Tohickon.

VI. Average annual yield of streams.

| | | |
|---|---|---|
| VII. | Maximum stream flow | Perkioman, Neshaminy and Tohickon. |
| VIII. | Minimum stream flow | |

IX. Monthly and daily yield of Perkiomen, Frederick and Tohickon.

It may be well to call particular attention to the following important facts which appear in the foregoing tables.

The average daily flow of the Perkiomen for the past thirteen years (the year ending September 30), was 172,176,600 gallons. The daily flow for 1896 was 103,281,686 gallons, being 45,228,175 gallons less than the flow of 1895 and 68,894,914 gallons less than the average for the past thirteen years. The rainfall on the watershed was 2.50 inches less than the average for thirteen years and yet it was 1.48 inches more than in 1895. The average inches of rainfall flowing in the stream for the past thirteen years was 23.80. The number of inches flowing during 1896 was 14.31.

The average daily flow of the Neshaminy for the past thirteen years was 152,748,326 gallons. The daily flow for the year 1896 was 94,879,848 gallons, being 49,467,-038 gallons less than the flow for 1895, and 57,864,478 gallons less than the average for the past thirteen years. The rainfall on the watershed was 1.17 inches more than 1895 and 5.32 inches less than the average for the past thirteen years. The average rainfall flowing in the stream for thirteen years was 23.037 inches. The number of inches flowing during 1896 was 14.344.

The average daily flow of the Tohickon the past thirteen years was 140,843,436 gallons. The daily flow for the year 1896 was 81,479,537 gallons, being 45,785,063 gallons less than the flow for 1896 and 59,363,899 gallons less than the average for the past thirteen years. The rainfall on the watershed was 4.56 inches more than in 1895, and 3.02 inches less than the average for the past thirteen years. The average inches of rainfall flowing in the streams for the past twelve years was 28.98. The number of inches flowing in 1896 was 16.55.

The year ending September 30th shows, for ten months, the lowest stream flow on record. The average daily flow, per square mile, of the Perkiomen for the past thirteen years was 1,123,109 gallons, of the Neshaminy 1,098,642 gallons and of the Tohickon 1,378,688 gallons. The average daily flow per square mile of these streams for ten months of the year was 297,000 gallons for the Perkiomen, 298,000 gallons for the Neshaminy, and 372,000 gallons for the Tohickon. The daily flow of the Perkiomen for the month of August was about 25,000,000 gallons per day, or 170,300 gallons per square mile per day, of the Neshaminy about 15,900,000 gallons per day, or 114,300 gallons per square mile, and that of the Tohickon 10,600,000 gallons per day, or 104,000 gallons per square mile per day.

In the report for 1895 attention was called to the discrepancy shown during the year by these streams between the amount of water flowing off and the rainfall on the watershed, the run off being less than that which, from the experience of former years, was to be expected from the observed rainfall. In 1896 the run off from December 31, 1895, to January 1, 1897, was very much less than that due to the rainfall on the area including the three watersheds and over the country immediately surrounding these. The rainfall in 1896 was 3.64 below the average and 8 inches more than that of 1895, which was eleven inches below the average. The comparison shows that 8 or more inches of rainfall must have gone into the ground storage to supply the depleted condition caused by the drought in the latter part of 1895.

In connection with this subject Mr. Thomas J. Beans, of Moorestown, N. J., who has voluntarily furnished the Bureau with valuable rainfall data, says, in his report for the year 1896: "The average yearly rainfall during the past 33 years having been 44 inches, the rainfall of 1896, 38.85 inches, of 1895, 35.90 inches, has so affected the near surface water supply that wells and springs are so low or so dry that more houses and farms are without needed water than at any time during record."

The sum of the daily records of inches of water wasted over the top of flash-boards at Fairmount dam during 1896 amounted to a total of 42 feet 4 inches, or nearly double that of 1895, which was 23 feet 5 inches. The computed flow of the Schuylkill into Flat Rock and Fairmount pools for the entire year of 1896 was 477,667,243,250 gallons, giving a daily average of 1,308,677,378 gallons.

The total flow as thus stated is made up as follows:

| | |
|---|---|
| Total flow over flash boards | 118,623,216,881 |
| Total steam pumpage | 78,733,796,401 |
| Total water pumpage | 8,959,846,128 |
| Water power (30 gallons to pump 1) | 268,795,383,840 |
| Leakage at dam and locks | 2,555,000,000 |
| Total | 477,667,243,250 |

The flow over the flash-boards was computed by Francis weir formula from the daily reported head over the flash-boards.

The steam and water pumpages are taken from the report of the General Superintendent, where they are given as deduced from plunger displacements.

The average rainfall at eighteen stations in the valley was 42.58 inches, of which about 15 inches are computed as flowing in the stream. The greatest monthly flow occurred in February and the least in June. The greatest daily flow was on February 6th, when 48 2-3 inches were recorded as wasting over the flash-boards for 24 hours.

The average flow of the Delaware at Philadelphia during June, July, August, September and October, 1895, as estimated by the United States Engineer's Office here, from its gaugings above Trenton was 333,333 cubic feet per cubic feet per minute, or 3,360 million gallons per day.

The following-named persons have served as observers and rodmen during the entire year:

John G. Hilsman, rodman and gauge observer, Rush Valley P. O.

George W. Wood, rodman and gauge observer, Spring Mount, Pa.

A. F. Stover, gauge observer, Point Pleasant, Pa.

Dr. George M. Grim, gauge observer, Ottsville.

George Lowder, gauge observer, Smith's Corner.

Dr. J. A. Roth, gauge observer, Seisholtzville.

A. W. Walton, gauge observer, Doylestown.

H. L. Shull, gauge observer, Lansdale.

The Bureau is indebted to the following-named persons who have kindly furnished rainfall records:

Mr. Thomas MacKellar, Germantown, Pa.

Mr. J. L. Heacock, Quakertown, Pa.

L. M. Dey, United States Weather Bureau.

Mr. Benjamin Shoemaker, Pennsylvania Hospital, Philadelphia.

Mr. E. F. Smith, Chief Engineer of Canals, Reading, Pa.

Mr. Thomas J. Beans, Moorestown, N. J.

Dr. Charles Moore, Pottstown, Pa.

During 1896 all observations on rainfall were taken uniformly in accordance with the instructions given at the beginning of the year.

Respectfully,

JOHN E. CODMAN,

In charge of Hydrographic Work.

# TABLE II.

*Rain Storms exceeding in rate 0.25 inches per hour, as recorded by the Automatic Rain Gauge at Philadelphia for the year 1896.*

| Date of Observation, 1896. | AUTOMATIC RAIN GAUGE. | | | | | Remarks. |
|---|---|---|---|---|---|---|
| | TOTAL FALL. | | MAXIMUM FALL. | | | |
| | Amount in Inches. | Duration in Hr. Min. | Amount in Inches. | Duration in Minutes. | Rate per hour during maximum fall. | |
| January 24th, rain storm | 1.57 | 27—20 | .25 | 40 | .375 | |
| February 6th, rain storm | 3.74 | 15—10 | .75 | 60 | .75 | |
| April 21st, shower | .32 | 2—30 | .16 | 15 | .64 | |
| May 3d, rain storm | .90 | 6—10 | .65 | 25 | 1.80 | |
| May 14th, shower | .30 | 1—20 | .20 | 25 | .52 | |
| June 9th, rain storm | .84 | 1—40 | .78 | 40 | 1.17 | |
| June 14th, rain storm | 2.42 | 16—05 | .40 | 40 | .60 | |
| June 25th, rain storm | .53 | 8—40 | .25 | 20 | .75 | |
| July 22d, rain storm | .81 | 15—30 | .45 | 20 | 1.35 | |
| July 27th, shower | .82 | 1—45 | .72 | 30 | 1.44 | |
| July 30th, shower | .40 | 1—5 | .35 | 10 | 2.10 | |
| September 5th, rain storm | 1.68 | 10—5 | .75 | 15 | 3.00 | |
| September 16th, rain storm | .54 | 13—50 | .20 | 15 | .80 | |
| September 19th, shower | .37 | 4—15 | .10 | 10 | .60 | |
| September 30th, rain storm | 1.12 | 12—10 | .15 | 10 | .90 | |

# TABLE III.

*Rain Storms exceeding in rate 0.25 inches per hour, as recorded by the Automatic Rain Gauge at Forks of Neshaminy for the Year 1896.*

| Date of Observations, 1896. | AUTOMATIC RAIN GAUGE. | | | | | Remarks |
|---|---|---|---|---|---|---|
| | TOTAL FALL. | | MAXIMUM FALL. | | | |
| | Amount in inches. | Duration in Hr. Min. | Amount in inches. | Duration in minutes. | Rate per hour during maximum fall. | |
| February 6, rain storm | 5.25 | 19—50 | .65 | 35 | 1.11 | |
| February 29, rain storm | 1.61 | 13—15 | .20 | 10 | 1.20 | |
| March 19, rain storm | 1.89 | 16—10 | .27 | 24 | .50 | |
| April 21, shower | .65 | 2—00 | .45 | 60 | .45 | |
| May 3, shower | .64 | 2—25 | .39 | 25 | .93 | |
| May 11, shower | .37 | 25 | .37 | 25 | .83 | |
| May 26, rain storm | 1.01 | 5—05 | .27 | 24 | .62 | |
| June 9, shower | .34 | 2—05 | .25 | 28 | .53 | |
| June 14, rain storm | 2.07 | 3—15 | .45 | 60 | .45 | |
| July 22, rain storm | 1.73 | 14—00 | .20 | 15 | .80 | |
| July 24, rain storm | .32 | 12—40 | .20 | 15 | .80 | |
| July 27, shower | .60 | 2—00 | .30 | 20 | .90 | |
| July 29, shower | .84 | 1—20 | .15 | 10 | .90 | |
| September 5, rain storm | 3.44 | 18—30 | 2.20 | 80 | 1.65 | |
| September 17, shower | 1.49 | 3—00 | 1.08 | 28 | 2.31 | |
| September 19, shower | 1.44 | 4—45 | 1.20 | 52 | 1.40 | |

# TABLE IV.

*Rain Storms, exceeding in rate 0.25 inches per hour, as recorded by the Automatic Rain Gauge at Frederick for the year 1896.*

| Date of Observations, 1896. | AUTOMATIC RAIN GAUGE. | | | | | Remarks. |
|---|---|---|---|---|---|---|
| | TOTAL FALL. | | MAXIMUM FALL. | | | |
| | Amount in inches. | Duration, Hrs. Min. | Amount in inches. | Duration in Minutes. | Rate per hour during maximum fall. | |
| February 6th, rain gauge | 3.88 | 21—10 | .40 | 25 | .96 | Thunder shower. |
| March 19th, rain gauge | 1.08 | 15—30 | .20 | 12 | 1.00 | |
| April 21st, shower | .84 | 2—45 | .51 | 35 | .87 | |
| May 19th rain guage | .45 | 5—00 | .20 | 12 | 1.00 | |
| May 28th, rain gauge | .81 | 4—15 | .35 | 24 | .88 | |
| June 17th, shower | .61 | 1—10 | .45 | 28 | .96 | |
| June 21st, shower | .59 | 3—00 | .20 | 12 | 1.00 | |
| June 27th, shower | .63 | 1—40 | .35 | 24 | .88 | |
| July 3d, shower | 1.30 | .40 | 1.30 | 40 | 1.95 | |
| July 7th, shower | .61 | 1—20 | .30 | 12 | 1.50 | |
| July 9th, rain storm | 1.82 | 6—45 | .75 | 30 | 1.50 | |
| July 22d, rain storm | .73 | 11—00 | .30 | 20 | .90 | |
| July 22d, rain storm | 1.55 | 3—5 | .85 | 55 | .92 | |
| July 27th, shower | .47 | 1—56 | .20 | 15 | .80 | |
| July 29th, shower | .61 | 4—45 | .20 | 15 | .80 | |
| September 6th, rain storm | 3.06 | 16—45 | .45 | 15 | 1.80 | |
| September 30th, rain storm | 1.66 | 11—00 | .20 | 10 | 1.20 | |

# TABLE V.

*Inches of Rainfall Flowing in the Perkiomen, Neshaminy and Tohickon Creeks.*

| Watersheds. | Area in Miles. | Percentage of Total Area. | | | | Average for 13 Years, (1883–1896). | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Woodland. | Cultivated. | Flats. | Roads. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
| Perkiomen at Frederick, 13 years....... | 152. | 25 | 71 | 2 | 2 | 3.12 | 3.67 | 3.88 | 2 25 | 1.16 | 0.92 | 1.39 | 1.03 | 1.06 | 0.96 | 1.71 | 1.99 | 23.79 |
| Neshaminy, below Forks, 13 years...... | 139.3 | 6 | 92 | ½ | 2 | 3.58 | 4.20 | 3.82 | 2.10 | 1.02 | 0.69 | 0.99 | 0.88 | 0.94 | 0.75 | 1.53 | 2.17 | 23.03 |
| Tohickon, 13 years................................. | 102.2 | 24 | 72 | 2 | 2 | 4.17 | 4.93 | 4.77 | 2.61 | 2.04 | 0.90 | 1.37 | 1.27 | 1.37 | 0.95 | 2.12 | 2.50 | 28.98 |
| Perkiomen at Frederick......... Maximum, 13 years.................................. | | | | | | 5.40 | 9.73 | 5.58 | 3.48 | 6.66 | 2.65 | 4.89 | 2.48 | 3.68 | 2.36 | 6.67 | 3.77 | |
| Perkiomen at Frederick......... Minimum, 13 years.................................. | | | | | | 0.59 | 1.25 | 2.38 | 0.97 | 0.46 | 0.28 | 0.17 | 0.28 | 0.16 | 0.20 | 0.34 | 0.91 | |
| Neshaminy, below Forks......... Maximum, 13 years.................................. | | | | | | 6.77 | 10.44 | 5.55 | 3.57 | 7.41 | 1.67 | 5.47 | 3.37 | 3.51 | 2.55 | 6 31 | 4.56 | |
| Neshaminy, below Forks......... Minimum, 13 years.................................. | | | | | | 1.60 | 0.90 | 1.84 | 1 03 | 0.35 | 0.08 | 0.04 | 0.14 | 0.03 | 0.06 | 0.11 | 0.41 | |
| Tohickon .............................. Maximum, 13 years.................................. | | | | | | 7.34 | 10.41 | 6.37 | 4.76 | 8.58 | 3.43 | 6.41 | 3.75 | 5.49 | 3.54 | 7.97 | 4.28 | |
| Tohickon .............................. Minimum, 13 years.................................. | | | | | | 0.54 | 1.19 | 2.98 | 0.73 | 0.30 | 0.08 | 0.11 | 0.10 | 0.04 | 0.05 | 0.14 | 0.67 | |

## Table VI—*Average Annual Yield of Sundry Wa'ersheds to October 1, 1896.*

| Watersheds. | Period covered, years. | Area in miles. | Average rainfall in inches. | Average rainfall flowing off in inches. | Per cent. flowing off. | Average annual yield in gallons. | Average daily yield in gallons. | Average yield in cubic feet per second per square mile of drainage area. | Average yield in cubic feet per second per square mile of drainage area for each inch of rainfall. |
|---|---|---|---|---|---|---|---|---|---|
| Perkiomen at Frederick | 13 | 152.0 | 48.047 | 23.799 | 49.505 | 62,862,919,723 | 172,176,600 | 1.753 | 0.0364 |
| Neshaminy, below Forks | 13 | 139.3 | 47.984 | 23.037 | 48.010 | 55,765,906,900 | 152,748,326 | 1.696 | 0.0353 |
| Tohickon | 13 | 102.2 | 50.251 | 28.980 | 55.680 | 51,464,789,606 | 140,843,436 | 2.132 | 0.0424 |
| Sudbury, Mass. | 21 | 75.2 | 45.845 | 22.328 | 48.000 | 29,149,776,000 | 79,862,400 | 1.644 | 0.0360 |
| Croton, N. Y. | 17 | 338.0 | 45.970 | 22.760 | 49.500 | 135,400,000,000 | 371,600,000 | 1.680 | 0.0365 |

## Table VII—*Minimum Stream Flow.*

| Stream. | Minimum Flow Previous to 1896. | | Minimum Flow, 1896. | |
|---|---|---|---|---|
| | Cubic feet per 24 hours. | Date. | Cubic feet per 24 hours. | Date. |
| Perkiomen at Frederick | 518,400 | September 15, 1895. | 457,920 | October 6, 1895. |
| Neshaminy, below Forks | 108,864 | September 28, 1885. | 380,160 | October 3, 1895. |
| Tohickon | 17,280 | July 23, 1885. | 207,360 | October 5, 1895. |

## Table VIII—*Maximum Stream Flow.*

| Stream. | Maximum Flow Previous to 1896. | | Maximum Flow, 1896. | |
|---|---|---|---|---|
| | Cubic feet per 24 hours. | Date. | Cubic feet per 24 hours. | Date. |
| Perkiomen at Frederick | 757,641,600 | May 21, 1894. | 586,543,680 | February 6, 1896. |
| Neshaminy, below Forks | 778,619,520 | May 21, 1894. | 752,284,800 | February 6, 1896. |
| Tohickon | 747,351,360 | May 21, 1894. | 562,896,000 | February 6, 1896. |

# PRECIPITATION AND STREAM FLOW ON PERKIOMEN, NESHAMINY AND TOHICKON WATERSHEDS.

| Date, 1895. | PERKIOMEN, AT FREDERICK. Area of Watershed, 152 Square Miles. Rainfall in inches. | Inches of rainfall flowing off. | Percentage flowing off | Monthly yield of stream. Cubic feet. | Average daily yield of stream. Cubic feet. | Average daily yield of stream. Gallons. | Average yield in cubic feet per second per square mile. |
|---|---|---|---|---|---|---|---|
| October | 3.460 | 0.231 | 7 | 84,269,6 0 | 2,272,600 | 20,358,986 | 0.207 |
| November | 1.875 | 0.337 | 20 | 132,960,960 | 4,432,032 | 33,153,899 | 0.337 |
| December | 3.125 | 0.912 | 29 | 322,116,480 | 10,390,854 | 77,728,985 | 0.791 |
| 1896. | | | | | | | |
| January | .910 | .593 | 65 | 209,615,040 | 6,761,800 | 50,581,776 | 0.515 |
| February | 5.965 | 3.501 | 59 | 1,236,401,280 | 42,634,527 | 318,928,408 | 3.246 |
| March | 4.430 | 3.826 | 86 | 1,350,976,320 | 43,579,900 | 326,000,289 | 3.318 |
| April | 1.845 | 0.968 | 51 | 341,798,400 | 11,393,280 | 85,227,652 | 0.868 |
| May | 3.705 | 0.462 | 12 | 163,166,400 | 5,438,880 | 40,685,345 | 0.414 |
| June | 4.535 | 0.479 | 15 | 169,283,520 | 5,642,784 | 42,210,953 | 0.430 |
| July | 9.310 | 2.002 | 21 | 706,916,160 | 22,803,747 | 170,584,371 | 1.736 |
| August | 1.205 | 0.339 | 28 | 107,300,160 | 3,461,296 | 25,892,291 | 0.263 |
| September | 5.180 | 0.647 | 12 | 228,467,520 | 7,615,584 | 56,968,524 | 0.580 |
| Totals | 45.545 | 14.311 | 31 | 5,053,271,840 | 13,806,754 | 103,281,686 | 1.051 |
| October | 4.715 | 1.475 | 30 | 521,095.680 | 16,809,538 | 125,744,069 | 1.286 |
| November | 4.715 | 2.058 | 44 | 726,840,000 | 24,228,000 | 181,238,022 | 1.845 |
| December | 0.645 | 0 808 | 125 | 285,500,160 | 9,209,682 | 68,893,205 | 0.701 |
| Totals for 1896 | 47.160 | 17.125 | 36 | 6,047,360,640 | 16,568,111 | 123,938,069 | 1.261 |

| Date, 1895. | NESHAMINY, BELOW FORKS. Area of Watershed, 139 3 Square Miles. Rainfall in inches. | Inches of rainfall flowing off. | Percentage flowing off, | Monthly yield of stream. Cubic feet. | Average daily yield of stream. Cubic feet. | Average daily yield of stream. Gallons. | Average yield in cubic feet per second per square mile. |
|---|---|---|---|---|---|---|---|
| October | 3.256 | 0.082 | 3 | 26,602,560 | 858,147 | 6,419,386 | 0.071 |
| November | 2.206 | 0.110 | 5 | 35,562,240 | 1,185,408 | 8,867,468 | 0.100 |
| December | 1,853 | 0.401 | 22 | 129,885,120 | 4,189,842 | 31,342,193 | 0.348 |
| 1896. | | | | | | | |
| January | 1.313 | .590 | 45 | 190,762,560 | 6,153,631 | 46,032,357 | 0.511 |
| February | 7.787 | 4.733 | 61 | 1,531,440,000 | 52,808,280 | 395,023,367 | 4.388 |
| March | 5.093 | 4.373 | 86 | 1,415,292,480 | 45,654,600 | 341,520,103 | 3.793 |
| April | 1.626 | 1.067 | 65 | 345,427,200 | 11,514,240 | 86,132,403 | 0.956 |
| May | 2.853 | 0.381 | 13 | 123,189,120 | 3,973,842 | 29,747,401 | 0.330 |
| June | 4.700 | 0.404 | 9 | 130,913,280 | 4,363,776 | 32,643,309 | 0.363 |
| July | 5.120 | 1.040 | 20 | 336,528,000 | 10,855,742 | 81,206,589 | 0.904 |
| August | 0.976 | 0.204 | 21 | 65,983,680 | 2,128,506 | 15,922,329 | 0.177 |
| September | 5.880 | 0.960 | 16 | 310,608,000 | 10,353,600 | 77,450,306 | 0.860 |
| Totals | 42.663 | 14.344 | 35 | 4,642,194,240 | 12,683,591 | 94,879,818 | 1.005 |
| October | 2.636 | 0.928 | 30 | 300,844,800 | 9,704,670 | 72,595,973 | 0.806 |
| November | 4.130 | 1.524 | 37 | 493,188,480 | 16,439,616 | 122,976,860 | 1.336 |
| December | 0.846 | 0.755 | 89 | 244,339,200 | 7,881,910 | 58,960,781 | 0.655 |
| Totals for 1896 | 42.960 | 16.960 | 39 | 5,488,516,800 | 15,037,032 | 112,484,804 | 1.249 |

| Date, 1895. | TOHICKON. Area of Watershed, 102.2 Square Miles. Rainfall in inches. | Inches of rainfall flowing off. | Percentage flowing off. | Monthly yield of stream. Cubic feet. | Average daily yield of stream. Cubic feet. | Average daily yield of stream. Gallons. | Average yield in cubic feet per second per square mile. |
|---|---|---|---|---|---|---|---|
| October | 3.855 | 0.093 | 2 | 21,980,160 | 709,037 | 5,303,911 | 0.080 |
| November | 2.110 | 0.135 | 5 | 51,986,880 | 1,732,896 | 12,962,962 | 0.196 |
| December | 2.510 | 0.667 | 26 | 158,423,040 | 5,110,421 | 38,228,594 | 0.579 |
| 1896. | | | | | | | |
| January | 1.180 | 0.537 | 45 | 127,491,840 | 4,112,963 | 30,767,098 | 0.466 |
| February | 7.895 | 4.586 | 58 | 1,088,712,800 | 37,541,821 | 280,822,323 | 4.252 |
| March | 5.437 | 5.478 | 100 | 1,300,622,400 | 41,955,561 | 313,850,391 | 4.752 |
| April | 1.475 | 0.731 | 50 | 173,586,240 | 5,786,208 | 43,283,839 | 0.655 |
| May | 3.178 | 0.303 | 9 | 72,003,060 | 2,322,680 | 17,375,284 | 0.268 |
| June | 4.070 | 0.176 | 4 | 41,791,680 | 1,393,056 | 10,420,782 | 0.158 |
| July | 8.055 | 2.539 | 31 | 602,881,920 | 19,447,804 | 145,129,869 | 2.202 |
| August | 1.630 | 0.185 | 11 | 44,003,520 | 1,419,533 | 10,618,844 | 0.161 |
| September | 5.830 | 1.122 | 29 | 266,474,880 | 8,882,496 | 66,445,683 | 1.006 |
| Totals | 47.225 | 16.552 | 35 | 3,949,958,420 | 10,792,236 | 81,479,537 | 1.222 |
| October | 2.672 | 1.064 | 40 | 252,668,160 | 8,150,586 | 60,970,617 | 0.923 |
| November | 4.082 | 2.340 | 57 | 555,370,560 | 18,512,352 | 138,482,001 | 2.096 |
| December | 0.940 | 0.801 | 85 | 190,114,560 | 6,132,728 | 45,876,191 | 0.694 |
| Totals for 1896 | 46.444 | 19.861 | 42 | 4,715,721,620 | 12,919,785 | 96,646,702 | 1.463 |

## Table 1.

*Monthly Precipitation on Sundry Watersheds, Compared with U. S. Weather Bureau Observations at Philadelphia, 1896.*

Elevations are in Feet Above Sea Level.

| | Philadelphia Series. | | | | | Schuylkill Series. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | U. S. Weather Bureau. | Water Bureau, Automatic. | Water Bureau, Ground Gauge. | Pennsylvania Hospital. | Germantown. | Lebanon. | Reading. | Pottstown. | Browers. | Hamburg. |
| Elevation | 207 | 66 | 49 | 25 | 368 | 480 | 207 | 150 | 86 | 365 |
| 1896. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. |
| January | 1.57 | 1.73 | 1.88 | 1.90 | 1.41 | 1.11 | 1.08 | 1.97 | 1.27 | 0.80 |
| February | 6.87 | 6.56 | 6.67 | 6.11 | 7.11 | 6.31 | 4.88 | 7.00 | 6.65 | 4.68 |
| March | 4.11 | 4.40 | 4.77 | 4.63 | 4.98 | 5.29 | 4.85 | 5.39 | 5.09 | 5.02 |
| April | 1.10 | 1.28 | 1.29 | 1.31 | 1.52 | 1.29 | 1.10 | 1.83 | 1.40 | 2.05 |
| May | 2.27 | 2.23 | 2.40 | 3.04 | 2.47 | 4.54 | 1.78 | 3.07 | 3.37 | 4.96 |
| June | 4.05 | 5.19 | 5.29 | 4.58 | 5.06 | 4.51 | 2.85 | 3.01 | 3.51 | 4.03 |
| July | 3.27 | 3.02 | 3.18 | 3.66 | 4.47 | 6.38 | 3.92 | 6.30 | 5.36 | 6.00 |
| August | 0.46 | 0.54 | 0.61 | 0.45 | 0.78 | 0.56 | 0.48 | 0.55 | 0.74 | 1.96 |
| September | 2.76 | 3.91 | 4.14 | 3.02 | 5.13 | 2.92 | 3.66 | 6.33 | 8.57 | 4.84 |
| October | 2.08 | 2.68 | 2.68 | 2.18 | 3.00 | 4.70 | 2.81 | 3.95 | 3.47 | 4.25 |
| November | 2.50 | 2.70 | 3.27 | 2.43 | 3.70 | 4.76 | 3.45 | 4.28 | 3.56 | 4.75 |
| December | 1.00 | 0.87 | 0.89 | 1.04 | 1.25 | 0.68 | 0.40 | 0.63 | 0.69 | 0.97 |
| Total | 32.04 | 35.11 | 36.98 | 34.35 | 40.88 | 43.05 | 31.26 | 44.31 | 43.68 | 44.31 |
| Percentage | 100 | 109 | 115 | 107 | 128 | 134 | 98 | 138 | 136 | 138 |
| 14 years yearly average. Inches | 38.13 | 39.35 | 41.57 | 43.61 | 47.30 | 45.52 | 42.86 | 48.77 | 43.21 | 43.47 |
| 14 years yearly average. Percentage | 100 | 103 | 107 | 114 | 124 | 119 | 112 | 127 | 110 | 114 |
| Average deficiency or increase, 1896 | 6.09 | 4.24 | 4.59 | 9.26 | 6.42 | 2.47 | 11.60 | 4.46 | 0.47 | 0.84 |
| Percentage deficiency or increase | 16.0 | 10.8 | 11.0 | 21.2 | 13.6 | 5.4 | 27. | 9.2 | 1.1 | 1.9 |

| | Perkiomen Series. | | Delaware Series. | | | Tohickon Series. | | | | Neshaminy Series. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seisholtsville. | Frederick. | Easton. | Moorestown. | West Chester. | Ottsville. | Quakertown. | Smith's Corner. | Point Pleasant. | Lansdale. | Forks of Neshaminy. | Doylestown. |
| Elevation | 870 | 300 | 340 | 65 | 455 | 390 | 536 | 480 | 119 | 350 | 143 | 405 |
| 1896. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. | Precipitation. |
| January | 1.09 | 0.83 | 1.03 | 2.81 | 1.87 | 0.87 | 1.30 | 1.23 | 1.32 | 1.11 | 1.80 | 1.03 |
| February | 6.11 | 5.82 | 6.24 | 6.41 | 6.77 | 7.41 | 7.29 | 8.13 | 8.75 | 6.81 | 9.08 | 7.47 |
| March | 4.58 | 4.28 | 3.99 | 6.13 | 5.42 | 4.96 | 4.67 | 5.57 | 6.55 | 4.65 | 5.59 | 5.04 |
| April | 1.81 | 1.88 | 1.23 | 1.25 | 1.49 | 1.41 | 1.61 | 1.49 | 1.39 | 1.42 | 1.81 | 1.65 |
| May | 4.69 | 2.72 | 4.41 | 2.77 | 1.58 | 3.85 | 2.91 | 3.14 | 2.81 | 2.73 | 3.16 | 2.67 |
| June | 3.83 | 5.24 | 3.98 | 4.48 | 5.84 | 3.36 | 3.03 | 4.55 | 5.34 | 5.57 | 4.46 | 4.07 |
| July | 10.86 | 7.74 | 10.28 | 3.12 | 3.54 | 9.69 | 8.20 | 7.21 | 7.12 | 5.40 | 4.62 | 5.31 |
| August | 1.75 | 0.66 | 3.47 | 0.76 | 0.95 | 0.45 | 0.67 | 2.20 | 3.20 | 0.83 | 0.78 | 1.32 |
| September | 5.18 | 5.18 | 4.49 | 4.15 | 6.91 | 6.95 | 7.04 | 6.09 | 3.24 | 3.10 | 8.65 | 5.89 |
| October | 5.38 | 4.05 | 2.38 | 2.54 | 2.14 | 2.55 | 3.50 | 2.39 | 2.25 | 3.55 | 2.17 | 2.19 |
| November | 5.63 | 3.80 | 4.46 | 3.18 | 4.17 | 4.17 | 4.51 | 4.28 | 3.37 | 3.88 | 4.55 | 3.96 |
| December | 0.83 | 0.56 | 0.49 | 1.25 | 0.59 | 1.89 | 0.79 | 0.82 | 1.25 | 0.75 | 0.72 | 1.07 |
| Total | 51.74 | 42.76 | 46.45 | 38.85 | 41.27 | 47.56 | 45.52 | 47.10 | 46.59 | 39.80 | 47.39 | 41.70 |
| Percentage | 161 | 133 | 145 | 121 | 129 | 149 | 142 | 147 | 145 | 124 | 148 | 130 |
| 14 years yearly average. Inches | 50.26 | 46.51 | 46.78 | 45.59 | 51.81 | 49.49 | 49.60 | 50.28 | 50.41 | 46.30 | 48.25 | 47.31 |
| 14 years yearly average. Percentage | 131 | 122 | 122 | 119 | 136 | 1.9 | 130 | 132 | 132 | 121 | 127 | 124 |
| Average deficiency or increase, 1896 | 1.48 | 3.75 | 0.33 | 6.74 | 10.54 | 1.93 | 4.08 | 3.18 | 3.82 | 6.50 | 0.86 | 5.61 |
| Percentage deficiency or increase | 2.8 | 8.0 | 0.7 | 14.8 | 20.3 | 3.9 | 8.2 | 6.3 | 7.6 | 14. | 1.8 | 11.9 |

# APPENDIX F.

## Report of Chief Draftsman.

BUREAU OF WATER.

*January 25, 1897.*

MR. JOHN C. TRAUTWINE, JR.,
Chief of Bureau.

SIR:—The following report of work under my charge in the drafting room for the year 1896 is respectfully submitted.

One hundred and seventy-seven drawings relating to the design and construction of buildings, boilers, engines, reservoirs, intakes and conduits have been made and recorded.

Many of these drawings required much labor and time in perfecting them and included the following:

| Subjects. | No. of Drawings. |
|---|---|
| Miscellaneous castings | 10 |
| Plans of buildings, grounds, etc | 13 |
| Plans and details of reservoirs | 6 |
| Special machinery | 14 |
| Detail of engine and boiler | 4 |
| Illustrating various reports | 75 |
| Miscellaneous details | 25 |
| Pipe plans traced | 30 |
| Total | 177 |

Specifications for various subjects which required to be advertised were prepared.

From data prepared by the Boiler Inspectors about two hundred and twenty-two calculations for boiler horse power were made. From these calculations are determined the water rents to be paid by owners of steam boilers using city water.

During the year the photographer employed by the Bureau and detailed to this department made about 3,000 blue-prints of various parts of machinery, detail plans, etc., which were used at the machine shop and stations. About 400 photographs were also made, which included views of breaks in water pipes at Tweny-ninth street and Allegheny avenue on January 8, at Thirty-third and Queen streets on March 14, and at Thirty-third and Oxford streets on July 11, also of Roxborough reservoir, showing condition of same and repairs needed, of Queen reservoir, showing work of relining, etc., of Fairmount reservoir, before, during and after repairs of banks, etc., of Mt. Airy reservoir, showing condition of same after water was drawn off, and of repairs to same, of pipe at Fifty-fourth street and Girard avenue, showing cut at foot of George's Hill, of Park trolley line, of low water at Fairmount dam on September 3, of high water in Neshaminy creek, at Rushland, Pa., on February 6, and views taken at Fox Chase, Lawndale, and Bridesburg.

As Chief Draughtsman I designed and superintended the construction of a measuring trough and weir at the Frankford reservoir for use in testing the 15 million gallon pump at the Frankford Station.

Accompanying this report is a side elevation showing the relative position of the trough, the pumping main and the reservoir banks, also a sectional view showing the construction of the weir. The weir has also been used for testing the accuracy of the 48-inch Venturi meter.

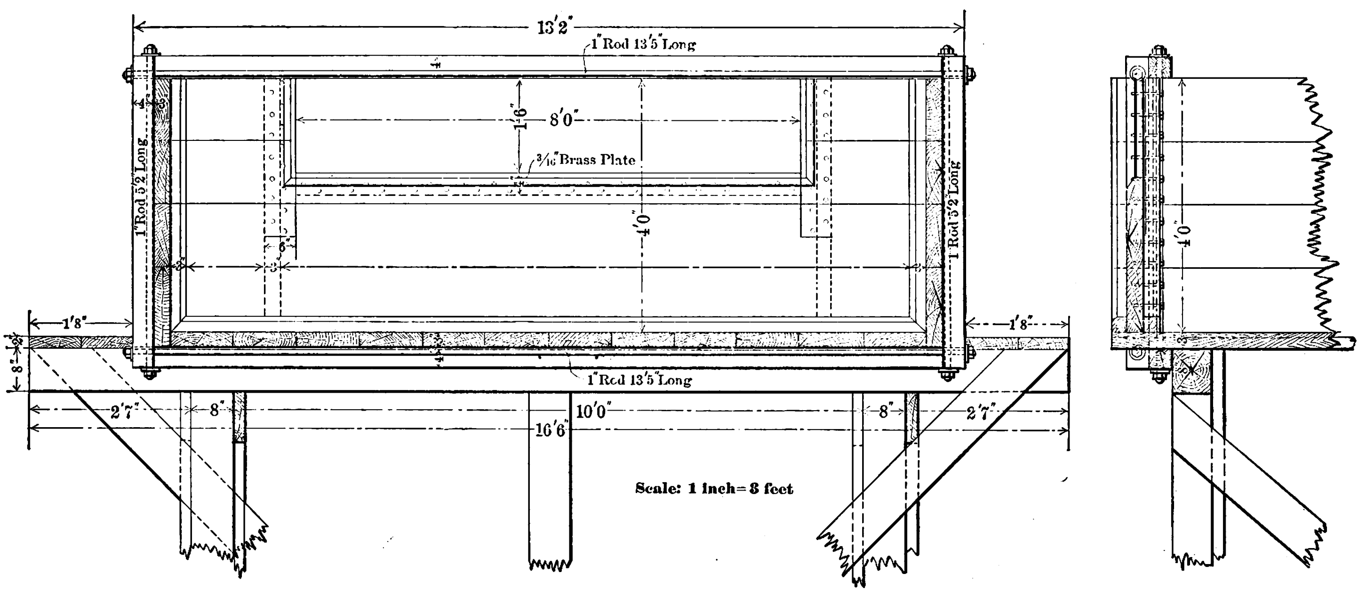
Observations were made on both weir and Venturi meter on November 18, 19, 20, 23 and 24 by Professor Spangler, of the University of Pennsylvania, and members of his class in engineering. The results of these observations are given in a report to you by Professor Spangler, in which he says: "It appears from these results that the Venturi meter, properly adjusted, can be made to read practically identically with the weir, and as this is the only method we have of determining the accuracy of the Venturi, these experiments show that it is as accurate as the weir if properly adjusted."

During the year, in company with the General Superintendent, I visited the cities of St. Louis, Cincinnati, Louisville, Indianapolis, and Chicago for the purpose of inspecting the various pumping plants, reservoirs, etc., of those cities and to acquire information respecting the management of their water supplies. A verbal report of this visit was made to you in November last.

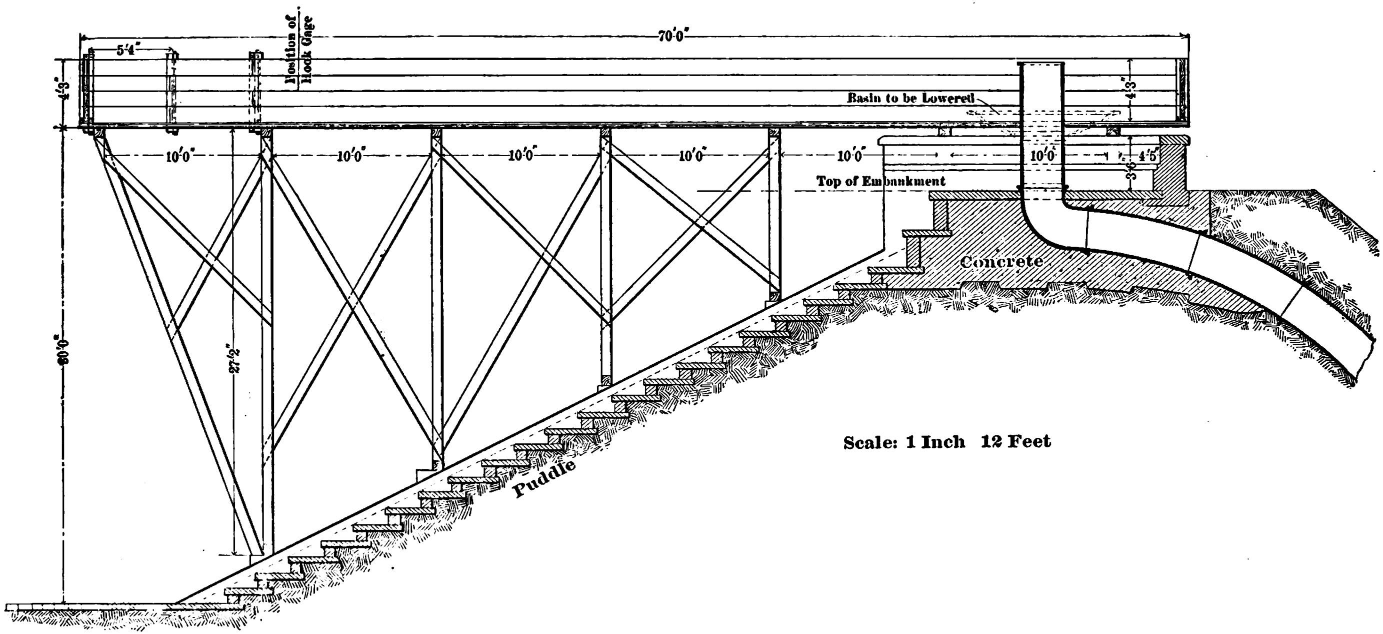
The daily pumpage chart and the daily stream flow charts for the hydrographic work have been prepared as in former years.

I am, yours respectfully,

JOHN E. CODMAN,
*Chief Draftsman.*




Scale: 1 inch= 8 feet


70'0"
5'4"
Position of Hook Gage
4'3"
Basin to be Lowered
4'3"
10'0"
10'0"
10'0"
10'0"
10'0"
10'0"
4'5"
3'6"
Top of Embankment
Concrete
30'0"
27'½"
Puddle
Scale: 1 Inch 12 Feet

# APPENDIX G.

## Propositions Respecting Future Water Supply.

An Ordinance introduced April 16, 1896, by Mr. McCoach, Select Council, and referred to Water Committee.

AN ORDINANCE

Authorizing and empowering the Mayor to enter into a contract or lease with the Philadelphia Water and Filter Company for the enlargement and purification by filtration of the water supply of Philadelphia and making necessary appropriations therefor.

SECTION 1. *The Select and Common Councils of the City of Philadelphia do ordain,* That the Mayor of the City of Philadelphia be and is hereby, authorized and directed to enter into and execute a contract or lease with the Philadelphia Water and Filter Company for the use, occupation and enjoyment of its entire property, rights, privileges and franchises, consisting (1) of all the property of whatsoever nature, kind or description formerly belonging to the Schuylkill Navigation Company, hereinafter described; and (2) certain filtering plant or plants to be erected, fully and particularly described as follows:

(Here follows a description of the Company's property.)

Together with all and singular the property of the Philadelphia Water and Filter Company, whether herein specified or not.

Also, the filtering plant or plants to be erected by the

Philadelphia Water and Filter Company, upon ground to be furnished by the City of Philadelphia, under the direction and supervision of the Department of Public Works, and upon plans and specifications to be approved by them, which filtering plant or plants shall be capable of filtering three hundred million (300,000,000) of gallons of water per day of an absolutely pure and wholesome quality.

SECT. 2. The terms and conditions of the contract or lease hereby authorized shall be as follows:

TIME TO BECOME OPERATIVE.—The said contract or lease shall be entered into and executed by the parties immediately upon the passage of this ordinance, and shall constitute from the date of its execution a binding contract upon both parties to carry out all its provisions. This ordinance and lease authorized under its provisions shall take effect and become operative as to the payment of rent, and possession of the property hereby demised shall pass to the City of Philadelphia within six months after its passage, or upon the approval of the title to the demised property in the lessor by the City Solicitor.

DURATION.—The lease shall be for the period of fifty years from the date upon which the City takes possession of the demised property.

PROPERTY LEASED.—The property hereby leased shall consist as fully described and set forth in Section 1 of this ordinance, and such other property as is required to be conveyed under the terms of this lease.

CONSIDERATION.—The rental of the said property and the payment on account of purchase money as herein provided for shall be three hundred and seventy-five thousand (375,000) dollars per annum, to be paid semi-annually in equal amounts of one hundred and eighty-seven thousand five hundred (187,500) dollars each, the first semi-annual payment to become due and payable six months from the day the City takes possession of the demised property as herein provided, and each six months thereafter until the termination of the lease.

Additional Covenants.—Said lease shall also contain the following covenants and agreements:

1. That at the expiration of said fifty years upon full payment by the City of Philadelphia of the amount of each annual rental all property, rights, privileges and franchises of whatsoever nature, kind and description hereby demised, or intended to be demised, shall become the property absolutely and in fee simple of the City of Philadelphia without any further cost or expense for which this lease shall be, and is intended to be, a full and sufficient conveyance upon no other conditions than those named herein, and the said Philadelphia Water and Filter Company shall, if required, in addition hereto make to the City of Philadelphia a good and valid deed of title to same, free and clear of all liens, charges and encumbrances whatsoever.

2. It also further agreed that the City of Philadelphia shall maintain in good order and condition all the property hereby demised during the term of the said lease; shall pay all charges and expenses incident thereto, and shall maintain, operate and keep in good order and repair at its own cost and expense the said filtering plants; it being fully understood and agreed that the City of Philadelphia shall have full power and authority to do any and all acts in connection with said property, and to make any and all changes in same that may be necessary in any way to its full and proper enjoyment by the said City during the term of this lease.

3. It is also covenanted and agreed that the said Philadelphia Water and Filter Company shall rebuild Flat Rock Dam under plans and specifications to the approved by the Department of Public Works.

4. It is also covenanted and agreed between the parties hereto that upon the City's taking possession of the property

demised by this lease, the said Philadelphia Water and Filter Company shall transfer or cause to be transferred, assigned and conveyed unto the City of Philadelphia all leases of water-rights or water-power now owned or hereafter to be acquired by it for the sole use, advantage and profit of the said City of Philadelphia, and it is hereby further covenanted and agreed that the said company shall assign, transfer and convey unto the City of Philadelphia any property, right or privileges of any kind whatsoever, which they have or may hereafter acquire, not hereinbefore enumerated in the Schuylkill river, or any of its tributaries or any of the shores thereof.

SECT. 3. The Director of the Department of Public Works shall, within fifteen days after the submission to him of the plans for filtering plants as herein provided, designate the ground upon which they shall be erected, and shall also give his approval of the plans and specifications of the said plants or make such changes in them as will carry out the conditions of this ordinance.

SECT. 4. The sum of one hundred thousand (100,000) dollars is hereby appropriated to new Item in the annual appropriation to the Department of Public Works (Bureau of Water), for the purpose of preparing the ground and of making suitable pipe connections to and from filtering plants, to connect the various pumping stations with the said filtering plants and of doing such other work as may be necessary to carry out the purposes of this ordinance, and the further sum of three hundred and seventy-five thousand (375,000) dollars is hereby appropriated to new Item in the annual appropriation to the Department of Public Works, for the payment of the first instalment of the rental of the pproperty leased under the terms of this ordinance, from the date as herein provided.

SECT. 5. The said Philadelphia Water and Filter Company shall give to the City of Philadelphia a bond of indemnity, with good and sufficient surety, in the sum of one hundred thousand (100,000) dollars for the faithful performance of all the conditions of this lease and of the ordinance authorizing it, and also against all liens, charges or encumbrances against the property leased by the City under the terms of this ordinance.

SECT. 6. All ordinances or parts of ordinances inconsistent herewith are hereby repealed.

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Mr. Bringhurst of Select Council, June 25, 1896. Referred to the Water Committee.

## AN ORDINANCE

Authorizing and directing the Mayor of the City of Philadelphia to enter into a contract for supplying water to the City of Philadelphia.

SECTION 1. *The Select and Common Councils of the City of Philadelphia do ordain*, That the Mayor of the said City be and he is hereby authorized and directed, upon the passage of this ordinance, to enter into a contract with the Philadelphia Water Supply Company, a corporation duly organized under the laws of the State of Pennsylvania, and located in the City of Philadelphia, for the supply of water to the City of Philadelphia, in the manner and under the conditions hereinafter set forth.

SECT. 2. The terms of this contract shall be as follows:

1. The said water company shall contract with the City of Philadelphia to build, construct, equip and maintain at its own cost and expense, a system of water supply from the river Delaware, in two separate sections, the first section to have its point of intake located on the west bank of the Delaware river, in State of Pennsylvania, about three miles

above the City of Trenton, from which point to the point of delivery in the City of Philadelphia, there shall be constructed a suitable steel plate aqueduct pipe line of a daily capacity of one hundred and seventy-five million gallons of water. A filtering plant shall be located near the point of intake, and of a capacity to filter the entire waters of said aqueduct. A pumping station of a capacity to handle the waters of said aqueduct shall be located adjacent to said filter plant, together with a water tower of an elevation sufficient to flow said water to the Queen Lane Reservoir, in the Twenty-eighth Ward of the City of Philadelphia. Said aqueduct at a convenient point shall supply water to the Wentz Farm Reservoir in Frankford. The second section of said aqueduct system shall be entirely separate and independent of the said first section, and shall have its point of intake on the west bank of the river Delaware, in State of Pennsylvania, about six miles above Easton, at the river elevation of about two hundred and ten (210) feet, at which point shall be located a filter plant through which the waters will pass when necessary before entering the aqueduct. This aqueduct shall be a steel plate pipe line of daily capacity of one hundred and seventy-five (175) million gallons, that shall deliver its water by gravity at the East Park Reservoir, in the City of Philadelphia.

2. That the said water company shall commence the construction of said water system within six months, and complete the first section within fifteen months and the second section within three years from the date of the contract.

3. That the combined aqueducts of said company shall be of a capacity sufficient to deliver three hundred and fifty million gallons of water daily.

4. That it shall be no part of the duty of the said water company to distribute said water in the Ciy of Philadelphia from its aqueduct line, but to conduct the water and deliver it at the reservoirs as hereinbefore provided.

5. That the City of Philadelphia shall be at no expense or responsibility whatsoever in the construction, equipment and maintenance of said aqueduct and water system, except to provide proper places to receive the waters at the point of discharge in the City of Philadelphia and the connections at the reservoirs.

6. That the said water company shall agree in said contract to make such extensions of its said system, from time to time, as the requirements of the City of Philadelphia may demand, which shall, in case of dispute, be settled by arbitration, and the notice of such requirement shall be such as the Councils of the City by ordinance shall deem proper, and said company shall be given reasonable time wherein to provide for and make such extensions as may be decided upon.

7. That the said water company shall furnish to the City good filtered water through the aqueducts aforesaid, and shall agree that at all times its said works and plant will be kept in the highest degree of efficiency, and the City shall have the right at all times, by its proper officer appointed for that purpose, to inspect the works of the said water company.

8. In the event of any delay in the completion of the conduits from causes which the said water company cannot control, it shall be allowed a corresponding extension of time for the completion of the same.

9. That the said water company shall have the right, which is hereby granted it, to construct any part of said aqueduct system within the limits of the City of Philadelphia necessary to reach such reservoirs or point of delivery as may be designated and prepared therefor. And any necessary changes in gas mains, water mains or sewers that may be necessitated on the aqueduct route through the City of Philadelphia, securing a complete right of way, are to be made by the City, it being understood that the

water company shall have a complete right of way, within the limits of the City of Philadelphia, without cost to the said water company except for the construction of its aqueduct line to point of distribution.

10. That the Councils of the City of Philadelphia shall grant all necessary authority at any time to enable said company to carry out its contract with the City.

11. That the City of Philadelphia shall at all times provide proper and ample reservoirs as receiving and storage basins for the waters delivered from the company's aqueducts.

12. That neither party to said contract shall have any right of action in regard to any question arising thereunder until the question shall have first been submitted to arbitrators, one to be chosen by each party and the third by the two thus chosen, and the decision of any two of said arbitrators shall be final and conclusive. In the event of either party refusing to appoint an arbitrator the other party may apply to either of the Courts of Common Pleas of Philadelphia to appoint said arbitrator.

13. That the said contract shall provide that in the event of the failure of said company to fully comply with the terms of this ordinance, both before or after completion of said works, the City shall have the right in the event of such failure continuing for a period of thirty days, to proceed as provided in Paragraph 12, and in the event of the company's continued default to enter into possession of said works and conduct the same at the cost and expense of said company and subject to its contracts and obligations until said company shall, by proper assurances, give evidence of its ability to conduct said works to meet the full requirements of said contract.

14. That said contract shall be for the period of fifty (50) years from the passage of this ordinance, and shall provide that the City of Philadelphia shall have the right

at any time after ten (10) years from the completion of the entire works, to become the owners of the entire plant of said water company, by paying therefor the cost of erecting and maintaining the same, with interest thereon at the rate of ten per centum per annum, deducting from said interest all dividends theretofore declared. Provided, however, and it shall be stipulated in said contract, that at the end of said period of fifty years the City of Philadelphia shall either purchase said plant at a price to be agreed upon or fixed by arbitrators selected under the provisions of Paragraph 12 hereof, or renew this lease upon the same terms and conditions for another period of fifty years, and so on thereafter at the end of each period.

15. That the said water company shall bind and oblige itself to keep careful supervision of the waters of the river from whence it draws its supply at all times to protect the same from any contamination that can be prevented or abated, under the laws of Pennsylvania, and at all times to enforce the laws of the Commonwealth in such case made and provided.

16. For and in consideration of the construction, operation and maintenance of the foregoing described new system of water supply by the said the PHILADELPHIA WATER SUPPLY COMPANY, the City of Philadelphia shall pay, and it does hereby agree to pay, each year during the existence of the contract to the said the Philadelphia Water Supply Company a sum equal to sixty (60) per cent. of the City's gross income in each year from the Bureau of Water, including all present sources of income and based on present established rates. Provided, however, that no payment shall be made by the City until the plant is completed as hereinafter stipulated; that is to say, upon completion of the said first section of said aqueduct ready for delivery of water, the payment of a sum equal to thirty per cent. of said gross income in each year shall commence and be made

yearly therefor; and upon completion of the said second section ready for delivery of water, the payment of an additional sum equal to thirty per cent. of said gross income in each year shall commence and be made therefor, said payments to be made quarterly on the first days of March, June, September, December of each and every year during the term of fifty years or until same is sooner terminated by purchase of the plant by the City of Philadelphia to said water company or such person as it may designate to receive the same. The date of commencements of payments to be when each section of said company's works shall be completed and the water ready to be turned into the receiving reservoirs or basins.

17. This ordinance shall become binding as a contract between the City of Philadelphia and the Philadelphia Water Supply Company of Philadelphia, upon filing with the Mayor of the City a written acceptance by the said Philadelphia Water Supply Company within sixty days from the passage of this ordinance, otherwise the company shall forfeit all rights under this ordinance, and the same shall become void and of no effect.

18. This ordinance when accepted as provided in section 17 hereof, shall not be altered, changed or amended without the consent and concurrence of both parties hereto and interested therein.

DEPARTMENT OF PUBLIC WORKS.

BUREAU OF WATER.

Juniper and Eilbert Streets.

MR. JOHN C. TRAUTWINE, JR.,

*Chief.*

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*Philadelphia, November 30, 1896.*

MR. R. R. BRINGHURST,

Chairman, Committee on Water.

DEAR SIR :—At a meeting of your Committee, held October 30, I was requested to prepare an estimate of the probable cost, to the City, of constructing works similar to those contemplated in the proposition of the Philadelphia Water Supply Co., now before your Committee, and to furnish information respecting the probable revenues and expenditures of this Bureau, as they would be affected by the passage of that ordinance. In response to this request, I now beg to report as follows:

At the outset I wish to express my obligations to Mr. Henry Birkinbine, the engineer of the company, who has not only, with the company's permission, placed before me, in confidence, the details of his estimates, together with plans and profiles of the proposed conduit lines and other works proposed, but has, at my request, repeatedly called at the Bureau and in every way aided us in arriving at our estimates.

In default of both the time and the means for examining the country traversed by the conduits and for designing the various structures required, the assistance thus rendered by Mr. Birkinbine has been of the greatest service.

Thus aided, and with the assistance of Mr. John E. Codman, Chief Draughtsman of this Bureau, I have made a careful study of the proposed work, and, as a result of this, I submit, as my estimate, that the total cost of the work, including the two lines of conduit and their appurtenances, two intakes, two filtering plants, one pumping station, real estate, interest on plant during construction, engineering, legal expenses, and incidentals will approximate to $33,-000,000.

In the nature of the case, any such estimate can be, at best, but a rude approximation. Even after traveling over the line, as Mr. Birkinbine has done, the determination of the relative quantities of rock and of earth excavation must be matter of guesswork, as must also the actual depth of cutting required. Estimates of the cost, per pound, of the conduit, laid in the trench, during the next three years, must also be largely matters of personal judgment.

Understanding the request to refer to exactly such a plant as that proposed by the company, I have not concerned myself with any modifications of the plans, but have figured upon those submitted by Mr. Birkinbine, although it is quite possible that some departures from these might be found advisable.

For instance, I have taken, as the cost of each of the filter plants, an estimate given Mr. Birkinbine by a contractor, and based upon plans furnished the company by Mr. Henry Roeske, and laid before your Committee at its last meeting, whereas, by Mr. Hazen's estimates, which are generally considered as erring, if at all, upon the side of cheapness, a so-called "natural sand" filter, of the European type, would cost more than twice as much.

In addition to the cost of constructing works similar to those to be built by the company, we must consider the cost to the City of providing, for the company, the right of way called for in Section 9 of the ordinance.

Mr. George S. Webster, Chief of the Bureau of Surveys, estimates that the cost of making necessary changes in sewers will reach not less than..............$1,000,000
and that of land and consequential damages not less than.............................. 5,000,000
Mr. William K. Park, Chief of the Bureau of Gas, estimates the cost of moving gas mains at .................................. 1,500,000
but if the company's conduits are lowered, so as to pass under the gas mains, this expense may be avoided.
The cost of changes in water mains may be taken at.............................. 50,000

making a total of..........................$7,550,000
or......................................$6,050,000
if no change is required in gas mains.

Here I beg to remark that the ordinance should clearly define what manner of changes are to be taken as "necessary" or "necessitated," viz: whether those which shall involve the least expense to the *City* or those which shall involve the least expense to the *Company*.

Coming now to questions affecting the operations, revenues and expenditures of the Bureau, we are confronted with even far greater uncertainty than in the matter of first cost; for the whole future of the City's water supply depends upon the prevention of waste. Until this matter is settled, we are merely speculating in the dark as to the future consumption, which is the fundamental factor in all our calculations.

I submit herewith a diagram presenting several estimates of water consumption and of revenue to the City and to the company.

On this diagram, lines drawn in black refer to water consumption, and lines drawn in red refer to revenues.

Beginning at the lower left-hand corner of the sheet, I have plotted, on this diagram, the average total daily consumption for each year from 1875 to 1895, based upon the plunger displacements of our pumps. This is the method necessarily employed in pumpage works for arriving at the present consumption; it is the only one thus far available for us, and we endeavor to compensate for the known causes of error by making a deduction to cover them. Furthermore, this is the method that has always been employed here, so that figures based upon it are of value at least in comparing our consumption at different dates.

It will be noticed that the daily consumption, which increased by only about 3,000,000 gallons each year between 1875 and 1885, then suddenly began to increase much more rapidly, the increase, between 1885 and 1895, averaging about 14,000,000 gallons each year. This is attributed, first, to a very marked increase in the number of water-consuming appliances, and second, to large extensions of our pumpage and distributing system, which brought water more freely to the appliances in use.

The diagram shows that, if the consumption goes on increasing as rapidly as during the last ten years, the 350,000,000 gallons daily supply provided by the works at present contemplated by the company and embraced in the present estimate, will all be in demand in 1905, or six years after the time of completion specified in the ordinance, while, at the expiration of the contract, in 1946, the consumption will have reached nearly 1,000 million gallons daily.

Beginning with the present year, I have, however, added a second line, plotted on the assumption (which I consider a very safe one) that a general use of meters, by cutting off utterly useless and indefensible waste, will reduce the consumption by one-half. Under these conditions, the 350 million gallon limit of the works now under consideration would not be reached until 1928, while, at the expiration of the contract, in 1946, the daily consumption would be not quite 500 million gallons.

Turning now to the red lines, or those representing revenues, you will find, further up, on the left of the diagram, a series of dots representing the total gross revenues of the Bureau, from all sources, for each year from 1875 to 1895. The red line drawn through these dots indicates that the gross revenue increases by a nearly equal amount each year. I have therefore prolonged the line upward (line A) on the supposition that this increase will continue at about the same rate.

It is very important to note, here, that under our present system of charging for water by schedule rates, *the gross revenue of the Bureau increases less rapidly than the consumption of water.* To illustrate this, I have added the line B, which shows how the gross revenue would increase if the present relation of revenue to consumption were to be maintained.

You will see, also, that it is most important, in the event of the passage of the ordinance, that the "present established rates," on which the payment of 60 per cent. to the company is to be calculated, should be clearly defined. If the present rate of increase of consumption is maintained, and if "present established rates" are taken to mean "present established *schedule* rates," then the company's revenues will be as represented, approximately, by the dotted red line marked "60 per cent. of A;" whereas, if "present established rates" can be shown to mean the "present established *ratio between revenue and consumption*," the company's revenues will be as represented by dotted red line marked "60 per cent. of B."

If, again, meters are generally introduced, and if "present established rates" are taken to mean "present estabiished *meter* rates" (4 cents per thousand gallons), the company's revenue (assuming the correctness of the dotted black line representing the estimated consumption with general use of meters), will be as shown by dotted red line marked "60 per cent. of meter rates, etc."

In reply to your question as to the sufficiency of the remaining 40 per cent. of the gross revenue to meet the remaining expenses of the Bureau, I would submit the following rude calculation:

| | |
|---|---|
| Expenses of Bureau during 1895, after deducting those which would not have been incurred under a gravity system | $1,000,000 |
| Corresponding expenses for 1900 | 1,500,000 |
| Annual extension of distribution system | 250,000 |
| Annual extension of reservoir system | 600,000 |
| Total annual requirements of Bureau in 1900 under Company's system | $2,350,000 |

You will notice that in estimating the current expenses for 1895 I have assumed an increase of 50 per cent. in five years, which was the approximate rate of increase between 1878 and 1892. During the last few years the increase has been much more rapid than this.

The estimated total gross revenue of the Bureau in 1900, based upon present schedule rates and the continuance of the present rate of increase of consumption, is $3,250,000, 40 per cent. of which is $1,300,000.

The expenses for 1895, upon which my estimate is based, include $722,000 on account of distribution. This provides a fair allowance for normal annual extensions of the distribution system. Hence, if that system were now in proper shape, no further allowance for its extension should appear in the table, but the distribution system is now greatly in arrears, as shown by the fact that our estimate for new mains, for 1896, was about $2,000,000, and that we are still asking for this amount, none having been granted for this year. I have therefore added $250,000 for the probable annual extension of the distribution system in 1900.

It will be observed that Section 11 of the proposed ordinance specifies "That the City of Philadelphia shall at all times provide proper and ample reservoirs as receiving and storage basins for the waters delivered from the company's aqueducts," and that Section 12 provides for the arbitration of all questions between the City and the company, including, no doubt, that as to what constitute "proper and ample reservoirs."

In arriving at my estimates for annual extensions of the reservoir system I have been governed by the following considerations:

The cost of Queen Lane Reservoir, including land damages and the repairs now in progress, is about $6,000 per million gallons of storage capacity. Assuming that our daily consumption will continue to increase at the rate of 14,000,000 gallons per year, and that for each million gallons per day we continue to provide 7,000,000 gallons storage capacity, the additions will be at the rate of 7 by 14 equal say 100 million gallons per annum, and the annual cost for extensions of reservoir capacity, therefore, $600,000. This entire amount is added, inasmuch as no extensions to the reservoir system were made in 1895, upon which my estimate is based.

On the one hand it might be urged that the two conduits together would contain nearly one and one-half days' supply at present rates, and that the company proposes to supply filtered water, so that a less storage capacity might suffice, but, on the other hand, it must be borne in mind that the crippling of one of the company's two conduits would mean the loss of one-half of the daily supply until repairs were made. I believe, therefore, that $600,000 is as little as should be set down for annual extensions of the reservoir system.

This illustrates forcibly how all estimates of the future water supply hinge upon estimates of the future consumption, which, in turn, are governed almost entirely by the adoption or neglect of means for the prevention of waste.

On an accompanying blue-print will be found a summary of the estimates herein submitted.

Very respectfully,

JOHN C. TRAUTWINE, Jr.,

*Chief of Bureau.*

## Summary of Approximate Estimates Relating to the Proposition of the Philadelphia Water Supply Company to Furnish Water from the Delaware River, November, 1896.

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### FIRST COST.

Mr. Birkinbine's estimate..................$28,000,000
Estimate of Bureau of Water..............$33,000,000

---

Cost to City of providing company with right of way.....$6,000,000 to $7,500,000

---

Company's Annual Revenue, 60% of Gross Receipts of Bureau.

| BASED UPON. | YEARS. | | | | | |
|---|---|---|---|---|---|---|
| | 1900 | 1910 | 1920 | 1930 | 1940 | 1946 |
| Schedule rates and rate of consumption as between 1885 and 1895.................. | 1,900,000 | 2,500,000 | 3,000,000 | 3,500,000 | 4,000,000 | 4,300,000 |
| Rate of consumption as between 1885 and 1895 and present revenue per gallon consumed... | 2,300,000 | 3,500,000 | 4,600,000 | 5,800,000 | 7,000,000 | 7,800,000 |
| Present meter rates on consumption reduced 50 per cent.................. | 1,200,000 | 1,900,000 | 2,500,000 | 3,200,000 | 3,800,000 | 4,200,000 |

Figures on this side of line refer to plant at present contemplated.

Figures on this side of line refer to plant as extended to meet future requirements.

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Estimated current expenses of Bureau in 1900, under Company's plan, including extensions to reservoir and distribution system........$2,350,000
40 per cent. of estimated gross revenue of Bureau in 1900*..........................$1,300,000

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* Based upon present schedule rates and continuance of present rate of increase of consumption.

*Philadelphia, December 7, 1896.*

THOMAS M. THOMPSON, ESQ.,
Director, Dept. of Public Works.

DEAR SIR :—At a meeting of the Water Committee of Councils, held on Monday evening last, November 30, I presented, by request, a report upon certain matters relating to the proposition of the Philadelphia Water Supply Company. A copy of that report has been transmitted to you.

I feel it incumbent upon me now to lay before you my replies to certain criticisms to which my report was then subjected, together with my comments upon certain remarks then made respecting the general proposition.

The company's estimate of the cost of constructing the proposed works was about 29 million dollars. My estimate of the cost to the City if it should undertake to do the same work was 33 million dollars, and was not criticised.

My estimate of the cost to the City of furnishing to the company the right of way required by the ordinance, including estimates from Chiefs Webster and Park, of the expenses incidental to moving sewers and gas pipes respectively, and amounting to between 6 and 7½ million dollars, was, however, sharply challenged.

I have accordingly conferred again with these two gentlemen, requesting them to put me in position to correct or to confirm my estimate, as the case might be.

Chief Webster replies that, while it would require a month to make any nice determination of the matter, he sees no reason to suppose that the result would vary materially from his estimate.

Chief Park is of the same view respecting his estimate.

As to my estimates of future consumption, it is true that the idea of a consumption of 1,000 million gallons per day, even in 1946, seems almost laughable, but it is none the less true that, *if the present rate of increase were maintained*, we should reach that figure at about that time. No doubt our increasing perplexities will have forced us, long before that time, to begin practicing those economies which we should have practiced long ago. It is, however, probable that, if our population continues to increase as in the past, our actual consumption will show an increase somewhere between the two lines shown on my diagram. As explained in my report, the upper one of these two lines represents the average rate of increase existing between 1885 and 1895, while the lower one shows this rate reduced one-half by the general use of meters. Those who are familiar with the statistics of our use and waste of water and with what meters have done in other places, will generally admit that this assumption is reasonable.

Granted the correctness of my estimates of future consumption, the calculation of the Bureau's and of the company's future revenues is a mere matter of multiplication.

My estimate of the future annual expenses of the Bureau, as related to the 40 per cent. of our gross revenue which will remain at our disposal in the event of the passage of the ordinance, shows annual expenses $2,350,-000 and annual income $1,300,000. This estimate has been criticised as excessive on the side of expense.

In reply I will say that in arriving at $1,000,000 as our present approximate annual expense for matters other than those of which the company would relieve us, I have followed two methods: first, adding together those items of expense which would still have remained, and, second, deducting from our gross expenses those items from which the company would relieve us, including all expenses connected with our main pumping stations except Roxborough, which, as I understand, might still remain in service. If it did not, a new high-service station would have to be built, to pump from East Park or Queen Lane Reservoir into that at Roxborough. These two methods checked approximatately.

As explained in my report to the Committee, I am, I believe, well within bounds in adding to this estimate of our present annual expense 50 per cent. as the probable increase within the next five years, the increse of annual expense during the last few years having been much more rapid than this.

It seems to be admitted that an allowance of $250,000 per annum for extensions to the distribution system may not be unreasonable, but my estimate of $600,000 for annual cost of extensions of reservoir system was regarded as excessive.

As stated in my report to the Committee:

"In arriving at my estimates for annual extensions of the reservoir system I have been governed by the following considerations:

"The cost of Queen Lane Reservoir, including land damages and the repairs now in progress, is about $6,000 per million gallons of storage capacity. Assuming that our daily consumption will continue to increase at the rate of 14 million gallons per year, and that for each million gallons per day we continue to provide 7 million gallons storage capacity, the additions will be at the rate of 7x14=say 100 million gallons per annum, and the annual cost for extensions of reservoir capacity, therefore, $600,000. This entire amount is added, inasmuch as no extensions to the reservoir system were made in 1895, upon which my estimate is based.

"On the one hand it might be urged that the two conduits together would cotain nearly one and one-half day's supply at present rates, and that the company proposes to supply filtered water, so that a less storage capacity might suffice, but, on the other hand, it must be borne in mind that the crippling of one of the company's two conduits would mean the loss of one-half of the daily supply until repairs were made. I believe, therefore, that $600,000 is as little as should be set down for annual extensions of the reservoir system."

It is, of course, to be hoped that the Department will be put in position, before 1900, to take effective measures for the reduction of waste of water; but, as we have no assurance of this, it is better, in order to keep our calculations on the safe side, to reckon without it, and it will hardly be urged that we should provide less total capacity than would give seven days' storage.

It remains, then, to examine the cost of storage per million gallons. In my estimate I took Queen Lane Reservoir as being intermediate in size between the East Park and new Roxborough, and figured thus:

| | |
|---|---|
| Land damages | $800,000 |
| Construction and repairs | 1,500,000 |
| | $2,300,000 |

As the intended capacity, at 30 feet depth, is 383 million gallons, this gave a trifle over $6,000 per million gallons of storage capacity.

As it was necessary to prepare my report in the greatest haste, it was out of the question to inform myself closely as to the amount of land damages, the figures for which are not a part of the records of this Bureau, and I was obliged to content myself with an estimate based upon the recollection of assistants in the Bureau. From data since furnished me by Mr. James Alcorn, Assistant City Solicitor, it appears that the land and incidental damages, some of which are not yet adjusted, will hardly exceed $463,500. Ihave, therefore, to revise my estimate for Queen Lane Reservoir, as follows:

| | | |
|---|---|---|
| Construction (including retained percentages) | $1,188,058 08 | |
| Repairs (estimated) | 383,569 87 | |
| | | $1,571,627 95 |
| Damages (estimated) | | 463,500 00 |
| | | $2,036,127 95 |

Cost per million gallons storage capacity, $5,314.

Ihave, however, taken advantage of the opportunity for revision, by compiling similar figures for our other two large reservoirs, East Park and new Roxborough, with the following results:

| | |
|---|---|
| East Park: | |
| Real estate | $12,875 00 |
| Construction— | |
| Embankments (1871-4) | 1,326,565 84 |
| Completion (1887-9) | 862,439 88 |
| | $2,189,005 72 |
| Repairs, estimated | 75,000 00 |
| | $2,276,880 72 |

For the cost of real estate I have taken 103 acres, as measured by planimeter, at $125 per acre, the average cost at the time of purchase for park purposes, 1870-4, as given by Mr. Thomas S. Martin, Secretary of the Park Commission.

| | |
|---|---|
| Roxborough Reservoir: | |
| Real estate (as given by Mr. Alcorn) | $61,350 00 |
| Construction | 523 709 14 |
| Repairs (estimated) | 136,000 00 |
| | $721,059 14 |

The capacity is 147 million gallons, and the cost, per million gallons, therefore, $4,905.

Summing up, we have:

| | Capacity in Millions of gallons. | Total Cost. | Total cost per million gallons of storage capacity. |
|---|---|---|---|
| East Park............. | 689 | 2,276,881 | 3,305 |
| Queen Lane............ | 383 | 2,035,128 | 5,314 |
| Roxborough (new)..... | 147 | 721,059 | 4,905 |
| | 1,219 | 5,033,068 | 4,129 |

Taking, therefore, the cost of one million gallons of future storage capacity at $4,000 instead of $6,000, we have, for an annual increase of 100 million gallons in storage capacity, an annual expense of $400,000 instead of $600,000. This will reduce my estimate of annual expense in 1900 from $2,350,000 to $2,150,000.

Mr. Birkinbine, the company's engineer, has expressed to me his belief that it would not be found advisable, under his company's plan, to maintain the present ratio between storage capacity and consumption, and that, therefore, little, if any, further extension of our reservoir system need be calculated. While this may be matter for discussion, I am not prepared to grant the position. Granting it, my estimate of annual expense in 1890 would be still further reduced to $1,950,000 as against $1,300,000 receipts; but if the company proposes to adopt, as a feature of its system, the understanding that no increase shall be required in the present storage capacity of, say, 1,400 million gallons, this should be distinctly specified in the ordinance and contract, and not left to the decision of the arbitrators.

Turning now from the discussion of my report to that of the general subject, I remark that it has been stated, even by those who express themselves as opposed, on general principles, to corporate control of our works, that if the Department continues inactive in the improvement of the water supply, or if it has no well-defined plan of its own, it may be necessary to resort to the expedient of turning the matter over to a private corporation.

I need not remind you that for a year or more the Department has been before Councils with a well-defined plan of operations for the immediate future and that until very recently Councils have declined to enable the Department to put even the beginning of this plan into execution.

During the discussion, Mr. Rudolph Hering was frequently quoted as giving preference to a supply from the upper Delaware. Mr. Jones, counsel for the company, quoted from Mr. Allen Hazen's recent report to the Woman's Health Protective Association to this effect, but omitted to quote from the paragraph immediately preceding, in which Mr. Hazen says:

"The additions to our knowledge of the nature and results of filtration during the last ten years have materially changed the aspects of the case, and Mr. Hering has himself indicated that if he were reconsidering the subject he would give serious attention to the filtration of the present supply."

In my report for 1895 I said:

"Since the date of Mr. Hering's final report, in 1886, it has been abundantly demonstrated, notably by the extensive and elaborate experiments made at Lawrence, Mass., and described in the reports of the Massachusetts State Board of Health, that thoroughly pure and safe water may be obtained from rivers by means of filtration. He therefore urges the advisability of experiments for the purpose of determining to what extent the waters of the lower Delaware and Schuylkill rivers, close to the upper portions of the City, may be rendered thoroughly satisfactory by means of a modern system of filtration.

I may add that Mr. Hering has this matter of filtration very warmly at heart, that he considers it of the first importance that just such a beginning should be made, and that within a few weeks he has expressed, on my behalf, and as my personal friend, the earnest wish that my name may not go down to posterity coupled with the consummation of such a catastrophe (his own word) as that contemplated in the pending ordinance.

I trust that by thus stating Mr. Hering's position and so rendering inexcusable the continued misquotation of his views, I may succeed in putting a stop to them in respectable circles.

In reply to a question, I stated, at the meeting, that our maximum daily pumpage frequently exceeds the daily flow of the Schuylkill at the time, and I was, on this account made to appear as authority for the gross misstatement that our present surces of supply were practically exhausted, whereas I have repeatedly urged, and had so stated at the meeting, that in the Delaware at our doors, we have a practically inexhaustible supply, which, I believe, needs only filtration to render it perfectly acceptable.

If this is the case (and a relatively inexpensive practical experiment will demonstrate whether it is or is not the case), we have no need to bind the City to the annual payment of 60 per cent. of the Bureau's gross receipts for aqueducts ; and filtration, by rendering this vast supply available on a large scale, will not only (as was stated at the meeting) improve the quality of our water, but will enormously increase the quantity properly and cheaply at our disposal.

Yours very respectfully,

JOHN C. TRAUTWINE, Jr.,

*Chief of Bureau.*

# AN ORDINANCE

Introduced February, 1897,

To provide for furnishing to the City of Philadelphia an adequate and permanent supply of filtered water from the Rivers Delaware and their tributaries, and to provide adequate storage capacities for the retention and conservation of water therefrom, for the use for public consumption at the aforesaid City of Philadelphia, delivered through the medium of sand filter beds, and to authorize the Schuylkill Valley Water Company to construct the storage basins, reservoirs, filter beds, conduit, and other parts of the said water system to be purchased by the City of Philadelphia and paid for out of the surplus water revenues of the said City.

SECTION 1. *The Select and Common Councils of the City of Philadelphia do hereby ordain,* That the Schuylkill Valley Water Company, a corporation organized and existing under and by virtue of the laws of the State of Pennsylvania, shall be and is hereby authorized and empowered to construct and maintain a system of storage basins and reservoirs upon and adjacent to the Schuylkill and its tributaries, having an aggregate storage capacity of not less than ten billions of gallons of water, and to deliver and furnish to the City of Philadelphia aforesaid during the term hereinafter defined such quantity or quantities of water as, together with its present supply, will be sufficient for the daily public consumption of said City, to be distributed through an existing plant for public water distribution therein; and further to construct and operate a system of sand filtration, consisting of two plants, the one for filtering the waters of the river Schuylkill and its tributaries, and the other for filtering the waters of the river Delaware and its tributaries, through the medium of sand filter beds; and further to construct a conduit for conveying the waters of the Schuylkill, filtered as aforesaid, to and into the present pumping stations at Queen Lane, Spring Garden, Belmont and Fairmount with the proper intakes and connections; and further to construct a reservoir at or near Wentz Farm, to be used in connection with the present pumping station at that point, which said reservoir shall have a storage capacity of not less than fifty millions of gallons of water: *Provided, however*, that the said water company shall not be bound to provide or supply water at the said various pumping stations beyond the actual daily needs of the said City, and that the maximum quantity of water which the said water company may be required to supply under this ordinance shall not at any time, together with that derived from the present means of supply, exceed in the aggregate three hundred millions of gallons of water for each or any twenty-four hours from the river Schuylkill aforesaid, or seventy-five million gallons in like time from the river Delaware.

Aud further, when the said system has been completed and operated for a full term of fifty years, as defined, and the said water company shall have received from the said City, for each and every of the said fifty years, the full sum of nine hundred thousand dollars per year, together with one dollar and eighty-five cents ($1.85) for each and every million gallons of filtered water delivered at the various pumping stations, for cleansing the filters, as particularly defined in Sections 14 and 15 of this ordinance, then in that event the said City shall have the sole and exclusive ownership thereafter of all the dams, reservoirs, water rights, lands, easements, filters, conduits, pipe lines and all the property to be acquired or constructed under this ordinance, as prescribed in Section 17 of the same.

Sect. 2. The City shall and hereby does grant to the said water company the right to use such streets and highways within the City limits as may be required for the economic and proper construction of the water system hereby authorized, or any part thereof, free of charge: *Provided,* That the said water company shall at its own expense restore the said streets and highways to a proper condition, subject to the approval of the Director of Public Works, it being understood that whenever the proposed conduit or pipe lines of the said water company shall interfere with or injure the existing lines of water, gas, electrical or sewer mains or other property of the City beneath the surface of the said streets or highways, that the said water company is hereby required and authorized to remove and relay at its own expense any of such mains or to restore such other property to its original condition, under the supervision of the Director of Public Works.

At the aforesaid pumping stations, including the said reservoir at Wentz Farm, the City shall furnish the necessary lands, rights of way and easements for the construction of the intakes and pump connections, and for other necessary purposes, free of all cost or charge to the said water company, but the said water company shall acquire, at its own cost and charge, all other lands, rights of way, easements, franchises and property which may be necessary and requisite for the construction, maintenance and operation of said works, and the City shall incur no liability of any nature on account of the acquisition of said lands, rights of way, easements, franchises and property, or on account of damages arising from the construction, maintenance and operation of said works, but the water company shall indemnify the City against all such liability or damages or claims for damages, and shall, at its own cost and expense, defend the City against all such claims.

Sect. 3. The plans and specifications for all the works herein authorized shall be subject to the approval of the Director of Public Works, and no work shall be done in the construction of the storage basins, reservoir, filter beds or conduits, or other works herein authorized, until the plans and specifications for such work shall have been approved by the Director of Public Works by an instrument in writing, which instrument shall express the rights and obligations of the City and of the Water Company under this ordinance, and which instrument the said Director of Public Works is hereby authorized and directed to execute on behalf of the City when he shall have approved of the aforesaid plans and specifications. The said plans and specifications, when approved by the Director of Public Works, are hereby declared to be a part of this ordinance with like force and effect as though incorporated herein.

The said water company shall begin the construction of the reservoirs and storage basins aforesaid within sixty days after the receipt of notice in writing from the Director of Public Works that the same must be begun, subsequent to the passage and approval of this ordinance and the approval of the specifications for said construction by the said Director, and the said water company shall within fifteen months from the date of the receipt of the said written notice complete such a number of reservoirs or storage basins as will have a storage capacity of at least three billions of gallons of water, and the said water company shall within the time herein limited for the completion of the said work fill or cause to be filled the said reservoirs or basins, and shall continue to store and retain therein at least the aforesaid quantity of water at all times thereafter, until the date hereinafter fixed for the complete acquisition by the City of title to the said basins and reservoirs, it being expressly ordained, however, that either the said water company or the said City may draw, or cause to be drawn, said or any part of said water from said reservoirs or storage basins, or either or any of them, to meet the exigencies of the said City in seasons of drought as defined herein, and any consequent diminution of the aforesaid quantity of water as held in storage shall not be a violation of the provisions of this ordinance.

And the said water company shall, within two years thereafter, provide such additional storage basins or reservoirs, along and upon said river Schuylkill and its tributaries, as will have an additional storage capacity of seven billions of gallons of water, and said basins or reservoirs, when so completed, shall be filled and kept filled by said water company at all times thereafter until the date herein fixed for the complete acquisition by the City of title to the said basins and reservoirs, it being hereby ordained that the said water company or the City may draw or cause to be drawn from the said last-mentioned basins or reservoirs, or either or any of them, such quantity of water as may be necessary to meet the exigencies of the said City, as hereinbefore specified, and such consequent diminution of the aforesaid quantity of water so held in storage shall not be a violation of the provisions of this ordinance.

A season of drought shall be deemed to exist within the meaning of this ordinance when the flow of water in the river Schuylkill at Lewis' Dam is less in any twenty-four hours than four hundred millions of gallons of water.

Sect. 4. The said water company, as each storage reservoir or basin is completed and until the conduit herein provided for is completed and ready for use, shall, upon written demand of the Director of Public Works, deliver into the body of the stream of the Schuylkill river so much of the water so held in storage as in the judgment of the said Director may be required by the City in times of drought, and such delivery or deliveries shall be deemed a proper delivery of stored water for the uses of the said City within the meaning and intent of this ordinance.

SECT. 5. The said water company shall at all times during the continuance of the powers and privileges granted by this ordinance keep in good repair all of the dams, reservoirs, storage basins and their appurtenances erected and constructed by said water company, and shall provide such attendants as may be necessary for the proper preservation and operation of the same.

SECT. 6. The said City shall have the right by its proper officers at all times to enter upon the property and works of the said company, for the purpose of inspecting the same, and in case at any time the said company shall fail to furnish the waters from its reservoirs or storage basins in such quantities as may be required by the said City for its aforesaid public water supply, then in that case it shall be within the power of the City, through its own employees or those of the said water company, to so regulate the flow of water as to meet the requirements of the City, and the Director of Public Works of said City shall determine and regulate the daily supplemental flow to be drawn from the storage reservoirs of the water company.

SECT. 7. The said water company shall be deemed to have fulfilled its obligations to said City, in providing storage for water as herein defined, when it has secured and provided storage capacity as herein specified for ten billions of gallons of water and has stored the same subject to the uses of the City as herein provided, and it is further ordained that nothing in Section 6 of this ordinance contained shall be construed as authorizing or empowering the said City to draw from the said, or any of the said, storage basins or reservoirs any water in such manner as to reduce the quantity held in storage below the quantity fixed by Section 3 of this ordinance, except in seasons of drought as herein defined.

SECT. 8. The works to be constructed or acquired by the said water company, pursuant to the provisions of this ordinance, shall be under the supervision of the Department of Public Works of said City, and are declared to be a part of the Water Works of the City of Philadelphia, exclusively and permanently appropriated to the public use of the said City. Should the said water company at any time fail to make such repairs and betterments as may be necessary for the safety of the City or the preservation of its water supply, within thirty days after the receipt of notice from the said Director of Public Works, calling attention to the specific repairs or betterments deemed by him to be necessary, then and in that case the city may enter upon said property, and make or procure to be made such necessary repairs or betterments at the cost and expense of the said water company. The term betterments, however, is not intended to mean an enlargement, reconstruction, or extension of the works or any part thereof, but only such repairs and renewals as are necessary to the preservation and use of said or any part of said works.

The water company shall also deposit with a trust company of good standing in the City of Philadelphia the sum of thirty-five thousand dollars annually, which said sums so deposited shall accumulate for the full term of fifty years as a guarantee fund for the maintaining and repairing of the works as ordained by this ordinance. Should the said water company at any time refuse or neglect to make the repairs necessary for the maintenance of the works as provided in this section, and fail to begin the same within thirty days from the receipt of notice in writing from the Director of Public Works, calling attention to the specific repairs deemed by him to be necessary, and to push the same to prompt and speedy conclusion, then and in that case authority shall be and hereby is given to the said Director to enter upon said works and to make such needed repairs, and the expense incurred in making said needed repairs shall be paid to the City by the trust company acting as trustee, out of the specific fund created by this section, upon filing with it proof of the necessity of said repairs and of the actual cost of making the same.

If at the expiration of the said period of fifty years the said works are in good repair and acceptable to the City, or the terms of this ordinance have been complied with by the water company and the works have been delivered to the City as ordained, then and in that case the said accumulated fund deposited with the trust company in accordance with this section shall be and is hereby ordained and declared to be the property of the water company, and all right and interest of the City therein shall cease.

It is further ordained that any interest paid or allowed by the trustee of this fund shall be the property of the water company, and payable to it as the same falls due.

SECT. 9. The water company shall and is hereby authorized to construct a system of sand filtration, to consist of two filter beds or plants, located, the one at or near the storage basins to be constructed as herein ordained for storing the water of the Schuylkill river, for the purpose of filtering the waters so stored, and the other to be located at a point to be determined by the Director of Public Works at or near the Frankford Station, for the purpose of filtering the water of the river Delaware. Each of the said filter beds or plants shall be constructed substantially as follows:

The bottom of the filter beds shall be covered with concrete. Upon this drain tiles will be laid in open joints for the purpose of collecting the filtered water. Above this will be deposited a course of broken stone or coarse gravel to the depth of twelve (12) inches, upon which will be laid a deposit of fine gravel to the depth of nine (9) inches, upon which a third course of coarse sand will be laid to the depth of twelve (12) inches, and over all a deposit of fine sand to the depth of three (3) feet, making a total average depth of sand for filtering purposes of five feet nine inches (5 ft. 9 in.). The filters shall be able to carry a depth of water of not less than four feet. The filter provided for the waters of the river Schuylkill and its tributaries shall be capable of filtering, when required, not less than three hundred millions of gallons of water per day, and that provided for the river Delaware and its tributaries shall be capable of filtering, when required, not less than seventy-five millions of gallons of water per day.

The said filters shall be examined from time to time as required, by the Director of Public Works, but not oftener than once in thirty days, by a Committee, consisting of three analytical chemists, one to be appointed by the Director of Public Works, another by the Water Company and the third by the two so appointed, and all official tests to be binding upon the City and the Water Company, shall be made in the presence of the three chemists aforesaid, and the official tests so made in order to be valid and binding must be signed by all three.

Should the tests so made, in the opinion of at least two of the said Committee, show that the condition of any filter is not such as to give the filtering efficiency obtainable from sand filters of like construction elsewhere in use at the time of said tests, then and in that case it shall be the duty of the said Committee to ascertain the cause of inefficiency of filtration, and thereupon the Water Company shall cause the necessary changes and repairs to be made, subject to the provisions of Section 8 of this ordinance.

Sect. 10. The Water Company shall begin the construction of said filtering system within sixty days after the receipt in writing from the Director of Public Works that such construction must be begun, subsequent however, to the passage and approval of this ordinance, and the approval of the specifications for said work by said Director, and shall complete the same within three years thereafter.

Sect. 11. The said Water Company shall further construct or cause to be constructed a conduit having a capacity sufficient for the conveyance of three hundred millions of gallons of water for each and every twenty-four hours, which said conduit shall connect the filter beds upon or adjacent to the Schuylkill river as aforesaid with the aforesaid pumping stations within the City of Philadelphia in such manner as shall be approved by the Director of Public Works.

It is further ordained that the said Water Company shall begin the construction of said conduit within ninety days after the receipt of written notice by it from the Director of Public Works that such work must be begun, subsequent however, to the passage and approval of this ordinance and the approval of the specifications for said work by the said Director, and shall complete the same within three years thereafter.

Sect. 12. The said Water Company shall maintain or cause to be maintained the reservoirs, dams, storage basins, filter beds, and conduits after the same have been completed and ready for operation as herein defined, for the full term herein defined, at its own cost and expense, and at the expiration thereof shall turn over and deliver to the said City all of said reservoirs, storage basins, dams, filter beds and conduits in working order: *Provided,* There shall have been paid to the said water company by the said City the sums required by the 14th and 15th Sections of this ordinance.

After the intakes aforesaid shall have been completed and accepted by the Director of Public Works, all alterations or changes in the construction or location thereof shall be made by the City, at its own cost and charge.

Sect. 13. The water company shall within sixty days after the passage and approval of this ordinance file with the City Solicitor a bond in the penal sum of one million dollars, guaranteed by a surety company authorized to do business in the State of Pennsylvania, which bond is to be approved by the City Solicitor, and shall be conditioned upon the faithful performance of the obligations imposed upon said water company by the terms of this ordinance.

Said bond shall further provide for indemnifying the City against all liability, damages and claims for damages growing out of the construction, maintenance and operation by the water company of the works herein authorized, and for defending the city at the expense of the water company against all such claims. And the Mayor of the City of Philadelphia shall have power, whenever and as often as it appears to him that claims of such magnitude are pending in the courts that the existing security of the city against such claims is inadequate, to require the filing of an additional bond in a penal sum not exceeding one million dollars, to be guaranteed and approved as hereinbefore provided.

SECT. 14. The compensation to which the water company is entitled for the property to be acquired by the city as herein provided, and for the other obligations assumed by the water company, except the cleansing of the filters, is hereby defined as follows:

Whenever the said water company shall have provided storage capacity as defined for three billions of gallons of water, and shall have the said quantity of water on storage ready for the use of the City, as provided in Section 4 of this ordinance, then the said water company shall be entitled to receive semi-annually thereafter for the term of fifty years, out of the surplus revenues of the Water Bureau, as hereinafter defined, the sum of one hundred thousand dollars.

Whenever the water company shall have completed the filter bed for filtering the waters of the river Delaware, together with the reservoir at Wentz Farm, with all the appurtenances thereto belonging, as provided in Sections 1 and 9 of this ordinance, then the said water company shall be entitled to receive semi-annually thereafter for the term of fifty years, out of the surplus revenues of the Water Bureau, as hereinafter defined, the further sum of seventy-five thousand dollars.

When the water company shall have satisfactorily completed the entire system as hereby ordained, and the same shall have been accepted and approved by the Department of Public Works, then the water company shall be entitled to receive semi-annually thereafter, out of the surplus revenues of the Water Bureau, as hereinafter defined, such a sum or sums as will, when taken with the payments hereinbefore authorized, maks up a total semi-annual payment of four hundred and fifty thousand dollars, to be paid to the water company during the full term of fifty years from the completion of the entire system.

The payments in this section provided shall be made semi-annually, on the first days of January and July in each year, out of the surplus revenues of the Water Bureau. The surplus revenue of the Water Bureau is hereby defined to be the excess of the total receipts for water over the ordinary expenses of the maintenance and operation of the water system, estimated according to the method now in use, adopted by the City of Philadelphia. No payments for extensions, alterations or improvements in the water system and no extraordinary expenditures which may become necessary for any cause shall be considered in estimating the amount of said surplus revenues. The water rate shall not be diminished below the rates now existing in such a manner that the surplus revenues of the Water Bureau shall be reduced below nine hundred thousand dollars annually, until all the payments provided by this section have been made. In case a deficiency occurs in the surplus revenue of the Water Bureau for any year, so that the same is insufficient for the payments herein provided, the deficiency shall be paid, with interest at the rate of six per cent. per annum, out of the surplus revenue of the first year in which it is possible to make such payment, in addition to the semi-annual payments regularly becoming due.

The aforesaid compensation of the water company is charged exclusively upon the fund herein set apart for that purpose, and this ordinance shall never be construed as imposing any liability upon the City of Philadelphia for the same or any part thereof.

The gross receipts for water are hereby pledged to the water company to secure the payments in this section provided, subject to the right of the City to make therefrom the ordinary expenditures for the maintenance and operation of its water system. The water rents shall be payable to and shall be received by the Receiver of Taxes for the purposes and subject to the lien herein declared, and the said Receiver of Taxes shall pay over the same to the City Treasurer, to be held by him in trust for the protection of the said lien. The water rents received during each year shall be credited to an account to be entitled "Revenues of the Water Bureau pledged to the Schuylkill Valley Water Company." Ordinary expenditures for the maintenance and operation of the water system may be made by the Treasurer upon warrants drawn by the Director of Public Works and countersigned by the Comptroller, and may be charged to said account. As the payments herein provided fall due the Treasurer shall ascertain the amount of surplus revenue of the Water Bureau, as herein defined, for the current year, and if the same be sufficient to meet the payments to the water company herein provided, he shall make such payments upon a warrant to be drawn by the Director of Public Works and countersigned by the Comptroller. The surplus beyond such payments standing to the credit of said account at the end of each fiscal year shall be covered into the City Treasury as net income from the Water Bureau, and the account for that year shall then be closed.

If at any time the City shall desire to terminate the pledge hereby ordained, it may be done by setting aside the sum or sums payable to the water company during the current year, to be held by the City Treasurer in trust as a fund specifically applicable to the making of such payment or payments.

Sect. 15. As compensation for cleansing the filters, the water company shall be entitled to receive the further sum of one dollar and eighty-five cents per million gallons of filtered water delivered at the pumping stations aforesaid, to be paid monthly, on the tenth day of each month, for the water delivered during the preceding month. And in case such payments shall cease, or shall not be made, the water company shall be relieved of all obligations to cleanse the filters and from all liability on account of the quality of the water delivered as aforesaid.

Sect. 16. Of the sums so paid to the water company by the caid City the said water company shall set aside, by proper instrument in writing, to a reliable trust company, to be selected by the said water company, such annual sums as will be sufficient, together with the interest thereon, to meet the actual cost of the works contemplated by this ordinance at the expiration of the various terms of payments as defined herein. It is not intended by the terms of this section to impose upon said water company the obligation to issue any securities, but only to provide for the liquidation of the actual cost of construction out of the annual sums to be paid therefor by the City, nor does this subdivision in any way affect or control the sums to be paid hereunder for the cleansing of the filter beds.

Whenever it shall appear that the said actual cost of construction has been paid or liquidated, then this clause shall become inoperative.

It is further ordained that should the said water company issue or cause to be issued any bond, note or other evidence of debt which would be a lien upon the property or plant which is to be delivered to the said City at the times and under the conditions herein provided, then it shall be a condition of said or any like issue that said or any lien upon said or any part of said property shall expire at the time fixed herein for the delivery of said works and system to said City, subject to all of the conditions governing the same.

Sect. 17. At the expiration of said term of fifty years, and upon the payment by the said City of all the installments payable thereon, then and in that case the property and improvements herein authorized and ordained shall be and are hereby declared to be the property of the said City, free and clear of all title or interest of the said water company, and no further payments shall be due and owing the said water company from the said City by virtue of the terms of this ordinance.

Sect. 18. This ordinance shall not take effect unless the said water company shall, within thirty days from the passage of the same and its approval by the Mayor of said City, accept the terms thereof in writing, properly executed and delivered to the Mayor.

Sect. 19. The privileges, powers and obligations and benefits conferred upon the said water company hereby shall likewise inure to the benefit of any and all successor or successors, assign or assigns of said company.

Sect. 20. This ordinance shall take effect immediately upon its passage.

## AN ORDINANCE

Authorizing and directing the Mayor to enter into a contract with the Pennsylvania Sanitation Company, for the filtration and purification of the water supply of the City of Philadelphia, under the processes and systems owned and controlled by said company, and making the necessary appropriation thereto.

SECTION 1. *The Select and Common Councils of the City of Philadelphia do ordain,* That the Mayor of the City of Philadelphia be, and he is hereby authorized and directed, upon the passage of this ordinance, to enter into and execute a contract with the Pennsylvania Sanitation Company, for the purchase, erection and construction of water filtration and purification plants, for the sum of three million (3,000,000) dollars; the said plants to be erected upon land now owned by the City of Philadelphia, and under the direction and supervision of the Department of Public Works, from drawings and specifications prepared by the Pennsylvania Sanitation Company, and to be approved by the Director of the said department; the said plants to be capable of purifying and filtering three hundred million (300,000,000) gallons of water per day, of good potable quality.

SECT. 2. Payment to be made in monthly instalments during the progress of the work, upon estimates made by the City Engineer of the value of the work done. Ten per centum of each monthly estimate to be retained by the City until the completion of the whole work and its acceptance by the Department of Public Works.

SECT. 3. The sum of three million (3,000,000) dollars is hereby appropriated to new Item , in the annual appropriation to the Department of Public Works for the purchase money of the said plants to be erected by the Pennsylvania Sanitation Company, under the terms of this ordinance.

SECT. 4. The said Pennsylvania Sanitation Company shall give to the City of Philadelphia a bond of indemnity with good and sufficient sureties, in the sum of one hundred thousand (100,000) dollars, for the faithful performance of all the conditions of the contract and of the ordinance authorizing it, and also against all liens, charges or encumbrances against the filtering plants purchased by the City under the terms of this ordinance.

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*Philadelphia, June 11, 1896.*

To the Mayor and Councils of the City of Philadelphia.

GENTLEMEN:—In connection with the proposition of the Pennsylvania Sanitation Company, the company beg leave to submit a brief explanation of the system of filtration which it proposes to furnish in the event that the accompanying ordinance shall meet with your favorable consideration.

This system contemplates the erection of filter beds directly over or immediately adjacent to the reservoir. These beds to be composed of various kinds of filtering material, sand predominating. The structure will be entirely of stone, concrete and steel, and will be divided into compartments whereby the flow of water is at all times under complete control and regulation. An adjustable screening floor is placed over the filtering material in each compartment, holding the water temporarily in suspension and preventing the close packing of the filters. Solid matter which may be held in suspension in the water is arrested by the top filtering surface beneath the screening floor, while the water itself percolates through the filtering material and flows trough the open air as rain into the reservoirs. The effluent water is completely filtered and oxygenized and reaches the reservoir free and pure.

No chemicals are required in the operation of the system with their usual offensive odors and injurious effect upon the water which is used for drinking purposes. Reliance is placed upon the purifying action of the air, than which all authorities agree that there is no better disinfectant. By the company's system, this valuable agency is made use of to the fullest extent, the design being to subject the water completely to its effect.

By the natural action of the water itself, there is set up within the filtering material a species of micro-organism which prey upon and destroy the germs of diseases which may be present in water which is simply clear but not pure, and the system is designed to offer the most favorable conditions under which these germ destroyers may be cultivated and allowed to effect their beneficent action upon the water. Recent researches made by other communities alive to the importance of this subject have amply demonstrated the foregoing. The method of application of the principles used in the operation of these filter beds are protected by Letters Patent of the United States, Canada and England.

A most important consideration in connection with a project of this nature is the cost of maintenance and operation. The company is confident of its ability to demonstrate its system's special claim to consideration in this particular. It is believed that no other proposition will be made to your Honorable Bodies which will commend itself so favorably. The expense of operation is limited to the cost of attendance and occasional renewals of a small portion of the filtering material. Expert attendance is not required.

The company wil be pleased to send its representative to address a committee of your Honorable Bodies and to present some of its exhibits.

Respectfully submitted,

THE PENNSYLVANIA SANITATION CO.

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*Philadelphia, October 6, 1896.*

MR. R. R. BRINGHURST,
Chairman of Committee on Water.

DEAR SIR:—Having arranged to make an inspection of the Water Supply System of New York on to-morrow and Thursday, I regret that I shall not be able to attend the meeting of your Committee to-morrow afternoon.

In case my views should be asked respecting the ordinance directing the Mayor to enter into a contract with the Pennsylvania Sanitation Company for the erection of filters over the reservoirs for the purification of the water supply of the City, I beg to submit the following:

As I remarked before the Committee on Filtration, I consider that for the City to select any system of filtration for all its water without very much more careful scrutiny than it has as yet been possible to give to the matter, would be as unwise as for a man to select his wife by drawing lots from a hat.

Filtration of such quantities of water as those required by our City should be undertaken only after careful comparison of existing systems by experts, and is not, by any, to be entered into unadvisedly or lightly. Even in the small plant, to cost say $250,000, for which the Department of Public Works has asked an appropriation from Councils, I should not for a moment think of selecting any one system, however excellent, but should select, with expert advice, for comparative test, a number of the most approved systems now before the public, including, of course, the open sand filter, upon which there are no patents.

I believe that if it is found advisable to apply filtration to all of the water furnished by the City, it will also be found advisable to adopt different systems in different locations, the choice in each case being governed by the peculiarties of the situation.

If, however, Councils are determined that all of the City water shall be filtered by one system, let them advertise for competitive bids, so that the best and most economical system may be selected.

Or, if Councils are determined to select a system without experiment, let it, by all means, be the old-fashioned, slow, or so-called "natural," sand filtration, which has, at least, demonstrated its usefulness by many years of successful use on an enormous scale in London and other European cities. This, while it will exclude competition between systems, will give the City at least the benefit of competition between contractors, and relieve it of excessive payments on account of patents.

The foregoing consideration apply, as you will see, to the broad question of selecting any type of filter without careful and exhaustive experiment and study in the hands of experts, and ought, I think, to be sufficient to forbid any such precipitate action.

Coming, however, to a consideration of the particular system and ordinance now before you, I note that the system has not yet been applied to the filtration of water destined for city supply, excepting the small quantity of sewage which the City of Reading contributes to the supply of Philadelphia through the vehicle of the Schuylkill river. In company with the Mayor and other officials of the City of Reading, I have visited the sewage filtration plant constructed by the Pennsylvania Sanitation Company in that city, and while I am by no means qualified by such a visit to pronounce upon the merits of the system, it may be proper to state that the effluent, as I observed it there retained enough of the odor of the original sewage to condemn it as drinking water.*

I have looked forward to a further and more thorough examination of this plant with Mr. Deary, the President of the Company, who has kindly offered to explain it more thoroughly to me, but the opportunity for this has not yet arrived.

I note, further, that, under the ordinance, the company, upon the completion of the works, will have received two million seven hundred thousand (2,700,000) dollars, and that the only protection the City will then have to ensure the satisfactory working of the plants, will be a bond of one hundred thousand (100,000) dollars deposited by the company, and the 10 per cent. retained, amounting to three hundred thousand (300,000) dollars.

Very respectfully yours,

JOHN C. TRAUTWINE, Jr.,

*Chief of Bureau.*

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* This odor was noticed at the outfall from a long pipe through which the filtered sewage flows to the river. On a subsequent visit, although the odor at the outfall remained, the effluent, examined at a point above the entrance to the pipe, appeared to be perfectly odorless. Mr. Deery, President of the Sanitation Co., stated that the pipe in question had been used for the supply of unfiltered sewage. J. C. T., Jr.

# APPENDIX H.

## REPORT

OF

# H. W. SPANGLER AND D. A. DECROW,

## EXPERTS,

On Test of Two Holly Triple-Expansion Vertical Engines, at Spring Garden Pumping Station, April 10-15, 1896.

*Philadelphia, May 26, 1896.*

MR. JOHN C. TRAUTWINE, JR.,

Chief of the Bureau of Water, Philadelphia, Pa.

SIR :—We, the undersigned, appointed to make the tests called for in paragraphs 19, 20 and 21 of Specifications for Pumping Engines to be erected in the engine house at the Spring Garden Pumping Station, have the honor to make the following report :

The following are the principal dimensions of each of the engines as furnished by the maker :

Style of Engine, Vertical Triple Expansion.

Style of Pumps, Vertical Double Acting, outside packed plungers.

*Principal Dimensions.*

| | | |
|---|---|---|
| Number and Diameter of H. P. Steam Cyls....... | One 36 | inches |
| Number and Diameter of Int. Steam Cyls........ | One 62½ | inches |
| Number and Diameter of L. P. Steam Cyls...... | One 92 | inches |
| Number and Diameter of Pump Plungers........ | Three 30 | inches |
| Number and Diameter of H. P. Piston Rod....... | One 7½ | inches |

| | | | |
|---|---|---|---|
| Number and Diameter of Int. Piston Rod | One | 7½ | inches |
| Number and Diameter of L. P. Piston Rod | One | 8 | inches |
| Number and Diameter of Plunger Rods | Three | 6 | inches |
| Number and Diameter of Air Pumps | One | 26 | inches |
| Stroke of all Pistons and Plungers | | 60 | inches |
| Diameter of Main Discharge Pipe | | 48 | inches |
| Diameter of Main Suction Pipe | | 48 | inches |
| Length of Discharge Main | | 3,300 | feet |
| Length of Steam Pipe (approximately) | | 300 | feet |

The contract requirements are as follows :

## *Duty.*

The duty required of the engines will be not less than one hundred and twenty million (120,000,000) of foot pounds with one hundred and forty (140) pounds of steam pressure at the engine throttle.

The equivalent of one hundred (100) pounds of coal being taken as one million (1,000,000) heat units.

The duty will be computed by the following formula :

$$\text{Duty} = \frac{\text{Foot pounds of work done}}{\text{Total number of heat units consumed}} \times 1{,}000{,}000.$$

The total foot pounds shall be determined by properly tested pressure gauges placed on the pumping and suction mains, to which shall be added the pressure due to the difference in the height of the gauges.

The total number of heat units shall be measured from the temperature of the feed water taken at a point where it enters the boiler, to steam of the temperature shown by pressure gauges on the boiler.

An allowance of three per cent. will be made for entrained water in the steam.

All feed-water will be carefully weighed.

All steam used in running the engines, or any part of appliance connected with the successful working of the same, shall be taken from the boilers to which the feed-water is weighed.

Condensed steam from the jackets shall be trapped and wieghed during the whole time of the test.

The feed-water will be pumped to the boilers by a separate donkey-pump, supplied with steam from another boiler.

The capacity test may be made at any time after the engines shall have been put in full operation, and will be computed by weir measurement or plunger displacement, making due allowance for slip, as the Chief of the Bureau of Water may determine.

The duty tests shall be made within three (3) months after the engines shall have been put in operation.

The test will continue for twenty-four (24) hours consecutively, during which time the engines shall work smoothly and steadily without heating or vibration, at or above the contract rate of delivery, and with piston speed, boiler pressure, and other conditions as above stipulated, the Bureau of Water furnishing boilers of capacity sufficient to maintain an ample supply of dry steam at one hundred and forty (140) pounds pressure at the engine throttle, and burning anthracite coal of good quality.

It was agreed that the South Engine should be used for making the tests here called for, and accordingly the test was made on that engine. A shorter test was made on the North Engine, to make sure that the engines did not differ materially.

As called for in the specifications, the total foot pounds were determined by properly-tested pressure gauges placed on the pumping and suction mains, to which was added the pressure due to the difference in height of the gauges.

All the feed-water was weighed.

All the steam used in running the engines was taken from the boilers to which the feed-water was weighed.

Condensed steam from the jackets was trapped and weighed during the time of the test.

The total number of heat units is measured from the temperature of the feed-water taken at the boiler to steam having three per cent. of moisture and at the pressure supplied.

This paragraph was interpreted to mean that the heat units chargeable against the engine was the difference between the amount received by the engine and that rejected by the engine; and the duty has been worked out on this basis also, which, while not that literally called for, is believed to be that intended.

### *Test of South Engine No. 439.*

| | |
|---|---|
| Trial commenced | 1.45 P. M., Apr. 10, 1896 |
| Trial ended | 1.45 P. M., Apr. 11, 1896 |
| Duration of trial | 24 hours |
| Total number of revolutions | 30,362 |
| Average revolutions per minute | 21.08 |
| Average piston speed per minute | 210.08 ft |
| Calculated pump-plunger displacement per revolution U. S. gallons | 1079.57 gals |
| Capacity of engine per 24 hours, making no allowance for slips | 32,777,904 gals |
| Capacity of engine per 24 hours, allowing .7 per cent. for slip | 32,548,459 gals |
| Excess of capacity over contract requirement | 8.5 p. c. |
| Excess of piston speed over contract limitation | 5.4 p.c. |

AVERAGE TEMMPERATURES.

| | |
|---|---|
| Main feed-water at boilers | 118° F |
| Jacket drain | 219° F |
| Air-pump discharge | 104° F |

AVERAGE PRESSURES.

| | |
|---|---|
| Steam pressure 137.1. Corrected | 141.1 lbs. |
| Water head in feet 120. Corrected | 117.8 ft. |
| Vacuum | 26.1 in. |
| First receiver | 35.6 lbs. |
| Second receiver | 2.5 lbs. |
| High pressure and intermediate jackets | 79.9 lbs. |
| Low pressure jackets | 33.3 lbs. |
| Gauge on suction, 10.9 in. Corrected | 5.9 in. |

| | |
|---|---|
| Distance between centre of pressure and vacuum gauges corrected for position of vacuum gauge | 20.7 ft. |
| Barometer | 30.24 in. |

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| | |
|---|---|
| Total head pumped against | 145.2 ft. |
| Foot pounds of work done per 24 hours | 39,486,196,926 ft. lbs. |
| Total feed water pumped to boilers | 316,778 lbs. |
| Measured leak to engine No. 440 | 667 lbs. |
| Water weighed from separator | 9,454 lbs. |
| Net water sent to engine, making no allowance for leaks | 306,657 lbs. |
| Total heat in 306,657 lbs. of steam containing 3 per cent. moisture at 141.1 lbs. gauge pressure | 357,378,067 H. U. |
| Total heat in 306,657 lbs. of water at 118° F. | 26,372,502 H. U. |
| Heat units used by engine | 331,005,565 H. U. |
| Duty on above basis | 119,291,641 ft. lbs. |
| Duty on above basis (plunger displacement). | 120,132,569 ft. lbs. |

During the test there was considerable leakage from the steam mains, and an allowance of 120 pounds per hour is a fair one for this. Making this allowance the following is obtained :

| | |
|---|---|
| Net water sent to engine, allowing 120 lbs per hour for leaks | 303,777 lbs. |
| Total heat in 303,777 lbs. of steam containing 3 per cent. moisture at 141.1 lbs. gauge pressure | 354,021,716 H. U. |
| Total heat in 303,777 lbs. water at 118° F. | 26,124,822 H. U. |
| Heat units used by engine | 327,896,894 H. U. |
| Duty on above basis | 120,422,601 ft. lbs. |
| Duty on above basis (plunger displacement). | 121,271,502 ft. lbs. |

On the basis of the heat received by the engine, less the heat rejected by the engine, making no allowance for leaks, we have, as above :

| | |
|---|---|
| Total heat in 306,657 lbs of steam, containing 3 per cent. moisture, at 141.1 lbs. gauge pressure | 357,378,067 H. U. |

| | |
|---|---|
| Heat in 25,877 lbs. of jacket water at 219° F. rejected | 4,859,701 H. U. |
| Heat in 280,780 lbs. condenser discharged at 104° F. rejected | 20,216,160 H. U. |
| Total heat rejected | 25,075,861 H. U. |
| Total heat used | 332,302,206 H. U. |
| Duty on above basis | 118,826,166 ft. lbs. |
| Duty on above basis (plunger displacement). | 119,663,813 ft. lbs. |

Allowing the same amount as before for the losses from the steam pipes, we have for

| | |
|---|---|
| Total heat in 303,777 lbs. steam, containing 3 per cent. moisture, at 141.1 gauge pressure | 354,021,716 H. U. |
| Heat in 25,877 lbs. of jacket water at 219° F. rejected | 4,859,701 H. U. |
| Heat in 277,900 lbs. condenser discharge at 104° F. rejected | 20,008,800 H. U. |
| Total heat rejected | 24,868,501 H. U. |
| Total heat used | 329,153,215 H. U. |
| Duty on this basis | 119,962,969 ft. lbs. |
| Duty on this basis (plunger displacement).. | 120,808,629 ft. lbs. |

---

| | |
|---|---|
| H. P. developed in high pressure cylinder | 321 |
| H. P. developed in intermediate cylinder | 247 |
| H. P. developed in low pressure cylinder | 330 |
| Total indicated horse power | 898 |
| Total horse power accounted for from water pumped | 831 |

### *Test of North Engine No. 440.*

| | |
|---|---|
| Trial commenced | 5.15 P. M., April 15, 1896 |
| Trial ended | 9.15 P. M., April 15, 1896 |
| Duration of trial | 4 hours |
| Total number of revolutions | 4,876 |
| Average revolutions per minute | 20.32 |
| Average piston speed per minute | 203.2 |
| Calculated pump plunger displacement per revolution, U. S. gallons | 1,079.57 |
| Capacity of engine per 24 hours, making no allowance for slip | 31,583,900 gals. |
| Capacity allowing 7 per cent. for slip | 31,362,813 gals. |
| Excess of capacity over contract requirement | 4.5 p. c. |
| Excess of piston speed over contract limitation | 1.6 p. c. |

AVERAGE TEMPERATURES.

| | |
|---|---|
| Mean feed water at boiler | 144.4° F. |
| Jacket drain | 222.3° F. |
| Air pump discharge | 99° F. |

AVERAGE PRESSURES.

| | |
|---|---|
| Steam pressure 140.2 lbs. Corrected | 142.2 lbs. |
| Water head 135 feet. Corrected | 131.3 ft. |
| Vacuum condenser | 25.5 in. |
| First receiver | 34.6 lbs. |
| Second receiver | 1.5 lbs. |
| High pressure and intermediate jackets | 82 lbs. |
| Low pressure jacket | 36.6 lbs. |
| Gauge on suction 9 in. Corrected | 4 in. mercury |
| Distance between centres of pressure and vacuum gauges corrected for position of vacuum gauge | 20.7 ft. |
| Barometer | 30.12 in. |

---

| | |
|---|---|
| Total head pumped against | 156.5 ft. |
| Foot pounds of work done per 24 hours | 41,008,851,848 ft. lbs. |
| Total feed water pumped to boiler | 56,050 ft. lbs. |
| Water weighed from separator | 1.524 lbs. |
| Water corresponding to difference of boiler level at beginning and end of test take-off | 466 lbs. |
| Total steam supplied to engine (4 hours) | 54,060 lbs. |
| Steam per 24 hours | 324,360 lbs. |
| Total heat in 324,360 lbs. of steam containing 3 per cent moisture at 156.9 lbs | 378,365,940 H. U. |
| Jacket water 4 hours—4,018 lbs. 24 hours | 24,108 lbs. |
| Heat in 24,108 lbs. jacket water at 222.3° F. | 4,609,450 H. U. |
| Heat in 300,252 lbs. condenser water at 99° F. | 20,119,887 H. U. |
| Heat rejected by engine | 24,729,337 H.U. |
| Heat used by engine | 353,636,603 H. U. |
| Duty | 115,963,256 ft. lbs. |
| Duty (plunger displacement) | 116,780,721 ft. lbs. |

---

| | |
|---|---|
| H. P. developed in high pressure cylinder | 353 |
| H. P. developed in intermediate cylinder | 239 |
| H. P. developed in low pressure cylinder | 331 |
| Total indicated horse power | 923 |
| Total horse power accounted for from water pumped | 863 |

The horse power given above was determined from indicator cards, a few of which were taken during the test.

The percentage allowed for slip above is the amount determined by weir measurement of a ten million gallon engine of this class working against about 175 pounds pressure tested by the Pittsburgh Testing Laboratory, Ltd., on behalf of the City of Pittsburgh.

In conclusion, Engine No. 439 exceeded the contract capacity by 8.5 per cent. The contract called for a duty of 120 million foot pounds. The duty on plunger displacement was 120,808,629, or allowing the above percentage for slip 119,962,969. Engine No. 440 exceeded the contract capacity by 4.5 per cent. The duty on plunger displacement was 116,780,721. Engine No. 440 was tested against a head of 156.5 feet, which was 16.5 feet above contract requirement.

Respectfully submitted,

(Signed) H. W. SPANGLER,

D. W. DECROW.

# REPORT

OF

Test of No. 2 Southwark Triple-Expansion High-Duty Vertical Pumping Engine, at Queen Lane Pumping Station, September, 1896. By John E. Codman, Chief Draftsman, in Charge of Test.

*Philadelphia, October 8, 1896.*

MR. JOHN C. TRAUTWINE, JR.,
Chief of Bureau of Water.

DEAR SIR:—Acting under your direction, I have superintended the 30-day trial test of the 20-million gallon pumping engine No. 2, built by the Southwark Foundry and Machine Company at the Queen Lane Pumping Station.

Before starting the test, the manhole cover-plates on the three pump chambers were removed and one hundred pounds of water pressure admitted above the delivery valves. At this pressure and under those conditions, viz: with the engines at rest, both the valves and the plunger packing were found to be practically water-tight.

The test began at 12, noon, September 1, and continued until 3 hours 5 minutes P. M., October 1, the test being continued past noon in order to compensate one or two short and unavoidable stoppages during the test. During this run of 30 days the engine made, on an average, 21.91 revolutions per minute, and pumped an average of 20,063,547 gallons of water every 24 hours. On ten of the thirty days, the delivery fell below twenty million gallons per 24 hours. In most cases this deficiency was due to brief slowing down of the pump for the purposes of this Bureau. Some difficulty was caused by air which accumulated in the suction main and passed thence into the pump chamber under the high-pressure steam cylinder. The by-pass in the pump chamber was partly opened to allow this air to escape and remained open during nearly all the test. It is extremely difficult, if not impossible, to run the engine at full capacity without some device to permit the escape of the air brought up with the water. Aside from this difficulty the engine ran smoothly and performed its work satisfactorily.

The following are the principal dimensions of the engine, obtained from the detail drawing furnished by the Southwark Foundry and Machine Company.

*Style of Engine.*

Steam End, Vertical Triple Expansion.
Pump End, Vertical Single-Acting.

*Principal Dimensions.*

| | | |
|---|---|---|
| High pressure steam cylinder. Diameter | 37 | inches |
| Intermediate pressure steam cylinder. Diameter | 62 | inches |
| Low pressure steam cylinder. Diameter | 96 | inches |
| Pump plungers, three. Diameter | 34½ | inches |
| Piston rods, two for each cylinder. Diameter | 5¼ | inches |
| Stroke of pistons and plungers | 54 | inches |
| Suction main. Diameter | 48 | inches |
| Discharge main. Diameter | 48 | inches |
| Suction main. Length | 250 | feet |
| Discharge main to Queen Lane Reservoir (pumping through fountain on top of reservoir bank). Length | 8,200 | feet |

The contract requirements are stated in the specifications as follows :

*Duty.*

"The engines shall be first subjected to a duty trial "during thirty (30) consecutive days by the Chief Engi-

"neer of the Bureau of Water, with regular employees of "the Bureau, during which time the engine or engines "must perform an average duty of one hundred and ten "millions (110,000,000) of foot pounds, computed by the "following formula :

$$\frac{PXNXHX\,100}{W} = \text{Duty.}$$

"in which P=pounds of water delivered per stroke; N= "number of strokes during trial; H=total fluid resistence, "including static and frictional heads measured to the sur- "face of the water in pump well, allowing one pound for "friction through the pump and passages, and W=num- "ber of pounds of coal consumed. The coal to be of fair "quality."

In making the computation, 3 per cent. has been deducted for slip from P (the number of pounds of water delivered per stroke).

Your attention is called to the very vague and meaningless expression for determining the quality and amount of coal consumed. No provision is made for ascertaining the amount of moisture on the coal or for making an allowance on its account, and this moisture is a considerable item, especially where, as in this case, the coal is exposed to the weather.

Neither is any allowance made for blowing the boilers down once a day.

In determining the duty, both of these items should be deducted from the gross amount of coal consumed.

By observation and by weighing samples I found the moisture on the coal amounted to 4 per cent., by weight, of the coal itself. The loss from blowing the boilers down once every day I have computed at 2 per cent., and the coal required to evaporate the moisture on the coal was ½ per cent. of all the coal consumed.

The duty by the above formula and without allowance for moisture or for blowing off, was 89,229,428 foot pounds per 100 pounds of coal.

Making the allowance for blowing off (2 per cent.) for weight of moisture on the coal (4 per cent.) and for evaporating that moisture ($\frac{1}{2}$ per cent.), the duty becomes 95,432,000 foot pounds.

The coal used is a Schuylkill buckwheat, with 15.7 per cent. of ash, and fairly represents the fuel at present used in the regular operation of our works.

I transmit herewith a blue-print table showing in detail the results of the test for each day and the averages and totals for the month.

I am, very respectfully,

(Signed) JOHN E. CODMAN,
*Chief Draughtsman.*

*Philadelphia, December 16, 1896.*

THOMAS M. THOMPSON,
*Director of Public Works*
AND
THE SOUTHWARK FOUNDRY AND
MACHINE COMPANY.

GENTLEMEN :—The undersigned appointed jointly by yourselves to make duty tests of the pumping engines in the Queen Lane Station as directed by paragraph 32 of the specifications issued by the Department of Public Works, Bureau of Water, October 20, 1893, a copy of which is attached to this report marked "Appendix A," would respectfully present the following report.

The pumping station contains four vertical triple expansion steam pumping engines with single acting plungers, erected by the Southwark Foundry and Machine Company, each designed and proportioned to raise 20,000,000 gallons of water to a height of 250 feet through a pumping main 8,200 feet long. The contractor was required to construct and erect the four engines complete, doing all the work and furnishing all the material within the building necessary for their satisfactory and successful operation. As the four engines were constructed from one set of patterns, and as each had been operated satisfactorily without appreciable differences being noted, it was decided (after consultation with the Superintendent of the Bureau of Water), that a special test of each engine was unnecessary, and No. 2 engine was selected upon which to make the twenty-four hour run. As however the lengths of suction pipes connecting each engine with the forebay and the directness of the forcing mains vary, as illustrated by Fig. 1 it was deemed advisable to make a supplemental test of Engine No. 4, lasting four hours.

Each of the four engines have independent suction mains 48 inches in diameter, leading from a forebay to the pumps, the water at ordinary stages of the river being 8 feet 8 inches below the center of the main inlet to the pumps; the plungers when at the top of the stroke being 18 feet 2 inches above this river level. Each of these suction mains connects with the forebay by means of a quarter turn provided with a foot-valve, and vary in length. The length of suction main of No. 2 engine from forebay to where it enters the pump is approximately 285 feet, and that of No. 4 engine is 320 feet. Leaks had been reported in these mains, and at intervals during the tests the action of the pumps indicated that considerable air entered with the water, causing the pumps to pound and presenting a possibility of danger to the pumps unless the present method of supplying them with water is improved.

During the test, steam was supplied from the battery of boilers Nos. 7, 8, 9, 10, 11 and 12. From the center of this battery the distance to the throttle valve of engine No. 4 was approximately 280 feet, and to that of engine No. 2 approximately 215 feet.

Fig. 1 will show the plan of the pump house, boiler house, steam connections and also the location of suction and force main connections.

The following are the principal nominal dimensions and measured dimensions of each of the engines.

### *Nominal Dimensions of Each Engine.*

| | | |
|---|---|---|
| High pressure piston............ | Diameter = 37″ | Mean area = 1,053.56 |
| Immediate pressure piston....... | Diameter = 62″ | Mean area = 2,997.42 |
| Low pressure piston................. | Diameter = 96″ | Mean area = 7,216.58 |

Piston rods, 5¼″ diameter (two for each piston).
Plunger, 34½″ diameter.
Stroke of pistons and plungers, 4.5 feet.

### *Measured Dimensions of No. 2 Engine.*

| | | |
|---|---|---|
| High pressure plunger............. | Cir. = $108\frac{15}{32}''$<br>Diam. = $34.53''$ | Area = 936.27 sq. ins.<br>Stroke, $54''$ |
| Intermediate pressure plunger... | Cir. = $108\frac{15}{32}''$<br>Diam. = $34.53''$ | Area = 936.27 sq. ins.<br>Stroke, $54''$ |
| Low pressure plunger.................. | Cir. = $108\frac{31}{64}''$<br>Diam. = $34.53''$ | Area, = 936.53 sq. ins.<br>Stroke, $54''$ |

Total plunger displacement per revolution of engine, 87.78 cubic foet.

### *Measured Dimensions of No. 4 Engine.*

| | | |
|---|---|---|
| High pressure plunger............. | Cir. = $108\frac{15}{32}''$<br>Diam. = $34.53''$ | Area = 936.27 sq. ins.<br>Stroke, $54\frac{1}{64}''$ |
| Intermediate pressure plunger.. | Cir. = $108\frac{7}{16}''$<br>Diam. = $34.52''$ | Area = 935.72 sq. ins.<br>Stroke, $54''$ |
| Low pressure plunger ............. | Cir. = $108\frac{31}{64}''$<br>Diam. = $34.53''$ | Area = 936.53 sq. ins.<br>Stroke, $54''$ |

Total plunger displacement per revolution of engine, 87.81 cubic feet.

Total plunger displacement per revolution of engine, 87.81 cubic feet.

The steam inlet to the high-pressure cylinder is 8 inches in diameter, and the suction and discharge pipes are each 40 inches in diameter at the pump, enlarging to 48 inches a few feet away. Each pump chamber contains 89 suction and 90 discharge valves, with a net area of nine square inches through each valve, the area through valves being 810 square inches.

All the dimensions except those marked measured were furnished by the contractor.

The capacity test described by paragraph 29 of the specifications was "to be computed by weir measurement, or plunger displacement, making due allowance for slip." There is no method of measuring the water flowing to the pumps, and had this been possible, such measurement would have been vitiated by the reputed leaky condition of the suction main, which would seem to be verified by the evident presence of air when the pumps were in operation. Owing to the length of these suction mains, and the height to which the water was drawn, the chances for such leakage were magnified. The water after leaving the pumps passes through a 48-inch forcing main 8,200 feet long, which discharges into a mushroom fountain at the Queen Lane reservoir, and from this the water flows over spillways into the north or south basin. As the question of the integrity of the reservoir was in litigation at the time of these tests, the actual quantity delivered could not be calculated by determining the rate at which the reservoir filled less allowances for evaporation, etc., and the velocity of approach at the spillways would not permit of these being used as weirs. It might have been possible to construct a weir projecting into one of the basins, but we were unwilling to assume that the forcing main which had previously proved defective, was free from leaks, and the only course left was to calculate the delivery of the pump by plunger displacement. It is not presumed that the delivery of the pumps corresponded with the actual area of the plungers multiplied by the stroke, but any arbitrary allowance for slip would be practically a guess, and the presence of air in the pump chambers would further complicate such allowance. It was therefore decided that unless the test should show that the requirements of the specifications were not met, or were exceeded by a very slight margin, justice to both parties would suggest reporting the delivery of the pumps as plunger displacement.

The specifications called for the following specific method of procedure, which was carried out in detail.

The engines were "required to perform a duty of not less than one hundred and twenty millions (120,000,000) of foot pounds, with one hundred and forty (140) pounds of steam pressure at the throttle."

The equivalent of one hundred (100) pounds of coal was taken as one million (1,000,000) heat units, and the duty computed by the following formula :

$$\text{Duty} = \frac{\text{Foot pounds of work done}}{\text{Total number of heat units consumed}} \times 1{,}000{,}000$$

The total foot pounds was determined by tested pressure gauges placed on the pumping and suction mains, to which was added the pressure due to the difference in the height of gauges.

The total number of heat units was "measured from the temperature of the feed-water taken at a point where it enters the boiler, to steam of the temperature shown by pressure gauges on the boiler."

An allowance of three (3) per cent. was made for entrained water in the steam.

All feed water was carefully weighed.

All steam used in running the engines, or any part of the appliance connected with the successful working of the same, was taken from the boilers to which the feed-water was weighed.

Condensed steam from the jacket was trapped and weighed during the whole time of the test.

The feed-water was pumped to the boilers by a separate donkey pump, supplied with steam from another boiler.

The test of No. 2 engine was continued for twenty-four (24) hours consecutively, during which time the engines worked smoothly and steadily without heating and with little vibration, above the contract rate of delivery, and with piston speed, boiler pressure, and other conditions approximately as above stipulated.

The temperature at which the water would ordinarily be supplied to these boilers was measured during the time of the test, and this temperature was used in making the calculations called for, but in order to handle this water properly its actual temperature during the test was reduced to 119 degrees by addition of cold water from the City mains.

*Record of Twenty-four Hour Test with No. 2 Engine.*

Time of test: From Noon, Nov. 27, 1896, to Noon, Nov. 28, 1896.

| | |
|---|---|
| Water pressure by gauge, pounds per square inch: | 98.57 |

| | |
|---|---|
| Suction by gauge, pounds per square inch....... | 3.29 |
| Pressure due to difference in height of the gauges, pounds.............................. | 11.14 |
| Total water pressure, pounds per square inch.... | 113.0 |
| Corresponding total head, feet.................. | 260.7 |
| Plunger displacement per revolution of engine, cubic feet.................................. | 87.78 |
| Revolutions in 24 hours........................ | 32,337 |
| Foot pounds of work done in 24 hours............ | 46,190,752,659 |
| Water pumped into boilers in 24 hours, pounds... | 354,763 |
| Water from separator in 24 hours, pounds........ | 19,413.5 |
| Steam used by engine in 24 hours, pounds........ | 335,349.5 |
| Steam pressure at boilers, gauge pounds per square inch................................ | 148.7 |
| Barometer, pounds per square inch............... | 14.77 |
| Heat units per pound of steam................... | 1,167.67 |
| Head units used by engine in 24 hours................ | 391,577,550 |
| Heat units restored by feed water............... | 55,175,053 |
| Temperature of feed water....................... | 195.8° |
| Heat units restored by engine in 24 hours........ | 55,175,053 |
| Heat units chargeable to engine.................. | 336,402,497 |
| Duty: Foot pounds per million heat units........ | 137,307,996 |

The foregoing calculations while strictly in accordance with the wording of the specifications do not in our opinion fulfil the intent thereof, and the following calculations charge each engine with the heat actually received and credit it with that actually rejected.

*Record of Twenty-four Hour Test with No. 2 Engine.*

| | |
|---|---|
| Foot pounds of work done, as above............ | 46,190,752,659 |
| Steam used by engine, as above.................. | 335,349.5 |
| Steam presure at engine, pounds per square inch | 144.29 |
| Barometer, pounds per square inch............. | 14.77 |
| Heat units per pound of steam................. | 1,166.98 |
| Heat units used by engine in 24 hours.......... | 391,346,159.5 |
| Water from jackets in 24 hours.................. | 40,390.5 |
| Temperature of water from jackets.............. | 284.9° |
| Heat units restored by jacket water in 24 hours.. | 10,271,708 |
| Temperature of overflow....................... | 137.76° |
| Heat units restored by overflow in 24 hours...... | 31,253,855.6 |
| Heat units chargeable to engine in 24 hours..... | 249,820,595.8 |
| Duty: Foot pounds per million heat units....... | 132,041,261 |

MISCELLANEOUS DATA.

| | |
|---|---|
| Revolutions per minute | 22.46 |
| Gallons of water pumped in 24 hours | 21,234,687 |
| Excess of capacity requirement of specifications | 6.2% |
| Piston speed per minute, feet | 202.1 |
| Excess of speed limitation of specification | 1.1% |
| Indicated horse power, steam cylinders | 1,013.5 |
| Indicated horse power, water cylinder | 946 |
| Steam pressure in first receiver, pounds | 35 |
| Steam pressure in second receiver, pounds | 3 |
| Vacuum, inches | 24 |
| Steam pressure in high pressure jacket, pounds. | 144 |
| Steam pressure in intermediate jacket and reheater jackets, pounds | 83 |
| Steam pressure in low pressure jacket, pounds. | 39 |

## *Record of Four Hour Test with No. 4 Engine.*

Time of test: From 7.30 P. M. to 11.30 P. M., Dec. 11, 1896.

| | |
|---|---|
| Water pressure by gauge, pounds per square inch | 97.14 |
| Suction by gauge, pounds per square inch | 3.20 |
| Pressure due to the difference in height of gauges, pounds per square inch | 11.14 |
| Total water pressure, pounds per square inch | 111.48 |
| Corresponding total head, feet | 257.2 |
| Plunger displacement per revolution, cubic feet | 87.81 |
| Total revolutions | 5,388 |
| Foot pounds of work done in 4 hours | 7,595,398,944 |
| Corresponding foot pounds of work done in 24 hours | 45,572,393,664 |
| Water pumped into boilers in 4 hours, pounds | 56,362 |
| Computed amount of water required to bring the level of water in the boilers at the end of the test to the level at the beginning, pounds | 1,646.4 |
| Water from separator in 4 hours, pounds | 3,555.5 |
| Steam used by engine in 4 hours, pounds | 54,452.9 |
| Steam pressure at engine gauge, pounds per square inch | 147.1 |
| Barometer, pounds per square inch | 14.77 |
| Heat units per pound of steam | 1,167.4 |
| Heat units used by engine in 4 hours | 63,570,493 |
| Water from jackets, pounds | 7,068 |
| Temperature of water from jackets | 285.18° |

# Record of Data taken during the thirty day trial test of Engine No. 2, at Queen Lane Pumping Station.

| | ENGINE OBSERVATIONS. | | | | | | WATER OBSERVATIONS. | | | | | | COAL. | | DUTY. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days. | Daily Counter Reading. 665,319 | Revolutions per 24 hours. | Revolutions per minute. | Steam pressure.* | Feed water. Temperature.* | Reading of vacuum gauge.* | Average daily reading water pressure gauge.* | Average daily reading suction lift.* | Total lift in feet plus 2.33 ft. friction. | Pounds of water discharged per revolution, less 3% for slip. | Gallons discharged per revolution, less 3% for slip. | Gallons per 24 hours, less 3% for slip. | Pounds of coal consumed per 24 hours. | Ashes per 24 hours. Pounds. | Millions of foot-pounds per 100 pounds of coal. | REMARKS. |
| 1 | 697,565 | 32,246 | 22.40 | 140 | 121 | 26¾ | 235 | 33.6 | 271.0 | ............ | ............ | 20,570,000 | 53,865 | 8,677 | 85.6 | Test began Sept. 1st, 12 M. |
| 2 | 729,748 | 32,183 | 22.35 | 142 | 124 | 26¾ | 235 | 34.3 | 271.6 | ............ | ............ | 20,370,000 | 58,211 | 7,887 | 82.7 | |
| 3 | 761,268 | 31,520 | 21.88 | 142 | 127 | 26½ | 235 | 34.2 | 271.5 | ............ | ............ | 20,000,000 | 48,211 | 8,743 | 86.1 | |
| 4 | 792,705 | 31,437 | 21.80 | 143 | 125 | 26½ | 235 | 33.8 | 271.1 | ............ | ............ | 20,000,000 | 53,500 | 8,126 | 85.6 | |
| 5 | 824,354 | 31,649 | 21.98 | 143 | 124 | 26½ | 235 | 32.1 | 269.4 | ............ | ............ | 20,100,000 | 51,732 | 8,306 | 85.5 | |
| 6 | 855,908 | 31,554 | 21.99 | 143 | 122 | 26½ | 235 | 30.9 | 268.2 | ............ | ............ | 20,100,000 | 50,556 | 8,609 | 85.7 | |
| 7 | 887,178 | 31,270 | 21.72 | 144 | 125 | 26½ | 235 | 31.4 | 268.7 | ............ | ............ | 19,900,000 | 48,412 | 6,832 | 86.6 | |
| 8 | 919,040 | 31,862 | 22.12 | 142 | 126 | 26½ | 235 | 32.4 | 269.7 | ............ | ............ | 20,180,000 | 55,433 | 8,798 | 86.3 | |
| 9 | 950,792 | 31,752 | 22.05 | 143 | 129 | 26½ | 235 | 32.5 | 269.8 | ............ | ............ | 20,190,000 | 46,821 | 6,916 | 87.4 | |
| 10 | 982,296 | 31,504 | 21.89 | 142 | 128 | 26½ | 235 | 32.5 | 269.8 | ............ | ............ | 20,000,000 | 48,116 | 7,358 | 88.0 | |
| 11 | 1,013,027 | 30,731 | 21.34 | 143 | 134 | 26½ | 235 | 32.5 | 269.8 | ............ | ............ | 19,500,000 | 55,573 | 8,629 | 87.1 | |
| 12 | 1,044,699 | 31,672 | 22.00 | 142 | 133 | 26½ | 235 | 32.6 | 269.9 | ............ | ............ | 20,180,000 | 55,744 | 7,899 | 86.6 | |
| 13 | 1,076,158 | 31,459 | 21.84 | 141 | 135 | 26½ | 235 | 32.8 | 270.1 | ............ | ............ | 20,000,000 | 52,029 | 9,091 | 86.7 | |
| 14 | 1,107,519 | 31,361 | 21.77 | 142 | 133 | 26½ | 235 | 33.0 | 270.3 | ............ | ............ | 19,930,000 | 48,369 | 7,963 | 87.1 | |
| 15 | 1,139,259 | 31,740 | 22.04 | 139 | 139 | 26½ | 235 | 32.5 | 269.8 | 5,297.92 | 635.92 | 20,150,000 | 46,858 | 7,620 | 87.6 | Stopped 12 minutes. |
| 16 | 1,170,654 | 31,395 | 21.80 | 142 | 132 | 26½ | 235 | 32.3 | 269.6 | ............ | ............ | 20,000,000 | 50,236 | 7,473 | 87.6 | |
| 17 | 1,200,331 | 29,677 | 20.61 | 139 | 127 | 26½ | 235 | 32.2 | 269.5 | ............ | ............ | 18,850,000 | 52,751 | 7,344 | 87.2 | Stopped 1 hr. 20 minutes. |
| 18 | 1,232,074 | 31,743 | 22.04 | 142 | 133 | 26½ | 235 | 32.3 | 269.6 | ............ | ............ | 20,150,000 | 38,992 | 8,105 | 88.4 | |
| 19 | 1,263,809 | 31,735 | 22.04 | 141 | 130 | 26½ | 235 | 32.0 | 269.3 | ............ | ............ | 20,150,000 | 51,366 | 8,096 | 88.3 | |
| 20 | 1,295,873 | 32,064 | 22.26 | 141 | 130 | 26½ | 235 | 32.4 | 269.7 | ............ | ............ | 20,350,000 | 59,477 | 7,174 | 87.6 | |
| 21 | 1,327,561 | 31,688 | 22,00 | 139 | 127 | 26½ | 235 | 32.3 | 269.6 | ............ | ............ | 20,180,000 | 54,564 | 7,773 | 87.5 | Stopped 52 minutes. |
| 22 | 1,358,069 | 30,508 | 21.19 | 142 | 130 | 27 | 235 | 32.4 | 269.7 | ............ | ............ | 19,400,000 | 45,142 | 8,125 | 87.9 | |
| 23 | 1,387,703 | 31,634 | 22.00 | 142 | 130 | 27 | 235 | 32.4 | 269.7 | ............ | ............ | 20,180,000 | 45,685 | 7,536 | 88.3 | |
| 24 | 1,421,222 | 31,519 | 21,88 | 141 | 132 | 27 | 235 | 32.4 | 269.7 | ............ | ............ | 20,000,000 | 50,095 | 8,075 | 88.4 | |
| 25 | 1,452,506 | 31,284 | 21.72 | 141 | 131 | 27 | 235 | 32.4 | 269.7 | ............ | ............ | 19,900,000 | 48,191 | 7,770 | 88.6 | |
| 26 | 1,483,792 | 31,286 | 21.72 | 142 | 132 | 27 | 235 | 32.6 | 269.9 | ............ | ............ | 19,900,000 | 43,463 | 7,513 | 89.1 | |
| 27 | 1,514,971 | 31,179 | 21.65 | 142 | 130 | 27 | 235 | 32.9 | 270.2 | ............ | ............ | 19,800,000 | 47,329 | 7,464 | 89.4 | |
| 28 | 1,545,869 | 30,898 | 21.46 | 142 | 131 | 27 | 235 | 33.0 | 270.3 | ............ | ............ | 19,650,000 | 47,882 | 7,445 | 89.5 | |
| 29 | 1,576,196 | 30,327 | 21.06 | 142 | 133 | 27 | 235 | 32.8 | 270.1 | ............ | ............ | 19,300,000 | 50,468 | 8,364 | 89.3 | |
| 30 | 1,611,800 | 35,604 | 21.88 | 141 | 131 | 27 | 235 | 32.2 | 269.5 | ............ | ............ | 2[illegible],600,000 | 58,009 | 8,801 | 89.2 | Stopped 41 minutes. |
| | | Total, | | | | | Average | Average. | Average. | | | Average, | Total, | Total, | Average,† | Test ended Oct. 1st, 3.05 P. M. |
| | | 946,481 | 21.91 | | 129.4 | 26¾ | 235 | 32.59 | 269.96 | | | 20,063,547 | 1,517,080 | 238,512 | | |
| | | N | | | | | | | H | P | | | W | | | |

* Deduced from hourly readings.

† As determined by Formula: $\frac{P \times N \times H \times 100}{W} = \text{Duty.}$

$$\frac{5{,}297.92 \times 9{,}464.81 \times 269.96 \times 100}{1{,}517{,}080} = 89{,}229{,}428$$

Percentage of waste in coal, 15.7
" " moisture in coal, 4.0
" " loss from Blowing off, 2.
Fires cleaned twice every 24 hours.

| | |
|---|---|
| Heat units restored by jacket water in 4 hours.. | 1,799,371 |
| Temperature of overflow.......................... | 136.12° |
| Heat units restored by overflow in 4 hours...... | 4,943,192 |
| Heat units chargeable to engine in 4 hours..... | 56,827,930 |
| Corresponding heat units chargeable to engine in 24 hours.............................. | 340,967,580 |
| Duty: Foot pounds per million heat units..... | 133,656,092 |

MISCELLANEOUS DATA.

| | |
|---|---|
| Revolutions per minute........................ | 22.45 |
| Gallons of water pumped in 24 hours........... | 21,236,080 |
| Excess of capacity requirement of specifications .................................. | 6.2% |
| Piston speed per minute...................... | 202.05 |
| Excess of speed limitation of specifications..... | 1.0% |
| Indicated horse power, steam cylinders......... | 1,011 |
| Indicated horse power, water cylinders........ | 933 |
| Steam pressure in first receiver, pounds per square inch.............................. | 37 |
| Steam pressure in second receiver, pounds per square inch.............................. | 3.2 |
| Vacuum, inches.............................. | 23.2 |
| Steam pressure in high pressure jacket, pounds per square inch........................... | 147 |
| Steam pressure in intermediate jacket and in reheater jackets, pounds per square inch... | 80 |
| Steam pressure in low pressure jacket, pounds per square inch........................... | 40 |

We therefore report that the engines have more than fulfilled the requirements of the specifications.

Signed, H. W. SPANGLER,
EDWARD T. CHILD,
JOHN BIRKINBINE.

# APPENDIX J.

Specifications used in Repairing Queen Lane and New Roxborough Reservoirs.

In this Appendix are given the technical portions of specifications used in the repair of Queen Lane and Roxborough Reservoirs, as follows :

1. September, 1895. Concrete footing wall, south basin, Queen Lane.

3. November, 1895. Retaining wall and reconstruction of outer slope, Queen Lane.

4. November, 1895. Drain, Queen Lane.

5. November, 1895. Concrete footing wall, north basin, Queen Lane.

16. July, 1896. Asphalt lining, south basin, Queen Lane.

17. August, 1896. Asphalt concrete lining, one basin, Roxborough.

18. September, 1896. Grouting brickwork on inner slopes, Queen Lane.

19. September, 1896. Asphalt lining, north basin, Queen Lane.

22. November, 1896. Coping for retaining wall, Queen Lane.

Most of the specifications contain, also, provisions generally similar to the following :

The Contractor shall begin work within ten (10) days from the date of notice from the Engineer, and shall complete it within eighty (80) working days from the date of such notice.

Work shall be immediately suspended, and shall remain suspended, whenver, in the judgment of the Engineer, such suspension is necessary. Time during which the work is thus suspended shall not be counted against the Contractor as forming part of the time required for the completion of the work.

If the Contractor, by reason of other causes over which he has no control, is subjected to hindrance or delay, he may be granted, at the discretion of the Engineer, a corresponding extension of the time for the completion of the contract; but no other allowance shall be made on such account.

The Contractor shall employ only skilled and experienced workmen, satisfactory to the Engineer, and shall personally superintend the work.

The Contractor shall observe all City ordinances in regard to work of this character, and shall be held responsible for any accidents to persons or property occurring before the final acceptance of the work and resulting from his performance of the contract or during the progress of the work unless it can be shown that such accidents are due to the operations or neglect of the Engineer.

All work done, and all materials, methods and appliances used, must be satisfactory to the Engineer, and samples of all materials must be furnished in ample time for testing before they are to be used.

All materials rejected must be at once removed from the work and disposed of to the satisfaction of the Engineer. If the Contractor fails to remove such materials, as here specified, the Engineer may remove them at the Contractor's expense.

All work completed under this specification shall be under the care of the Contractor until the entire work has been accepted by the Director; and any damages sustained by such work from any cause other than gross neglect or misconduct on the part of the Engineer before such final acceptance, shall be made good at the expense of the Contractor.

The Contractor, his heirs or assigns, shall maintain the work in good order, and the basin practically free from leakage under a head of thirty (30) feet, to the satisfaction of the Director, for five (5) years following its acceptance by the Director, making all repairs and additions which may be necessary for such maintenance.

In this specification the term "Director" refers to the Director of the Department of Public Works, and the term "Engineer" refers to the Chief of the Bureau of Water or his authorized assistants.

All disputes between the City and the Contractor, or between one Contractor and another, whether under this specification alone or under this and others, shall be referred to the Director, and his decision shall be final and conclusive.

At any time when required by the Engineer, the Contractor shall furnish all necessary facilities for an examination of the work done. If the work is not in accord with this specification, or is otherwise defective, it shall be immediately removed and replaced by the Contractor at his expense, and he shall in that case bear also the expense of examination.

No allowance shall be made to the Contractor for any work or extra work, unless the Contractor is directed in writing by the Engineer to do such extra work at a price satisfactory to the Director.

For each day of twenty-four (24) hours, during which the work shall remain unfinished after the time specified in the contract for its completion, the sum of one hundred (100) dollars shall be retained by the City out of moneys due the Contractor, or the City may recover such sum by law, not as a penalty but as liquidated damages.

If the Contractor abandons the work, or fails at any time to comply fully, faithfully and promptly with the requirements of this contract and specification, then the contract shall become null and void and the security bonds forfeited, and the materials delivered at and built in the work shall be the property of the City of Philadelphia. The cost of the completion of the work shall be charged against any moneys still due the Contractor, or against his surety.

No buildings, sheds or tents, to be used as quarters for workmen or animals, will be allowed on any part of the reservoir.

When the work is completed, the Contractor must, within thirty (30) days, clear the reservoir and its surroundings of all rubbish caused by construction, and of all sheds, etc., erected in connection with the work. In default of such clearance by the Contractor, the Engineer may effect it at the Contractor's expense.

No part of the present work shall be disturbed, except with the consent of the Engineer, but any changes in the existing work, which may be required by the work herein specified, shall be made by the Contractor.

The prices paid shall include all fees and royalties for patented inventions, and all charges for materials, contrivances or processes used in connection with the work.

Partial payments will be made monthly, upon the estimates of the Engineer, as the work progresses; but twenty (20) per cent. of the value of the work done each month will be retained by the Director, to be paid to the Contractor thirty (30) days after the acceptance of the completed work by the Director.

Before the final payment is made, the Contractor must furnish acceptable proof of a proper and satisfactory release of all claims on account of fees and royalties, on account of labor or material, or on any other account whatever.

This specification shall be attached to, and form a part of, the contract to be made in pursuance thereof.

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## SPECIFICATION No. 1.

For the building of a concrete wall at the foot of the inner slope of the south basin of Queen Lane Reservoir.

### *Outline of Work Required.*

The work will consist in :

(*a*) The removal of the present concrete floor lining, for such a width, extending from foot of slope, and for such a length, as may be found necessary; and the removal of any portions of the slope lining that may be designated by the Engineer.

(*b*) The excavation of a trench at the foot of the slope, the trench to extend down to rock and to be of such length as may be designated by the Engineer.

(*c*) The filling of this trench with hydraulic cement concrete, which shall be carried up, extended at top, and finished, as indicated in Fig. 2, and as specified herein.

Bidders will submit prices for these three items separately, as directed in Section VIII.

### *Removal of Present Floor Lining.*

The approximate thickness of the present floor lining is four (4) inches. In general, the width of the strip to be removed is that which may be necessary to provide for the digging of the trench and to include those cracks which have appeared within a few feet of the slope. Its length will be approximately that of the trench to be excavated. (See 69.)

The cutting of the concrete must be done by means of picks, chisels or other pointed or edged tools. The use of machinery will be permitted, subject to the approval of the Engineer. No explosives shall be used, and sledges must not be used directly except upon pieces which have already been completely severed from the main body of the floor. The edges cut must be cleared of all loose pieces and dust.

Any fractures or other damage caused in the adjacent floor lining shall at once be repaired by the Contractor and at his expense.

The broken concrete shall be removed to a site to be designated by the Engineer. If the site thus designated necessitates a haul of more than two hundred (200) feet from the reservoir property, the Contractor shall be allowed, for hauling, at the rate of two (2) cents per cubic yard for each additional one hundred (100) feet of haul.

*Excavation of the Trench.*

In general, the sides of the lower portion of the trench will be vertical; its width will be two (2) feet six (6) inches, and its depth will be such as may be necessary to reach the rock foundation; but the Contractor shall increase the width of the trench or otherwise change its cross-section, as may be directed by the Engineer. It is intended that the trench shall extend along the entire foot of the inner slope of the south basin (Fig. 1), a distance of about thirty-six hundred (3,600) feet. (See 5 and 71.)

The material to be excavated is believed to be, in general, as indicated in Fig. 2; that is to say, there is a clay lining, two (2) feet in thickness, under the concrete floor and passing under the foot of the concrete slope lining; and between this and the rock are layers of sandy clay and disintegrated or broken micaceous rock, varying in total thickness from 0 up to ten (10) feet.

No increase or diminution of the contract price per cubic yard will be made on account of any deviation of the actual strata, in character, thickness or location, from the approximate statement given under (8).

The trench may be excavated by manual labor or by machinery. If machinery is used it must be subject to the approval of the Engineer.

The clay excavated shall be kept carefully separate from the other material, and shall be carried, by the Contractor, into the north basin. For this purpose the Contractor shall have the privilege of using one or both of the lower pass-pipes in the division bank, provided that no damage shall thereby be done to said pipe or pipes, or to their appurtenances.

The other material excavated shall be carried up the inner slope, by such appliances as may be approved by the Engineer, and deposited in such places, beyond the foot of the outer slope, as may be designated by him. Allowance for extra hauling will be made as in (6).

The trench and the present concrete slope lining shall be shored, at the Contractor's expense, wherever, in the judgment of the Engineer, such shoring may be necessary, and in such manner as he may approve. Timber used for shoring shall be removed as the work progresses, and no allowance shall be made to the Contractor for such timber.

The rock surface, left exposed by the excavation, shall be thoroughly cleared of all loose stones or other loose material, all of which shall be removed as specified under (6) and (12) with regard to the material to be excavated.

In general, irregularities in the surface of the rock may be allowed to remain; but where that surface has an inclination of more than three (3) inches in one (1) foot in either direction transversely to the line of the trench, it shall be rendered level by the use of pick or chisel, and without the use of explosives.

The Contractor shall construct such dams or other works as may be necessary to keep the trench properly dry, and shall pump out or otherwise remove all surplus water which may nevertheless be found therein.

### *Concrete Filling of Trench.*

Prior to the commencement of the filling, the rock surface at the bottom of the trench shall be thoroughly washed, in such manner as may be approved by the Engineer, so as to remove any sand, dust or other loose material which may have remained after the excavation, or which may have been deposited since; and the surface of the rock and that of the wooden moulds shall be thoroughly wet when the filling is begun. The sides of the trench also shall be clean and wet when the concrete is deposited.

### *Concrete.*

Composition—The concrete shall be composed as follows :

Stones from one (1) to one and one-half ($1\frac{1}{2}$) inches in greatest dimensions, 4 parts.

Gravel, 2 parts.

Sand, 1 part.

Cement, 1 part.

The proportions of stone, gravel, sand and cement are to be measured dry, and not merely estimated, and a barrel (400 pounds) of cement shall be taken as equivalent to four and one-half ($4\frac{1}{2}$) cubic feet.

The Engineer reserves the right to vary the proportions of these ingredients, without change in the contract price per cubic yard, provided the volume of cement, measured as directed in (19), shall not exceed one-sixth (1-6) of that of the other ingredients before mixing.

Stone.—The stone used in the concrete shall be of freshly broken, angular granite, trap, quartz, or other hard rock. Immediately before mixing, it must be washed thoroughly clean by means of a hose, and when it is mixed it must be still wet from this washing, but must carry no water except that which adheres to the stones.

Gravel.—The gravel shall be similar to that known to the Bureau of Surveys as New Jersey gravel.

Sand.—The sand used in the concrete shall be clean, dry-screened, tide-washed bar sand (quartz).

Cement.—The cement used shall be American or European artificial ("Portland") cement of a brand satisfactory to the Engineer, who shall be notified immediately upon the receipt of each shipment of cement upon the work.

The cement shall have a specific gravity of not less than three (3), and shall leave a residue of not more than one (1) per cent. by weight, on a No. 50 sieve; fifteen (15) per cent. on a No. 100 sieve, and forty (40) per cent. on a No. 200 sieve. The sieves shall be of wire cloth of No. 35, No. 40 and No. 40 (Stubb's gauge) wire, with two thousand five hundred (2,500), ten thousand (10,000) and forty thousand (40,000) meshes per square inch, respectively.

The neat cement, mixed with water to a stiff plastic paste and made into pats one-half (½) inch thick, with thin edges, shall, when immersed in water after hard set, show no signs of checking or disintegration. Similar pats, in air, at a temperature between 60° and 70° F., shall develop initial set in not less than thirty (30) minutes.

Briquettes of neat cement, one (1) square inch in cross section, shall develop the following ultimate tensile strengths :

24 hours (in water after hard set), 125 pounds.

7 days (1 day in air, 6 days in water), 400 pounds.

28 days (1 day in air, 27 days in water), 500 pounds.

Briquettes formed of one (1) part cement and three (3) parts standard quartz sand as used by the Inspector of

Cements of the Bureau of Surveys, shall develop the following ultimate tensile strengths :

7 days (1 day in air, 6 days in water), 150 pounds.

28 days (1 day in air), 27 days in water), 200 pounds.

All cement shall meet such additional requirements as to hot water, set and chemical tests, as the Engineer may determine. The requirements for set may be modified where the conditions are such as to render it advisable.

The contractor shall afford every facility for inspecting and testing the cement.

The Engineer shall have the privilege of taking, at any time, a sample from any part of any barrel of cement furnished by the Contractor, and of rejecting any cement which, when tested by such samples, fails to meet the requirements specified.

The mixing of the concrete shall not be delayed pending the testing of the cement, but any concrete mixed with cement which fails to stand the tests herein specified, shall be taken out of the work and replaced with satisfactory material.

Accepted cement, if not used immediately, must be kept in the barrel and thoroughly protected from the weather. The barrels must not be placed on the ground without blockings under them.

No cement will be inspected or used unless delivered in suitable original packages properly branded.

Water.—The water shall be clean, and shall be used in such proportions as the Engineer may direct.

Mixing.—The materials for the concrete may be mixed by machinery, subject to the approval of the Engineer.

If done by manual labor, the mixing shall be performed upon a wooden platform or in a wooden box, of character and dimensions acceptable to the Engineer, and in such manner as he may direct.

Any concrete which, in the judgment of the Engineer, has been injured by an excess of water or otherwise, or has had time to set before being deposited and rammed, shall be rejected and at once removed.

Depositing. The concrete must not be dropped into the trench or placed in it by means of a chute, but must be so deposited that the ingredients shall remain evenly incorporated, as mixed, and free from dirt or other foreign matter.

The concrete shall in all cases be deposited in such widths as to fill completely the entire width of the trench before ramming, whether that be the standard width of 2 feet 6 inches or some greater width, as required by the Engineer.

The concrete shall be deposited in horizontal layers not more than six (6) inches in thickness; and each layer, immediately after it is deposited, shall be rammed with rammers of such form, material and construction as may be approved by the Engineer, until the mortar appears upon the surface, and until the concrete is in perfect contact throughout with the sides of the trench, with the end of the layer last laid and with the mould at the other end of the layer; whereupon the layer next above shall immediately be deposited and rammed, and so on.

In general, the layers of concrete shall not be less than fifty (50) feet in length, and the end of each layer shall be placed one (1) foot back of the end of the layer next below, as indicated in Fig. 3.

The moulds for the ends of the layers shall be of such form and dimensions as to leave those ends as shown in Fig. 3.

The layers shall be placed in piles, each pile extending from the bottom of trench to the top of the work; and, when a pile has been begun, the work must not be interrupted until the pile including the top, with its connections with floor and slope is completed.

At the top, the concrete shall be extended, as shown in Fig. 2, so as to form a connection with the edge of the present concrete floor lining on the one hand, and with the surface of the present concrete slope lining on the other.

When a pile is completed, it shall be protected from all disturbances, as by walking, wheeling or working over it, until it has been allowed twenty-four (24) hours for set, and its surfaces shall be kept wet during all that time.

Where new work is to join old work, or new work which has had time to set, special care must be taken to secure a perfect union between the two, in order that the structure may be made monolithic so far as these joints are concerned. For this purpose, the ends or edges of the work already set must be made perfectly clean and thoroughly wet, and then washed over with a grout of the cement herein specified, mixed neat with clean water in proportions to be determined by the Engineer.

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## SPECIFICATION No. 3.

For the building of a retaining wall, and for the reconstruction of the outer slopes at the Queen Lane Reservoir.

### *Outline of Work Required.*

The work will consist in :

(*a*) Excavation for the foundation of the retaining wall.

(*b*) Building a rubble masonry retaining wall along a portion of the foot of the present outer slope of the bank.

(*c*) Reconstructing the present outer slope of banks to a general inclination of 2 to 1.

(*d*) Sodding or seeding the slopes.

*Excavation for Foundation.*

It is believed that the excavation for the foundation of the wall is principally in loose soil, but no allowance will be made on account of other material which may be encountered. Grade stakes for this work will be given by the Engineer.

The excavation shall be carried down to hard rock in place, or to firm earth or gravel, at the discretion of the Engineer. In rock, the excavation shall be carried to such a depth as to give the wall a footing of twelve (12) inches.

The excavated material may, with the permission of the Engineer, be used in reconstructing the slopes.

The excavation shall in no case be opened more than fifty (50) feet in advance of the masonry filling, unless by express permission of the Engineer.

*Foundation Masonry for Retaining Wall.*

When required by the Engineer the bottom course of the wall shall be of concrete.

The concrete used shall be composed of one (1) part cement, two (2) parts sand and four (4) parts broken stone.

The cement shall conform with the requirements specified under Section VII below.

The sand shall be clean, dry-screened, tide-washed bar sand (quartz).

The stone shall be broken into pieces, all of which shall pass through a one-and-a-half ($1\frac{1}{2}$) inch ring, and shall not be longer than two and one-half ($2\frac{1}{2}$) inches. It shall be brought to the work from the crusher without screening. Immediately before mixing, it shall be washed clean and when it is mixed it shall be still wet from this washing, but must carry no water except that which adheres to the stones.

The footing, or first stone course of the foundation shall be of stones from nine (9) to twelve (12) inches thick, and not less than nine (9) square feet in bed area. The other stones in the foundation shall be one-man and two-man stones. All foundation stones shall be thoroughly bedded in mortar composed of one (1) part cement and two (2) parts sand, and each course shall be grouted with liquid cement mortar.

### *Retaining Wall.*

The retaining wall above the foundation shall be of first-class rubble masonry, of Conshohocken stone or other stone of approved quality.

The outside, or showing face, above the surface of the ground, shall be of broken-range quarry-faced ashlar. All outside joints shall be pointed with cement mortar, cut to an even width.

### *Mortar and Grout.*

All mortar shall be composed of two parts of clean, sharp, dry-screened, tide-washed bar sand and not less than one part of cement. Grout shall consist of one part of such sand and not less than one part of cement.

The ingredients for mortar shall be proportioned by measure and thoroughly mixed dry in a tight box of suitable dimensions, and the proper amount of clean water shall afterward be added.

No greater quantity of mortar shall be prepared than is required for immediate use; and any that has set, or that has been standing longer than two hours, shall be rejected.

The ingredients for grout shall be proportioned by measure and thoroughly mixed dry on a clean board. They shall then be added to clean water in a clean, tight barrel, or other suitable receptacle, and continuously stirred until the proper consistency is obtained.

*Cement*

All cement used on the work shall be American or European artificial ("Portland") cement, of a brand satisfactory to the Engineer, who shall be notified immediately upon the receipt of each shipment of cement upon the work.

The cement shall have a specific gravity of not less than three (3), and shall leave a residue of not more than one (1) per cent., by weight, on a No. 50 sieve; fifteen (15) per cent. on a No. 100 sieve, and forty (40) per cent. on a No. 200 sieve. The sieves shall be of wire cloth of No. 35, No. 40 and No. 40 (Stubb's gauge) wire, with two thousand five hundred (2,500), ten thousand (10,000) and forty thousand (40,000) meshes per square inch, respectively.

The neat cement, mixed with water to a stiff plastic paste and made into pats one-half (½) inch thick, with thin edges, shall, when immersed in water after hard set, show no signs of checking or disintegration. Similar pats, in air, at a temperature between 60° and 70° F., shall develop initial set in not less than thirty (30) minutes.

Briquettes of neat cement, one (1) square inch in cross section, shall develop the following ultimate tensile strengths :

24 hours (in water after hard set), 125 pounds.

7 days (1 day in air, 6 days in water), 400 pounds.

28 days (1 day in air, 27 days in water), 500 pounds.

Briquettes formed of one (1) part cement and three (3) parts standard quartz sand, as used by the Inspector of Cements of the Bureau of Surveys, shall develop the following ultimate tensile strengths :

7 days (1 day in air, 6 days in water), 150 pounds.

28 days (1 day in air, 27 days in water), 200 pounds.

Mortar taken from the mixing box and moulded into briquettes one (1) inch square in cross section shall, after one (1) day in air and six (6) days in water, develop an ultimate tensile strength of thirty (30) pounds.

The Engineer shall have the privilege of taking, at any time, a sample from any part of any barrel of cement furnished by the Contractor, and of rejecting any cement which, when tested by such samples, fails to meet the requirements specified.

Accepted cement, if not used immediately, must be kept in the barrel and thoroughly protected from the weather. The barrels shall not be placed directly on the ground but shall have blockings under them.

No cement will be inspected or used unless delivered in suitable original packages properly branded.

### *New Steps and Platform.*

The new steps and platform, required for the stairway at the inlet pool and at the eastern end of the division bank, shall be of blue flagstone, hard and compact, not subject to injury by frost or water. They shall be carefully and thoroughly set in cement mortar of the character herein specified.

### *Coping.*

The entire retaining wall and the wing walls at the stairways and stop-houses, shall be covered with a coping of North River flagstone, four (4) inches thick, in lengths of not less than six (6) feet. About fifty (50) feet of this will be three (3) feet three (3) inches wide; the remainder will be two (2) feet three (3) inches wide.

### *Character and Appearance of Work.*

All showing faces of masonry, and all steps and coping, must be similar in character and appearance to that now in place.

*Reconstruction of Slopes.*

The material removed from the face of the bank shall be placed behind the retaining wall at foot of slope, substantially as shown in Fig. 27 B—793, in layers six (6) inches thick, and shall be sprinkled and thoroughly rolled with a one-horse puddling roller, weighing about fifteen hundred (1,500) pounds. Where the space is too narrow for the use of the horse roller, wooden hand rammers shall be used. The bank shall then be brought to the intended surface with material obtained in the neighborhood, which must also be sprinkled and compactly rolled in layers of not more than six (6) inches in thickness.

The faces of the slopes shall be over-filled sufficiently to allow for dressing off to finished lines before sodding or seeding.

*Sodding or Seeding.*

When the slopes are finished, sod shall be laid upon them for a width of two (2) feet from the top edge, and upon the top of the bank, for an equal width from the same edge, extending entirely around the reservoir.

The sods shall be cut from grass lands free from weeds, and the soil on the slopes and top shall be well worked before the sods are laid upon it. The sods on the slopes shall be secured to them by wooden pegs one (1) inch square and one (1) foot long.

The remainder of the slopes shall be sodded, as above specified, or seeded, at the discretion of the Engineer.

If seeded, the slopes shall be sown with a mixture of lawn-grass seed and oats, in equal parts.

Any sliding or settlement of the sodded or seeded surface which may occur through natural causes before the final acceptance of the work, shall be repaired by the contractor.

## SPECIFICATION No. 4.

For the laying of a terra cotta drain pipe around Queen Lane Reservoir.

### *Outline of Work Required.*

The work will consist in:

(*a*) Excavating trenches.

(*b*) Laying terra cotta drain pipe.

(*c*) Refilling the trenches.

### *Trench.*

The trench shall be dug upon the lines and to the depths shown in drawing No. 27B—793, accompanying this specification, or to such other depths as the Engineer may direct.

The excavation shall commence at the highest elevation and proceed as directed by the Engineer.

The trench shall be kept properly free from water by pumping, at the Contractor's expense.

The excavation will be in loose soil or decomposed rock. No allowance will be made on account of quicksand, should such be encountered.

The trench shall at all times be so protected by shoring and bracing, or otherwise, as the Engineer may direct, and at the Contractor's expense.

No more than fifty (50) feet of the trench shall be opened at any one time in advance of the laying of the drain pipe, unless by a written order from the Engineer, covering the distance therein specified.

When directed by the Engineer, the Contractor shall increase the width or depth of the trench, or both, as the Engineer may direct, and shall prepare for the drain pipe such concrete or masonry foundation as the Engineer may require.

### *Terra Cotta Pipe.*

The terra cotta pipes shall be ten (10) inches in internal diameter, and at least three-quarters ($\frac{3}{4}$) of an inch thick; of standard quality, unglazed, made of the best material, thoroughly and perfectly burned, and of homogenous texture, without cracks or imperfections.

As the work proceeds, the interior of the pipe shall be carefully cleaned by means of a disc, mould or swab filling the entire bore of the pipe, and attached to a rod sufficiently long to pass two joints from the end of the pipe last laid.

No allowance will be made for bends or branches.

The mouth of the pipe shall be carefully protected from all blasts, and the excavations in all cases shall be fully completed at least twenty feet in advance of the laying of the pipe. In all cases the mouth of the pipe shall be provided with a board or other stopper, carefully fitted to the pipe to prevent earth or other substance from entering it.

Each joint shall be surrounded with a rope or band of twisted hay or straw, and gravel shall be packed around this, in order to prevent the washing in of sand and fine earth.

### *Manholes.*

Manholes shall be built in the manner shown in Drawing No. 16 E—476. They shall be carried up to the established grade, or to such other heights as may be required.

The brick work shall be of the best quality; the joints neatly struck and pointed on the inside, and the outside of the manhole neatly plastered with Portland cement mortar. A proportion of bats, larger than half bricks, may be used in manholes with the permission of the Engineer.

Galvanized wrought-iron rods or steps shall be built in, as shown in Drawing No. 16 E—476.

Every manhole shall be fitted with a cast-iron head and grating, as shown in Drawing No. 9 C—246.

*Re-filling Trench.*

The trench shall be re-filled with broken stone to a distance of three (3) feet above the top of the drain pipe.

On top of the broken stone large flat stones shall then be laid in such manner as to cover the entire width of the trench.

The remaining portion of the trench shall be filled with the material taken out in excavating it.

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DECEMBER, 1895.

SPECIFICATION NO. 5, FOR THE BUILDING OF A CONCRETE WALL AT THE FOOT OF THE INNER SLOPE OF THE NORTH BASIN OF QUEEN LANE RESERVOIR.

Is nearly identical with Specification No. 1 for a similar wall in the south basin.

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JULY, 1896.

SPECIFICATION NO. 16, FOR RE-LINING THE SLOPES AND FLOOR OF THE SOUTH BASIN OF QUEEN LANE RESERVOIR.

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*Outline of Work Required.*

The work will consist in:

(*a*) Cleaning and priming the surface of the slopes and applying two coats of melted asphalt with burlap between them, and paving with bricks, laid flat.

(*b*) Cleaning and priming the surface of the floor, applying a two-inch layer of asphalt concrete and covering this with a single coat of melted asphalt.

(*c*) Cleaning the interior and exterior brickwork and floor of the stop house and applying two full coats of cerion to the walls and a coat of asphalt to the floor.

The area of the slopes is twenty-seven thousand six hundred and eighty-two (27,682) square yards, more or less. The area of the floor is seventy-seven thousand seven hundred and forty-three (77,743) square yards, more or less.

*Asphalt.*

The asphalts to be used shall be best refined Bermudez Asphalt, from the asphalt lake in the State of Bermudez, Venezuela, and F grade Alcatraz "liquid" asphalt, or other liquid California asphalt of equal quality. These will hereinafter be designated as Bermudez and Alcatraz, respectively.

As brought upon the work, the asphalt shall contain, in its refined state, not less than ninety (90) per cent. of bitumen soluble in rectified carbon disulphide or in chloroform. The remaining ingredients shall be such as to exert no injurious effect upon the work. Not less than two-thirds (2-3) of the total bitumen shall be soluble in petroleum naphtha of 70° Beaumé or in acetone. The asphalt shall not lose more than five (5) per cent. of its weight when maintained for ten hours at a temperature of 300° F.

The use of coal tar, petroleum residuum, or so-called artificial asphalts will not be permitted in any portion of the work or in any of the mixtures to be used.

The mixture to be used in forming the coats of melted asphalt and the asphalt concrete shall consist of Bermudez and Alcatraz in proportions to be designated by the Engineer. It will hereafter be designated as Mixture. The Mixture shall be melted, and shall then be maintained at such temperature and for such length of time as the Engineer may specify.

The edges and surfaces of all old or new asphalt work shall, if required by the Engineer, be heated when new material is laid in contact with them.

### *Preparation of Concrete Surfaces.*

The Contractor shall remove the clay on the floor, and shall otherwise clean and dry the present concrete surfaces of the slopes and floor and shall make such repairs in them as, in the judgment of the Engineer, are necessary, leaving them sound and free from loose particles and friable materials. He shall also remove any projections which might penetrate the asphalt coat or render it sensibly deficient in thickness in places. Such cracks in the present floor lining as may be designated by the Engineer shall be opened out and cleaned, treated with the priming coat described under (15) and filled with Mixture.

The Contractor shall remove the finish of the asphalt and sand used in 1895 for filling out the triangular space between the top of the curved concrete finish and the slope itself, and shall trim the top of the concrete finish to such depth that it shall present a full and square bearing for the bricks to be placed on the slopes, as shown in Fig. 9 F—259.

### *Priming Coat.*

All concrete surfaces to which Mixture or Concrete is to be applied, shall first, and when perfectly clean and dry, be painted with a priming coat consisting of a solution of Alcatraz in benzine of 62° B. gravity, in proportions to be designated by the Engineer. No admixture of heavier oils shall be permitted for the purpose of attaining to this standard. Any portions of the priming coat, which, in the judgment of the Engineer, have become injured, by exposure or otherwise, before the application of the paint coat, shall be restored by the Contractor.

(*a*) Work on Slopes.

*First Mixture Coat.*

On the slopes, the first coat of Mixture shall extend over the entire inner concrete surface, from the edge of the present Neuchatel asphalt pavement on top, to the square upper shoulder of the new concrete finish at foot, cut to receive the lowest course of brickwork as specified under (14), over said shoulder and for a width of four (4) inches down over the asphalt on the concrete finish at the foot of slope.

*Burlap.*

As the first coat is laid upon the slopes, new, heavy, coarse, open-mesh burlap, temporarily fastened at the top of the slope, shall be stretched upon it.

As the brickwork is completed, the upper end of each strip of burlap shall be secured, as indicated in drawing 9 F—259, to an iron bar three-quarters ($\frac{3}{4}$) inch square, and this bar, with the burlap, shall be laid in the right angle left at the top of the brickwork, as shown.

The burlap shall extend down the slope to the square shoulder cut to receive the foot of the brickwork in the top of the curved finish of the concrete footing wall constructed in 1895, and shall not impair the squareness of the corners at the top of that finish.

*Second Mixture Coat.*

The second coat of Mixture for the slopes shall be spread upon the top of the burlap, and shall extend over the entire surface of the first coat. At the discretion of the Engineer, it may be extended to a width of six (6) inches or less beyond the lower edge of the first coat.

*Thicknesses.*

Each coat of Mixture shall be of such thickness as may be specified by the Engineer, not exceeding one-eighth ($\frac{1}{8}$) inch.

*Paving.*

The present Neuchatel asphalt pavement on the top of the banks shall be restored and extended as shown in Fig. 9 F—259. The broken edge at B shall be prepared as the Engineer may direct.

Where the Neuchatel asphalt paving has been removed, both coats of mixture shall be extended to cover the exposed concrete surface, up to the cut edge of the pavement.

*Brickwork.*

Upon the second coat of Mixture, and footing upon the top of the curved concrete finish, as shown in Fig. 9 F—259, shall be placed a single layer of paving bricks, burned hard entirely through, regular and uniform in size and shape, and of compact texture, laid flat. The bricks shall be warm and thoroughly dry when they are about to be laid.

The lowest course of bricks shall be carefully brought to a firm and square bearing on the asphalt, both upon the surface of the slope and upon the top of the concrete finish at the foot of the slope; and each brick thereafter, as it is laid, shall be similarly bedded, both upon the slope and upon the bricks below it.

Immediately in advance of, and above, the bricklaying, shall be spread a portion of the priming coat, covering an area sufficient to receive the bricks about to be laid. The second Mixture coat, softened by the priming thus applied, must still be soft when the bricks are laid upon it.

Any spaces remaining between the edges of the brickwork and the stop-houses, pass-pipes or any other structures encountered, shall be filled with Neuchatel asphalt paving mixture.

(*b*) Work on Floor.

*Asphalt Concrete.*

The asphalt concrete shall be composed of Mixture, prepared and manipulated as directed in (11), and broken stone.

The largest of the pieces into which the stone is broken, shall pass through a one (1) inch ring, and shall not be more than one and a half ($1\frac{1}{2}$) inches in length.

The broken stone shall be heated, in such manner and to such temperature as the Engineer may direct, and thoroughly incorporated with the Mixture in such proportion as to ensure the covering of each particle of stone, etc., with asphalt, and the filling of all voids between them.

The concrete thus formed, while still hot, shall be laid in place in such manner as to avoid disintegration of its mass, and thoroughly tamped or rolled, or both, in the discretion of the Engineer, to a final thicknes of two (2) inches, over the entire floor, and finished off, at the edges, as shown in Fig. 9 F—259.

### *Mixture Coat.*

A final coat of Mixture, not less than one-sixteenth (1-16) inch thick, shall then be applied over the entire surface of the asphalt concrete, and beyond its edges to the point marked C in Fig. 9 F—259.

## (*c*) Work on Stop-House.

### *Walls.*

The interior and exterior brickwork of the stop-house shall be cleaned of all loose lime, mortar, cement and dirt, by means of steel or other brushes, and treated with two full coats of Cerion.

### *Floor.*

The floor of the stop-house shall receive a priming coat, as specified under (15) and a coat of Mixture not less than three-sixteenths (3-16) inch thick.

AUGUST, 1896.

## SPECIFICATION NO. 17, FOR ASPHALT CONCRETE LINING OF ONE BASIN OF THE NEW RESERVOIR AT ROXBOROUGH.

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### *Outline of Work Required.*

The work will consist in:

Applying to the slopes and to the floors a layer of asphalt concrete. This layer shall be covered with a coat of melted asphalt, and shall also have, on the floor, a coat of melted asphalt below it.

### *Character of Asphalt.*

The asphalt shall be a natural asphalt, or a mixture of natural asphalts, containing, in its refined state, not less than ninety (90) per cent. of bitumen soluble in rectified carbon disulphide or in chloroform. The remaining ingredients shall be such as to exert no injurious effect upon the work. Not less than two-thirds (2-3) of the total bitumen shall be soluble in petroleum naphtha of 70° Beaumé or in acetone. The asphalt shall not loose more than five (5) per cent. of its weight when maintained for ten hours at a temperature of 300° F.

The use of coal tar, petroleum residuum, or so-called artificial asphalts will not be permitted in any portion of the work or in any of the mixtures to be used.

### *Asphalt Priming Coat.*

The surfaces of the slopes and of the floor shall be rendered clean and dry by the Contractor, and such cracks in the present concrete floor lining as the Engineer may specify shall be cleaned or opened out, treated with a priming coat and filled with asphalt or with asphalt concrete, as he may require and to his satisfaction.

The surfaces shall then be painted with a solution of asphalt in benzine 62° B. gravity, in proportions satisfactory to the Engineer. No admixture of heavier oils shall be permitted for the purpose of attaining to the gravity specified. Any portions of the priming coat which, in the judgment of the Engineer, have become injured, by exposure or otherwise, before the application of the paint coat, shall be restored by the Contractor.

The priming coat shall be applied to all brick or concrete surfaces to which an asphalt paint coat or asphalt concrete is afterward to be applied.

### *First Asphalt Paint Coat.*

The asphalt for the paint coat shall be melted, and shall then be maintained at such temperature and for such length of time as the Engineer may direct. During that time it shall be continuously stirred, so as to acquire uniform consistency and to avoid danger of burning.

Any asphalt which has been burned shall be rejected.

The priming coat shall be clead, warm and dry when the asphalt paint coat is laid upon it.

The melted asphalt shall be poured, at such temperature as the Engineer may require, upon the primed surface, and spread with brooms or brushes, to a uniform thickness. On the slopes the thickness shall not be less than one-sixteenth (1-16) of an inch, but shall be as near that thickness as possible, and not greater than one-eighth ($\frac{1}{8}$) of an inch. On the floor the thickness shall be such as may be specified by the Engineer, not exceeding one-eighth ($\frac{1}{8}$) inch.

The edges of all work that has cooled shall be properly heated when new material is laid in contact with them.

Special pains shall be taken to secure a perfect joint between the several coats and the present Neuchatel pavement.

*Asphalt Concrete.*

The asphalt concrete shall be composed of the melted asphalt described under III, prepared and manipulated as directed in (12, and broken stone).

The largest of the pieces into which the stone is broken shall pass through a three-quarter ($\frac{3}{4}$) inch ring, and shall not be more than one (1) inch in length. The stone shall be used as it comes from the crusher and without screening, and sand and dust shall be added to it in such proportions as the Engineer may direct.

The broken stone, with its admixture, as described in (19), shall be heated to such temperature as the Engineer may direct, and the melted asphalt shall then be added in such proportion that each particle of stone, etc., shall be coated with asphalt and all its interstices filled with it, and the whole mass shall be thoroughly incorporated.

The concrete thus formed, while still hot, shall be laid in place in such manner as to avoid disintegration of its mass, and thoroughly tamped or rolled, or both, in the discretion of the Engineer, to a final thickness of one and one-half ($1\frac{1}{2}$) inches.

At the foot of the slope the concrete shall be of extra thickness and rounded off as shown in Fig. 9 F—260.

If required by the Engineer, the asphalt concrete shall be applied while the first asphalt paint coat is still hot, or the latter shall be heated to receive the asphalt concrete.

*Second Asphalt Paint Coat.*

The second asphalt paint coat shall be similar to the first in composition and in thickness, and shall be applied in the same manner and while the surface of the asphalt concrete is still hot; or, at the discretion of the Engineer, the surface of the asphalt concrete shall be heated to receive the second asphalt paint coat, and the latter shall in any case be tamped, rolled or smoothed, at the discretion of the Engineer, with hot irons and while it is still hot.

SEPTEMBER, 1896.

## SPEIFICATION NO. 18, FOR GROUTING THE BRICK WORK ON THE INNER SLOPES OF ONE OR BOTH BASINS OF QUEEN LANE RESERVOIR.

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### *Outline of Work Required.*

The work will consist in:

Grouting the brick lining of the inner slopes of one or both basins of Queen Lane Reservoir.

The area to be treated is approximately twenty-eight thousand (28,000) square yards in the north basin, and twenty-seven thousand (27,000) square yards in the south basin.

### *Grout.*

The grout shall be composed of Portland Cement, of a brand satisfactory to the Engineer, and of clean, sharp, tide-washed bar sand, in the proportion of one (1) part of cement to one (1) of sand.

The Engineer shall have the privilege of taking, at any time, a sample from any part of any barrel of cement furnished by the Contractor, and of rejecting any cement which, when tested by such samples, fails to meet the requirements for the brand selected, as determined by previous tests made by the Bureau of Surveys.

No cement will be inspected or used unless delivered in suitable original packages properly branded.

Accepted cement, if not used immediately, must be kept in the barrel and thoroughly protected from the weather. The barrels shall not be placed directly on the ground, but shall have blockings under them.

The cement and sand shall be mixed dry in clean wooden boxes or barrels, and the water shall then be added.

The water must be clean, and no more of it shall be used than will enable the grout to fill all the joints in the brickwork to the satisfaction of the Engineer.

The grout shall be constantly stirred, and shall be used as mixed. Any portion which has been allowed to stand shall be rejected.

Before the grout is applied, all joints in which dust, mud or other rubbish has accumulated shall be cleaned out, and all asphalt appearing upon the surface of the bricks, whether brought there by exudation through the joints or otherwise, shall be removed.

The grout shall be poured and broomed in such a manner as to fill thoroughly all of the joints between the bricks.

After preliminary setting and before final setting, the excess of grout remaining on the surface of the bricks shall be removed by washing and scrubbing so as to leave a surface similar to that shown at the foot of the slope in the south basin, adjoining the stop-house on the south.

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SEPTEMBER, 1896.

## SPECIFICATION NO. 19, FOR RELINING THE SLOPES AND FLOOR OF THE NORTH BASIN OF QUEEN LANE RESERVOIR.

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Is nearly identical with Specification No. 16, for the South Basin.

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NOVEMBER, 1896.

## SPECIFICATION NO. 22, COPING OF RETAINING WALL AT QUEEN LANE RESERVOIR.

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*Outline of Work Required.*

The work will consist in:

Furnishing and setting coping stone on retaining walls at Queen Lane Reservoir.

The length required is about 4,000 feet of Fig. A or B, and about 225 feet of Fig. C or D.

*Stone.*

Bidders will submit, with their bids, samples, one foot long, and six (6) inches deep, of the stone or stones which they propose to furnish, cut and dressed to a thickness of six (6) inches and shaped as at A in Drawing 9 F—261, accompanying this specification. Each bidder will submit four (4) prices per linear foot, one (1) for each of the four (4) figures in Drawing 9 F—261, and these prices shall include all labor and material, and all special stones, such as those which may be required at corners, etc. All stone furnished must be uniform in color and in texture, and must conform, in these respects, with the sample or samples furnished with the bid.

*Dimensions.*

The stone shall be six (6) inches or eight (8) inches thick, at the option of the Director, and the cross-sections shall be as shown in Drawing 9 F—261. No stone shall be less than six (6) feet long, except in making closures. Stones shall not exceed the dimensions shown in Drawing 9 F—261, and any stone falling short of any of the finished dimensions by more than quarter ($\frac{1}{4}$) inch will be rejected.

*Dressing.*

The faces marked "d" in Drawing 9 F—261, and the ends, shall be dressed to correspond with those of sample in the office of the Bureau.

*Laying.*

Each stone shall be laid on a bed of cement mortar placed under the front edge and the two ends, and on flat sprawls placed under the back, and shall then be thoroughly grouted with grout composed of one part sand and one part cement. The widest showing bed joint shall not exceed one-half ($\frac{1}{2}$) inch.

The stones of Figs. A and B shall be laid with an inclination of one-quarter ($\frac{1}{4}$) inch in three (3) feet, as shown in Drawing 9 F—261.

On walls with sloping tops, at the stairways and stop-house vaults, each stone shall be anchored to the wall by two iron dowls one (1) inch by one-half ($\frac{1}{2}$) inch six (6) inches long, which shall be leaded into the stone and placed in a hole drilled in the wall and filled with cement mortar immediately before placing the stone.

### *Mortar.*

The mortar shall be composed of one part of clean, sharp, dry-screened, tide-washed bar sand, and not less than one part of cement.

The ingredients shall be proportioned by measure and thoroughly mixed dry in a tight box of suitable dimensions, and the proper amount of clean water shall afterward be added.

No greater quantity of mortar shall be prepared than is required for immediate use; and any that has set, or that has been standing longer than two hours, shall be rejected.

### *Cement.*

The cement shall be American or European artificial ("Portland") cement, of a brand satisfactory to the Engineer, who shall be notified immediately upon the receipt of each shipment of cement upon the work.

The cement shall have a specific gravity of not less than three (3), and shall leave a residue of not more than one (1) per cent., by weight, on a No. 50 sieve; fifteen (15) per cent. on a No. 100 sieve, and forty (40) per cent. on a No. 200 sieve. The sieves shall be of wire cloth of No. 35, No. 40 and No. 40 (Stubb's gage) wire, with two thousand five hundred (2,500), ten thousand (10,000) and forty thousand (40,000) meshes per square inch, respectively.

The neat cement, mixed with water to a stiff plastic paste and made into pats one-half (½) inch thick, with thin edges, shall, when immersed in water after hard set, show no signs of checking or disintegration. Similar pats, in air, at a temperature between 60° and 70° F., shall develop initial set in not less than thirty (30) minutes.

Briquettes of neat cement, one (1) square inch in cross section, shall develop the following ultimate tensile strengths:

| | | |
|---|---|---|
| 24 hours (in water after hard set), . . . | 125 | pounds. |
| 7 days (1 day in air, 6 days in water), . | 400 | " |
| 28 days (1 day in air, 27 days in water),. | 500 | " |

Briquettes formed of one (1) part cement and three (3) parts standard quartz sand, as used by the Inspector of Cements of theBureau of Surveys, shall develop the following ultimate tensile strengths:

| | | |
|---|---|---|
| 7 days (1 day in air, 6 days in water), . | 150 | pounds. |
| 28 days (1 day in air, 27 days in water), . | 200 | " |

Mortar taken from the mixing box and moulded into briquettes one (1) inch square in cross-section shall, after one (1) day in air and six (6) days in water, develop an ultimate tensile strength of thirty (30) pounds.

The Engineer shall have the privilege of taking, at any time, a sample from any part of any barrel of cement furnished by the Contractor, and of rejecting any cement which, when tested by such samples fail to meet the requirements specified.

Accepted cement, if not used immediately, must be kept in the packages and thoroughly protected from the weather. The packages shall not be placed directly on the ground, but shall have blockings under them.

No cement will be inspected or used unless delivered in suitable original packages properly branded.

# APPENDIX K.

## Report of Prof, H. W. Spangler on Experiments with Venturi Meter at Wentz Farm.

UNIVERSITY OF PENNSYLVANIA.

*Philadelphia, Pa., January 13, 1897.*

MR. JOHN C. TRAUTWINE, JR.,

Chief of Bureau of Water.

DEAR SIR:—The following is the report of the comparisons between the Venturi meter and weir readings, taken at Wentz Farm, November 19th, November 20th, and November 23d, 1896:

The principal dimensions of the weir are as follows:

| | | | | | |
|---|---|---|---|---|---|
| Length on the weir | 8.013 | ft. | | |
| The zero reading for the hook gauge | .093 | ft. | | |
| From the bottom of the trough to the crest of the weir | 2 | ft. | 6 | in. |
| Width of trough | 11 | ft. | 10¼ | in. |

A number of preliminary experiments were made, and it was decided to make the length of each run about forty minutes, taking readings every minute. The discharge from the pipe supplying the weir was pulsating so that there was a certain amount of wave motion in the trough itself, producing a corresponding but smaller wave in the box in which the hook gauge was placed. The alternate readings with the hook gauge were therefore made at the highest and the lowest point of the wave in the box. The Venturi recording apparatus was actuated by hand, one reading being taken for every reading on the weir, the difference in the successive readings being the number of cubic feet of water passing the Venturi in ten minutes.

The first table herewith gives, in the first column, the time at which the readings were taken, the second column the reading of the hook gauge at the top of the wave, the third column the reading at the end of the next minute and at the bottom of the wave, the fourth column the actual reading of the Venturi counter, and the fifth column the quantity of water passing the instrument in ten minutes. At the end of each test is given the average height on the weir and the average number of cubic feet of water for ten minutes.

From the data of Table No. 1 the quantity of water passing the weir was determined, allowance made for the velocity of approach and the quantity again determined, both by Francis' and Smith's formula. Table No. 11 gives these results. The various quantities are arranged in order of the quantity of water flowing. The first column gives the number of the experiment, the second the corresponding head on the weir, the third the quantity of water flowing per second without taking account of the velocity of approach, the fourth the total head including the velocity of approach, the fifth column gives the quantity of water using the velocity of approach by Francis' formula, the sixth column gives the quantity of water using the velocity of approach by Smith's formula, the seventh column gives the quantity per minute as determined from the Venturi reading, and the last two columns show the amount which must be added to the Venturi reading to make it correspond with the quantity of water as determined from Francis' formula. It will be noted that the quantities as determined from Francis' and Smith's formulas are practically identical.

The apparent error of the Venturi meter varies then from 5.2 to .5 per cent., the average being 2.1 per cent.

The question of the adjustment of the meter was then considered, and an attempt has been made hereafter to re-adjust the readings of the Venturi meter to see whether these readings cannot be made to corespond wtih the quantity of water as determined from the weir, and for these purposes the quantity as determined from the Francis formula has been taken as a basis.

The recording apparatus of the Venturi meter is arranged for adjustment in such a way that an arangement shaped like a cam, which drives the recording apparatus, can be moved vertically, increasing or decreasing the amount of the readings, but not in proportion to the increase in height. The cam is so arranged that for a difference in height between the zero reading and those given hereafter the quantity of water recorded is proportional to the numbers set down in the table.

Thirty-eight points are given on this curve, but for our purpose six only have been used; those corresponding to the sixth, twelfth, eighteenth, twenty-fourth, thirtieth, and thirty-sixth points on this cam.

Table No. III gives the corresponding heights on the cam. That is, for a height above the zero reading .355 the reading is proportional to six cubic feet of water passing. For a height corresponding to 1.440 the reading is proportional to twelve cubic feet of water, etc.

It was assumed that the curve of this cam would satisfy the equation $Q = {}^{m} h^{n}$ and from the values given of Q and h it is found that the value of Q varies as $h^{493}$

The last column gives the values of Q coresponding to the different heads taken in table No. 111, and shows that the formula represents the relation to within .15 per cent.

Table IV. shows the application of this formula. In this table we have assumed that Q is equal to $h^{493}$, the **h in** table No. IV. not being the height on this cam itself, but numbers proportional thereto.

The columns in table No. IV. are as follows:

The first column is the number of the experiment, the second and third columns are the quantity of water and the corresponding value of h from the weir reading, the third column being practically the .493 root of the second. Colunms four and five are the corresponding values for the Venturi reading. Column six is obtained from column five by adding to it the average difference, 23.6, between the corresponding readings of column three and column five. Column seven is the quantity of water determined from the h of column six, and this is the value the Venturi would have given had it been properly set for the experiments that were made. The difference between column two and column seven is put down in column eight, which shows the actual amount to be added to or substracted from the calculated meter reading, and the last column shows the percentage value of these, the average value being far within the limits of the error of the rest of the experiments.

It appears from these results that the Venturi meter properly adjusted can be made to read practically identically with the weir and as this is the only method we have of checking the accuracy of the Venturi, these experiments show that it is as accurate as the weir if properly adjusted.

Very respectfully,

(Signed) H. W. SPANGLER.

# TABLE No. 1.
## (Condensed.)

| Test No. | Number of Readings. | Height on weir. Feet. | Hook Gauge, average reading. Feet. | Quantity Flowing, as indicated by Venturi Register Average. | |
|---|---|---|---|---|---|
| | | | | Cubic Feet in 10 Minutes. | Cubic Feet per Second. |
| 1 | 43 | 1.0286 | 1.1216 | 16,109.5 | 26.85 |
| 2 | 42 | 1.1513 | 1.2443 | 19,124 | 31.87 |
| 3 | 41 | 0.7622 | 0.8552 | 10,028 | 16.35 |
| 4 | 41 | 0.8495 | 0.9425 | 12,002 | 20.00 |
| 5 | 41 | 0.9615 | 1.0546 | 14,592 | 24.32 |
| 6 | 42 | 1.0702 | 1.1632 | 17,297 | 28.83 |
| 7 | 42 | 1.1408 | 1.2338 | 19,046 | 31.74 |
| 8 | 41 | 0.7525 | 0.8455 | 9,810 | 16.35 |
| 9 | 41 | 0.8745 | 0.9675 | 12,605 | 21.01 |
| 10 | 42 | 0.9558 | 1.0488 | 14,454 | 24.09 |
| 11 | 42 | 1.0488 | 1.1418 | 16,820 | 28.03 |
| 12 | 41 | 1.1420 | 1.2350 | 19,005 | 31.68 |

# TABLE No. II.

*(Quantities in Cubic Feet per Second.)*

| No. of experiment. | Head on Weir. | Quantity without allowance for velocity of approach. | Total head including allowance for velocity of approach. | Quantity with allowance for velocity of approach. | | Quantity from Venturi. | Add to Meter. | |
|---|---|---|---|---|---|---|---|---|
| | | | | Francis' formula. | Smith's foamula. | | Amount | Per cent. |
| 8 | .7525 | 17.09 | .7556 | 17.20 | 17.15 | 16.35 | .85 | 5.2 |
| 3 | .7622 | 17.42 | .7654 | 17.53 | 17.48 | 16.71 | .82 | 4.9 |
| 4 | .8495 | 20.45 | .8536 | 20.60 | 20.57 | 20.00 | .60 | 3.0 |
| 9 | .8745 | 21.35 | .8789 | 21.50 | 21.48 | 21.01 | .49 | 2.3 |
| 10 | .9558 | 24.34 | .9613 | 24.55 | 24.49 | 24.09 | .46 | 1.9 |
| 5 | .9615 | 24.55 | .9671 | 24.77 | 24.77 | 24.32 | .45 | 1.8 |
| 1 | 1.0286 | 27.12 | 1.0351 | 27.37 | 27.40 | 26.85 | .52 | 1.9 |
| 11 | 1.0488 | 27.91 | 1.0556 | 28.18 | 28.21 | 28.03 | .15 | .5 |
| 6 | 1.0702 | 28.75 | 1.0774 | 29.04 | 29.08 | 28.83 | .21 | .7 |
| 7 | 1.1408 | 31.59 | 1.1491 | 31.93 | 32.01 | 31.74 | .19 | .6 |
| 12 | 1.1420 | 31.64 | 1.1503 | 31.98 | 32.06 | 31.68 | .30 | 1.0 |
| 2 | 1.1513 | 32.02 | 1.1588 | 32.36 | 32.23 | 31 87 | .49 | 1.5 |
| | | | | | | Average... | ............ | 2.1 |

## TABLE No. III.

| Height. h. | Reading proportional to Q. | Assuming equation Q, m, h, n. | Calculated from equation Q. |
|---|---|---|---|
| .355 | 6 | .77815 = log. m + n (—.44977) | 6.007 |
| 1.440 | 12 | 1.07918 = log. m + n .15836 n. | 11.981 |
| 1.347 | 18 | 1.25527 = log. m + .61455 n. | 17.951 |
| 5.905 | 24 | 1.38021 = log. m + .77122 n. | 24.023 |
| 9.295 | 30 | 1.47712 = log. m + .96825 n. | 30,044 |
| 13.435 | 36 | 1.55630 = log. m + 1. 12824 n. | 36.034 |
| | | Normal equations. | |
| | | 7.52623 =6 log. m + 3.09085 n. | |
| | | 4.71736 = 3.09085 log. m + 3.29733 n. | |
| | | Log. m = 1.00041. n = .493. | |
| | | $Q = h^{.493}$. | |

## TABLE No. IV.

| Number of Experiment. | Weir. | | Venturi. | | Corrected. | | Add to Meter. | |
|---|---|---|---|---|---|---|---|---|
| | Q. | H. | Q. | H. | H. | Q. | Am't. | per ct. |
| 8 | 17.20 | 320.5 | 16.35 | 289.3 | 312.9 | 16.991 | .204 | 1.2 |
| 3 | 17.52 | 333.2 | 16.71 | 302.5 | 326.1 | 17.341 | —.186 | —1.1 |
| 4 | 20.60 | 462.1 | 20.00 | 435.7 | 459.3 | 20.531 | .064 | 0.3 |
| 9 | 21.50 | 504.4 | 21.01 | 481.2 | 504.8 | 21.510 | —.006 | —0.03 |
| 10 | 24.55 | 659.8 | 24.09 | 635.0 | 658.0 | 24.523 | .023 | 0.09 |
| 5 | 24.77 | 671.7 | 24.32 | 647.6 | 671.2 | 24.753 | .012 | 0.05 |
| 1 | 27.37 | 823.0 | 26.85 | 791.4 | 815.0 | 27.240 | .134 | 0.5 |
| 11 | 28.18 | 873.2 | 28.03 | 863.8 | 887.4 | 28.407 | —.223 | —0.08 |
| 6 | 29.04 | 927.7 | 28.83 | 914.1 | 937.7 | 29.190 | —.152 | —0.1 |
| 7 | 31.93 | 1,124. | 31.74 | 1,111. | 1,134.6 | 32.058 | —.032 | —0.1 |
| 12 | 31.98 | 1,128. | 31.68 | 1,107. | 1,130.6 | 32.009 | —.030 | —0.1 |
| 2 | 32.36 | 1,156. | 31.87 | 1,121. | 1,144.6 | 32.203 | .160 | 0.05 |

Very respectfully,

[Signed] H. W. SPANGLER.

# APPENDIX L.

## AN ORDINANCE

Providing for and Regulating the Use of Water Meters.

SECTION 1. *The Select and Common Councils of the City of Philadelphia do ordain,* That on and after January 1, 1897, the Director of the Department of Public Works shall, from time to time, as appropriation may be made therefor, place meters upon the pipes supplying water to all establishments to be known and designated as the "meter class," as specified below, and shall thereafter charge the water rents of such establishments in accordance with the quantities ascertained by the use of such meters and at the rates hereinafter provided in Section (3).

The meter class shall comprise establishments as follows:

A.

Apartment Houses,
Arsenals,
Asylums,
Bath Houses,
Boarding Houses,
Bottling Establishments,
Breweries,
City Hall,
Charitable Institutions, as defined in Section 5,
Club Houses,
Distilleries,
Dye Houses,
Green Houses,
Hospitals,
Hotels,
Ice Cream Saloons,
Laundries.
Manufactories,
Marble and Stone Yards,
Market Houses,
Office Buildings,
Prisons,
Public Bulidings,
Restaurants,
Saloons,
Skating Rinks,
Slaughter Houses,
Stables,
Swimming Pools,
Washing, Dyeing and Finishing Establishments.

## B.

All properties (including private dwellings or residential properties) where the following appliances are used, viz.:

Aquaria,
Cellar Drainers,
Fountains,
Horse Troughs,
Lawn Sprinklers,
Motors,
Steam Boilers (except for heating private residences),
Swimming Pools,
Storage Tanks (unless the water from the overflow is exposed to view),
Tubs, Vats and Tanks (except laundry tubs in private dwellings),
Urinals (unless flushed from overhead tank),
Water Closets (unless flushed from overhead tank),
Appliances used for watering vessels for navigation.

## C.

All properties whose business, in the judgment of the Director of the Department of Public Works, is such as to require the use of meters for the prevention of waste of water.

Sect. 2. Upon the application of the owner of a private dwelling or residential property, the Director of the Department of Public Works is authorized to place a meter on the service pipe supplying such dwelling or property, and to charge the water rents thereafter at meter rates.

Sect. 3. All charges for water by meter shall be at the rate of thirty (30) cents per thousand (1,000) cubic feet, except that the following establishments, to be classed as "public benefit," shall be charged at the rate of four cents per thousand (1,000) cubic feet:

Charitable institutions.
(List of Institutions to be filled in.)

Municipal institutions.
(List of Institutions to be filled in).

SECT. 4. Wherever water is charged by meter, the minimum annual charge shall be as follows:

| | |
|---|---|
| For ½ inch ferrule | $5 00 |
| For ⅝ inch ferrule | 7 50 |
| For ¾ inch ferrule | 12 50 |
| For 1 inch ferrule | 20 00 |
| For 1½ inch ferrule | 45 00 |
| For 2 inch ferrule | 80 00 |
| For 3 inch ferrule | 180 00 |
| For 4 inch ferrule | 320 00 |
| For 6 inch ferrule | 720 00 |

except that in the case of "public benefit" institutions, as defined in Section 3, the charge shall be only for the quantity actually consumed.

SECT. 5. Whenever the owner or occupant of any premises shall wilfully or negligently permit the city water to flow to waste through any appliances not supplied through a meter, and shall fail to discontinue such waste after notice from the Bureau of Water, the Chief of the Bureau shall, at the expiration of the time specified in the notice, place a meter upon the pipe or pipes supplying the premises, and shall thereafter charge the water rent at meter rates.

SECT. 6. All meters shall be and remain the property of the City, and shall be maintained free of cost to the consumer.

SECT. 7. Meter rents shall be payable quarterly to the Receiver of Taxes at his office. If any such rents shall remain unpaid ten days after the receipt of the quarterly bill, the Bureau of Water shall serve a notice upon the delinquent consumer, and, at the expiration of five days after the serving of the notice, if the rent be not paid, the premises shall be deprived of water until all arrears are paid. If, in disregard of this provision, the water is turned on again before the payment of all arrears, the ferrule shall be detached from the water main and it shall not be re-attached until all back rents are paid and the necessary permits procured for the replacing of the ferrule.

Sect. 8. The Bureau of Water, immediately after introducing a meter upon any service pipe shall place a seal upon the meter; and the breakage of such seal, the removal of the meter, or other interference with it, shall subject the person, firm or corporation using said meter to a fine of two hundred and fifty (250) dollars for each offence, and upon failure to pay said fine within ten (10) days after due notification from the Chief of the Bureau of Water, the premises shall be deprived of water until the said fine of two hundred and fifty (250) dollars and the cost of repairs to the meter, if any, shall have been paid.

Sect. 9. All ordinances or parts of ordinances inconsistent herewith shall be, and the same are hereby, repealed.

# APPENDIX M.

## REPORTS ON COAL-DUST POLLUTION.

*Philadelphia, June 30, 1896.*

Mr. Thomas M. Thompson,
**Director, Dept. of Public Works.**

Dear Sir:—I respectfully submit herewith a report upon the pollution of the Schuylkill River and its tributaries by coal dust from the anthracite coal regions.

As stated in my Annual Report for 1895, my predecessor, Mr. John L. Ogden, in his report for 1888, stated as follows:

"After a general rain in the Valley the Schuylkill is at first yellow from the flow of the nearer streams, which run principally through cultivated land. It is afterward dark or black from the washings of the culm piles in the coal regions.

"In January the breaking of the Milldale Rolling Mill dam, one and a half miles above Port Clinton, was the cause of the black appearance of the water at that time. The coal dirt and slush that had accumulated in the dam were brought down by the freshet produced by the break."

In my report for 1895 I again urged that legal measures be taken to prohibit the fouling of the stream in this way, and that, if necessary, the powers of the State Board of Health should be so extended as to give it jurisdiction in such matters.

On January 4th of this year, in my reply to your Reference No. 4, I wrote you in regard to a communication from Mr. English, that that gentleman was undoubtedly right in supposing that the discoloration of the Schuylkill River at that time was caused by particles of coal dust; that this view was borne out by examinations made at that time by Dr. Bolton, Chief Bacteriologist of the Health Board, but that in my judgment the main source of the trouble was not in the vicinity of the City, but in the Schuylkill anthracite coal region, recent heavy rains in that region having washed down large quantities of coal dust.

On January 6th I transmitted samples of water taken from the forebay at Fairmount and showing a progressive improvement in the character of the water, and remarked that we should, however, be subject to a repetition of the trouble after every heavy rain in the upper Schuylkill until either the coal operators are restrained from throwing their waste into the river or the Department is put in position to provide ample settling or filtering facilities.

On January 8th I wrote you, suggesting an inquiry into the powers and duties of the State Board of Health, in order to secure, if possible, the co-operation of that body in the prevention of the pollution of the river by coal dust.

Eearly in the year the Law Department of the City, at your suggestion, took up the matter and conferred with me upon the subject, and steps were taken looking to a visit to the coal regions for the purpose of gathering information upon the subject.

In May, on motion of Mr. Meehan, Councils passed a Resolution requesting the Law Department to investigate the subject.

On June 22-25, I visited the Schuylkill coal region in company with Mr. J. W. Catharine, Assistant City Solicitor; my Assistant, Mr. Amasa Ely, and Captain A. C. Huckey, who has spent most of his life in the Upper Schuylkill region, and who volunteered to act as guide, spending the entire time in driving through the valleys of Panther Creek, above Tamaqua; of the Schuylkill proper, between Tamaqua and Pottsville; of Mill Creek, above Pottsville; of Wolf Creek, above Minersville, and other points, including the breaker of the Philadelphia and Reading Coal and Iron Company on the Schuylkill River, below Schuylkill Haven.

In these investigations we sought to obtain information respecting the processes by which the pollution is caused, the means taken to prevent or reduce such pollution, and the names of the parties responsible for it. A report of this visit is submitted herewith.

The coal dust which is washed into the river appears to proceed principally from two sources, namely: First, the recent introduction of water into the breakers for the purpose of washing coal in the various stages of its passage through them, and, second, the establishment of small breakers, called "washeries," for the purpose of working the culm heaps in order to extract from them the small merchantable sizes.

Both of these classes of works discharge streams of water heavily charged with fine coal dust, but in most cases more or less effective precautions are taken to prevent the entrance of this water into the streams.

In spite of these precautions, however, much of the water finds its way into the streams, and the result is that nearly all of the streams in the coal region, and for some distance below, run very black, and their beds and banks are now composed chiefly of coal dust, so that every flood necessarily washes a considerable quantity of this material into the Schuylkill.

So far as we can judge, but little pollution comes from direct washing by rain of the culm heaps themselves. These do not appear to be generally scored by rain, and the ground about them is not covered by coal dust.

The remarks of those whom we met in the coal regions generally confirmed this view, although one or two of the proprietors of washeries, or breakers, charged a considerable proportion of the pollution to the culm banks themselves, and it is possible that where the culm heaps stand very close to the banks of streams they may be undercut in times of flood and much culm may thus fall into the stream.

Mr. Edwin F. Smith, Engineer and Superintendent of the Canal Division, Philadelphia and Reading Railroad Company, is of the opinion that much of the trouble which has recently been experienced has arisen from the recent abandonment and destruction of the company's dams on the Schuylkill proper between Port Clinton and Schuylkill Haven. These dams had previously become more or less fouled with coal dust, which, upon their destruction, of course passed down the river.

To my mind, it is evident that, even if the further pollution of the streams could be immediately stopped, the coal dust which has already been deposited in them would continue to foul the lower stream after heavy rains for some years to come, although it is quite possible that under these circumstances the trouble would gradually diminish.

The means taken to prevent the flow of coal dust into the streams consist in the construction of dams upon flat pieces of ground, the dams consisting generally of gravel, or fine soft culm, or of broken slate, etc. The dams of gravel or culm, owing to their density, are provided with sluices or weirs through or over which water can drain off, while, when slate is employed in the construction of the banks, the material itself is sufficiently porous to allow the water to filter through it. In the former case sedimentation, and in the latter case filtration, is employed as the purifying agent. Both methods vary greatly in efficiency, the effluent being, in some cases, almost as black as the water fed to the dam, and, in other cases, nearly clear.

The dams themselves, however, containing, as they do, enormous quantities of coal dust, show that, however imperfect these methods may be they have at least held back the dust contained within them.

Very respectfully yours,

JOHN C. TRAUTWINE, Jr.

Chief of Bureau.

## REPORT OF VISIT OF JUNE 22–25, 1896.

Leaving the Reading Terminal, Philadelphia, at 4:05 P. M., on Monday, June 22, in company with Mr. J. W. Catharine, Assistant City Solicitor; my Asistant, Mr. Amasa Ely, and Captain A. C. Huckey, who has spent most of his life in the Upper Schuylkill region, and who volunteered to act as guide, we went by the Little Schuylkill directly to Tamaqua, arriving there at 7:10 P. M.

The Little Schuylkill enters the main stream at Port Clinton, which is now the head of navigation and which occupies the gap where the Schuylkill River issues from the Blue Mountains. Just below this point is the Blue Mountain dam, or dam No. 16, now the uppermost dam of the system. It was evidently very much shoaled by coal dust. Captain Huckey states that when, as a boy, he was familiar with this dam, it had a general depth of 25 feet, and that it was always kept thoroughly dredged by the Navigation Company before the lease to the Philadelphia and Reading Railroad Company. Since that lease, however, and especially since the extensive fouling of the river by coal dust, the company does not undertake to do more than keep a channel open through the pool.

Ascending the Little Schuylkill from Port Clinton to Tamaqua, we found its water very black throughout.

A mile above Port Clinton is the site of the Milldale dam, the breaking of which, in 1888, gave rise to the appearance of coal dust in the Schuylkill water at Philadelphia, as mentioned in the report of my predecessor, Mr. Ogden, for that year. A mile further up is the flouring mill at Molino, which has suffered much damage by reason of the filling of its dam and mill-race with coal dust. The bed and banks of the stream throughout are largely composed of coal dust.

The first washery we passed was that of Beard & Shindel, at Reynolds, about ten miles above Port Clinton. It was idle when we saw it and it has been so for some time, but it is intended to re-commence operations there.

Extensive piles of culm occupy both banks of the Little Schuylkill.

In the evening we examined the Little Schuylkill and Panther Creek in the vicinity of Tamaqua.

We found the water of Panther Creek very much blackened by the operations of the coal breakers of the Lehigh Coal and Navigation Company, in the Panther Creek Valley, but the water of the Little Schuylkill proper above the mouth of Panther Creek has, until within a very few weeks, been quite clear. Now, however, it is beginning to be fouled by the operations of the breaker at Old Silver Brook, at the very head of the stream, seven miles above Tamaqua.

This breaker has been washing its coal for some years, but it is only recently that the coal dust has made its appearance as far down as Tamaqua, after filling up dams on the stream, as mentioned more particularly below.

We also called on Mr. Schick, one of the owners of the flouring mill at Molino, already mentioned. From Mr. Schick we learned that the culm fills their dam and their mill-race, the latter 500 feet long.

In former years it was sufficient to wash the mill-race once in six months, whereas now it requires washing every two or three days. The washing is accomplished by opening the waste weir at the lower end of the race and partly raising the head gate, thus creating a scouring action in the race. They also found their turbines and other machinery in process of destruction by the mechanical action of the coal dust and the chemical action of the acids contained in the mine water, which the operation of washing carries into the stream. They are claiming damages, and owners of the breakers seem willing to grant them, as they do not dispute their share of the nuisance.

On Tuesday morning, June 23, we proceeded in an open carriage up the Panther Creek Valley as far as breaker No. 5, which is just beyond Lansford, in Carbon County, a distance of about six miles.

The Greenwood breaker, about one and a half miles from Tamaqua, on the north side of the valley, belonging to the Lehigh Coal and Navigation Company and leased to Garber, was idle.

The next breaker reached, No. 11, was also idle, but we were shown through it, in order to gain a general idea as to the processes employed.

At breaker No. 10 we examined the culm deposits and tasted the water issuing from the mines before it reached Panther Creek and before it was polluted by coal dust. We found it very strongly astringent, quite sufficiently so to account for its popular name of "alum water."

At breaker No. 12 we noticed a new channel extending from the washery and discharging directly into Panther Creek.

At breaker No. 8, above Coaldale, four and a half miles from Tamaqua, there is no washery; the breaker being what is called a "dry breaker."

At breaker No. 9 a trough for the conveyance of water charged with coal dust leads directly from the breaker into the creek, and a new trough, exactly similar, has just been constructed on the other side of the breaker.

Opposite Lansford, five miles above Tamaqua, the Nesquehoning tunnel, built 1869-70, carries the Tamaqua Branch of the Central Railroad of New Jersey through the Nesquehoning Mountain to Hauto, in the valley of the Nesquehoning, a tributary of the Lehigh.

At breaker No. 5, above Lansford, we examined the surroundings with considerable care. Here, as at other breakers, the water carrying the coal dust in suspension is led from the breaker through wooden troughs, and discharged upon the ground at their ends. The troughs are extended from time to time, and thus a considerable area is covered with coal dust to a depth of several feet.

At breaker No. 5 this trough had reached a length of several hundred yards, and we saw, in places, evidences that the coal dust in it had accumulated sufficiently to necessitate its being shoveled out and piled up alongside of the flume. Below the lower end of the flume the black water discharges upon the surface of the dirt pile and flows over it for one or two hundred yards further. We found, in many places, a hard crust formed under this stream upon the top of the soft dust, no doubt owing to the action of chemicals in the mine water used in the breaker for washing the coal.

Near the lower end of the dirt pile a very feeble dam, or rather fence of boards, had been built, but this had been entirely wrecked, and a new dam, of similarly defective construction, had been built about two hundred feet further down; but this, also, had become broken, so that the black water discharged freely through it.

Returning to Tamaqua by the same route, we learned that the town of Lansford is supplied with water from streams on the south slope of Broad Mountain, a mile or two to the north; the pipes passing through the Nesquehoning tunnel, already mentioned. The water is furnished through street hydrants. This water is supplied, also, to the collieries and the breakers for use in boilers and for washing.

As the mine water injures the boilers and machinery it is used as little as possible.

We were informed that all of the coal treated in the breakers of the Panther Creek Valley is subsequently sent to a breaker at Hauto, in the Nesquehoning Valley, for further treatment.

Returning to Tamaqua, we talked with Mr. Spiese, an intelligent merchant of that place, who confirmed the accounts of pollution from the Old Silver Brook breaker, at the head of the Little Schuylkill, belonging to the Silver Brook Coal Company. Mr. Spiese says that Mr. Harry A. Welde, who is interested with the DuPonts, of Wilmington, Del., in the gun-powder business, has five or six dams in the upper Little Schuylkill, between Tamaqua and Mintzers, and that these have all been filled up from the source named. It would seem to be the overflow from these dams which is now fouling the water of the Little Schuylkill at Tamaqua.

We also caled on Mr. Shindle, of Beard & Shindle, the proprietors of the washery which we passed in the train on the Little Schuylkill at Reynolds, five miles below Tamaqua. Mr. Shindle claims that they throw all their dirty water into the excavation made by taking culm out of the pile, and that none of it goes into the stream.

We left Tamaqua at 1:15 P. M. in an open carriage, en route for Pottsville, via the valleys of the Wabash, which enters the Little Schuylkill from the west at Tamaqua, and of the Schuylkill proper.

At Tuscarora, four miles from Tamaqua, we noticed a small washery north of the road and west of the town.

At Middleport, eight miles from Tamaqua, we left the river and the main road and drove northward, returning to the river again at New Philadelphia, at the mouth of Silver Creek, two miles below.

About two miles north of Middleport we passed an abandoned colliery, where a washery, operated by a Mr. Priest, is said to work the culm now produced at the Kaska William colliery.

At Kaska William the mine was open, but the works were not running.

On Silver Creek, half a mile above New Philadelphia, we visited a colliery and breaker, operated, as we understand, by the Philadelphia and Reading Coal and Iron Company. Here, as in most of the modern collieries mining a dirty coal, water is used throughout the cleaning operations. The water, leaving the breaker heavily charged with coal dust, is led by wooden flumes and deposited upon a dump, or dam, about 300 feet square, 13 feet deep at its lower side, and containing about 20,000 cubic yards of material. This was bounded on three of its sides by a weak bank of soft coal dirt provided with three sluices. Water passing through these carries some coal dust with it, and passes into a box by the road-side, in which is the foot-valve of a suction main supplying a pump at the breaker. At the time of our visit the water in the box, which is provided with a waste-valve, was low, so that the foot-valve was dry. In one compartment of the box we found, floating upon the water, a thick mass, evidently composed of grease and coal dust.

On the Schuylkill, below New Philadelphia, we visited a washery formerly owned by Mr. P. J. Kelly, but sold by him to McTurk & Tyler, of 322 Walnut street, and now operated by him for them. We found Mr. Kelly at the washery, which, however, had just stopped for the day when we arrived. Mr. Kelly is now dumping his dirty water upon a bank retained within a substantial dam of slate, and he claims that the water filtering through this dam when the washery is in operation is perfectly clear. As the dirt pile is extended, the dam is correspondingly lengthened. Some dirt has washed into the stream above the south end of the east bank.

Further down the stream, on the same side and at the same works, we found an old dirt bank similarly protected on the stream side by substantial slate banks, but filled to the top and piled up above them.

On the north side of the stream we noticed an older and lower dump, which appears to have been protected on the stream side by banks of coal dust. They showed no signs of having been scored by rain.

Mr. Kelly states that washing on a small scale was in use when he was a boy, say thirty or forty years ago, and Captain Huckey confirms this; but, according to Mr. Kelly, the first washery on the present system was started in Mahanoy Valley about eight years ago.* He visited this at the time and started his present washery about six years ago. He washes from three hundred to three hundred and fifty tons of culm per day, obtaining from fifty to seventy-five per cent. of small merchantable coal.

Mr. Kelly expects to exhaust his present culm pile in three or four years more.

About three years ago he shipped several car loads of the refuse dust to a party in New Jersey, to be made into fuel bricks, but he has had no further orders for it for that purpose.

After spending the night at Pottsville, we drove, on Wednesday morning, through St. Clair, on Mill Creek, to the new breaker of the St. Clair Coal Company, which occupies the former site of the Johns breaker, just above St. Clair, on the left or east bank of Mill Creek. We found in charge Mr. W. W. Patterson, who is interested in the breaker. He expressed himself as in hearty sympathy with any efforts to prevent the pollution of the stream, and as being anxious to do anything in his power to prevent such pollution.

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* Mr. Dana C. Barber, in his report of a Sanitary Survey of the Schuylkill Valley, dated February 28, 1885, published in Report of Philadelphia Water Department for 1884, page 249, refers to the processes as having been in use during "the last three years."

The breaker, which was started only a week or two ago, and which is not yet in full operation, takes its water from dams in the hill back of it.

The greater part of the discharge of coal dust water is through two flumes into a pit over an old mine. A drift extends into the hill from this pit, but the principal opening is said to be immediately below. The pile of dust formed here is protected by a dam of slate or cinder.

The water discharged here at any rate disappears from view, as does also a smaller quantity discharged at the foot of the breaker over the railroad track; no better means of disposal having yet been devised for it.

Examining the banks of the creek along the breaker property, we found water issuing at two points. At the upper one there was a small and perfectly clear discharge, which, however, had an astringent, ferruginous taste. This appears about one hundred feet below the breaker. The larger stream, about two hundred feet further down, is much less clear, but still by no means heavily charged.

Leaving Mr. Patterson's breaker, we proceeded up the Valley of Mill Creek to New Castle Station, and then, turning to the left, up a small stream entering Mill Creek at the station.

Just above the station we found what appeared to us the most flagrant case of pollution with which we had met. This was a double washery, consisting of two portions, one on each side of the stream, and belonging, as nearly as we could learn from a man who seemed to be interested, to a concern calling itself the Broad Mountain Coal Company.

The culm piles from which these washeries are supplied lie along the creek for some distance up, and the culm is brought from them to the washeries in troughs by water taken from the stream still higher up. These troughs are led through and across the culm piles, and men are stationed there shoveling into them the culm, which is then brought down into the washery by a stream of water constantly flowing.

We found several large streams of very black water flowing from both branches of the washery directly into the stream. The proprietor claimed that the dirt goes into an old working further up the road, but upon examining this working we found it dry and nothing going into it, and, in view of its considerable elevation above the washeries, it is difficult to see how it could serve any important purpose in this respect.

About half a mile above the washery just described we passed the nearly new breaker of the Roberts Coal Company, on the hill-side, on the north of the same valley.

Here we found the dirt discharged into a dam similar to that at Silver Creek breaker; that is, the bank was built of soft culm and provided with several sluices. One of these sluices we found discharging tolerably clear water, while the other, at the same time, was discharging quite blackish water.

About a quarter of a mile southwest of New Castle, on the headwaters of Butcher Creek, which flows into the west branch of the Schuylkill just above Mine Hill Gap, we found a colliery on the right hand side of the road, operated by three brothers named Davis. One portion of their operations consists of a surface stripping of the mammoth vein. From this comes a considerable quantity of surface dirt, which mixes with the culm, giving it a brownish appearance. Water is taken from Butcher Creek and from an old working. The dirty water is discharged into a gravel dam, several hundred yards below the breakers. A little of the water which filters through the soil under this dam comes out quite clear, but the main body passes off by an overflow weir at one end of the dam, and is heavily charged.

Owing to the heavy rain, which delayed our movements, we were obliged to abandon our purpose of visiting the operations at Mackeysburg, in the Hechscherville Valley, and turned southward through Mine Hill Gap to Minersville, passing the large Oak Hill breaker at the foot of the hill on the right side of the stream in the Gap.

In the afternoon we left Minersville and drove up Wolf Creek, a small stream which flows through Minersville and enters into the west branch of the Schuylkill at the lower end of that town.

About one and a half miles north of Minersville, on the left, or east, bank of Wolf Creek, we found the small colliery and breaker of the Little Diamond Coal Company, in charge of Mr. Simons, who showed us over the works. Here the discharge is into a dam built partly of gravel and partly of slate, and drained by a small trough. At the time of our visit the works were not in operation, and the trough from the dam was not discharging, but its appearance indicated that the water in it had run pretty black.

Alongside of Mr. Simon's breaker, and just above it, we found the washery of the Stoddard Coal Company, and were shown over the works by Mr. Hollenbeck, one of the company.

This is the largest operation of the kind that we saw, with the largest dirt bank and the most complete arrangement for taking care of the discharge.

The culm is brought from a very large culm heap on the opposite side of Wolf Creek, by means of belt conveyors running along the heap. The link belt is armed with iron blades nearly fitting the conveyor trough, into which the culm is shoveled down short steep iron troughs laid upon the surface of the culm heaps.

Water for the washery, already heavily charged with coal dust by operations further up stream, is taken from Wolf creek, and some clear water is pumped from an abandoned working.

The waste water from the washery, heavily charged with coal dust, is led by a trough from the upper part of the washery to the top of a very large dump, which is enclosed by high banks of slate. The water, filtering through these banks at numerous places along the base into Wolf creek, is generally heavily charged, but one or two small leakages were quite clear.

The increase in the height of the dump has carried it above the level at which the discharge could be properly handled by gravity, and has necessitated the erection, within the last six or eight months, of a conveyor similar to that bringing culm from the bank. It is about two hundred feet long, with a lift of about twenty-five feet, and is placed on top of the heap immediately opposite the washery. The water discharged from the washery by the trough enters the conveyor trough and is lifted, with the dirt, to the top of the conveyor, and then discharged through short troughs upon the surface of the pile.

We then drove, via the valley of the West Branch of the Schuylkill, to Schuylkill Haven, on the main stream, just below the Junction, and walked to the large coal storage plant of the Philadelphia and Reading Coal and Iron Company, about two miles below, and on the right or south bank of the river. Here there are enormous coal bins built upon the hill-side at a considerable elevation above the railroad, and in connection with these there is a large "wet" breaker.

The wash from this breaker is emptied into large dams built of soft culm and provided with sluices.

We found two openings through the uppermost dam, and the waste from them seemed to proceed into other dams constructed at lower levels and adjoining the upper one.

Time did not permit us to make investigation of these lower dams or to satisfy ourselves as to the extent to which they retained the dust discharged into them.

## REPORTS OF SUPPLEMENTARY VISITS.

Wednesday, July 15, 1896.

Left Minersville at 8 A. M. and drove through Mine Hill Gap, leaving Oak Hill colliery on the left.

Drove westward up the Heckersville valley through Coal Castle to Heckersville. Crossed valley to Howell & Courtney's colliery on south side. Breaker has been in operation about a year. It is "half dry," using water only in lower portion of the breaker, and chiefly on chestnut and smaller sizes of coal; sometimes on stove, if slaty. Superintendent Smith, who has been in charge but a few weeks, showed me over the ground below the breaker. He has just introduced, in the breaker, a washing device for retaining the coarse stuff from the dust.

The water used in the breaker is stored in wooden tanks on the side of the hill behind the breaker.

The dust is deposited in a long and narrow valley and is held back by a short dam built of culm, with one sluice. At the time of my visit, 9 A. M., the sluice was dry, the breaker having been in operation only two hours.

The jigs are washed every few hours, and this adds more dirt to the discharge.

Superintendent Smith says that at Maltby colliery, Forty Fort, near Wilkesbarre, and at Eckley B. Coxe's breaker, settling tanks are used for the deposit of the dust by the water, and that in the Wyoming region the culm can be used entire (with the dust) for firing with McClave and other blowers. He claims that in that region the particles of dust are cubical, and that the high pitch of the strata in the Schuylkill region causes the dust to become more finely ground, and thus renders it unfit for use under boilers and more difficult of removal by sedimentation.

Thomaston Colliery, of Philadelphia Coal and Iron Company, on south side of valley. Very large dam, built of culm, with sluices. Discharge quite black. A large pumping station is maintained about half a mile below the breaker for the purpose of raising water from the mine and discharging it into the west branch of the Schuylkill.

Mackeysburg, Glen Carbon Station, Richardson Colliery, Philadelphia and Reading Coal and Iron Company, on north side of valley, just above Mackeysburg. Large dam, built of slate from old washery, now abandoned. The water can be heard filtering through the slate. It comes out more or less black according to rate of filtration.

The stream of black water flowing to the dam was about three feet wide and two inches deep. Velocity about one foot per second. This would give a discharge of half cubic foot per second.

Glendower Colliery, near head of valley. Discharges into a dam. Owing to rain, did not stop.

Left Heckersville valley and drove over the hill to Minersville, stopping at Lytle Colliery on branch of Pennsylvania Railroad. Gentleman in charge tells me that there is a small washery there, for preparing coal for the furnaces, and that the jigs in the breaker are washed. Owing to rain, did not examine dam.

In the afternoon visited York Farm Colliery of Lehigh Valley Coal Company, about one and a half miles west of Pottsville. The discharge is on the west, or lower, side of the breaker, and forms the main body of a small stream flowing westward into the west branch of the Schuylkill. The water is received in two settling pools, one immediately below the other, and both about half a mile below the breaker. These are formed by dams of gravel taken from the banks of the stream, and the discharge in each case is over a weir.

The water, which is very black as it comes from the breaker, is greatly improved by its passage through the two setting pools, but still issues from the second one slightly discolored by fine dust.

*Saturday, August 15, 1896.*
*Glendower Colliery.*

Visited Glendower Colliery, Philadelphia and Reading Coal and Iron Company, near head of Heckscherville valley, and examined dams for retention of coal dust. Found two very extensive dams, separated by the west branch of the Schuylkill, which is bridged by a trough. The water is led from the breaker to the dams in wooden troughs lined with sheet iron. When the dam has filled up, it has been cut through at the lower end and the water allowed to flow through the opening into a lower dam formed further down stream.

The sides of the dams are protected by strips of sheet iron tied together with loops of wire, and, in the newer portions, provided with flares at intervals of about 15 feet. These flares are small plates of sheet iron extending out into the dam and pointing obliquely down stream. They are supported by culm piled behind them.

The ends of the dams are far less thoroughly protected, apparently in order to allow the water to flow off.

The outer slopes of the fine culm banks enclosing the dam were badly gullied by rain.

The north dam has, at its eastern end, an outlet through a series of small dams to a meadow, through which flows the west branch. The meadow is covered several feet deep with coal dust, which is gullied by the stream flowing from the north dam. The stream must be much polluted when the breaker is running. Found new sheet iron piled on the ground near lower end of main north dam, evidently with a view of closing it.

Ascertained location of Lytle Colliery, at head of a stream feeding the west west branch.

Visited Pine Hill and new colliery at the extreme head of Wolf creek, about half a mile above the Diamond and Stoddard operations visited with Mr. Catherine.

The water, with coal dust, is carried from the breaker to the dam through a wooden trough lined with sheet iron. The iron was very rusty and showed no indications of coal dust or of recent use. The trough passes through a culm bank and the stream flows down the eastern side of the bank into a small dam which appears to have no outlet.

A small overflow from a bend in the trough at top of bank flows down the western side of bank and around it into Wolf creek.

Noticed troughs leading steeply from old culm banks to dam of breaker.

Trolley to Pottsville. Drove to Schuylkill river and down its left bank to Schuylkill Haven.

The large bend in the river here was utilized by the Navigation Company for the construction of a waste weir and channel, the latter reaching the river just below dam No. 7, close to the railroad bridge.

The meadow through which this channel flows and the flat lands along the river below it are covered with coal dust. Walked to Mine Hill Junction via railroad, and back by road and highway bridge.

# APPENDIX N.

## CONCLUSIONS REACHED RESPECTING SAND FILTRATION IN PHILADELPHIA.

**By Allen Hazen, C. E., in a report to the Womans' Health Protective Association of Philadelphia.**

### *Population and Quantity of Water to be Provided.*

The population of Philadelphia in 1880 was 847,170. In 1890 it had increased to 1,046,946. Assuming that the increase from 1890 to 1900 is at the same rate as for the ten years before 1890, the population in 1900 will be 1,294,000. For the purpose of estimating the quantity of water required I assume that the population will be 1,300,000, and that of this number 800,000 will be resident in the low district; 260,000 will be resident in the district supplied from the Queen Lane Reservoir; 100,000 in the Roxborugh district, and that 140,000 people will occupy the Belmont district west of the Schuylkill River.

I have further assumed that the average consumption of water for all seasons of the year will have been reduced by the introduction of meters to 100 gallons per capita, but that at times of maximum consumption as much as 150 gallons per capita daily may be required, making a total filtering capacity required of 195,000,000 gallons. This quantity of water is much less than that now being used, but I beleve it is ample for all purposes with a reasonable system for the sale of water.

### *Estimates of Cost.*

The following estimate of cost of works required to filter the quantity of water mentioned in connection with the various pumping stations has been made up from approximate data, and while not exact, the figures are upon ample basis, and will be sufficiently close to the truth for your purpose. The estimates are as follows, by pumping stations:

| | | |
|---|---|---|
| Belmont pumping station, 7 acres of filters; capacity, average, 14,000,000; maximum, 21,000,000 gallons daily. | | |
| Land now owned by the city. | | |
| Receiving basin | $35,000 | |
| Filters | 254,000 | |
| Piping and connections | 28,000 | |
| Total | | $317,000 |
| Roxborough pumping station, 5 acres of filters; capacity, average, 10,000,000; maximum, 15,000,000 gallons daily. | | |
| 40 acres of land | $40,000 | |
| Receiving basin | 28,000 | |
| Filters | 198,000 | |
| Piping and connections | 34,000 | |
| Total | | $300,000 |
| Queen Lane pumping station, 13 acres of filters; capacity, average, 26,000,000; maximum, 39,000,000 gallons daily. | | |
| 40 acres of land | 200,000 | |
| Receiving basin | 54,000 | |
| Filters | 472,000 | |
| Piping and connections | 61,000 | |
| Total | | $787,000 |
| Cambria site; Spring Garden pumping station, 30 acres of filters; capacity, average, 60,000,000; maximum, 90,000,000 gallons daily. | | |
| Land now owned by the city. | | |
| Receiving basin | $103,000 | |
| Filters | 1,030,000 | |
| Piping and connections | 445,000 | |
| Total | | $1,578,000 |
| Frankford pumping station, 10 acres of filters; capacity, average, 20,000,000; maximum, 30,000,000 gallons daily. | | |

| | | |
|---|---|---|
| 20 acres of land.............................. | $20,000 | |
| Centrifugal pumps and accessories for lifting water from river to filters.......... | 55,000 | |
| Filters .................................... | 330,000 | |
| Piping and conections..................... | 4,000 | |
| Total .................................... | | 409,000 |
| Total cost of filters with a maximum capacity of 195,000,000 gallons daily in connection with existing pumping stations .................................... | | $3,391,000 |

In case the city is unwilling to bring itself to a reasonable use of water, and insists on wasting water as at present, the cost will be increased in proportion to the quantity of water required. The land provided for, however, at Roxborough and Queen Lane, is sufficient for the construction of filters with twice the areas of those estimated for, and this item would not, therefore, increase with additional filters on those sites.

The cost of the operation of the filters may be approximately estimated upon a very liberal basis at $3.50 per 1,000,000 gallons of water filtered, or, for the quantity of water estimated for, $166,075, annually. This capitalization at 5 per cent. amounts to $3,321,500.

When additional quantities of water are required, the capacity of filters at the Belmont, Roxborough and Queen Lane stations can be increased in connection with those now estimated for, the areas of land being ample for the requirements for a long period of years. The capacity of the filters on the site of the proposed Cambria reservoir, filtering water from the Spring Garden pumping station. can also be increased if desired, although the area of land available is apparently limited, and might not be sufficient for the ultimate requirements. It will, however, be better in many ways to get additional water for this district from the Delaware, instead of from the Schuylkill. Additional filters can be placed on the Delaware at any point selected as most suitable for this purpose.

As mentioned earlier in this report, investigations have not been made to determine the most advantageous point for taking the Delaware water. In case the water should be taken at a point immediately below Torresdale, works for an additional supply of 100,000,000 gallons daily would cost about $3,000,000, of which $1,100,000 would be required for filters, as much more for force mains from the filters to Market street, connecting at various points with the pipes leading the water to all parts of the city, and $800,000 would be required for pumps, land and various accessories.

The total cost of works for securing water in this way amounts to about $30,000 for every 1,000,000 gallons daily capacity secured, and the works would be of such a nature that any considerable part of them could be installed at nearly the same proportionate cost, and the capacity could be increased as required at the same rate. I do not consider that such a large additional quantity of water will be required in the near future, but the estimate is included that you may know the expense which will be involved in case the city insist upon having so large a quantity of water as 300,000,000 gallons or more per day.

### *Conclusions.*

The City of Philadelphia is now using water in a most wasteful and extravigant manner, and immediate measures should be taken to check such waste, and to reduce the consumption to a reasonable amount.

It is possible to construct sand filters similar to those in use at London, Hamburg and many other European cities, in connection with the existing pumping stations, of sufficient capacity to furnish water for all reasonable requirements, for the present population, and for that which may be expected in the near future.

When larger quantities of water are required, it will be possible to secure them from the Delaware River by means of filtration, and to use the water so obtained in connection with that from the present pumping stations. The quantity of water which can be secured in this way is practically unlimited, at least 1,000,000,000 gallons daily being available.

The cost of installing filters with all necessary accessories to filter an average of 100 gallons of water per day for every inhabitant in the city, and with a maximum capacity of 150 gallons per inhabitant per day, amounting to 195,000,000 gallons daily in all, may be approximately estimated at $3,400,000.


MAP OF
PHILADELPHIA
SHOWING
PRESENT INTAKES, PUMPING STATIONS
AND RESERVOIRS
TOGETHER WITH
PROPOSED FILTERS
AND CONNECTIONS.
● Pumping Station. X High service pumping station.
NOYES & HAZEN,
CONSULTING ENGINEERS,
BOSTON, MASS.
AUG. 1896.
SCALE OF MILES
0 1 2 3 4 5
CHESTNUT HILL
RES.
Wissahickon
FILTERING AREA
UPPER ROXBOROUGH RES.
Roxboro
LOWER ROXBOROUGH RES.
ROXBOROUGH PUMPING STA.
Mt. Airy
Mt. Pleasant
GERMANTOWN
Schuylkill River
CITY LINE
MANAYUNK
W. Manayunk
FILTERING AREA
RES.
QUEEN LANE PUMPING STA.
Falls of Schuylkill
Cynwyd
FILTERING AREA
BELMONT RES.
PUMPING STA.
Germantown Jc.
EAST PARK RES.
SPRING GARDEN PUMPING STA.
PUMPING STA.
FAIRMOUNT RES.
WEST PHILADELPHIA
Darby
Cobbs Cr.
Paschallville
Rockledge
Ashbourne
Cheltenham
Oak Lane
Lawndale
FRANKFORD RES.
Wayne Jc.
Coopersville
FRANKFORD
FRANKFORD PUMPING STA.
Frankford Cr.
Bridesburg
Wissinoming
Tacony
FILTERING AREA
Holmesburg
Pennypack Cr.
Bustleton
Torresdale
Poquessing Cr.
Palmyra
DELAWARE RIVER
CAMDEN
GLOUCESTER
BRADLEY & POATES ENGR'S N. Y.