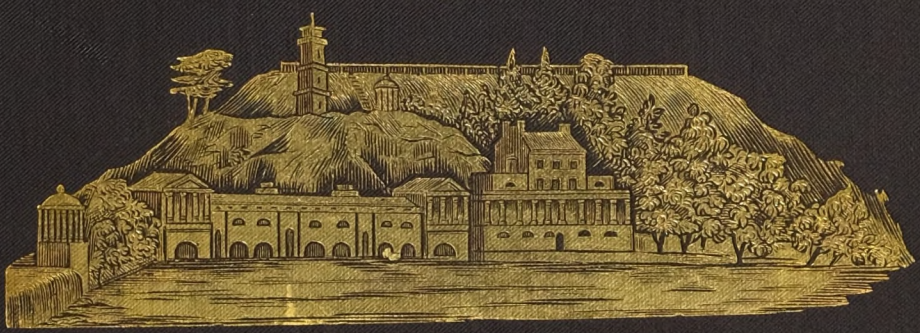
ANNUAL REPORT

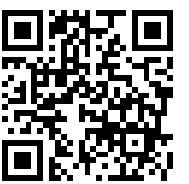
OF THE



WATER DEPARTMENT

PHILADELPHIA

1884



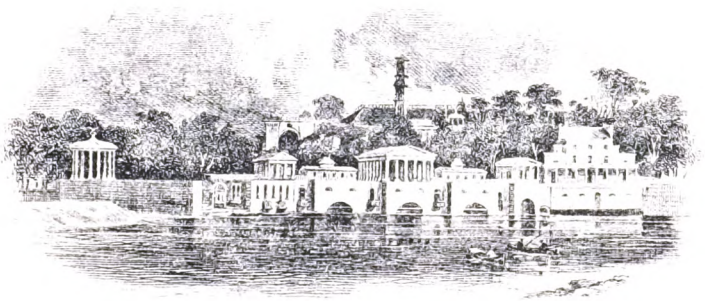
ANNUAL REPORT

OF THE

Chief Engineer

OF THE

PHILADELPHIA WATER DEPARTMENT



FOR THE YEAR 1884.

PHILADELPHIA:
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1885.

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JOINT STANDING COMMITTEE ON WATER,

For the year commencing the First Monday in April, 1884.

Select Council.	Common Council.
THOMAS GREEN (*Chairman*),	JOHN L. BALDWIN,
ALBERT A. ARDIS,	JOHN BARDSLEY,
CHARLES H. BANES,	J. RAYMOND CLAGHORN,
JOHN BRADY,	CHARLES H. CUMMINGS.
JOHN H. GRAHAM,	WILLIAM H. DOYLE,
SAMUEL HART,	THOS. L. HICKS,
GEO. W. HETRICK,	CHAS. W. KARSNER, M.D.,
HENRY JOHNSON,	J. FREDERICK LOEBLE,
PHILIP MITTON,	GEO. H. MCCULLY,
WM. THORNTON,	JOSHUA T. OWEN,
WM. B. TRITES, M.D.,	JOHN M. WALTON,
JOSEPH B. VAN DUSEN,	LEWIS T. YOUNG,
JAMES R. GATES,	CHARLES LAWRENCE,
President of Select Council.	*President of Common Council.*

PERSONNEL OF THE WATER DEPARTMENT.

CHIEF ENGINEER.

WILLIAM LUDLOW.

Assistant Engineers.

JOHN L. OGDEN, CHAS. G. DARRACH (to April 30, 1884),
LLOYD BANKSON, W. P. OSLER (to Oct. 25, 1884).

Draughtsmen.

John E. Codman, C. O. Lindroth, T. Mellon Rogers.

Chief Clerk—JOB T. HICKMAN.
Assistant Clerk—L. L. Dean.
Correspondence Clerk—George S. Zane (to March 15, 1884).
P. de Haven (April 1 to May 31, 1884, and from October 1, 1884.)
Thaddeus Webb (June 1 to Sept. 30, 1884.)
Pipe Recording Clerks—Wm. Whitby, Allen J. Fuller.
Time Clerk—William J. Innes.
Pipe Inspector—Theo. S. S. Baker.
Messenger—James G. Davis.

Telephone Operators.

Mattie Whittingham, George Weikman.

General Superintendent.

JOSEPH J. de KINDER.

Clerk to General Superintendent—John A. Hayes.

Engineers at Pumping Stations.

FAIRMOUNT—*First Engineer*, Joseph Moyer, (to April 30, 1884).
Joseph McElwell, (from May 1, 1884).
Second Engineer, R. K. Matlack,

SPRING GARDEN—*Engineer in Charge*, A. G. Bonsall.
Assistant Engineers, David Pyke, Wm. H. Wakefield.
Abram Stott, James Dean (from April 1).

BELMONT—*Engineer in Charge*, Christian Bezold.
Assistant Engineers, Jno. E. Smith, (to May 31, 1884).
Abram Stott, (to March 31, 1884).
Wm. Kiner, Thos. Seddon, (from May 1, 1884).

KENSINGTON—*Engineer in Charge*, David P. Perkinpine, (to March 31, 1884).
Wm. H. Smith, (Apr. 1 to July 20, 1884).
Joseph Owens, (from Aug. 1, 1884).
Assistant Engineer, Wm. Kiner, (to May 31, 1884).
Jos. Owens, (to July 31, 1884).
Robt. E. Parker, (from August 1 1884).

ROXBOROUGH—*Engineer in Charge*, Wm. H. Smith, (to March 31, 1884).
Theo. Acheson, (from April 1, 1884).
Assistant Engineers, Joshua Bartly, Lewis Culp.

MOUNT AIRY—*Engineers*, Archibald Weir, Archibald Jardine.
CHESTNUT HILL—*Engineer*, James McClenahan.
FRANKFORD—*Engineer in Charge*, Charles Douglass.

Works General.

Foreman Carpenter—Henry Guest.
Foreman Bricklayer—Frank A. Mooney.
Foreman Stonemason—Crawford Lukens.
Foreman Rigger—James Forrest
Foreman Laborer—Matthew J. Richmond.

Superintendent of Shop—JAMES F. NEALL.
Clerk to Superintendent of Shop—Chas. K. Adams (to July 5, 1884), John M. Curtis (from July 14, 1884).

PURVEYORS.

First District, John H. Holmes.
Clerk, Saml. Moore (Jan. 8, 1884), Wm. J. Mackey (from Sept. 1, 1884).
General Foreman, James Humes. *Foreman of Repairs*, W. W. Wellington.
Office, 11th and Wharton streets.

Second District, David A. Craig.
General Foreman, Michael Young *Foreman of Repairs*, Joseph Bryan.
Office, 918 Cherry streets.

Third District, Chas. J. Lowry.
Clerk, Geo B. Bunn. *General Foreman*, Daniel Ahern.
Foreman of Repairs, Wm. Magee.
Office, 1420 Frankford avenue.

Fourth District, John Montgomery.

Clerk, Arthur B. Cook. *General Foreman*, Geo. W. Showaker.

Foreman of Repairs, Jas. Hutchinson.

Office, 26th and Master streets.

Fifth District, Henry Dawson.

Clerk, Harry R. Wildey. *General Foreman*, Charles Franks.

Office, Lyceum Building, Roxborough.

Sixth District, David B. Morrell.

Clerk, Chas. H. Fletcher (to April 30, 1884), Jonathan Bonsall (from Oct. 20, 1884).

General Foreman, Daniel Boyer (from March 1, 1884).

Office, Town Hall, Germantown.

REGISTRAR'S OFFICE.

Registrar.

A. NEWLIN KEITHLER.

Registrar's Chief Clerk—Wm. J. Halliday.

Cashier—John F. Scheidt. *Permit Clerk*—E. S. Higbee.

Registering Clerk—A. Buckheister.

Entry Clerks—Geo. S. Macauley, Chas. D. Birney.

General Clerks.

Joseph Fisher, John M. Stacker, Chas. L. Hayden,
W. W. Widdifield, Chas. H. Russell,
Kennedy McNeal.

Chief Inspector—Thomas Orr.

Inspectors.

Edw. D. Thomas,	Edw. M. Rowe,	William Erwin,
W. H. Hergesheimer,	Wm. A. Agnew,	Louis Obermiller,
Jas. H. Graham,	James Cameron,	John Simon,
Albert C. Weaver,	Thos. S. Flanagan,	Theodore Yeager,
James Buchanan,	William Hasson,	George Crooks,
Wm L. Kensil,	Alex. McConnell,	William T. Pound,
	John Van Dusen.	

Messenger—Thomas J. Lister.

LETTER OF TRANSMITTAL.

PHILADELPHIA WATER DEPARTMENT.
April 1, 1885.

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

GENTLEMEN:—I have the honor to submit herewith the Annual Report of the Water Department for the year 1884.

The accompanying sub-reports are those of the Chief Clerk and Registrar, exhibiting the expenditures and receipts of the Department from January 1, 1884, to January 1, 1885; those of the General Superintendent, the Assistant Engineer in charge of the Distribution, and the Superintendent of the Shop, setting forth the mechanical operations connected with the work of pumpage, distribution, and repairs; and those of the Engineer in charge of Surveys, the Consulting Analyst, and the Sanitary Inspector, upon the surveys and investigations relating to the present and future water supply of the City.

The labors of the year were prosecuted actively to its close, and the considerable time required for the recording and consideration of the large accumulation of data, as well as the intricacy and importance of the matters under consideration, which forbade haste in its preparation, have somewhat delayed the completion of this Report.

Very respectfully,
WILLIAM LUDLOW,
Chief Engineer.

REPORT.

PRELIMINARY REMARKS.

While it is quite impossible within the compass of a report covering the operations for a whole year, of a Department so extensive and so technical as this, to set forth in full the multiplied details or to do more than indicate the most important and significant particulars, the condensed reports of the subordinate officers of the Department make it sufficiently manifest that the amount of work actually performed demanded unremitting industry and the utmost diligence for its accomplishment. The labors of the year, however, although arduous, enjoyed the great advantage of freedom from the overshadowing apprehension with regard to the maintenance of the supply, which made the season of 1883 one of such prolonged anxiety in view of a quite possible failure of the decrepit machinery and a consequent deprivation of water more or less general throughout the city. Having survived this period, as described in the last Annual Report, not only without disaster, albeit on a perilously narrow margin, but with an unexpected and gratifying absence of serious complaint, it was possible to continue the necessary work of further improvement with a comparatively easy mind, in view of the fact that the repairs and alterations that could be made during the winter months, and in especial the contracts entered into in 1883 for the erection of new engines and boilers, would place at the disposal of the Department sufficient pumping capacity to supply all legitimate needs during the ensuing season. These contracts, it will be remembered, were for two fifteen-million gallon Worthington Engines and ten Marine Tubular Steel Boilers, in a new house at the Spring Garden Station; one seven-and-a-half-million gallon Worthington Engine at the Roxborough Station, and one ten-

million gallon Corliss Engine, with four steel Boilers, at the Frankford Station. The particulars of these contracts were reported last year, and the data relating to their completion and the service of the new plant will be found under the reports of their respective stations.

EXPENDITURES AND RECEIPTS.

The means available for expenditure during the year 1884 were as follows:

1. Of balances on hand January 1, and held over from the preceding year to discharge contract and other minor liabilities, there were		$248,431 82
2. The amount of the annual appropriation to the Water Department for the year 1884, made in ordinance of December 31, 1883, was	$813,385 00	
3. This amount was increased during the year by transfers from other sources in the amount of	10,954 63	
Making a total appropriation of		824,339 63
And an available aggregate of		$1,072,771 45

The disposition made of these amounts, and a statement of the balances remaining on hand January 1, 1885, are shown in detail in the report of the Chief Clerk.

Of the total expenditures, $603,173.76 were for the general expenses and maintenance of the Department, and $378,614.80 were for improvements. The remainder covered several items, Surveys, Refunds, Payment of Deficiencies, etc., leaving a balance on hand January 1, 1885, available for the final payments on contracts, of $38,074.56.

The report of the Registrar contains data of great interest. The notable increase in receipts as well as the diminution of collections of arrears, is the result of the application of strict business methods and most unremitting diligence on the part

of the Registrar and his subordinate employés. Mr. Keithler has good reason to be proud of the handsome exhibit of an increase from $1,500,000 in 1882, to $1,800,000 in 1884, without in any respect increasing the water charges; and in one case, that of water supplied through meters, with a reduction from $1 to 60 cents per thousand cubic feet, or from 13⅓ cents to 8 cents per thousand gallons.

The large detailed Statement of Appliances, etc., accompanying the Registrar's Report, has been carefully compiled from the data furnished by the general re-inspection of the City, begun in 1883, and completed early in 1884. From this it appears that the total number of premises on the Registrar's books is 168,201, of which 146,898 are supplied with City water and 21,303 are not. The greater number of these latter is in the rural districts to which water-pipe has not been extended, but many of them are within access. The number of baths in dwellings is 77,010, and of water-closets, 40,741. These numbers, although slightly in excess of that of the houses supplied with them, constitute a favorable exhibit of the decent and comfortable homes of our population and their general disposition to cleanliness. Nevertheless, there are manifestly numerous houses destitute of these "aids of civilization," as they have been well termed. In particular, is the number of water-closets significant of the prevalence of cess-pools and privy-wells, or still worse, the non-existence, in some probably few cases, of any facilities whatever.

There is no reason why a house supplied with a bath should not also have direct connection with the sewer and so dispense with the foul and dangerous practice of storing putrescible waste matters upon the premises to the great detriment of the health of the neighborhood and of the City. It is worth serious consideration whether a building regulation should not be adopted, making it obligatory upon all builders to provide dwellings with the requisite apparatus for comfort, health, and cleanliness whenever it shall be practicable to do so. Further

reference to this subject will be made under the head of Plumbing Regulations.

It is good evidence of the fidelity and thoroughness with which, on the whole, the re-inspection of the City was made, that but few corrections have since been shown to be necessary, and these were readily amended by a re-examination of the few premises in question.

The comparative Schedule of Water-rents, appended to the Registrar's Report, was prepared from information in most cases obtained directly from the cities named, and tends to show that of all the great centres of population in the United States, Philadelphia has, on the whole, the lowest and most equitable rates of water charges, carefully conserving the manufacturing interests while enabling every household to take advantage of the so-called "modern conveniences" for the enhancement of domestic comfort and cleanliness. Still greater advantages can hereafter be gained in the direction both of cheapness and plenty, and surplus revenues of the Department (nearly $1,000,000 in 1884) show that there need be no lack of means by which to secure them.

The table of Meter Charges is a most interesting exhibit. Early in 1883 a preliminary investigation of the Registrar's books showed marked inequalities in charges and in some cases most singular disparities between those charges and the amount of water consumed. Later, it became manifest also, from both observation and computation, that a large proportion of the total daily pumpage was wasted, thereby entailing a heavy additional and unnecessary expense upon the City—since the expenditure of fuel and the wear and tear of machinery are directly proportionate to the pumpage and have no relation to the use or misuse of the water after delivery. Furthermore, this waste, by diminishing in effect the capacity of the basins and distributing mains, occasions an artificial scarcity which impairs the effectiveness of the Fire Department, hampers manufacturers, and interferes seriously with domestic comfort; and these disadvantages must, perforce, continue

until either the means of distribution shall be greatly increased or the waste prevented.

No arrangement having been concluded for the instrumental determination of domestic waste, the vigilance of the Department Inspectors, aided by casual information from citizens, had to be depended upon to correct the thousands of leaky and flowing hydrants, water-closets and basins—quite ineffectively, it must be admitted, in the absence of any plumbing regulations and supervision.

For the large consumer the obvious means to systematize and equalize water charges as well as restrict the waste, was to measure the water drawn and charge for it.

For this purpose, under the provisions of the joint resolution of Councils of May 18, 1870, authorizing the Chief Engineer to apply meters when necessary to ascertain the amount of water consumed, the establishments named on the meter schedule were supplied with meters, and the records kept. The result in many cases was quite unexpected both to the Department and to the consumers, and a large body of fresh and valuable information was rapidly obtained. The general system of rating premises for water rents, under which the Water Department, since its organization in 1854, has proceeded, is to make an inspection of the premises and base the charges upon the number and character of the water appliances in service, the charge for each appliance being regulated by a schedule in force in the old City previous to consolidation and re-enacted by ordinance thereafter. The charges against the several appliances named in the schedule were presumably proportioned originally in accordance with the average amount of water which it was supposed would be drawn from them; but as plumbing arrangements developed, and in especial as manufacturing methods were altered, and new devices, labor-saving and other, came into use, it was found necessary from time to time to amend the schedule. This was done by the joint action of the Chief Engineer and the Water Committee, without resubmitting the matter to Councils; but notwithstanding-

the changes, the schedule has failed to keep pace with industrial modifications, and continues to bear indications of its early origin. The record of the meters clearly brought out these points, and has served as a valuable aid in the re-adjustment of the details of charges, which is now under consideration by the Water Committee.

It was mainly upon this evidence that the Department recommended, and the Committee approved, a decrease in the charge for steam-power from $3 to $2 per horse-power, which is now the lowest charge in the United States. The old charge was probably a lower one, when it was adopted, than is the smaller charge now, since the introduction of condensing and compound engines, with other improvements in mechanical engineering, has effected a marked economy in both fuel and water, the latter being used over and over again. As will be seen by reference to the Registrar's detailed Statement of Appliances the number of steam engines and boilers in service in the City exceeds three thousand, with an aggregate horse-power in excess of sixty-five thousand. The reduction of $1 in the horse-power charge correspondingly relieves the steam-using industries and diminishes the revenues of the Department. The change was made early this year, in time to go into effect in making out the bills for 1885. The meter further developed the fact that in some establishments appliances were in use not named in the schedule nor known to the Department, and therefore not charged for, which, nevertheless, consumed large quantities of water. It also showed that in many cases the amount of water wasted was largely in excess of that usefully employed, as was evidenced by the rapid decrease of consumption so soon as the meter readings were made, and the managers saw that a proper and large economy could be effected by requiring their employés to stop unnecessary flow. The reduction in some instances was fifty per cent., and even as high as seventy per cent. This result was, of course, anticipated; since it is quite clear that, as a rule, little if any care will be taken to restrict the flow of water which is not charged for, nor even noted, and

that even were strict instructions given, employés will not take the trouble to obey them so long as their dereliction could escape observation. A pipe would be used, for example, to fill a tub, and the workman would throw the hose upon the floor and let the water run until he again had occasion to use it. In other cases a pipe in constant flow during the day would also be allowed to run after shutting down the mill. Leaking pipes were not repaired nor were urinals and basins shut off. All these sources of waste the meter readily controls to the advantage of every interest.

The establishments given in the Meter Statement are not all of those to which meters were provisionally or experimentally applied, but are selected as exhibiting the characteristic results afforded by direct measurement. In some the charges remain about the same by meter as by regular schedule rates; in others the meters, after correction of the waste, largely reduced the cost to the consumer; while in still others the increase by meters was so great as to show clearly the inadequacy and inequality of the schedule charges as based upon assessment of appliances. In these cases, as was natural, the meter was strenuously objected to; and, in fact, it was made evident that in regard to certain industries which are compelled to use immense quantities of water for cleaning and similar purposes the City could well afford to reduce the charge per thousand gallons below even the moderate rate of eight cents.

It would seem equitable, in considering these matters, that consumers using over a certain quantity should be allowed a reduced charge—either by a sliding scale, as has been adopted in many other cities, or by the minimum draught per day, or per annum, above which the reduced rate would go into effect.

It is in these two directions, of restricting waste and equalizing charges, that the meter exhibits its useful qualities; and under favorable circumstances its application to all large consumers would be attended with excellent results. This is now

done in many cities where the business of furnishing water has been carefully and intelligently regulated, and in several instances meters are universally applied even to private houses. In Philadelphia it would be unadvisable to so greatly enlarge the use of meters; and there are good reasons, since our supply is only necessarily restricted by the pumping and distributing facilities, for not putting meters in private houses.

The free use of water for bathing purposes is so desirable that it should be in every way encouraged and nothing done that would tend to restrict it. Furthermore, the number of premises supplied with water is so great as to forbid consideration of the general use of meters, certainly until at least the extensive expenditures for most urgent and indispensable improvements shall have been made.

With our present arrangements, too, meters are at a disadvantage from the character of the supply. The city water is frequently highly charged with sediment, and the meters are thereby, to a certain extent, obstructed, so that they register less than the amount passed through them. This fact operates against the City by diminishing the apparent consumption, although the consumer is correspondingly benefited. In some cases, too, the meter became choked and obstructed the flow, although this difficulty, under a proper system, need not continue. Whether any extension of the use of meters shall be hereafter made or not, the information furnished by them has been most valuable in clearly indicating where revision of the schedule charges is needed and how readily waste can be prevented.

At the present time, and for the current year, meter charges are made only to those establishments for which regular charges cannot be accurately scheduled—as, for example, those having a supply of their own, from wells, etc., and drawing upon the City for a portion only of what they use.

The Registrar points out the value to the Department of the services of the additional Inspectors authorized in 1883, and very properly invites attention to the absence of suitable

accommodations and facilities for the transaction of the large and steadily increasing business of his office.

The thorough regulation of this business will still require time to complete. There are many properties in relation to which the recorded information is defective, and many others which lack proper facilities. Frequently, numerous houses are connected and depend upon a single attachment to the main. As rapidly as these are disclosed, either from delinquency or failure of the pipe supplying them, separate attachments for each are ordered in compliance with the ordinance. There are also many cases of secret or forgotten attachments by means of which payment of water-rents is evaded. These sometimes are the cause of unpleasantness, but when discovered are remedied.

The gross waste of water from the constant overflowing of horse-troughs has been stopped by making it obligatory upon the owners to attach a ball-cock to cut off the inflow when the trough is nearly full. This was very necessary from the great waste and nuisance thereby created.

Numerous penalties were imposed for violation of the ordinance forbidding the use of water appliances without a permit from the Registrar. While the better class of plumbers are entirely in accord with the purpose of the Department to carry out the ordinance, it is probable that cases of this sort will continue to occur until some regulation is made whereby only competent and licensed plumbers shall be allowed to do business with the Department, and only then by compelling payment in every case of failure to comply with the city requirements.

STATIONS AND RESERVOIRS.

Upon the work of the Pumping Stations depend all the other operations of the Department; and the cost of fuel, service, and repairs constitute the largest proportion of its regular

annual expenditure. It is at the Stations, therefore, that the most serious responsibility is felt for the maintenance of the supply and where the most striking results might be looked for in seeking, by improvement of plant and methods and more systematic discipline, to increase the supply and reduce its cost. To this end the General Superintendent, Mr. de Kinder, has devoted himself for two years past with extraordinary energy and the most conspicuous success. To any one familiar with the appearance and work of the Stations in March, 1883, a comparison with their present condition would be sufficiently convincing.

But it is not alone in the establishment of order, cleanliness, neatness, and discipline that the good results are apparent. The salary roll of the eight stations in the appropriation ordinance for the current year 1885, notwithstanding the construction and equipment of an entirely new station at Spring Garden, with a daily capacity of over thirty million gallons, is less than that for 1883, as appropriated in December, 1882, by $17,265; and the bills for supplies, fuel, lubricants, gas, and small stores for 1884 is $29,151.67 less than for 1882. On the other hand the average daily pumpage in 1884 exceeded that of 1882 by 2,011,187 gallons. The effect of this is seen in the reduction of the average net cost of pumpage, to which Mr. de Kinder invites attention—the total pumpage being computed as so many million gallons raised to the height of one hundred feet. The reduction is from $6.66, in 1882, to $6.51, in 1883, and $5.54, in 1884, or nearly seventeen per cent. in two years, with the assurance of still better results in 1885.

The reduction in the salary list was readily effected by terminating the employment of the unnecessarily large number of people and requiring better service of those who were retained. The reduction in cost of fuel was effected by contracting for pea coal, instead of the higher priced egg, and making such modifications in the boilers and other apparatus as would secure from the cheaper fuel the same steam-making capacity as from the other. Inasmuch as for the first three months of 1884

egg coal was burned until the alterations could be completed, the bills of 1885 will certainly be less than for 1884.

The use of cheap and destructive lubricants was entirely stopped; but, notwithstanding the higher prices paid for the material used, the total cost was reduced over one-half by more scientific methods of application.

The putting of the engines in proper condition has largely increased their capacity or correspondingly reduced the pressure of steam necessary to operate them. In every respect the service of the Stations has been bettered and cost reduced, until now they can be depended upon, without apprehension, for a much larger supply than the basins can receive or the mains distribute.

No one can be more gratified with these results than the engineers and employés themselves at the Stations, who take interest and pride in their work and need no other stimulus to urge them to the perfecting of their service.

The General Superintendent's Report gives in detail the more important operations of the year. At Fairmount the Station was put in good order and the turbines in part overhauled. At a later period, when sufficient funds can be spared, judicious alterations should be made that will largely increase the efficiency of the turbines, which now use too much water in operation and are not perfectly adapted to their work. In fact the situation is rather a trying one for turbines, which are most effective when working under a constant head, to which their arrangement can be permanently adjusted. At Fairmount the tidal section into which the races discharge, rises and falls, on the average, six feet, varying the head from six to twelve feet every six hours, while this variation is still further increased by the rise of the river above the dam from zero to four or even six feet. The supply of water to the turbine having been adjusted for high-water, is too powerful when the tide is out; and, conversely, an arrangement suited to a head of twelve feet, becomes inoperative when the rise of tide drowns the wheels.

The alterations above referred to have been under consideration as well as the construction of a new turbine in the space of No. 2 (an old breast-wheel which was removed), but are not projected at the present time, both because other operations are more urgent and because the lack of storage facilities is such that the wheels must at times even now be stopped, since, the basins being full, there is no place to put the water. This condition of affairs must continue until adequate storage shall have been provided.

At Spring Garden is concentrated the most important plant and the largest amount of pumping is done. The station regularly supplies the high service distribution in the Twenty-eighth, Twenty-ninth, and adjacent wards, which take water directly from the engines; through the Corinthian Basin supplies the City south of South street; and through the Fairhill or Lehigh Avenue Basin supplies Kensington and the vicinity. Spring Garden is also connected with the Fairmount Basin, and when the Fairmount wheels are stopped by low water, can supply the old city (Vine to South). By means of the submerged main it is also connected with the Belmont Basin, and could keep West Philadelphia going in case the Belmont Engines should fail.

The new Engine and Boiler house was completed in June and the two new Engines, Nos. 9 and 10, of Worthington's make, each of fifteen million gallons capacity to the level of the proposed Cambria Basin, 165 feet above City Datum, were put in service, respectively, July 1st and August 5th. Of the ten new Steel Boilers, Marine Tubular, internally fired with Fox's corrugated furnaces, built by the Edge Moor Iron Co., four were under steam in June, two in August, two in September, and two in October. The Engines were tested and accepted finally in November, as shown by the appended reports of the expert engineers, Messrs. William Worthen and Henry G. Morris, representing respectively the Department and the Contractors.

New conduits between the river and the forebay were put in

and the forebay thoroughly cleaned. A coal bin, capable of containing fifteen hundred tons of coal, with chutes to fill the cars under cover, was constructed between the old and the new Stations; and the point of rock near the tunnel was removed by the Contractor, who took the stone in payment without cost to the city.

Old Engines Nos. 4 and 5, reported last year as practically unserviceable, were taken out and sold; and two old brick houses occupied as quarters by two assistant engineers, and much out of repair, were torn down and a new storehouse constructed near the site. An Edison Electric Plant for one hundred lights was put in the old Station and a similar one in the new, and connected so that either could be used for the service of both. Gas was cut off in September and a considerable expenditure thereby stopped.

The Station, in fact, has been almost reconstructed throughout, and a wonderful change is evident in its appearance as well as its efficiency and economy.

The new plant is very satisfactory, especially the Boilers, of which an efficiency test was made during the trial of the Engineers, and a report by Mr. Codman, of the Department, is appended. The old plant has been put in better order than it ever was, and the merits of the big Marine Engine, built by the Cramps, were thoroughly tested in the long run of two hundred and fifty-nine days, referred to in the General Superintendent's report. With the completion of the repairs to the old building now in progress, and the replacing of several of the Boilers, which were never economical and are now unserviceable, the Station can be considered finished.

The conglomeration of pumping mains back of the Station, as modified from time to time in the past to meet various needs, but without amending defects, was so complicated that but one or two men in the Department could be trusted to manage them; in addition to which, the connection of the new Engines 9 and 10 with the distribution system, made it necessary to effect an entire re-adjustment. This will shortly be

completed but will hereafter be still further improved by the use of hydraulic lifting appliances for the main valves so that the engineer on watch, by turning a handle in the Station, can raise and lower them.

The old sewer which drains Brewerytown, and passing the Station, discharges a large volume of very foul sewage into the pool at the Girard Avenue Bridge, was the occasion of a most annoying and dangerous embarrassment. During the construction of the Manayunk intercepting sewer along the river bank the flow from the old sewer was intercepted and in consequence the foul liquids were backed up in a permeable channel adjacent to the forebay for nearly its entire length and began to percolate through the few feet of intervening loose material into the water flowing to the pumps. Upon conferring with the Chief Engineer of the Survey Department I ascertained that his Department, although in charge of the sewers, was not authorized to cut off the flow from the old sewer and could not permit it to enter the intercepting sewer. As the danger to the public health was imminent and the nuisance created a particularly noisome and exasperating one the matter was laid before the Board of Health, who, after inspection, promptly ordered its abatement.

The ordinance of June 21, 1882, passed after the construction of the city sewer on Pennsylvania avenue, directed all persons discharging into the old sewer to sever their connections therewith and discharge into the new Pennsylvania avenue sewer, pumping up their waste fluids if necessary; and the City Solicitor was instructed to proceed against them if they failed to comply. The requirements of the ordinance had never been fully complied with and although the Board of Health took vigorous action the flow from the sewer still continues. The accumulation of foulness next the forebay has, however, been partially remedied by the construction by the Survey Department, of a short length of new brick sewer. It should be understood that the flow from this old sewer not only passes directly into the Pool but to a greater or less

degree enters the Spring Garden forebay and is pumped into the mains. It is to be hoped that before the advent of warm weather, at least, this flagrant source of pollution which Councils in 1882 ordered abolished, will be absolutely and forever abated.

The Belmont Station, upon which the supply of West Philadelphia depends, is in most excellent condition; and with the exception of replacing some parts of the engines and in particular the replacing of some of the old boilers which have been fifteen years in service and were never economical constructions at best, with new boilers of an improved type, may be regarded as entirely satisfactory for the present.

The defective arrangements of the pumping mains, adverted to in the report for 1883, have been corrected. Formerly No. 1 Engine pumped to the Basin through a thirty-inch main of its own, while Nos. 2 and 3 used the upper portion of the thirty-six-inch submerged main as a rising main. When the water was passing eastward through this main against the throw of the pumps great loss of action ensued and constant repairs were needed. To obviate this, No. 1 was also connected to the thirty-six-inch main, which is now exclusively used as a pumping main by all three pumps, while the thirty-inch was disconnected from No. 1 and connected with the submerged main abreast the Station. If the submerged main be now used the water will flow smoothly from the Basin without interference by the pumps. The new arrangement has worked very satisfactorily and given no trouble.

The pumpage at Belmont is limited by the capacity of a single distributing main from the Basin. When a new distributing main shall have been laid and increased the supply it will probably be necessary to enlarge the pumping capacity of the Station. This can readily be done at a comparatively moderate cost by enlarging the pump ends of the engines, the steam cylinders being of ample size to drive pumps of much greater capacity than those now operated by them. The pumpage of the Station could thereby be increased over fifty

per cent., although this cannot be estimated for with the present boilers, which are not reliable.

The submerged main from the Belmont Basin, which crosses the river below the Columbia bridge and thence is laid to near the Spring Garden Station, was temporarily repaired in the spring of 1883. It performed vitally necessary service in the following season; and, failing again in December, was thoroughly repaired in the summer of 1884, during low river. The break, it may be remembered, was near the east bank in the deepest part of the stream; and in order to avoid the construction of the usual double walled coffer dam which is generally used in work of this character, when divers cannot do it, Mr. de Kinder devised and skillfully executed the ingenious plan of a four-sided timber box, open at top and bottom, to be sunk over the pipe at the break. When the box was in position the pipe was raised by chains and a movable floor placed beneath, after which the water was pumped out and the box held down by canal boats hung to crossbeams and loaded with water. The variations in river level had to be counteracted by partially discharging or filling the boats, and the whole work called for the exercise of skill and courage and indefatigable industry. It was successfully accomplished and the repairs then thoroughly made by Mr. Montgomery, Purveyor of the Fourth District.

While it is very desirable that the pumping arrangements should be such as to render the supply independent of a construction of this kind, the submerged main is valuable as a recourse and may perhaps be more fully utilized hereafter.

The Roxborough Station is in excellent order, needing only some overhauling of the No. 2 Worthington and the construction of a coal bin. The new Worthington No. 3, seven and a half million gallons capacity, to the Roxborough Basin, 365 feet above City Datum, was put in service in January, and finally tested and accepted in June. A battery of eight old cylinder boilers which had become unserviceable, was sold and replaced

by the transfer from Frankford of four comparatively new Marine Tubulars.

This Station pumps to the Roxborough Basin and thence to the Mt. Airy Basin, supplying Germantown. At the Roxborough Basin is a small Station pumping to tanks to supply the high elevation of Roxborough, and at Mt. Airy Basin is another auxiliary Station, forcing water to the upper levels of that district and to Chestnut Hill, below Germantown avenue.

The Mt. Airy Station is not well constructed, an old schoolhouse having been used for the purpose, which is considerably out of repair; and the fact that the engines take water from the main below the level of the Basin occasions much inconvenience. These engines did not operate satisfactorily, mainly for this reason; but with certain alterations, including the use of a surface condenser and air-pump, were greatly improved and finally accepted by the Department. A coal shed and storehouse are needed, for which the material is on hand.

At Chestnut Hill the machinery is in fairly good condition, and a coal bin will be constructed. The supply at this Station is derived from springs, the flow of which is collected in two small reservoirs and a large well, whence it is pumped to a wooden tank on the summit of a tower. The water is generally of a high order of purity, but in summer diminishes in quantity, and occasionally, by exposure to the sun and vegetable growths in the shallow Basin, deteriorates in quality. Owing to the expansion of this beautiful suburb southward of Germantown avenue, the limited Chestnut Hill supply is reserved for the higher elevations, and Mt. Airy water is pumped to that part of the Hill towards the Wissahickon, below the avenue. Repairs are necessary to the tank, which was thoroughly cleaned in May; and it will be requisite hereafter to take some measure to protect and increase the supply. Were the basins and well covered over, the water in summer would be in much better condition; and aëration will, no doubt, likewise aid in keeping down the development of vegetable growth due to high temperature and lack of oxygen.

The Frankford Station supplies Bridesburg and vicinity from the Delaware at Lardner's Point. The new ten-million gallon Corliss Engine, built by Robert Wetherill & Co., of Chester, was put in service August 5th, and tested in December. The four new steel boilers built by the Edge Moor Iron Co., similar to those at Spring Garden, but destined for a working pressure of one hundred pounds instead of sixty, were ready for steam in July.

Much difficulty was experienced in making a satisfactory test of the engine, not by reason of any essential defects in the engine itself, as the expert's report shows a high duty, but on account of the condition of the pumping main to the Wentz Farm Basin. This main was laid with numerous summits and depressions and some sharp angles, without adequate provision for preventing leaks or relieving the pipe of air at the higher points where it accumulates. In consequence the measurement of flow at the weir never equaled the discharge as computed from the pump-action. Mr. Worthen's report, however, as well as the very full and careful experimenting by the Department, made it evident that, with the defects exterior to the engine remedied, it would fully meet the requirements of the contract, and the engine was therefore formally accepted. A careful examination of the pumping main will be made, to ascertain precisely its plan and profile, and formulate the measures necessary to amend its defects. These should not be permitted to continue, as they add largely to the cost of pumping, and actually endanger the safety of the pipe, which is the sole channel for the supply of Bridesburg and Frankford and the vicinity. The two trestles supporting the main were in a dangerous condition, and have been, in part, repaired. A new coal bin was built, and a gas-machine put in to light the Station, which is, in general, in good order. The conduit needs overhauling; and now that the new engine is in service, the long-deferred repairs to No. 2 Engine can be made.

The Kensington Station, situated near the mouth of Gunner's Run on the Delaware River, formerly supplied that

entire district from the Fairhill Basin. Of the three engines, two ancient and unserviceable machines were taken out and sold, and the remaining one, a Worthington, retained in service while the arrangements for supplying the Basin entirely from the Spring Garden Station were in course of completion. In view of the abandonment of this Station, very little expenditure was made upon it. The trunk put in, in 1883, to draw the water from mid-channel, instead of from the end of the wharf, improved the quality of the supply; but the fact that the sewage of seven hundred thousand people, and the waste products of an immense manufacturing area, are discharged into the stream within tidal reach of the inlet, is a sufficient argument for taking the supply from a less grossly polluted source. What disposition should eventually be made of this Station is a matter for consideration. I have been inclined to recommend its conversion into a Department repair shop, which is now rather inadequately accommodated on Cherry street, above Ninth; but I am inclined to believe that by moving the Second Purveyor's Office from the shop, and making certain additions, it can be rendered sufficient to attend to the greater part of the Department work and repairs. The Kensington Station would make a fine shop, with good facilities for transportation by water and rail and the contiguity to other shops. But it is too far removed from the points whence and to which the greater part of the work must be transported, and the expense of fitting it up would be greater than the alterations to the present shop. It is probably a valuable property, and if not needed for city purposes, its sale at a favorable opportunity should bring a good sum into the treasury.

The Reservoirs in general are in need of considerable repairs, and especially of cleaning. For many years this important matter has been postponed until, in some cases, the accumulation of mud and sediment, most of it of a highly deleterious character, has grown in depth to two, three, and even four feet. There were no means available last year that

could be spared from more urgent necessities; but I propose during this Spring to have at least the Fairmount, Spring Garden, and Corinthian Basins emptied and purified. Repairs to stops, valves, and connecting pipes are greatly needed, and the drawing off of the water will make an opportunity to get these done. The slopes and fencing all need attention, which will be given when funds can be secured.

THE DISTRIBUTION MAINS AND PIPES.

Mr. Ogden's Report gives in detail the account of the work connected with the distributing system of pipes, and his concluding comparative tabular statement, for the period 1880 to 1884, illustrates the increasing amount of labor performed year by year, the last largely exceeding in all respects that of previous years. Nevertheless, I regret to report that little has yet been accomplished to meet the more general and urgent necessities of a freer distribution and increased pressures.

In all, about twenty miles of pipes, weighing over seven million pounds, were laid, making a total of eight hundred miles now in the ground. One hundred and forty-seven additional fire hydrants were set, making a total of 5,887 in service, many of them, however, of obsolete and defective patterns. Six thousand service attachments were made, and six thousand feet of old pipe, of small dimensions, were replaced by new and larger pipe; 1,400 feet of this in Chestnut Hill.

For the supply of the Fairhill Basin from Spring Garden, instead of from Kensington, 2,258 feet of 36-inch main were laid northward on Ninth street, from Dauphin to Lehigh avenue, and thence a 36-inch main, 576 feet, to the Basin. This, with some minor alterations at other points, when finally completed, will enable the Department to abandon pumping at Kensington altogether.

To improve the supply to the heavy manufacturing region

east of Sixth and above Vine, a 16-inch main was laid in Poplar street, from Broad to Front streets, a distance of 6,675 feet.

In Germantown, sixteen thousand feet of 16-inch main were laid in Green street, the work being especially severe by reason of deep rock excavation and heavy grades. About 1,700 feet remain to be completed this spring, when the lower portion of Germantown will be much better supplied.

Of the projected eight thousand feet of 12-inch main on Ridge avenue, northward, for the supply of the Falls of Schuylkill, about five thousand feet were laid last year, leaving three thousand feet to be completed this spring. At present, the water supply to the Falls comes from the Roxborough Basin, to which height it is pumped at an unnecessary cost, only to run down again to the river bank. The 12-inch main will hereafter be connected with the East Park or the projected Cambria Basin, and furnish an ample supply at much less cost.

On Passyunk avenue, from Broad street to Schuylkill avenue, the Gas Trust laid 9,750 feet of ten-inch pipe, for the supply of Point Breeze and the vicinity, where, from the saturation of the earth with oil and other objectionable matters, the water taken from the soil had become entirely unfit to use for any purpose. This main, upon being laid, became the property of the City, and in anticipation of its incorporation into the general system, was provided with fire hydrants and suitable branches at intersecting streets.

These are all improvements in their way, much needed by their several localities, but the serious demand for a general improvement in quantity and pressure, in nearly every part of the city, remains to be met, and will call for the laying of numerous mains of large dimensions, with correspondingly large expenditures.

The appropriations for the current year have made some provision for this, by allotting $300,000 for new mains, and $100,000 for replacing old pipes of an inadequate capacity. The mains thus authorized are a 36-six inch, in West Philadelphia, which is projected down Fifty-second street, from the Basin

to Walnut street; one of 20-inch, down Gray's Ferry road; and a 12-inch main for the supply of Tioga. From these localities came the most urgent demands, and no doubt they are entitled to most serious consideration; but nearly all parts of the City are suffering from a short supply, whether for domestic or manufacturing purposes, hampering business and preventing comfort; and in especial is the vital matter of fire protection urgently pressing its claims to attention.

As the mains are now arranged, the old City, Vine to South between the two rivers, is supplied from Fairmount, which has an elevation of only 94 feet above City Datum, while the general surface of the streets ranges from ten to forty feet. In consequence of the low elevation of the Basin above the curb, and particularly the heavy pull upon the mains, the pressures in the street vary from five to twenty-five pounds, and, in consequence, in many portions not only is the supply insufficient, but the water fails to rise to bath tubs and wash-stands on the third and in many cases even on the second floors.

The City south of South street is supplied from the Corinthian Basin, altitude 120 feet above City Datum, by a main down Broad street, passing through the old City without being tapped; but notwithstanding the greater elevation, the distance, and the demand beyond the capacity of the mains, keeps this section in a condition of comparative drought, with probably no more than an average pressure of ten or eleven pounds. In some portions in summer no water can be obtained in houses in the day time. This condition of affairs is destructive to comfort and cleanliness, and injurious to important manufacturing interests which require the water, to say nothing of fire protection. It is estimated by city engineers that pressures of forty or fifty pounds may be regarded as fairly satisfactory, and it should be the object in providing for an improved system of distribution to secure this. It is not to be expected that this can be done without the construction of larger basins at greater elevations than the present, but with suitable mains a great improvement can be effected now. For example, a re-arrangement so that

a new main, say 36-inches in diameter, from the Fairmount Basin, shall connectwith the system below South street, and feed east and west. This will probably increase the pressure of these wards fiftyper cent., and largely augment the supply.

The old City will then exchange Basins with the region south of South street, and draw from Corinthian through the main on Broad street, thereby making both sections gainers. This re-arrangement, however, requires, to make it practicable, an expenditure of $50,000 or $60,000 for the laying of mains not specially authorized in the appropriation ordinance; and, furthermore, the replacing of many of the old and inadequate mains now in use by others of suitable dimensions. Particularly is this the case in the Fifth and Sixth Wards, where the immense aggregation of property at risk from fire was shown in the last report of the Department, and where such heavy losses occurred in the month of February last.

The region lying north of this, too, is rapidly growing in importance, especially as a centre of manufacturing industries. The expansion of the water system year by year in this district has been almost entirely effected by six-inch mains, the smallest size now laid for street supply, and care has not been taken on suitable streets to put in large trunk mains or feeders from which the six-inch pipe could take a full and ready supply; consequently it happens that the factories and mills, many of them dyeing establishments or morocco dressers or brewers, requiring an immense supply of water, are all pulling at once from an interminable length of six-inch pipe through which friction diminishes the flow, and the opening of two or three fire hydrants cuts off the supply and endangers safety. These facts clearly illustrate how essential it is that a water service should at all times be somewhat in advance of actual requirements, and be projected with a most careful study and anticipation of what will in the immediate future be a pressing need. Otherwise it becomes a perpetual drawback and a most exasperating hinderance instead of, as it should be, an indispensable aid and most potent auxiliary. Similarly, in the

building up of the suburbs, the city could well afford, after perfecting its service in built-up portions, to extend its water system and encourage building, which, as soon as completed, pays back the cost of the pipe, as well as water rents and increased taxes.

A business like this, so indispensable to every citizen, and so profitable to the City, while it should be managed with the most rigid economy and scrutiny of expenditure, should seek also to be both just and liberal to the citizen, and endeavor to forestall his needs rather than wait until his urgent demands and protests shall compel attention from an unwilling ear.

The West Philadelphia scarcity is due, not to lack of pumpage or deficient height of reservoir, but because the growth of population and expansion of building have not been properly anticipated. The Belmont pumps can meet all present demands, and the Basin has a fine altitude of 212 feet above City Datum.

It happens, however, that the only distributing main from the Basin, is one of twenty inches in diameter, incapable of transmitting, with the velocity due to the grade, a sufficient supply for the rapidly growing suburb, which, in its style of construction, with liberal spaces, numerous lawns and trees, and frequent fountains, uses proportionately more water per inhabitant than many other parts of the City. The new 36-inch main on Fifty-second street, will amend this difficulty, and furnish an ample supply, with an average pressure in excess of forty pounds.

For the high region north of Spring Garden and west of Ninth streets, including the Twenty-eighth and Twenty-ninth Wards, with portions of the Fifteenth, Nineteenth, and Twentieth, lying above the reach of any existing Reservoir, and, therefore, taking the supply direct from the pumps, there can be no remedy until a Basin of sufficient area and elevation to supply it is constructed. There is generally a sufficient pressure and supply, but the water is often highly charged with sediment, which chokes the pipes, discolors the water, and is

offensive at times to both sight and smell. The distributing mains, even the large ones, feel the injurious effect of this large mass of sediment, some of it quite coarse, which cements itself on the bottom of the pipe, and diminishes its available area.

Fortunately, it may be considered that this muddy water, however objectionable to the senses, in general contains less matter really injurious to health than when more clear; and, that when the river is flowing with the gentlest current, and has therefore deposited its load of visible impurities in the bed of the stream, it really contains the largest proportion of dangerous impurities. Still, muddy water is objectionable; but it can only be got rid of by prolonged subsidence or some method of filtration. For the present, neither is practicable, and either will cost some millions of dollars.

The East Park Reservoir, when completed, at the elevation of 133 feet above City Datum, will contain seven hundred million gallons, for the supply of all the City below Spring Garden street, say seven hundred thousand people, who, with fifty gallons each per day, can draw from the Basin for twenty days. It has cost one and a quarter millions of dollars, and will require as much more to complete it. The existing Basins of Fairmount, Spring Garden and Corinthian contain only about two days' supply.

For the high service, the Cambria Basin, with a capacity of two hundred and ten million gallons, and an altitude of 166 feet above City Datum, will contain three weeks' supply for two hundred thousand people.

The cost of constructing the Cambria Basin will be about $500,000 or $600,000, with say $350,000 for land damages, interest and contingencies, or in round numbers, $1,000,000.

The enlargement of the Mt. Airy Reservoir, too, is much needed, and the land can be procured to better advantage now than in the future. The capacity of the Basin now is 4,390,000 gallons, only two days' supply for the draught upon it. The estimated cost, exclusive of land damages, is about

$250,000 for a basin of fifty-five million gallons. Full reports of these two new constructions were made in the last annual report, and need not be repeated.

The Wentz Farm Basin is defective in construction, and its capacity is reduced two-thirds by the inability of its banks to retain water above the level of nine feet. The main difficulty is in the material used, which is largely a micaceous earth quite permeable to water, and readily becoming surcharged. The amount of clay available for puddle was limited, and too little of it was used to make amends for the defects of the main embankment. Its partial reconstruction, with either a clay hearting, or, preferably, a heavy deposit of clay on the wetted interior sides and bed, will involve considerable expenditure, for which, until more urgent matters are undertaken, no estimates have been prepared. Meanwhile the water, from its broad exposure, limited depth, and original defects, has a tendency in summer to accumulate vegetable and animal growths, which impair its potability and wholesomeness.

The Fairhill Basin, as well as the other old ones, exhibits a tendency to leak when filled to the full height, and it has therefore been found necessary to carry them two or three feet below what might be their level. This diminishes slightly the pressure on the mains, but can only be amended by partially reconstructing the banks. When this is done the opportunity might be improved to raise them permanently some feet higher, and so make them more capacious and give a better head.

An interesting combination of events took place in September, which illustrated clearly the narrow margin upon which the supply to certain sections depends. A stop on a 20-inch main out of the Fairmount Basin at Twenty-sixth and Callowhill became disarranged, and in trying to adjust it the pressure threw off the top, and the spouting water drove the men away. To stop the flow the Purveyor sought to close another stop on the same main on the bank of the reservoir. This jammed, and the efforts to shut it only broke the stop. Nothing remained to be done but to drain the Basin, as no re-

pairs could be made while the water was flowing. Pumping ceased, and everything was opened to empty the Basin as rapidly as possible. Meanwhile, the supply for the old city was drawn from Corinthian, which had its own districts to water in addition, but was fairly succeeding when a general and alarming diminution of pressure, from Vine to South streets, suddenly took place, and complaints poured in from all directions. Search was instantly made for the break, and continued for two days and a night, when at last it was discovered, by taking pressures all over the affected area, that the lowest point was in Eighth Street, above Arch. Upon going to that point the sound of escaping water at a sewer inlet told the story. The ten-inch main passed through the neck of a culvert which led to the sewer, and a piece of the main some four or five inches wide and eight or nine inches long had blown out, and the water was draining from the main to the sewer. It took forty-eight hours of constant search to find this break, and fifteen minutes was enough to close two stops and shut off the leak. The most remarkable fact was that the people living in the vicinity, observing the absence of water in their houses, burdened the mails with complaints to the Department, while the roar of the errant fluid was distinctly audible to them, and an intimation to that effect would at once have remedied the difficulty.

The important fact to note is that this one opening made in the main reduced the pressure generally over the old city nearly fifty per cent., from which it may be inferred how readily the greater part of the supply might be lost. Had a serious fire occurred at this time the Fire Department would have been terribly crippled. The fact also illustrates how largely the supply is reduced by waste, which probably is constantly doing what the break in the Eighth street main did for two days.

The incidental draining of the Fairmount reservoir showed not only that it was in great need of cleaning from the deposit of foul mud, but that all the stops and apparatus of the Basin

were out of repair and unfit for service. The other Basins no doubt require similar investigation, and will receive it at the earliest practicable opportunity.

In July the Department found itself able, for the first time in many years, to spare water for sanitary purposes, and I therefore addressed a letter to the Mayor, suggesting that in each police district an officer be designated, under permits to be issued by the Water Department, to take charge of flushing the gutters, in order to prevent the accumulation of foul and stagnant matters, and thereby enhance the sanitary condition of the city. It is true that the Water Department should not be called upon to clean the gutters or streets, any more than the sewers should be required to receive matters of this sort, which tend to fill them and obstruct the flow of fluid sewage, but of two evils it seemed best to choose the less. The Mayor kindly and promptly approved the suggestion; and in the fall, the Chief of Police, in response to my request, wrote that the gutters had been flushed wherever necessary, and on an average about twice a week, the work being done late at night, when no inconvenience to consumers would becaused.

Mr. Ogden invites attention to the important need of the Department for suitable Purveyors' Yards, for the storage of material, which must be kept constantly on hand. By successive deprivations the Department is now without any really adequate accommodation in any part of the city, and is compelled to store materials in the streets, subject to loss and damage.

The attention of Councils was invited a year ago to this matter, which is really one of importance, but no effective action has yet been taken.

THE DEPARTMENT REPAIR SHOP.

The Shop is a valuable and in fact quite necessary adjunct to the Department, enabling it to make repairs, whether to machinery or other appliances, without loss of time and at moderate cost. For the heaviest class of work recourse is had to other

shops with larger plant, but ordinary repairs and in particular the assembling and fitting of valves, stops and fire-hydrants are done in the shop by men specially accustomed to this work and without loss of time.

The shop should be enlarged in order to make it more nearly equal to the requirements and useful to the city. For this purpose the Second Purveyor's office should be elsewhere located, and the ground now leased by the city at Ninth and Cherry street, be occupied by an enlargement of the building so as to provide space for machinery and other facilities. The necessary improvements would cost about $10,000.

By the resignation of James F. Neall the Department has lost a valuable officer, who, since March 1876, had discharged the duties of Superintendent of the Shop with zeal and fidelity. Mr. Neall resigned, March 31, in consequence of his election to the office of Police Magistrate.

PLUMBING REGULATIONS.

In the Report for 1883, page 59, the desirability of plumbing regulations was touched upon in connection with the waste of water and the injury to the public health due to defective plumbing work and appliances, as follows:

"The relations of the Water Department to the plumbing business are extremely intimate. It is upon the plumbing appliances in a house that the water charges are made, and any defect or changes therein affect the revenue of the Department. They should therefore be strictly regulated by law and the possibility of bad or dishonest work prevented. Furthermore, the work of the plumber is a matter of life or death to the inmates of a house.

"Civilization, while it has enhanced the comforts of life in this respect, has introduced into our houses a most deadly enemy unless due precautions are taken to control it. The plumber, therefore, should be a workman sufficiently intelligent and

conscientious and versed in his art to be trusted with a matter of such vital importance, which, furthermore, should not be left to his sole discretion, but be supervised by some competent authority under regulations established by law. At present the legislation bearing upon this subject is extremely defective, and the example of other cities should be followed in procuring as speedily as may be more effective administration for the protection of the public health against the fatal effects of ignorance and dishonesty."

Continued observation of the practical aspects of this subject over the field of the entire city, and close acquaintance with the multiplied cases and classes of cases calling for amendment which another year's investigations have disclosed, have so fully established the importance of the adoption by the City of a carefully considered and effectively enforced code of regulations for plumbers and plumbing work that in the absence of any action by either City Councils or the State Legislature it seems essential to again invite attention thereto.

The relation of bad plumbing to the waste of water and a consequent unnecessary charge upon the City in the annual expense of the Water Department were so fully set forth in the Department Report for 1883 that it is only necessary to refer to the facts there stated. An additional point however may be touched upon.

With the exception of an ordinance or two relating to wash-paves and curb stop-cocks the Department is now without authority to exercise any control over the plumbing work of premises beyond the simple provision that the service pipes connecting them with the main shall be laid at at least an equal depth below the surface, and this condition is no doubt frequently violated.

The pipes and fixtures may be of the most worthless character, both in design and material, and arranged and connected in the most faulty and derelict manner without any one but the owner, who seldom knows anything of these matters, having the right to object or interfere. In consequence the

appliances are more often defective than good, and besides leaking largely in ordinary use, frequently burst and flood the premises until the water can be turned off, whereby both the owner and the City are victimized and put to a large unnecessary expense.

A proper system of regulation and registration would prevent all this, and the cost of the service would be more than repaid in the reduction of expenditure for pumpage and distribution, to say nothing of the protection of the taxpayer from robbery and annoyance. As the case stands, any man however incompetent who chooses to do so can call himself a plumber, and although there are ordinances forbidding irregular attachments and designed to punish crooked work, nothing short of a small army of inspectors could prevent it, and incessant domiciliary visiting is both offensive to the individual and repugnant to the private rights of the citizen to be secure from unnecessary intrusion in his home. If therefore any means can be devised by which this annoyance can be obviated it should be adopted.

In its relation to the public health, the importance of the matter is still more urgent. In a city having a public water supply, and sewers for the water carriage of waste, the mains and pipes deliver the water to the premises, and the drains and sewers receive it after doing its work, and carry it off with its additional load of foul and putrescible matters. The two systems therefore are in effect continuous, the point of junction being the dwelling, and as danger to health may lurk in either, the work of connecting the two bears perhaps a closer relation to the healthfulness of the domicile than any other single condition.

In particular does modern sanitary science recognize the danger from untrapped and unventilated pipes by which so-called sewer gases may gain entrance to the interior of dwellings, and these gases may be generated within the house pipes themselves in greater virulence than in the sewer, although, being in many cases without odor or other material evidence of their presence, they may not be apparent to the senses.

The common carriers of the zymotic diseases are now recognized as being either contaminated drinking water or a contaminated atmosphere, and by means of these two media are disseminated the bacteria of disease—microscopic plants which under the favoring conditions of moisture and warmth, propagate with incredible rapidity, and are capable of causing disease when absorbed into the human system.

Now it is in great measure the work of the plumber which either exposes us to or protects us from this hidden peril, and it is almost incredible that he should be called in to discharge his duties, upon which must later depend the health and lives of the family, without being required or able to submit the least evidence of his qualifications for so critical a task. No well regulated community permits a physician to practice without the diploma that he can gain only through the protracted study of medicine under competent instructors, and which certifies to the public that he has passed a rigid examination and is qualified to save life and do battle with disease.

No druggist is permitted to expose his wares for sale or to fill a physician's prescription, without a suitable guarantee that he is thoroughly conversant with the art of compounding drugs, and that his potions will act as the weapons against disease and not as the allies and instruments of death.

But the plumber, whose incompetence or dishonesty may be fully as deadly, after possibly a few months' service with a man no wiser than himself, puts out his sign and invites the public to call him in and pay him for work which may shortly bring grief and desolation to the household. He exhibits no proof of his knowledge and responsibility, nor of his acquaintance with the best known laws of sanitation, and his work is hidden from view in dark and secluded parts of the house, behind walls and woodwork, with no one to examine his plans or to inspect the result of his labors when completed.

Hence the multiplicity of sewer connections without the semblance of a trap, the sewer vent pipe leading into the hot-air flue instead of the smoke flue, the ventilating pipe termi-

nating in the attic instead of projecting through the roof, the disjointed drain-pipe in the cellar, the current of sewer gas into the bed chamber, the overflow pipe from the cistern leading directly to the sewer pipe, the joints of drain pipe open from original defects or from settlement, the rusty nail driven through the lead, and the other thousand and one violations of the common laws of sanitation,—the rotten pipes and leaky fixtures perpetually out of order, and the source of perpetual annoyance and expense, causing foul drainage, damp and polluted soil, and general unhealthfulness of the home. Hence the prevalence of zymotic diseases which yearly slay their victims and sicken many more, impairing health, sapping vitality, causing loss of time and wages, and rendering the subject an easy prey, if not directly to the effects of contaminated air and water, then to the first prevalent epidemic or source of disease.

City Councils can do no wiser or more needful thing for the protection of the public than to enact such legislation as shall provide for the examination and licensing of competent plumbers and the rejection of the incompetent and unworthy.

Provision should also be made for compelling plumbers to submit plans for approval by some competent official authority, and receive formal permits, and for the subsequent inspection of their work before it is covered in from sight, to verify its condition and accordance with approved plans.

Regulations are also needed in regard to the dimensions and weight of pipe and character of fixtures that can be used, in order to protect the public from imposition and the city from loss, as well as other regulations establishing for the guidance of the plumbing fraternity the known principles of modern sanitary science so that not even by inadvertence or carelessness can the public health be imperilled.

In these matters as in most others it is not the cheapest work or material which is the most economical. Bad plumbing may even be worse than none, and the annual money losses to citizens from defective plumbing would more than pay for good and intelligent work, leaving out of account the

great aggregate of unnecessary sickness and suffering due to preventible diseases, which the vital statistics of all cities sufficiently attest.

It will be found, I doubt not, that in formulating proper plumbing regulations to which conformity can be secured by official scrutiny, the better class of plumbers is ready and willing to co-operate in the fullest measure in both their own protection and that of the public against imposture and robbery, and so raise their craft to the dignity of a mechanical art by rescuing it from the hands of the ignorant and sordid.

The consideration by other cities of the importance of this subject has resulted in the adoption of plumbing regulations so that Philadelphia now is the exception to the rule that requires all matters of this sort to be subject to official supervision.

THE DEPARTMENT OFFICES.

It appears necessary to invite the attention of Councils to the serious disadvantages connected with the continued occupancy of the present offices of the Department.

The building at the northwest corner of Thirteenth and Spring Garden streets is of brick and plaster with three floors of about 3,500 square feet floor space each.

It was poorly constructed originally and is now much out of repair notwithstanding the efforts of the Commissioner of City Property to make it presentable. The heating arrangements and appliances are extremely defective and the drainage and ventilating arrangements still more so. The health of the occupants who are compelled to spend long hours daily in a vitiated atmosphere, has been affected almost without exception and there is great danger that in the end a fire may terminate the difficulty, although at the cost of the destruction of maps, records and other property indispensable to the business of the Department and only replaceable if at all at a very considerable cost.

The first floor is divided between a branch gas office and the office of the Registrar of the Department with his force of clerks and inspectors numbering thirty-seven in all. The Registrar collects the water rents of the entire city and issues all permits to builders, plumbers and others, and to his office must come all persons having business of this kind to transact, while he is crowded into four or five small rooms in the back part of the building. The public who throng the yard to pay their water rents are compelled to spend hours standing on the bare ground exposed to the weather, while the clerks who are crowded elbow to elbow can make out and receipt their bills.

The second floor being occupied by a Grand Army Post, the offices of the Chief Engineer with his assistants, draughtsmen and clerks, and the General Superintendent with his clerks, a total of twenty-six persons, are relegated to the third floor which receives the emanations from below as well as the coal and sewer gases from the defective flues and pipes.

To this floor must come all having business with the Department other than that transacted by the Registrar. The space is entirely inadequate. There is not a single room sufficient to its special purposes nor one having the most ordinary accommodations and facilities for business. Even supposing that the entire building were available instead of a half only—and that the least convenient and desirable—it would still be totally unsuitable as the headquarters of a great city department, whether in point of space, sanitary condition, interior arrangements or accessibility.

The large receipts of the Registrar's office must daily be transported to the new City Hall for deposit in the City Treasury, and there is constant occasion for the Water Department to communicate with the City Controller and the Highway and Survey Departments. Members of Councils, tax-payers and the public generally having business with the City Departments must make a special journey to Thirteenth and Spring Garden streets for the purpose of reaching the Water Department. In the interest of the public as well as of the Depart-

ment the present arrangements should be terminated and suitable provision made either in the Public Buildings, or preferably, while they are under construction, adjacent thereto. If occupancy of the present quarters must be continued through another season, it will be requisite to make extensive alterations in the Spring Garden building.

In this connection I desire to express my deep sense of obligation to Gen. Huidekoper, the Postmaster and Custodian, and to Mr. McArthur, the Supervising Architect of the New Post Office building at Ninth and Chestnut streets, for the courtesy and interest displayed by them in not only consenting but taking some personal trouble to aid in securing permission from Washington for the temporary occupancy by the Department Survey parties of some of the space in the Post Office building for draughting purposes. The Department offices were quite incapable of furnishing the needful space, even supposing their sanitary condition such as to justify quartering more people in them.

The rooms of the Post Office are of generous dimensions, with an abundance of light, air and warmth such as are essential for the accomplishment of brain work requiring the full energy and intelligence of the worker which can only be developed under conditions of physical well-being and comfort. To have obtained similar accommodations in hired quarters would have involved considerable expenditure and been probably impracticable in any case.

I am in hopes that the privilege of remaining in temporary occupation of the Post Office room may continue until the draughting and compilation work of the surveys shall have been completed. Meanwhile it is earnestly represented that a proper administration of the affairs of the Department in its relation both to the public and to other branches of the City Government requires that suitable quarters be obtained for it, even should this temporarily involve some cost.

THE PRESENT WATER SUPPLY.

The total quantity of water pumped and delivered in the mains during the year 1884 was 25,495,179,353 gallons, an average of 69,658,969 gallons per day, which, reckoning the population at 960,000, is equivalent to 72½ gallons per day for every man, woman and child in the city.

The largest amount pumped in any one day was 95,686,444 gallons on May 28, 1884, and the least was 46,163,058 gallons on February 10, 1884.

The Kensington pumpage, for reasons sufficiently set forth in the last Annual Report, has been reduced as much as possible, and when certain modifications of the mains which are now in progress shall have been completed will be entirely suspended, after which the Fairhill basin on Lehigh avenue will be supplied from the Schuylkill.

With the exception therefore of the comparatively small quantity taken from the Delaware River at Lardner's Point for Bridesburg, Frankford and their vicinity, and the still smaller quantity derived from the springs at Chestnut Hill, the water supply of Philadelphia is pumped from the Schuylkill River at four principal stations, viz: Fairmount, Spring Garden, Belmont and Roxborough.

The Roxborough Station takes its water from above Flat Rock Dam and by means of the Roxborough and Mt. Airy Basins, respectively 365 and 362 feet above City Datum, with an auxiliary pumping station at each basin, supplies Roxborough, Manayunk, the Falls of Schuylkill, Germantown, Mt. Airy, and that part of Chestnut Hill south of the Germantown Pike.

The Belmont Station on the West bank just below the Columbia Bridge raises the water to the Belmont Basin, 212 feet above City Datum, for the exclusive supply of West Philadelphia.

The Spring Garden Station, on the East bank just above the Girard Avenue Bridge, through the Spring Garden and

Corinthian Basins (120 feet above City Datum) supplies the city below South Street and from Vine to Spring Garden Street, and by direct pumpage without a reservoir, supplies the city north of Spring Garden. This Station will also be charged hereafter with the supply of Kensington and the vicinity, through the Fairhill Basin, 114 feet above City Datum.

The Fairmount Station, situated at the dam, through the Fairmount Basins (94 feet above City Datum) supplies the old city from Vine to South between the two rivers.

Spring Garden and Fairmount supplement each other from time to time, the former delivering into the Fairmount Basin when the low stage of river restricts or stops the action of the turbines, and the latter pumping to the Corinthian Basin when the river is up and the Fairmount Basins full.

Of the total amount used in the city these four Schuylkill Stations pump 80.59 per cent., and the three lower ones, viz: Belmont, Spring Garden and Fairmount, drawing from the middle and lower end of the Fairmount Pool, pump 80.06 per cent.

From these statements two leading facts are apparent:

First. That the supply of the city is practically dependent upon the maintenance of the two dams, especially that at Fairmount since, should they give way, the Pool would be drained and the Stations left high and dry.

Secondly. That the quality and wholesomeness of the supply are dependent upon the condition of the Schuylkill in general, and in particular of the Fairmount Pool which constitutes in effect the main storage or subsiding reservoir of the city.

There should be no danger of the failure of the dams, since from time to time in the past they have been examined and repaired, and the deterioration due to gradual decay and the destructive action of ice and water have been amended. Nevertheless it must be recognized that the materials of which the dams are constructed are perishable and that at some time in the future it will be necessary to rebuild them.

Aside from the obligations of the city through its contracts with the Schuylkill Navigation Company to maintain the slack water navigation to Manayunk, and whatever may be hereafter adopted as the source of the future water supply, the Fairmount Pool is too beautiful and valuable a portion of the Park to warrant its degradation or abandonment. The dam will therefore no doubt be maintained in perpetuity, and when opportunity offers it should be rebuilt with imperishable materials and so converted into a permanent structure.

The second consideration, viz: that relating to the quality of the water, is far more urgent, since upon the wholesomeness and potability of the domestic water supply depend in great measure the well-being and comfort of the individual and the general health and prosperity of the community. Among all the varied and complex conditions of modern municipal existence, there is none excelling in vital importance the integrity of the water supply, unless exception should be made of its natural continuation and supplement the system of drainage, and there is no problem in city engineering giving rise to more solicitude and thought, and demanding more earnest attention and wise prevision.

There is scarcely a city in the civilized world that has not sooner or later been compelled to confront this problem and to seek heroic means for its solution. London, Paris, Berlin, Rome, Glasgow, Edinboro', Liverpool, Manchester and many smaller European cities; in our own country, New York, Brooklyn, Boston, Baltimore, Chicago, with numerous others, impelled by the increasing contamination and insufficiency of their local supply, have bravely faced their respective difficulties, and by large and in some cases immense expenditures, under the guidance and direction of the ablest engineering and sanitary intelligence and by every scientific aid which they could command, have labored with courage and persistence to secure and maintain that purity and abundance of water supply which is universally recognized as a vital necessity.

Philadelphia began well and acted as pioneer for them all.

She established the first public water supply in this country, and by suitable modifications and enlargements from time to time, strove to keep pace with that rapid material development which resulted from her favorable conditions and the enterprise and intelligence of her citizens. The Schuylkill in the earlier days furnished an abundance of wholesome water, and even supplied the power to drive the wheels by which it was drawn from the river and delivered into the distributing mains.

But as the population increased and the banks of the river became the seat of new industries, the pollution of the water proportionately augmented. The coal and iron industries came into existence in the upper valley, railroads were built, communities multiplied and prospered, and within the present city limits mills and manufactories were established which discharged their waste matters into the stream.

This condition of affairs had been anticipated at an early day and steps had been taken which it was supposed would be effective to guard against it. The final agreement made in 1824 between the city and the Schuylkill Navigation Company exacted that in making sale or lease of the water power from Flat Rock Dam the Company should introduce provisions forbidding the discharge into the river of dye stuffs or any noxious, fœtid or injurious matters, and that these should be confined in wells or repositories upon their respective premises.

Again in 1828 an act to protect the purity of the water supply was passed which forbade the casting of any "putrid or corrupt thing" or any noxious or offensive matters into the Schuylkill near the pumping stations. In 1832 (Act of February 7) more stringent provisions were enacted, as follows:

"If any person or persons shall wilfully take, lead, conduct, carry off, or throw, or shall cause to be taken, lead, conducted, carried off, or thrown into that part of the River Schuylkill which is between the Dam at Flat Rock and the Dam at Fairmount, near the City of Philadelphia, any carrion or carcass of any dead horse, or other animal, or any excrement or filth from any slaughter-house, vault, well, sink, culvert, privy, or neces-

sary, any offal or putrid or noxious matter, from any dye-house, still-house, tan-yard, or manufactory, or any matter or liquid calculated to render the water of said river impure, every such person, shall, for each and every such offence, forfeit and pay a sum not less than five dollars nor more than fifty dollars, at the discretion of the magistrate, to be recovered with costs of suit, in the same manner as debts under one hundred dollars are by law recoverable, by any person who shall sue for the same, before any justice of the peace within the county of Philadelphia, one-half to the person prosecuting and suing, and the other half to the use of the mayor, aldermen and citizens of Philadelphia.

"No length of possession whatever shall be available to bar or prevent the correction or removal of any nuisance existing, or which may hereafter exist, at or near that part of the River Schuylkill which is between the Dam at Flat Rock and the Dam at Fairmount."

Had these wise enactments, which have never been abrogated and are still the law of the Commonwealth, been enforced, much subsequent trouble and expense would have been avoided, but unfortunately, although the laws of decency were somewhat deferred to, the subtler laws of sanitation were unheeded. Out of sight was out of mind. Human nature is selfish, and nuisances multiplied until the growing pollution of the water occasioned loud complaints. In the report of the Water Department for 1853 the condition of the water is referred to as "unsatisfactory." In 1858 the Chief Engineer declared that objectionable drainage should be prevented, but the subject is treated with great caution. In 1860 the Department Report deals more openly with facts. The quality is still declared to be good but complaints have been received of foul taste and smell. The evil quality of the Girard Avenue sewer and the large pollution from Dobson's Run are referred to and it is boldly stated that Manayunk makes a common sewer of the river. The Chief Engineer quotes the laws against polluting the stream and urges their enforcement. Notwithstanding the increasing contamination the chemical analyses made from time to time still approved

the water, and in 1862 owing, no doubt, to the comparatively crude methods of those days, were unable to discover any organic matter at all in the Schuylkill supply. The supply from Kensington however, where catfish were cleaned near the mouth of Gunner's Run, is rather heavily reprobated, and in fact had been absolutely condemned as early as 1856. In 1864 and 1865 the complaints multiply and grow more urgent. The report states that a large amount of objectionable matter reaches the pool. The river is made a general carrier of refuse and sewage; the sources of pollution are rapidly increasing and the salubrity of the water is threatened. There is ample legislation but no enforcement of the law.

In 1866 it is stated that within no equal period of time has the amount of impurities drained into the Schuylkill increased to such an alarming extent as during the past year, especially at Manayunk. The discoloration of the stream is plainly discernible at the Falls and sometimes at the Columbia Bridge. There is no doubt that constant deterioration is going on and the Chief Engineer adds the very reasonable remark that a city with the wealth and population of Philadelphia should at least be able to have pure water.

In 1867 the Mayor in his annual message urged the formation of a Commission of Hydraulic Engineers to investigate and report upon the supply, but the measure having passed one branch of Councils failed in the other, whereupon the Park Commission which had been created in 1867, for the avowed fundamental purpose of protecting the purity of the water supply, made examination and prepared a report in which it is concluded that with proper precautious to guard it from pollution by the interception of all sewage by due enforcement of the law and the construction of sewers on both banks the Schuylkill might be still relied upon for many years. The Water Department Report for 1868 renews reference to the Manayunk drainage and prints a comparative analysis of the supply of various cities, prepared by Prof. Chandler for the New York Board of Health. This analysis shows that in respect of the

organic and volatile matters contained in 13 water supplies to American cities the Schuylkill water, which in earlier years had been noted for its general excellence, now stood precisely midway—six containing more and six less—and that the average of six London waters showed 1.15 parts of organic and volatile matters to 2.06 in the Philadelphia supply.

At about this time, however, the discrepancy which had long existed between the rapidly growing requirements of the city and the reservoir and pumping capacity of the Department plant, became a source of such overshadowing anxiety to its responsible head as to postpone the consideration of any less vital matter than the maintenance of the supply, and the procurement of more engines and storage facilities monopolized the attention of the Chief Engineer. With the re-construction of the dam at Fairmount, the introduction of new turbines, the construction of the new West Philadelphia Works, the beginning of work upon the great East Park Reservoir and the planning of a new station for the supply of Frankford, his hands were certainly full.

In the report for 1870 is published a table of comparative analyses of Schuylkill water made respectively in 1842 and April, 1870. It is not stated at what points the samples were taken and the spring rains generally have a favorable influence upon the quality of the water, but the fact is displayed that in the interval of twenty-eight years the amount of organic matter present in the water had increased over 700 per cent. In 1873 the Chief Engineer states that Manayunk "crowds the Schuylkill with factories," and is even disposed to believe that the water will compare unfavorably with that of the Delaware within the city limits. In 1874 he is distressed by a threatened water famine due to lack of sufficient pumping plant and by a putrescent fermentation of the water in the Basin supplying the Kensington district. He refers to Manayunk as the main source of fouling the Schuylkill and to the contamination of the Spring Garden forebay by the open sewer in its immediate vicinity.

He publishes an elaborate report by Dr. Cresson upon the quality of the Schuylkill, which is accompanied by analytical tables and much valuable information. The analyses showed that on February 9, 1872, the sewage in Fairmount forebay was 6.65 pounds in one million gallons, and this gradually increased until November when a large increment occurred, and later steadily increased until he says the water is occasionally charged with an amount of sewage exceeding that carried by the Thames at London and is at times totally unfit for use. On July 24, 1874, when, from the cessation of the flow of water over the dam, the objectionable drainage accumulated he found at the inlets to the Belmont, Fairmount and Spring Garden Stations respectively, sewage to the enormous amounts of 98.06, 97.14 and 121.37 pounds to the million gallons, and therefore asserts that unless some precautions are soon taken to prevent the influx of this great amount of sewage of animal matter into our source of supply we may certainly expect to have our city visited by some epidemic scourge.

"The pollution of the Schuylkill river has been increased to such an extent as occasionally to class the water as 'unwholesome' and prompt measures should therefore be taken to relieve it of sewage containing fœcal and decaying animal matter. The greatest proportion of these are now received from the streams draining into the pool of Fairmount dam. Preparations have been made to conduct that on the west side of the river below the dam by means of a sewer, and provision should at once be made for the sewage on the eastern shore."

The following table accompanied Dr. Cresson's report:

Results of the Examination of Water from the River Schuylkill.

CHARLES M. CRESSON, M. D., 417 Walnut Street, Philadelphia.

FROM WHENCE OBTAINED.	Anal. No.	DATE.	Total solid matter.	AMMONIA.			Sewage.	Sulphuric acid.	Chlorine.	REMARKS.
				Free.	Albuminoid.	From Nitr'tes.				
			POUNDS IN 1,000,000 U. S. GALLONS.							
1. Fairmount Forebay	329	Feb. 9, 1872	899.10	0.89	0.66	10.27	6.65	169.53	37.18	
2. Belmont Inlet	330	Feb. 9, 1872	928.80	0.17	2.13	.....	21.28	202.28	34.62	
3. Schuylkill River, below Manayunk, G. W.	336	Feb. 9, 1872	993.60	7.32	0.67	.....	6.65	198.53	39.95	No water over dam for eight days previous, and very little for fifteen days previous.
4. " " " Wissahickon Creek	335	Feb. 9, 1872	594.00	Traces only.	1.99	.....	19.96	63.67	39.95	
5. " " " Dobson's Mill	333	Feb. 9, 1872	982.80	0.17	0.70	.....	6.98	191.13	31.97	
6. " " " Simpson's Mill	334	Feb. 9, 1872	934.20	Traces only.	.....	.....	.....	195.07	37.28	
7. Creek below Spring Garden Water Works Inlet.	361	Apr. 26, 1872	.....	1.66	9.98	3.33	99.79	.....	.....	Sewage from slaughter houses, &c., on east side of river.
8. " " " " "	658	Sept. 5, 1873	.....	2.73	22.77	.....	227.68	38.57	65.71	
9. Schuylkill River, below Manayunk, G. W.	600	July 24, 1873	.....	4.57	6.86	.....	68.57	140.00	45.71	
10. " " " Wissahickon Creek	599	July 31, 1873	.....	17.14	4.57	.....	45.71	None.	40.00	
11. " " " Simpson's Mill	364	Apr. 20, 1872	.....	3.66	3.33	4.82	33.26			
12. " " " " "	656	Aug. 29, 1873	.....	0.46	2.28	.....	22.77	133.57	28.57	
13. Belmont Inlet	331	Mar. 9, 1872	901.80	0.17	1.33	.....	13.30	226.19	38.72	
14. " "	634	July 31, 1873	.....	15.17	3.21	.....	32.14	82.86	40.00	
15. " "	657	Sept. 5, 1873	.....	0.30	1.82	.....	18.21	127.14	50.00	
16. " "	1152	July 24, 1874	.....	2.43	9.81	19.43	98.06	70.00	31.29	No water over dam for four days previous.
17. " "	1266	Nov. 7, 1874	.....	None.	1.94	12.14	19.42	205.71	25.71	
18. Spring Garden Water Works Inlet	655	Aug. 27, 1873	.....	7.86	1.79	.....	17.85	122.85	40.00	
19. " " " "	1154	July 24, 1874	.....	2.42	12.13	14.57	121.37	71.43	31.43	No water over dam for four days previous.
20. Roxborough " "	1269	Nov. 7, 1874	.....	4.12	4.25	18.21	42.50	197.14	21.42	
21. Fairmount Forebay	329	Feb. 9, 1872	899.10	0.99	0.66	10.27	6.65	169.53	37.18	No water over dam for eight days previous.
22. " "	512	Jan. 6, 1873	1067.10	1.67	2.51	.....	25.17	91.11	110.00	Slight freshet. High water for two days previous.
23. " "	1025	Jan. 22, 1874	817.31	0.76	2.13	4.68	21.25	210.00	114.28	
24. " "	1153	July 24, 1874	.....	1.94	9.72	19.43	97.14	71.43	30.00	No water over dam for four days. Low water for ten days previous.
25. " "	1414	Jan. 19, 1875	998.57	1.21	3.06	24.28	30.60	168.57	71.42	No water over dam for six days previous.
26. Croton—New York City Supply	337	Mar. 7, 1872	507.60	0.99	0.99	1.25	9.97	34.92	21.36	
27. Loch Katrine—Glasgow	.....	.....	235.73	0.03	0.67	2.58	6.66	46.64	39.15	
28. Bala Lake	.....	.....	233.40	0.08	2.08	.....	20.82	29.15	60.80	
29. Thames—London Supply	.....	.....	2,577.30	0.24	1.33	28.82	13.32	261.56	118.28	From Watt's Dictionary, and Wanklyn, Chapman, and Smith's Manual.
30. " London Bridge	.....	.....	3,401.97	.....	4.91	.....	49.14	268.22	529.78	
31. River Lea, London	.....	.....	2,798.88	0.24	0.74	30.07	7.41	369.01	127.45	

The important features of these analyses, as regards the relative wholesomeness of the waters, are the amounts of the two ammonias. The great variability of the Schuylkill water at different seasons is well illustrated in this respect, and for purposes of comparison the water supply of Glasgow, derived from Loch Katrine, a nearly absolutely pure water, is highly instructive. The average amounts of free and albuminoid ammonias, the former indicating the recent oxidation of nitrogenous components, and the latter the presence of matters still capable of putrescence, in the waters of Loch Katrine are respectively 0.03 and 0.67, estimated as pounds in one million gallons. The Croton sample gives 0.99 and 0.99. The average of the Thames samples 0.24 and 2.33, while the average of the Schuylkill waters gives 3.13 and 4.64.

In October, 1875, a valuable and instructive report was submitted by a Commission of Engineers who had been called together by the Mayor in compliance with the ordinance of June, 1875, to consider the entire subject of the present and future water supply of the city. This Commission, whose organization was due to the alarming deficiency and dangerously augmenting pollution of the supply, was composed of eminent and capable men of the first rank in the profession. Their report deals largely with the question of pollution, devoting over fifty-six pages out of one hundred and forty-three exclusively to this subject, with numerous current references thereto in other portions. They state that the Schuylkill water, originally remarkably pure and wholesome, has been impaired by impurities accompanying the growth of population and the extension of industries, and that unless a remedy be applied it will ultimately be rendered unfit for domestic uses. The annual reports of the Department contain various recommendations for improving the quality, and in 1867 a special committee of the Park Commissioners made an able report devoted chiefly to the subject of the purity of the water and recommending measures for its protection. Nevertheless nothing has been done beyond the construction of a sewer to

keep the sewage of West Philadelphia out of the pool. They invite particular attention to the able paper prepared by a distinguished member of the Commission on the pollution of rivers, and quote freely from it in the main report, in particular the following: "Testimony can be multiplied to almost any extent in support of the position that manufactory refuse renders water unfit to drink and we should condemn the admission of all filth without waiting for scientific reasons and demonstrative proof. That which is in any way offensive to the sight, taste or smell, and the sense of decency or propriety, has no more right to a part in the composition of our drinking water than those substances which are actually proved to be deleterious to health." They note the diminished minimum flow of the Schuylkill from 500,000,000 gallons in 1816 to 245 or 250,000,000 gallons in 1874, and refer to the intimate relation of this fact to the subject of contamination since notwithstanding the large average volume of the stream, it is not adequate during periods of drought to correct the pollutions it receives, and as the inflow of polluting matter still continues, being steadily augmented in volume as the city grows and even in greater ratio, they recommend as a protection the construction of an intercepting sewer from above Manayunk, previously recommended by the Park Commission, or else that of a conduit to bring the purer water of Flat Rock to the main pumping stations below, the cost of either construction being estimated at about the same, viz., $1,000,000.

The paper by Col. Adams, to which special attention was invited, deals exhaustively with the general subject of the pollution of water supply, and traces the relation of disease thereto, especially of the intestinal disorders such as cholera, typhoid, dysentery and diarrhœa.

The whole tenor of the paper, which quotes at length from the best authorities, is to the effect that no sewage should be permitted to reach drinking water,—that grounds for distrusting its purity are good grounds for its rejection if a better supply be attainable; and since it is impossible by any known

method to restore water once contaminated by sewage to a condition of secure and reliable wholesomeness, the choice therefore lies between the absolute exclusion of sewage and the adoption of another source.

In the reports of the chemical examination of the water prepared for and submitted to the Commission, the authors state that "long continued experience of city life in various parts of the world has shown that water contaminated with animal refuse, such as the sewage of large cities, is fatal to health" and further "that it is not so much the quantity as the nature and condition of the dissolved organic matter that determine the goodness or badness of a water used as a beverage."

From these preliminary statements it might be expected that the chemist's report would contain an earnest remonstrance against the practice of using the Fairmount Pool as a cesspool and the receptacle for all descriptions of sewage and trade refuse, and present the most convincing evidence of this dangerous pollution, especially as the statement is made that offensive organic matter enters the Schuylkill in such quantities that in winter its presence is manifest even to so simple an investigator as a well constituted nose. It is therefore a surprise to find the opinion expressed that "the present water is good enough" and that the Schuylkill water in its mineral and organic content has now been shown to be "about as good a water as we might wish to find for a large city."

Passing by without comment the curious thought that the inhabitants of a large and wealthy city need be less scrupulous in regard to the purity and wholesomeness of their drinking water than those of less populous and important communities, a singular discrepancy is obvious between the acknowledged facts and principles and the announced conclusions.

Investigation shows that these conclusions are mainly derived from an analytical table, printed on page 108 of the Report and here reproduced, exhibiting the amounts of free and albuminoid ammonias contained in the several waters under examination,—these elements having been previously accepted

in the report as affording indications of recent and existing sewage contamination and therefore of comparative purity.

	Grains in 1,000 Gallons.	
	Free Ammonia.	Albuminoid Ammonia.
Fairmount	1.17	1.76
Belmont	5.85	5.11
Flat Rock	7.31	5.12
Perkiomen	1.46	7.31
Spring Garden	17.50	8.75
Delaware Basin	25.74	11.70
Bryn Mawr Artesian Well	None.	1.75
Thames River, London	1.00	5.31

Assuming the quantities to be given as intended, inspection of this table reveals some peculiar features. It is not stated when the samples of Schuylkill water were taken, but it must be assumed that they were collected about the same time, as the well known variability of the river from the influence of rains and freshets would otherwise have rendered the comparison of no value.

As might be expected the Delaware Basin, taking water from the Delaware river near Gunner's Run, makes the worst showing, and the Spring Garden sample, owing presumably to the influence of the sewer close by, the next. In albuminoid, Belmont and Flat Rock have slightly the advantage of the London average, while, singular to say, the Fairmount water is so far superior to all the others, as to be rivalled only by that from an artesian well in the country, four hundred feet in depth and beyond suspicion of sewage contamination. Upon this showing of the purity of the Fairmount sample is based the conclusion as to the satisfactoriness of the supply from the Schuylkill. Could this be really shown to be at all times true it is manifest that the other stations should be abandoned and the pumping plant, at whatever cost of re-arrangement, be concentrated at Fairmount, but to credit the statement, it is necessary to assume that a mysterious change takes place in

the water within a short distance of the Fairmount Dam. Furthermore since Flat Rock above the Pool is alleged to contain three times as much albuminoid and six times as much free ammonia as Fairmount at its foot, we are in effect called upon to believe, that in gathering the entire drainage of all Manayunk and the Falls, with four city sewers and numerous mills and other establishments vomiting large quantities of the vilest waste matters into it, the river has actually purified itself and been converted into a fluid rivaling the well water of Bryn Mawr. It is needless to say that this is in contravention of known facts and conceivable possibilities, and in opposition to the Report of the Commission itself and other official reports on the subject.

Further comment is unnecessary, nor would so much space have been accorded this paper, were it not believed that serious harm has resulted from it in furnishing excuses for inaction in a matter of vital importance, and to point out the danger of drawing conclusions solely from occasional laboratory investigations of a stream, which in uncertainty of temperament and instability of constitution, is equalled only by the meteorological conditions which give it birth. In such a case its cycle of changes must be systematically followed and investigated, and its physical and sanitary conditions be carefully determined and studied, and laboratory deductions must confirm the observations of the sanitary engineer or be unhesitatingly set aside in favor of the readily ascertained and verifiable physical circumstances.

The Report of the Commission was not followed by the construction of an intercepting sewer nor abatement of the foul drainage into the Pool, and in the Water Department Report for 1876 the Chief Engineer returns to the charge. "Under the guise of pure limpid water, organic matters convey the seeds of disease to the consumer." As the Schuylkill is the nearest and most economical source of supply its purity must be restored and future pollution prevented by diverting all refuse; but apparently despairing of this he quotes from an

eminent authority: "If water for domestic purposes is charged with organic matters in solution the best plan is to let it alone and go to a purer source." The subsequent reports seem to give it up.

In fact the long struggle of the Department to keep up with the increasing demand, irrespective of quality, had now culminated in manifest inability. The City was short of water in 1877 and 1878, and in 1879 and 1880 the Chief Engineer did not hesitate to predict a water famine unlesss immediate measures were taken to increase the pumpage and distribution in summer.

In 1881 the suggestion it made that sewage should be excluded from the river to improve the quality of the water, and that the expense of preventing pollution would be far less than the cost of a remote supply.

A sample of water taken from the Corinthian Basin in the latter part of June was sent to Prof. Leeds of the Stevens Institute at Hoboken, who desired it for comparison with other waters. According to the Department reports the month of June was unusually wet and the sample was taken after two heavy rainfalls and one moderate one. The Schuylkill therefore took high rank with other waters collected about the same time, Brooklyn only surpassing it, but notwithstanding this, the chemical report states that while it is safe drinking water the albuminoid ammononia is twice that present in the Brooklyn water and approaches very closely to the maximum allowable amount.

The Report for 1882 states that from the determinations of Mr. Edwin F. Smith of the Schuylkill Navigation Company, an experienced observer, the minimum flow of the river in 1881 was under 170,000,000 gallons as compared with a previous determination in 1874 of 245,000,000 and in 1816 of 500,000,000, showing that the marked diminution in the minimum flow still continued.

The total decrease in sixty-five years (1816–1881) has therefore been 66 per cent., an average of over one per cent. per

annum, and it remains to be seen how much further this will go. To appreciate the meaning of this decrease as illustrative of the changes that have taken place in the regimen of the stream and its great increase in variation of volume, producing corresponding variability in physical condition, it should be stated that the average flow throughout the year has been estimated at about 1,500,000,000 gallons daily with maxima several times greater. It is not probable that any considerable change has taken place in the total discharge of the stream so that whereas in 1816 the minimum flow was one-third of the average, in 1881 this proportion was reduced to about one-ninth, the sources of contamination meanwhile steadily increasing.

The 1882 report contains some discussion of pollution and urges its prevention, the subject being revived in consequence of an unhealthy condition of the upper Schuylkill due to deficient rain-fall and the accumulation of refuse in the dams of the Navigation Company.

In October, 1882, a Board of well-known engineers appointed by the Mayor, under the provisions of the ordinance of June 7, 1882, to consider what should be done for the present and future supply of the City, made a preliminary report. They find the Department plant to be dangerously limited and recommend more engines and boilers and additional storage. The Board calls attention to the necessity for complete surveys of localities whence a pure supply could be drawn, and are deeply impressed with the vital necessity of protecting the inlets to the stations from the large and constantly increasing amount of offensive sewage.

This brief *résumé* of the history of the Schuylkill supply, derived exclusively from the official published reports of the Water Department, and without reference to the considerable body of current literature on the subject, consisting of newspaper and magazine articles, reports and discussions in medical journals, private publications and other sources, is given in order that some conception may be formed of the gradual

deterioration of the stream and its increasing inability to fulfill the legitimate requirements of a water supply for the City, and as a suitable introduction to that systematic ascertainment of actual facts which was begun in 1883 and continued in 1884, upon which alone the City could base a correct judgment and formulate and provide the proper remedies.

In December, 1882, and January 1883, owing to a low stage of the river covered with ice, and the drawing down of the upper dams and canal levels with their accumulation of refuse matters, the Schuylkill got itself into a state of extreme nauseousness so that a disagreeable odor was diffused throughout the house. Dr. Leeds was engaged to investigate this and his report is found in the annual report of the Department for 1883. He attributes the difficulty to the decomposition of organic substances contained in the water while the river was covered with ice, and therefore could absorb no oxygen from the air nor free itself of the products of decomposition. He found the river highly charged with organic matter and the albuminoid ammonia the highest at the Fairmount forebay. He calls attention to the fact that in a stream like the Schuylkill, contaminated by sewers and factories, there is an incessant struggle between the constant pollution and the efforts of natural processes to restore the purity of the water. So long as these are not overtaxed the water may be used, but if surcharged with refuse, will deteriorate below the limit of admissible impurity, and this is often the case, especially at the Spring Garden and Fairmount forebays.

The Department report of 1883 contains a large body of facts and much discussion relating to the present and future supply. The Board of Experts made a final report in April, renewing their representations of the necessity for more power and larger reservoirs. Of the future supply they say: "At the points where the water for the City is now drawn its impurity is constantly increasing and is probably approaching the limit of wholesomeness.

"Formerly the character of the Schuylkill water was of the first rank among the sources of supply for cities. If this condition could be restored nothing better can be expected.

"The first duty of the City is to remove whatever sources of contamination are imparted within its own limits. The City's ownership of so much of the banks of the river as are contained in Fairmount Park is of the greatest importance in this respect, but the efforts of the Park Commission to preserve the purity of the water have been rendered almost nugatory by the constantly increasing drainage into the river from the east bank, caused by the growth of large manufacturing industries, and their attendant populations.

"Your Board believe that analyses will show that the deterioration in the quality of the Schuylkill water, justly complained of, is largely due to this cause, and that the completion of the sewer from Flat Rock to below Fairmount will tend to restore its wholesomeness by removing a most serious source of pollution. The construction of this sewer has for many years been urged upon the city authorities; first, by the Park Commission, and subsequently by others who have considered the subject, and it is a matter for congratulation that the work is at last to be undertaken.

"Supposing, however, that when this sewer is in use, and when the City has exhausted all other means of preventing contamination within its boundaries, is it possible to control the pollution of the stream at higher points?"

Councils had at length authorized the surveys which had repeatedly been recommended, and the systematic collection of physical data was begun and supplemented by extended analyses and sanitary surveys.

Dr. Leeds observes that there is on the average a progressive rise in the ammonias contained in the Schuylkill from Phœnixville to Fairmount, and his preliminary conclusions are:

First. That the supply from the Delaware at Kensington should be abandoned.

Second. That natural agencies are ordinarily adequate to effect the oxidation of the organic matters in the lower Schuylkill and sometimes to raise its condition to one of great purity. At other seasons these agencies utterly fail through the intervention of unusual disturbing forces and the lower Schuylkill is non-potable.

"Inasmuch as these failures are periodic and inevitable the supply from the lower Schuylkill should be abandoned unless these agencies can be effectively supplemented by artificial means."

The Chief Engineer remarks that "The Schuylkill, above Fairmount Dam, is the natural sewer, first and last, for a population of 350,000, largely engaged in manufacturing, and whatever may be the varying judgments of physicists as to the power of a running stream to purge itself of foreign contamination, it is very certain that the river itself has, from time to time, furnished the most convincing evidence of its inability to digest or dispose of the extraneous and injurious matters discharged into it.

"The character of the pollutions is as diversified as the occupations of the people. Sewage, chemicals, wool-washings, dye-stuffs, butcher and brewery refuse—there is almost nothing lacking—and the most singular feature of the case is that the worst and most deadly contaminations are those which enter the river within the city limits and under the control of the municipal authorities. The circumstance has this advantage, that matters can be amended whenever the City shall choose to exercise her powers, and the construction of the intercepting sewer on the east bank, from Manayunk to Fairmount, will no doubt be of great utility.

"It should not be believed, however, that the sewer—even should it accomplish all that it is designed for—will be able to do more than a part of the work. There will still be the entire pollution of the stream above the Flat Rock Dam to prevent or neutralize, the waters of the Manayunk Canal to purify, and the Wissahickon and other streams to regulate, and

in addition there will remain sources of contamination within the limits of the Fairmount pool itself that are not the less deadly because they are concealed from view and escape direct observation.

"The movement of ground water is, in general, slowly towards the river, and it will be years before the sewage-saturated soil underlying a long inhabited area, and filled with cess-pools, can free itself from poisons.

"In particular is there a subject from which sentiment and the imagination alike recoil, but to which the Engineer, in the interest of the public health, is forced to allude. Civilized communities have for generations recognized the danger to the living from the presence of the dead, and decreed that no well be dug in the vicinity of their last resting place, nor any water taken thence, lest the potency of lethal matter slay the living.

"Aside from the Engineering and other means of modifying the contaminations of the Schuylkill, involving years for their accomplishment, it must be said that little can be done to purify it. It is true that filtering the water will remove the visible impurities, and if thoroughly done, will render it a bright and sparkling fluid pleasing to the eye and generally acceptable to the palate, but the impurities thus removed are the least harmful of those contained in the water, and in reality, the river when muddiest from a recent freshet, is probably in its most wholesome condition, since it then contains the largest percentage of fresh water and the least of foreign matters. It is in summer, when the movement of the stream is the gentlest and the waters the most pellucid, that the largest proportion of dangerous contaminations is held in solution, and these the ordinary methods of filtering are powerless to remove. It is true that the passage of water through a mass of spongy iron has been found to oxidize in part the organic matter, but the cost of inaugurating a plant of this sort, or any filtering appliances such as are used in Europe, on the scale necessary to purify the water supply of Philadelphia, is too formidable to contemplate unless all other means of procuring a better supply shall prove impracticable.

When all was done, the organic matters would still remain, and it is these which constitute the real danger. It is known that the germs of cholera, of typhoid fever and other diseases, although their real nature or function can only as yet be guessed at, may be carried by water which to every sense is pure, and that these germs may entirely escape detection by the most subtle analysis, while existing in a condition of the deadliest activity and only awaiting admission to a living organism to develop their latent morbific energy. Against this danger science has no absolute specific, although the boiling of water is supposed to destroy the germs."

During the year 1884 the investigations and surveys relating to the present and future supplies were continued without cessation and in a thoroughly organized and systematic manner.

The field work of these is nearly completed and the present year 1885 will be mainly devoted to the work of compilation and recording.

The sanitary survey of the Schuylkill valley was completed to include all sources of pollution above the Dam at Fairmount.

The data were carefully collected by Mr. Barber whose appended report contains a full and concise account of the statistics of population and of the quality and amount so far as ascertainable, of the polluting elements which enter and are likely to enter the stream. A considerable amount of this could readily be intercepted or diverted with beneficial results, but there is a much larger quantity, such as the drainage of towns and the discharges from large mills, which could only be prevented from reaching the river by costly constructions.

As the facts were gathered they were submitted to Councils during the summer in successive reports covering Manayunk, the Wissahickon Valley and the remainder of the Fairmount Pool, and the variety and number of the sources of pollution within the city limits were shown to be so formidable that Councils who had already made provision for the partial construction of the many times recommended intercepting sewer on the East bank of the Schuylkill from above Manayunk to below Fair-

mount Dam, referred the reports to the City Solicitor with instructions to take such steps as were necessary to protect the health of the city from at least the more dangerous and readily remediable sources of danger. In consequence the Solicitor with great energy and good judgment, having made personal inspection of the several localities, selected three typical cases: one a house of entertainment with a large clientele and much water-closet drainage directly into the Pool near the mouth of the Wissahickon, another a particularly foul mill on the bank of the river in the upper part of Manayunk and a third another mill in Manayunk employing a large number of operatives whose excremental discharges passed into the stream. Against the proprietors of these, prosecutions were entered with the co-operation of the District Attorney, in the name of the Commonwealth, and after the finding of the true bills by the Grand Jury the cases were tried in the Court of Common Pleas No. 3.

Convictions were secured in all the cases and the judgment of the Court suspended to afford an opportunity for compliance with the requirements of the law.

The charge of Judge Thayer is so valuable a contribution to the law of sanitation and a declaration of the rights of individuals and communities in relation to the vital matter of the water supply as to justify its reproduction in this place.

THE COMMONWEALTH OF PENNSYLVANIA *vs.* SOULAS *et al.*

Pollution of river water used for drinking purposes.

Charge by THAYER, J. November 25, 1884.

"Gentlemen of the Jury, the case which you are engaged in trying is one of much importance and your responsibility is proportioned of course to its importance. The facts which have been proved by the evidence given on behalf of the Commonwealth are very few and simple. They are however very weighty, and it is my duty to add, have not been contradicted. The law also upon this subject is very plain. The defendants are charged in this indictment with maintaining a common nuisance by causing the excrement and foul water from the water closets and urinals upon their

premises, which are situated upon the bank of the Schuylkill river just above the confluence of the Wissahickon with that stream, to be drained into the river. It has been shown by witnesses, some of whom are experts in such matters, that the effect of this has been to pollute the drinking water of this city and to render it unwholesome and dangerous. Such pollution has also been shown by competent and credible evidence to have a direct tendency to produce disease in those who drink the water which is supplied to the city from the River Schuylkill.

Now it is very old and well settled law that to pollute a public stream is to maintain a common nuisance. It is not only a public injury, but it is a crime, a crime for which those who perpetrate it are answerable in a tribunal of criminal jurisdiction. An Act of Assembly forbids and punishes as crimes all common or public nuisances, and I know of no public nuisance more serious in its evil effects and more obnoxious to the denunciation of the law than to corrupt and poison a public stream from which large numbers of people obtain their drinking water. If the jury therefore find that the defendants have done the acts charged against them in this indictment, no doubt whatever remains that they are guilty of the offence of maintaining a common nuisance and ought to be convicted. If the water drained from the defendants' establishment into the river is of a foul and impure character, and if the effect of that is to pollute the water and render it unwholesome for drinking purposes, then they are guilty as they stand indicted, and it is your duty to say so.

"It is no defence to say that the premises are in the same condition and the drainage conducted in the same manner as when they obtained possession and began their occupancy. Their continuance of the nuisance is itself an offence against the law for which they are personally responsible. The law is perfectly well settled that no man can prescribe for a public nuisance, or defend himself by showing that others have violated the law before him. No length of time can justify a public nuisance, although it may furnish an answer to an action for a private injury. Public rights are not destroyed by private encroachments, no matter how long they have endured. Nor is it any defence that the river is also polluted from other sources, that impurities flow into it from sewers, and from towns and places above Manayunk. If the defendants have contributed to the pollution they are guilty. No man can excuse himself for violating the law upon the ground that others also violate it. It is said that the city ought to have built an intercepting sewer. But what of that? Perhaps it ought. But if the city has been guilty of negligence in that respect that fact does not justify the defendants in their violation of the law. It makes no difference whatever in the guilt of the defendants that the city has not taken steps to protect itself against the unlawful acts of those who pollute the stream. Nor ought your verdict to be affected in the slightest degree by the suggestion that if these pollutions of the river are stopped by indictments and convictions, the effect of that may be injurious to large business

interests, which are prosecuted under similar conditions upon the river. You have nothing to do with that. Such considerations cannot affect your duty in the present case. The law is to be enforced, and those who violate it are to be punished, no matter what the effect of that may be upon their business, for the law is above every personal and private interest. All persons engaged in business are bound to conduct that business in subordination to the law, and in such manner as not to injure the public. It has been argued also that the city ought to have resorted to a civil remedy against the defendants for the correction of these abuses, that it ought to have gone into a civil court and asked for an injunction against their continuance. Such suggestions have nothing to do with the case. It is sufficient that the defendants are arraigned by the Commonwealth, to answer for an infraction of her laws. If they have broken those laws they are in the proper tribunal to answer for their acts. Civil proceedings are slow, and in such proceedings, where the parties are private persons or corporations, which are a kind of artificial persons created by the State, many embarrassing and dilatory questions might obstruct and hinder the speedy abatement of the nuisance. In my judgment the remedy which has been chosen is the speediest and the most effective. It is a proper and lawful remedy, and you have no concern now with any other. The defendants are before you to answer the charge of maintaining a common nuisance, which is a public offence by the laws of Pennsylvania. The simple question which you have to decide is, whether the defendants are guilty of this offence. If they have done the acts which are charged against them in this indictment, then, as matter of law, I instruct you that those acts constitute the offence of maintaining a common nuisance, and they are guilty. Upon the question of fact you have the testimony of numerous witnesses examined by the Commonwealth, and they have not been contradicted by any witnesses produced by the defendants."

The jury found the defendants guilty without leaving the box. Sentence was suspended to afford the defendants an opportunity to abate the nuisance, the court intimating that if the nuisance should be immediately and wholly abated to the satisfaction of the officer to whom the supervision of such matters is entrusted by the city, it would be regarded as a sufficient satisfaction of the law, but unless this was done a severe sentence would be imposed upon the defendants, and the court, by virtue of the power conferred upon it by the Act of 1860, would, in addition, order the sheriff to abate the nuisance at the expense of the defendants.

The great importance of this adjudication as an exposition of the law of the land and indicating an effective and speedy method of righting abuses even of a long standing can hardly be overestimated, and must be attended with the greatest benefits wherever its authority and application shall be found to be necessary.

In particular will it no doubt effect a large decrease in the more dangerous contaminations which in great quantity reach the Fairmount Pool whence the main supply of Philadelphia is drawn, and to this end Councils and the several Departments of Law, Health, and Water have addressed themselves and will no doubt continue so to do.

Dr. Leeds' report will command close interest and attention. The systematic prosecution of his inquiries during nearly a full year not by occasional laboratory investigations, but by frequent and regular analyses in connection with personal local examinations enabled him to reach certain well defined conclusions in regard to the actual and relative condition of the several streams under consideration, which are of very great value in connection both with the present and future supplies.

He notes the great variability of the Schuylkill and its gross pollution by sewage. At some seasons the natural remedial agencies are adequate to the elimination of contaminations and render the waters potable and pleasant. At others they are quite unequal to the task and popular disgust and indignation are aroused.

The means of amendment are manifest—the exclusion of sewage, the modification of mill waste and the final purification and clarification of the water before delivery to the consumer.

In conclusion he says: "Whatever may be done in the future it is certain that one thing should be done at present and at once, and that is the rigorous exclusion of sewage from the Schuylkill, for on this point the most eminent authorities agree that the presence of sewage in drinking water is a predisposing influence towards cholera in time of epidemic, and an important factor at all times in the dissemination of intestinal disorders in general."

The history of the Schuylkill is both interesting and instructive. In earlier days a noble river with a bountiful and healthful drainage area of woodland, mountain and meadow, pouring a powerful and fairly equable current of pure water through its channel, the occupancy of its valley and the

growth and development of population and industries from source to mouth have greatly modified its characteristics. Generation after generation made fresh inroads upon its resources and added its quota of varied pollution, until at length the river, whose pure volume for a long period was able to eliminate the evidence of man's careless work and presence, and which even yet might have continued to do so were it not, Samson-like, shorn of its power of conservation by the ruthless cutting away of the forests and clearing of the land upon which it depended to equalize its flow, has become a sewage and trade-polluted stream whose failing volume in seasons of drought is unequal to the nauseous task of digesting and disposing of the extraneous and dangerous matters with which it is surcharged.

For the greater part of the year though subject to great variations in volume and quality from freshets due to the rapid accumulation of rainfall it is still a fairly good water and at times notably so. Again, as its power wanes, the constant accession of deleterious matters overloads it with contaminations, and its waters become foul and unwholesome.

The dwellers on the Schuylkill are not alone in thus failing to take the precautions which finally must be forced upon them. The world over, ignorance, carelessness and an apathy born of long immunity from retribution, have fouled the water courses whence the supply is drawn and only when an epidemic sweeps away its victims or a special and unusual fit of unwholesomeness seizes the stream is attention called to the necessity of amendment.

It is probable that mankind as a rule must continue to rely upon water courses for the needful supply. Very pure water may in some cases be derived from deep wells, but as a rule the quantity is limited and uncertain, and furthermore, water removed from contact with the air if at all polluted is liable to assume a dangerous capacity for infection from the absence of a surplus of oxidizing agencies. We must no doubt look to the mountains, whose sloping sides and inhospitable soil forbid

occupancy, as the gathering ground of water for the supply of the communities existing between them and the sea, and one of two things must be done: either the streams flowing thence must be protected as thoroughly as practicable throughout their length, or their sources must be intercepted above any polluting causes and conveyed by artificial channels to the point of delivery.

A good drinking water should be transparent, cool and sparkling, without color, odor or taste, with but a small amount of innocuous mineral matters in solution, the least possible quantity of vegetable matter, and be absolutely free from animal matter and in particular from excremental pollution.

It is no doubt true that water contaminated with organic matters even of the vilest descriptions (and in this respect as in some others man is his own worst enemy) can be drunk for long periods without noticeable or traceable effect upon the system. Nevertheless in such matters the instinctive animal sense is a safer and more intelligent guide than he who would assert the innocuousness of such admixture.

If the pollution were done before our eyes no one would think of using the water, but occurring out of sight we close the mental vision as well and literally go it blind.

There is now little if any dispute among instructed and scientific men that infected water is a common carrier of disease and that the continuous propagation of intestinal epidemics in especial is effected by this means, chief among them being typhoid fever and the choleraic diseases.

One of the very highest authorities on this subject, Dr. Sternberg, of the United States Army, in a recent article says: "There is little doubt that the intestinal fluxes generally, from the dread Asiatic pestilence to camp diarrhœa, are produced in this way by micro-organisms which for the most part find their way to the interior of the body in drinking water."

It has been contended however that a flowing stream possesses the power of self-purification and it has therefore been

assumed that matters deleterious to health may thereby be eliminated. There is much basis for this belief, but it would be dangerous to carry too far.

A flowing stream exposed to the full action of the atmosphere and the solar rays, especially if in rapid and turbulent motion, will undoubtedly effect the disapearance of matter which offends the senses, and of invisible organic substances in solution.

The organic and putrescent matters are oxidized and converted into innocuous residua which may be deposited upon the bed and banks of the stream. This is true of dead matter but how shall it be shown to be true of those living microscopic plants which scientific investigation has revealed to us as the agents of deadly disease as well as of indispensable natural processes of purification by the disintegration of effete matter. The weight of evidence is heavily against this theory. It has been proved beyond the shadow of a doubt that water which to every sense is pure may be charged with the most active and deadly potency from the presence, undetectable by any analysis however subtle save the methods of modern microbiology, of those beings whose power for good or ill seem to be in inverse proportion to their physical dimensions.

Furthermore, since the natural operation of purification depends upon the chemical action of oxygen, how shall it be perfected, supposing that the water has exhausted its supply of that powerful element by a previous charge of pollution, and therefore no longer has the weapon with which to contend with a new enemy?

It follows therefore that since disease may lurk in the most pellucid and attractive water, security can only be attained by such precautions as shall positively insure its protection from the germs of disease; and to do this all dangerous matters must be kept out.

An admixture of what may be called "healthy sewage," however it may disgust the sensibilities, can no doubt be absorbed without certain injury, but we can never be sure of the

physical condition of the persons whence that sewage is derived, and knowing what we do of the fatal character of certain diseases and of the mode of their propagation and transmission, what safe or decent course is there other than the rigid exclusion from our water supply of all those foul waste matters which the instinctive impulse of every animal rejects, and which over and over has been proven to convey the seeds of death—whose vitality is extremely persistent, and whose presence or absence could only be determined by actual tests upon living beings?

While trade and sewage contamination may be in great part kept from the river by an extended system of sewers or of complete local epuration before being allowed to enter the stream, the frequent turbidity of the Schuylkill is an ineradicable defect. It is due to the heavy rush of the rainfall down the slopes of the river and its affluents, from which at times the water is highly charged with sediment.

This sediment may be composed largely of insoluble earthy matters, and to that extent be innocuous to health, but it always destroys the appearance and potability of the water, clogs the pipes, and causes even greater public dissatisfaction than the more serious but unseen evil.

The only remedy is the establishment of filtering appliances on a scale sufficient to clarify the entire supply of the city, and these may take the form of filtering basins or of filtering plant and apparatus. These for so large a quantity as the city even now requires will cost a large sum, and for the present and until adequate storage and distribution facilities shall have been provided their introduction must be deferred.

The experiment of artificial aëration of the water to supply the lacking oxygen and decompose in part the organic substances present in the water, is about to be tried.

The investigation of this subject last spring and summer by Dr. Leeds made it probable that useful results could be attained at a very moderate cost. His laboratory experiments tended to show that the well known beneficial action of aëration upon

water would be greatly increased by effecting the commingling of the air and water under pressure, whereby a much more rapid and considerable absorption of oxygen by the water could be secured.

To effect this the simple and economical expedient of forcing air into the mains at the pumping stations where the pressure was that due to the elevation of the basin above the pump, and where the requisite power was at hand, suggested itself.

As no means were available for the purchase of air compressors, one-half of one of the two pumps operated by a turbine at the Fairmount Station, was converted into an air pump whereby the desired percentage of air, viz: about 20 per cent. by volume at the atmospheric pressure, was injected into the mains. The water thence passed through 3,000 feet of main to the Corinthian basin about 120 feet above the pump and therefore under an initial pressure of about 52 pounds. Under these circumstances the effect of the aëration was quite marked. The chemical data of comparison are given in Dr. Leeds' report, from which it will be seen that the carbonic acid was very largely increased and that the oxygen, notwithstanding its activity en route was at the end about 20 per cent. more than at the beginning. These results were so encouraging and so fully corroborated by a similar experiment on a larger scale made with the Hoboken supply at the suggestion of Dr. Leeds, that Councils made appropriation for partly equipping the Department with proper air compressing apparatus at the stations and these will shortly be in operation at Belmont and Spring Garden. While the Schuylkill supply is continued it is expected that the quality of the water can be much improved by the use of the process although it should be said that aëration can have but little effect on *turbidity* merely and will not therefore appreciably improve the appearance of the water.

SURVEYS FOR FUTURE SUPPLY.

I.—Physical Data.

The investigations begun in 1883 to ascertain the data upon which the solution of this very interesting and important problem must depend, were continued throughout 1884, and the reports of Mr. Hering and Dr. Leeds constitute a condensed summary of the operations of the year, and a partial exhibit of the conclusions thus far attainable.

It will be seen from Mr. Hering's report, that at the close of 1884 nine-tenths of the field work had been covered. During the present year the parties will be principally engaged in the office work of compiling, plotting and computing, with some interval given to filling in certain gaps in the out door work, for which the most favorable opportunity will be taken.

The greater part of this work will have been completed by the close of this year, and while the data are preparing it is unnecessary to undertake their discussion. A few considerations, however, may be presented in order to indicate the general nature and scope of the problem, and explain the aspects which it has assumed under partial investigation, so far as these can be reliably formulated.

The practical choice of a water supply for Philadelphia lies between the valley of the Schuylkill and that of the Delaware, and the three general items which must be consulted in making the decision are quantity, quality and cost, the relative importance of the three being in the order named. The investigation now in progress for two years will definitely determine the two last, although a longer period of observation will probably be necessary in order that there shall be no element of uncertainty in regard to *quantity*.

Not only does the total amount of rainfall vary from year to year within quite wide limits, so that several years' observations are requisite in order to be sure of including maxima and

and the still more important minima, but the proportion of this rainfall, which can be actually stored and utilized, varies in still greater degree. The duration and weight of individual storms and showers, the concentration of these into particular seasons, followed possibly by periods of drought, or their dissemination throughout the year, producing a more equable proportion between the several months,—all have a direct bearing upon this question. So also do the character and condition of the drainage areas.

The collections from forests, fields or rocky soils, from gentle gradients or steep descents, from moist lands or parched surfaces, will all show different results even with equal areas and rainfalls. It is therefore commonly accepted that careful observation of these points, and uninterrupted records of meteorological data are desirable, and in the case of important problems cannot safely be omitted unless the readily ascertainable facts suffice to determine the matter as it were "by first intention."

Philadelphia has a population at present of nearly one million, and within a generation hence will probably have twice that. The average daily pumpage is now about seventy million gallons per day, and in summer the amount required nearly reaches one hundred million. Furthermore, it has been shown in the history of developing municipalities that from the growth of manufacturing industries, freer use by individuals and greater luxury of plumbing appliances, from the extension of sewer systems and the necessity of flushing arrangements, the quantity of water consumed increases more rapidly than the population, thereby increasing the daily allowance per capita.

It would not therefore be safe to assume that a daily supply of two hundred million gallons will be at all in excess of what the city will require 25 or 30 years hence, and with works of the magnitude and cost of those now under consideration, it would be absurd to estimate for a smaller quantity or a briefer period of time. Upon this basis then, it may be agreed that as between the two rivers themselves the drainage area of either is

able to furnish a sufficient volume for a long time to come, but in the case of the Schuylkill there are two prominent facts which present themselves. One is that during the last 60 years the Schuylkill has displayed a marked diminution in its minimum flow.

The data on this point, as summarized in the report of the Commission of Engineers in 1875, is as follows:

In 1816 the flow was estimated at 500,000,000 per day; in 1825 at 440,000,000; in 1867 at 400,000,000; and in 1874 at 245,500,000, which is less than half the flow in 1816.

This remarkable decrease, not being accompanied by any great change in the rainfall nor probably in the total annual discharge of the river, is no doubt largely due to the destruction of the forests within the drainage area, whereby the conservative action of woodland has been lost, and the rainfall is permitted to descend rapidly to the bed and pass off in a succession of freshets. It so happens also that this low water flow occurs precisely when the largest supply is required, viz., in summer, although a winter minimum also occurs during some years.

It is obvious, therefore, that with an anticipated requirement of two hundred million gallons per day the Schuylkill will barely be able to supply it throughout the year, even supposing that the process of diminution of the minimum flow has gone and will go no further than was observed in 1874, and that at some time in the not distant future, the city will be pumping the entire low water discharge of the river, laying Fairmount pool dry and stopping the navigation as well as the use of water power both at Manayunk and the Fairmount Dam. For this reason projects to dam the river and store the freshets which now pass down and are lost in the greater volume of the Delaware, have from time to time been advanced and perhaps would have been seriously contemplated had it not been for the other fact above referred to.

This is the vital question of the *quality* of the Schuylkill water in regard to which full data are given in the reports of Dr. Leeds and Mr. Barber, the former by means of very nu-

merous elaborate analyses, and the latter by careful and thorough sanitary surveys and collection of data bearing upon the pollution of the stream. A discussion of this question under the heading "The Present Supply" is given elsewhere in this report, and it is not necessary in this place to say more than that it is evident that there was good reason on the part of the engineers who have heretofore studied the subject, to conclude that Philadelphia must in the end abandon the Schuylkill as a source of water supply, and therefore to turn their attention to the search for some other practicable source.

In this connection the Perkiomen, the main affluent of the Schuylkill, took a prominent place. As early as 1865 Mr. Birkinbine, then Chief Engineer of the Water Department, advocated the impounding of the waters of Perkiomen Creek and the conversion of the valley into a large reservoir by the construction of a Dam at a favorable point near Schwenksville, where two rocky prominences contracted the valley and formed a comparatively narrow gateway for the stream. The surface of the impounded lake would have such an altitude as to enable the water to flow by gravity to the city, and with the data then at hand the project presented favorable features.

The Commission of 1875, after considering the subject with great care, but unfortunately without the aid of such exact surveys and determinations of areas and rainfall as are requisite to authoritative conclusions, also gave the Perkiomen project a leading place on the assumption that an ample amount of water could be impounded for an average daily supply of two hundred millions to the city, but, conscious of the lack of accurate data, urgently recommended that thorough and careful surveys be made without delay.

When therefore the problem was again attacked in 1883, it was thought probable from the information available that the investigation would result in establishing the feasibility of the Perkiomen project, but as the Delaware project also had never been fully studied, in order not to lose time it was determined to organize two parties, one on each route.

At the present time final conclusions cannot be stated, but the leading fact is as follows: The Perkiomen does not itself, or even with such of its branches as it would be judicious to use, furnish the full supply of water required, and unless supplemented by some other source, cannot be depended upon for the future.

This fact, in connection with the known purity and large volume of the upper Delaware, and the discovery that the latter project was making a much better showing economically than could have been anticipated, at once gave it prominence.

Inasmuch, however, as the intention of the surveys was to exhaust the subject, a preliminary investigation of the upper Lehigh was made as a third possible source of supply. The facts were disclosed that while not excessive in quantity, the upper waters of the Lehigh are unsurpassed in purity, and that excellent sites for impounding dams could be found to store the water at high elevations, above reach of possible contamination, so that notwithstanding its comparative remoteness, the Lehigh project had its advantages, but could hardly be considered as yet taking rank as an isolated source of supply.

When it was believed that the Perkiomen would prove inadequate, the idea suggested itself that it might be reinforced by bringing sufficient of the Lehigh water into the upper valley of the Perkiomen to supplement its volume, and thereby restore its practicability as a source of supply.

In regard to the Delaware the leading facts are these: A conduit northward to the Delaware valley, near Point Pleasant, about half way between Trenton and Easton, would have about the same length, and cost about the same, as one to the Perkiomen. If the conduit should terminate at Point Pleasant, most excellent water could be had, although at the expense of pumping it from the river; but in going northward, it happens that the conduit crosses the valleys of several minor affluents of the Delaware, viz., the Pennypack, and the Big and Little Neshaminy, and taps the Tohickon near its mouth at Point Pleasant. All of these streams could be intercepted by dams,

and large reservoirs formed for a gravity supply, and especially is this the case with the Tohickon, which is not only excellent water, of considerable volume, and readily protected from pollution, but has the very favorable condition that when nearing the Delaware it enters a rocky gorge where a dam could be readily built, and a deep and capacious reservoir created. The object of these constructions is apparent. With the minor streams feeding the conduit, pumping from the Delaware would be superfluous for the greater part of the year, and would only be necessary when the diminished flow of the affluents in summer, or the deterioration of the impounded contents of the Basins should render them unable to maintain the supply. The meteorological and topographical data on these points are not yet computed, and hence it cannot be stated for what length of time pumping would be required, but it would probably not be necessary to draw from the channel of the Delaware for more than four or five months in the year.

It is possible that the project, as thus outlined, terminating provisionally at Point Pleasant, would be found satisfactory for many years to come, but the surveys will also determine the cost of continuing the conduit up the west bank of the Delaware to such point below the Water Gap as would permit of the river flowing directly into the conduit and thence by gravity to the city.

What remains to be finally determined, therefore, is as follows:

1. The cost and particulars of the conduit to Point Pleasant plus those of dams on the minor streams, increased by the capitalized cost of such pumping from the Delaware as shall be found requisite.

2. The cost, etc., of a purely gravity supply from the vicinity of the Delaware Water Gap.

3. The cost of the Perkiomen conduit and dam plus a pipe line from the upper Lehigh and such subsidiary constructions as shall appear necessary in that region. In all these estimates

the land damages, destruction of property, and similar charges must be included.

When these data shall have been ascertained, the final consideration of the subject can be at once undertaken, when the information as to the respective waters and water sheds furnished by analysis and sanitary survey, as well as the comparative geology, must all be taken into account.

The collection of the requisite information can, it is believed, be nearly completed during this year, and so the matter must be left for the present although some of the ascertained facts can be given here.

As projected, both the Perkiomen and Delaware conduits have the same internal diameter, 12 feet; the same grade, one in six thousand, and therefore the same capacity of delivery, viz.: 210,000,000 gallons in 24 hours. The level of delivery is the same in both, viz.: that of the Wentz Farm and proposed Cambria Basin, 166 feet above City Datum.

The Perkiomen conduit is $26\frac{55}{100}$ miles long, and its cost, exclusive of other charges, is computed as under $6,500,000.

The Delaware conduit to Point Pleasant is $32\frac{84}{100}$ miles long and will cost somewhat over $7,000,000—less, proportionately, than the other by reason of more favorable locations. The total length of the Delaware gravity conduit to below the Gap is 81 miles, and the cost $17,000,000. The minimum observed flow of the Delaware at the Water Gap on September 20, 1883, was seven hundred million gallons when the river was lower than had been observed for a generation. The Water Gap minimum for 1884 occurred September 23, and was in excess of one billion, the flow at Point Pleasant at the same time being 1,660,000,000, or two-thirds more. The Lehigh minimum at White Haven was in September, 1883, 76,000,000, and in October, 1884, 127,000,000. These amounts can, of course, be largely increased by the construction of natural storage basins in the mountains.

It is evident from these figures that the Delaware, whether at Point Pleasant or at the Gap, is capable, for generations to

come, of furnishing a most abundant supply for all the communities in its valley without any need for impounding its waters or interfering with the free flow of the stream.

Measures will be taken during the ensuing season to gauge the flow of the Schuylkill at some convenient point near the city. Current-meters will be used for this purpose since there is much difficulty in estimating the flow past Flat Rock and Fairmount Dams, owing to an unknown amount of leakage and the drawing aside of the water for manufacturing and power purposes and for navigation. In fact for months together there is no flow over the Dams at all. Another important part of the investigation will receive attention in the form of a sanitary inspection of the upper Delaware valley, gathering the statistics of populations and industries and exploring all possible sources of pollution with the same thoroughness as has been done in the case of the Schuylkill valley.

The information gathered by these surveys in general will constitute a large permanent addition to physical knowledge of the greatest value to both city and State, independently of the special purpose for which they were made. The intention has been to cover every essential feature, avoiding an unnecessary minuteness of elaboration, which would greatly add to the expense, but with such certainty of suitable approximation to the actual facts as shall form a secure basis for study and estimate with no elements of uncertainty and no lack of necessary information.

It is confidently believed that the work thus far accomplished will challenge comparison with any other of a similar nature elsewhere in the conscientiousness, thoroughness, accuracy, and economy with which it has been done; and its conduct and execution are in the highest degree creditable to Mr. Hering and his assistants, who have labored early and late to make them satisfactory and successful.

2. Analytical Data.

Dr. Leeds' analytical investigations of the several waters under consideration have now been continued systematically for an entire year with great care and thoroughness, the methods being the same as those elaborately described in the Annual Report for 1883, and he finds himself prepared therefore to indicate certain preliminary conclusions as to the comparative merits of the waters examined which it is not probable will be materially modified by a continuance of his labors.

His report contains data of the highest interest. It recites the general plan of operations pursued, based upon the experience of the previous year, making it possible to omit from further analysis such waters as those of the upper Lehigh which, from every point of view, can be regarded as habitually pure, as well as those whose condition of chronic pollution, such as the intake of the Kensington Pumping Station, rendered them unworthy of further study.

This elimination of certainties concentrated the work of investigation and comparison and reduced within practicable limits the still large remaining labor of collection and analysis.

The method pursued was to take a weekly series of samples alternating between the valleys of the Schuylkill and Delaware. For a basis of comparison one of these samples was always taken from the Delaware River at Point Pleasant. This standard sample is called the Byram sample in the analytical charts and so referred to in Dr. Leeds' report, Byram being a small station on the Belvidere Division of the Pennsylvania Railroad directly opposite Point Pleasant and therefore readily accessible by rail.

While Byram could be taken as, on the whole, illustrative of the qualities of Delaware water, it was found that Phœnixville could be adopted as a favorable exhibit of the characteristics of the Schuylkill. The river at that point is frequently clear and palatable and Dr. Leeds takes occasion to note its limpidity and attractive appearance.

As will be seen by examination of the chart the analyses were both numerous and thorough, covering every important feature, notwithstanding the very considerable labor required, and the conclusions deducible therefrom may be briefly generalized as follows:

Of all the waters examined the Water Gap heads the list in respect both of purity and softness, with Point Pleasant (Byram) a good second. After these come the Delaware affluents, the Tohickon and the Neshaminies being generally superior either to the Perkiomen or the Schuylkill. Of these two it is found that the Schuylkill at Phœnixville is often better than the Perkiomen at Zieglersville although the upper waters of the Perkiomen at Green Lane are comparable with those of the Delaware affluents.

The total solids in solution in the several waters constitute one basis of numerical comparison and estimate of quality, and the analytical exhibit on this point is as follows, the numbers expressing parts in 100,000:

Delaware at	Gap,	minimum	3.	maximum	7.
"	Byram,	"	3.95	"	9.5
"	Lardner's Point,	"	5.1	"	10.
Schuylkill at	Phœnixville,	"	10.	"	16.9

The most striking fact displayed in this table is that the Schuylkill in its best condition with reference to solid matters in solution contains as much as the Delaware at its worst, and that to show this equality the comparison must be made with the Lardner's Point water, a mile above Bridesburg, in the tidal section of the Delaware into which have been poured the sewage of Philadelphia and the river towns above, including Trenton. The Schuylkill minimum is double that at Lardner's Point and over treble that at the Gap.

Another point to be noted is the wide range within which the characteristics of flowing waters vary with the seasons and meteorological conditions. In the purest streams the maximum is about two and a half times greater than the minimum, this disproportion, as might be expected, diminishing with the increase of pollution and consequent rise of the minimum.

In this connection it is desirable to emphasize the statement made in the report for 1883 and enlarged upon by Dr. Leeds in his report herewith, that a clear and intelligent distinction must be recognized between matters in solution and matters in suspension. There is a widespread popular misapprehension on this point which it is important to correct, as it frequently leads to serious and even fatal consequences. To the unreflecting mind water is pure when to the eye it exhibits no trace of sediment and to the taste is palatable and gratifying. Yet nothing perhaps can be more attractive to every sense than the water drawn from a well in the built up portions of the city or adjacent to a cesspool and therefore highly charged with the most dangerous organic poisons. A fluid which is absolutely deadly in quality may thus present itself under the most alluring guise, and it must be confessed that in this respect even the utmost refinements of chemical science may fail to reveal its treacherous character, and micro-biology alone is equal to the task of analysis. This popular error is widely disseminated not merely in cities but in villages and even isolated dwellings where the occupants do not fear to dig the well and privy vault in convenient juxtaposition.

Another consequence of this error is a reliance upon subsiding basins and filtering processes to convert a turbid and contaminated fluid into a wholesome and acceptable one. These methods are of use and very generally in service when necessary, but it should be known that only matters in suspension can thereby be removed and that matters in solution are a portion of the water and pass freely through any filter, so that chemical treatment is needed to remove them unless the danger can be dealt with at its source by absolute exclusion.

This will explain why it is that the water at Phœnixville which sometimes has the appearance of a pure mountain stream is shown by analysis to contain three times as much solids in solution as the Point Pleasant water when in its least attractive condition. The fact is that a stream subject to contamination from matters dangerous to health is often most whole-

some when most turbid since the proportion of fresh rain water is greater and the earthy impurities which the rainfall has brought may contain little that is really deleterious and can be converted into a good potable fluid by filtration alone.

These considerations must all be carefully weighed before a final decision can be announced as to the future supply of Philadelphia, but it is of vital importance meanwhile that correct conceptions should be conveyed to the public and the general comprehension of the essential facts and arguments be directed and enlarged.

CONCLUDING REMARKS.

The creation and maintenance of a system of water supply to a great modern community is practically a never ending problem. The needs of each generation so largely transcend not alone those of the preceding one but even the estimates which could then have been formed of the future requirements as to almost invariably exceed reasonable anticipations and far outrun the capacity of the existing constructions even with considerable additions from time to time. Such in brief has been the history of almost all water supplies and especially has it been the case in American cities where the general habit is to meet present emergencies and let the future take care of itself. It should not be inferred that such a course is necessarily injudicious. With temporary provision such as the occasion requires and the means at hand render practicable, the matter at least gets itself arranged with some dispatch and American communities are too well accustomed to prosperity and development to entertain apprehensions as to their future ability to meet demands as they shall arise.

In some cases it is true that such partial provision creates difficulties when enlargements are required and in the end the aggregate expenditures may exceed those which would have been

necessary had bolder projects been inaugurated in the first place, but as large original estimates might have delayed the work indefinitely it was probably often the wiser course to proceed with less ambitious plans.

The real difficulty due to this cause is the unceasing watchfulness and provision needful to give timely warning of the approaching inadequacy of the existing plant and the resolution and persistence demanded from those charged with the special responsibility in constantly presenting and urging the requisite modifications and enlargements.

The intimate relation of water supply to the public health and other material as well as moral interests of the very first importance, need not be enlarged upon. It is second only, if second at all, to the protection of life and property with both of which in fact its connection is of the closest. The adequacy and satisfactory service of the Water Department must therefore be regarded as a municipal obligation and responsibility not exceeded in importance by any other and its neglect and insufficiency cannot be defended upon any grounds, even those of financial embarrassments and inability to raise the necessary funds for improvements.

Even these excuses disappear when, as is the case in Philadelphia, the Water Department so far from being a burden and expense is in reality a source of generous revenue which pays a heavy interest upon the total cost of the plant and in the past thirty years upon an expenditure of $19,000,000 has collected $28,750,000 and turned into the City Treasury a net profit of nearly $9,750,000.

The vigilance requisite to keep the service of the Department adequate to the demands of a great and prosperous community which has been referred to is shown in the fact that the uses of water increase in much greater ratio than the population.

This obviously comes about from the greater comfort and luxury of living, from the freer use of water for domestic and ornamental purposes, from the development of industries requiring large quantities in the arts of manufacture, from its

convenience and utility in maintaining public cleanliness and the thousand other uses of an element which is of universal application and the cost of which is merely that of taking it.

Without reference to other cities whose statistics would in some cases be still more striking, the following exhibit of the increase of population in Philadelphia since 1800 and the corresponding increase in the quantity of water supplied will sufficiently illustrate the fact.

Year.	Population.	Per cent. of increase of population.	Consumption per day in U. S. gallons.	Per cent. of increase in consump'n.	Gallons per head per day.
1800	70,287				
1810	96,287	37	669,041	.....	7
1820	119,325	24	1,834,836	174	16
1830	167,080	40	2,676,164	46	17
1840	258,037	54	5,004,099	90	20
1850 (Consolidation in 1854.)	408,762	58	8,697,534	74	21
1860	568,034	39	20,398,197	135	36
1870	674,022	20	36,720,030	80	55
1880	847,542	26	57,707,082	64	68
1884	956,000	13	69,658,969	21	73
Average, 1800-80		37¼	Average, 1810-80	94⅝	

The average increase in population in each full decade from 1810 to 1880 is 37¼ per cent. while that of water consumption is 94⅝ per cent.—over 2½ times greater. The effect of this is shown in the column of gallons per head per day which exhibits a steady increase.

In 1830 the supply per caput was only 17 gallons while in 1860 it had more than doubled to 36 gallons and in 1884 again

doubled to 73 gallons. Two facts may be noted in this connection:

The first is that this increase has taken place, during the last twenty years at least, in the face of an almost chronic condition of short supply if this can be assumed from the constant public complaints and the frequent representations by the Department.

The second is that under the conditions existing in Philadelphia the per caput allowance as long ago as 1860 was really sufficient for all actual needs and that the allowance in excess of about 40 gallons per day is in fact waste.

The antagonism of these two statements is apparent only. Philadelphia makes comparatively little use of water for ornamental purposes and next to none at all for the very important matter of flushing the sewers or washing the streets. For this last purpose in fact the flow from a fire-hydrant is disadvantageous rather than useful as the effect upon the cobble stones is to remove the gravel packing from between them and so tend to injure the street while the imperfect level and construction of the gutters prevent in general a free passage of the water to the sewer inlet. A heavy downpour of rain reaching all parts of the street surface at once is therefore the only effective purifier.

Furthermore there is comparatively little street sprinkling. The city does not itself undertake the task, which is therefore left to private individuals who only sprinkle such portion of the streets as they may be able to contract for with the residents. Under these circumstances what may be called the public use of water is restricted and the domestic and manufacturing uses cannot be made to account for the legitimate supply of over about 40 gallons per head per day. The amount drawn in excess of this is due to defective plumbing appliances and to willful waste.

It seems quite impossible to the average citizen to understand that the incessant dribble from his faucets or the constant running of his hydrant or water closet can make much difference,

or to appreciate the magnitude of the aggregate waste when such cases as his own are multiplied by thousands. The absence of plumbing regulations is responsible for much of this —ignorance and willfulness for more—and as a result the expenses of the Department are largely increased without benefit to any one, and waste and want therefore co-exist throughout the city. The correction of the evil is difficult. There is nothing more obnoxious than the suggestion that there should be any limitations imposed upon the drawing of water though perhaps the offended citizen or manufacturer would be one of the first to protest against his water charges and even to practice an injudicious economy in his household if he were required to pay for the actual quantity he drew.

Another serious cause of waste is found in the furnishing of water without stint or cost to the numerous city and public properties. I am clearly of opinion that the use of water in city properties and offices should be subject to at least as careful regulation as in others and in particular that the cost to the city of the Water Department should not be artificially enhanced in order to reduce the expense of maintaining the other Departments.

The Registrar's tables will show to how large an extent this is done without taking account of the great unnecessary waste due to defective fixtures and bad management. It would be a great advantage if the accounts of the Water Department could be so kept as to exhibit proper credit for service rendered to other city Departments as well as to citizens generally,—in other words that every Department should pay its own bills so that its real cost of maintenance should be clearly determined and not concealed by compelling other Departments to share the expense. Were this principle made one of general application I am satisfied that much improvement would be effected in the direction of greater system and economy of administration.

In closing my report for the year 1884 I beg leave to make due acknowledgment to Councils and to the Water Committee for the support and co-operation which, on the whole, have

been extended, and to commend to favorable consideration the personnel and efficiency of the Department as now organized.

As rapidly as they were discovered the unfaithful and the inefficient have been weeded out, and as vacancies occurred it has been a constant endeavor to supply the places with a better class of employés and so to raise the tone and improve the character of the service.

I am glad to say that at the present time a continuous and marked improvement in these respects is manifest.

The discipline is good, every man is held to accountability within the sphere of his duties, derelictions whether by intention or neglect are punished, and the employés in general display pride and interest in their work and feel a sense of personal responsibility without which it is hopeless to expect good results.

That these efforts to reach a higher plane have encountered obstacles and been attended with a greater or less development of friction and inertia cannot be denied. The organization covers an extensive field, and time is needed during the continuance of active work to infuse into it that spirit of fidelity and emulation which grows out of personal identification with the service. The considerable extent to which this now exists is mainly due to the feeling on the part of the employés high and low, that their continuance depends solely upon the need for and the satisfactory character of their service, and to the rule of the Department that its employees are servants of the city and as such their activities and energies should be so directed and controlled as best to serve its interests without arousing unnecessary political or other antagonisms.

It is unnecessary to say that these matters frequently obtrude themselves, mainly as I conceive, from the widespread impression among those who seek employment in the city Departments that pertinacity of application and weight of endorsements should command success in competition with proven fitness and competency.

Such however cannot be accepted as a basic principle in city

business or in any other, nor could any organization so constituted be created and maintained in an efficient and economical condition, especially one so varied and technical and requiring such intimate co-operation of its several parts as the Water Department.

I am persuaded that these views are in accord with those entertained by the great majority of our citizens and approved by their representatives in Councils.

APPENDIX

TO THE

CHIEF ENGINEER'S REPORT.

EXPERTS' REPORT ON PUMPING ENGINES AT SPRING GARDEN STATION.

December 30, 1884.

COL. WILLIAM LUDLOW,

Chief Engineer Philadelphia Water Department:

SIR:—Having been appointed as Experts to conduct the tests of the Pumping Engines furnished and set up by H. R. Worthington, at the Spring Garden Pumping Station for your Department, we make a "full joint report" as follows:

The test commenced at 11 A. M., November 20, on Pumping Engine No. 9 (Worthington's No. 193), and proceeded satisfactorily until 4.20 P. M., when a break in the main brought the test to a close without the definite results required by the contract, and it was therefore postponed until after the repair of the main; but the data taken will be submitted with those of later tests.

The second test was commenced at 12 M., November 24, and continued uninterruptedly 24 hours, terminating at 12 M., November 25. The capacity and duty tests were made simultaneously, the duration of capacity test being that required for the duty test No. 12 of the specification.

As the Roxborough Pumping Engine of the same maker and design had lately been tested by us for capacity by weir measurement, it was determined by you that the capacity might be "computed by plunger displacement with due allowance for slip," agreeably to No. 11 of the specification.

During the test, observations were often made of the length of stroke, and the average established at 49.9 inches.

The slip at the Roxborough Engine was found by the weir to be 2.5 per cent.; as the head or pressure on the main at Spring Garden was less than at Roxborough we estimate the slip at 2 per cent. The diameter of the pump pistons, as measured by your engineers, was found to be 37 inches and of piston rods 5 inches.

Area of 37 inch diameter piston	1,075.2
½ area of 5 inch diameter piston rod	9.8
Average net area	1,065.4 sq. in.

The number of single strokes of pumps during the 24 hours test was 76,344.

$$\frac{1065.4 \times 49.9}{231}$$ (less 2 per cent allowance for slip) 225.54 gallons.

225.54 × 76,344 17,218,545 gallons.

By the specification No. 4, "The Engines in all their parts must be so proportioned that each shall be capable of delivering fifteen million (15,000,000) gallons in twenty-four (24) hours." We therefore report that this Pumping Engine more than complies with the requirements for capacity.

No. 12. "The duty test will continue for twenty-four (24) hours consecutively, during which time the engine shall work smoothly and steadily without heating and vibration at the contract rate of delivery" (15,000,000 gallons in 24 hours), "and with a piston speed" (not to exceed 110 feet per minute), "boiler pressure" (not to exceed 60 pounds per square inch), "and other conditions as above stipulated. The Water Department furnishing boilers of capacity sufficient to maintain an ample supply of dry steam at sixty (60) pounds pressure, and burning anthracite coal of good quality, such as is in use by the Department."

No. 13. "The duty required of each Engine will be the equivalent of raising of not less than sixty-five million (65,000,000) pounds of water, one (1) foot high with the ex-

penditure of one hundred (100) pounds of coal on the basis of ten (10) pounds of water evaporated per pound of coal."

No. 14. "The duty will be computed by the following formula:

$$\frac{P \times N \times H \times 100}{W} = \text{duty},$$

in which P = pounds of water delivered per stroke; N = the number of single strokes during 24 hours, 76,344; H = total fluid resistance including static and frictional heads, allowing one pound for friction through the pump and passages; and W = the number of pounds of coal burned during the test."

The Pumping Engine as before stated worked continuously 24 hours, and delivered during this time into the main 17,218,545 gallons. It worked very smoothly and steadily, without heating or vibration; the piston speed varied somewhat, as will be seen by the tables appended, without difference in ease of working; its average during the test was 110.23 feet per minute; the average steam pressure in the engine room was 60.88 pounds per square inch; in the boilers about 2 pounds higher, or 62.88 pounds; and the water pressure or head, under which the work was done, was maintained by the Superintendent of your Department at standards convenient for the works, satisfactory to the contractor and approximately near to that estimated for the delivery into the proposed reservoir. The Water Department furnished 5 boilers of ample capacity for the supply of steam.

In determining the factors making up the formula for estimate of duty, we find the capacity of the pumps per single stroke to be 30.15 cubic feet; the weight of water per cubic foot at the average observed temperature of 43 degrees = 62.38 pounds; and P, consequently, $30.15 \times 62.38 = 1880.78$ pounds.

The total fluid resistance composed of the head, as shown on a gauge connected with the upper chamber of the pump, was 173.76, and the average depth of the water in the forebay below this gauge was 15.66 feet. By the contract, each engine was

to pump through 9,000 feet of 36 inch main, into the Cambria Reservoir, whose static height and head was to be 165.8 feet above the water in the forebay; but as this Reservoir is not completed, pressures were maintained by a gate at the average as above:

Head on main	173.76
Gauge above water in forebay	15.66
Friction allowed for the passages one pound	2.31
H =	191.73 feet.

The coal burned was Schuylkill Pea Coal, burning readily and giving a fair evaporative economy; but, as by the contract there is a standard of evaporation of 10 pounds of water per pound of coal, the factor W is estimated from the amount of water weighed and fed into the boilers, less the amount of water carried over with the stream into the steam cylinders, as determined by calorimeter tests:

Total amount of water fed into the boilers during the test was	406,575	pounds.
Entrained water (7.74 per cent.)	31,469	"
Water evaporated	375,106	"

$$W, \text{ therefore, } = \frac{375{,}106}{10} = 37{,}510.6 \text{ pounds of coal.}$$

$$\frac{P\ (1880.78) \times N\ (76{,}344) \times H\ (191.73) \times 100}{W\ (37{,}510.6)} = 73{,}391{,}750 \text{ pounds feet,}$$

or pounds of water raised one foot high.

The Pumping Engine, therefore, in duty amply complies with the contract, and the working throughout has been very satisfactory.

The tests of Pumping Engine No. 9, for capacity and duty, being so much in excess of the requirements of the contract, it was not considered necessary to test Pumping Engine No. 10, for the full period of 24 hours, as it was a complete duplicate of No. 9, and under the same conditions except that the steam cylinders of No. 10 were not fully clothed and lagged. At the close of the test of No. 9, at 12. M., November 25, the steam was shut off from it, and turned on to No. 10 and at 1 P. M.,

a test was commenced, which terminated at 4 P. M., 3 hours. During this time indicator cards were taken from steam and water cylinders as had been previously done on No. 9, and the water fed into the boilers was weighed, and the coal into the furnaces, as before. It was, as nearly as possible, a continuation of the first test, with a change of pumping engines only.

Although boiler tests of short duration are entitled to but little consideration, yet, as this last test in this respect was but an extension of the previous one, and, as the two Engines are identical in design, dimensions, material and workmanship, and the indicator cards on steam and water ends correspond very nearly, we have no hesitation in saying that Engine No. 10, were it subjected to the same test, would be equal to No. 9, in capacity and duty, and recommend that it be accepted as complying with the terms of the contract.

Respectfully submitted,

WM. E. WORTHEN,

In behalf of Philadelphia Water Department.

HENRY G. MORRIS,

On behalf of Henry R. Worthington.

EXPERT'S REPORT ON PUMPING ENGINE AT FRANKFORD STATION.

March 24, 1885.

COL. WILLIAM LUDLOW,

Chief Engineer Philadelphia Water Department:

SIR:—Agreeably to your request, I have made tests, as expert, of the pumping engine furnished and set up for your Department at the Frankford Pumping Station, by Robert Wetherill & Co., of Chester, Pa., and submit the following report of the results:

The test was commenced March 9, at 3.30 P. M., and continued until 4.05 P. M., March 10. During this time, owing

to a washout beneath the overfall at the weir, the engine was stopped from 11.45 A. M., to 0.16 P. M., March 10 (thirty-one minutes), to open the valve for the delivery of the discharge into the bottom of the reservoir instead of at the weir. This delay of thirty-one minutes was met by extending the test so as to give a net run of twenty-four hours.

It had been ascertained in the preliminary tests that there was considerably less delivery of water at the weir than was due to the piston displacement at the pumps. With the means at our disposal it was impossible to determine accurately how much was due to leak and diversions in the long main of three and three-fourths miles, with its branches, and how much to the loss of action in the pumps. The engine was run at different speeds, and the variations between displacement and delivery noted. The results will be given further on, but the first calculations of capacity and duty will be made on displacement.

The measures of pistons, cylinders, and strokes were furnished by your Department as follows:

Diameter of pump piston, 20 inches; stroke, 36 inches.
Diameter of piston rods, $3\frac{1}{16}$ inches.
Diameter of H. P. cylinder, 28 inches.
Diameter of L. P. cylinder, 56 inches.

Capacity.

For the test as above stated, March 9 and 10, the number of single strokes of the pump were 219,107; displacement, 48.13 gallons per stroke, or, in total, 10,555,620 for twenty-four hours.

Duty.

48.13 gallons per stroke, with a temperature of water at 33° Fahr. 401.32 pounds.
Strokes, as above, 219,107.

Average pressure, as established by gauge	189.90
Average difference of level between gauge and forebay	16.00
Allowance of friction by contract	2.31
Total fluid resistance in feet	208.21

Total weight of water delivered into boilers..... 174,225
Less entrained water established by previous test ($4\frac{8}{10}$ per cent)..... 8,363

165,862

At evaporation allowed by contract (ten pounds of dry steam for each pound of coal) the equivalent of coal consumed would be 16,586 pounds.

$$\frac{401.32 \times 219,107 \times 208.21 \times 100}{16,586} = 110,380,150 \text{ pounds feet.}$$

Indicator cards were taken from the steam cylinders and pumps for seven hours, 8 A. M. to 2 P. M., March 10, and the duty, as taken from the averages of steam cards was 120,383,400 pounds feet per 100 pounds of coal, at the rate of 10 pounds net of steam delivered to engines, as evaporated per one pound of coal.

During the same time the average of work done at the pumps, taken by indicator cards, was 112,636,600 pounds feet by the same standard of evaporation.

Loss of Action.

On December 30, a short test of twenty minutes was made of the delivery at the weir, and compared with the displacement of the pumps. The speed was twenty revolutions per minute and the loss of action nineteen per cent. On March 10, a similar test was made for one hour, at the same speed, with the same result. The engine at both tests ran silently, and as will be seen by pump indicator cards, the loss of action as far as it can be judged by these cards, should not be in excess of that of the Spring Garden engines; I therefore conclude that this loss of action is mostly due to escapes in the long rising main.

By a three-hour measurement at the weir during the test, the loss of action was twenty-nine per cent. It appears, therefore that even making a due allowance for the loss through the mains, there is a loss of action in the pumps that would reduce the capacity somewhat below that required by the contract, but that the duty would be nearly up to the requirements.

With regard to the working of the pumps, they generally ran quietly up to thirty-eight or thirty-nine revolutions per

minute (measured by displacement the contract quantity would require 36.1 revolutions), but at times there was considerable noise, due, I think, largely to the character of the water pumped. There is no strainer in the forebay, and the water was mixed with small sticks and floating *débris*. On taking off the bonnets after one of the tests chips were found beneath the valves.

There was no heating at any time.

The material and workmanship of the pumping engines are very good, speed easily adjustable, and easily regulated.

Respectfully submitted,

W. E. WORTHEN.

REPORT ON EFFICIENCY OF NEW BOILERS AT SPRING GARDEN AND FRANKFORD STATIONS.

PHILADELPHIA WATER DEPARTMENT,
January 6, 1885.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—The following results were obtained from the new steel boilers at the Spring Garden and Frankford Pumping Stations, on November 24 and 25, and December 29 and 30, 1884, during the trial tests of the new pumping plant at these stations.

The boilers are arranged in pairs, with one foot space from shell to shell, each pair connected to one steam drum, which is supported on the boilers in such a manner that the supports, bottom of drum, and sides of boilers form the connections to the smoke flue leading to the stack.

The coal and water were weighed on scales prepared for the purpose, and the observations were taken every hour.

The furnaces were fired as regularly as possible, the feed

water was pumped into the boilers almost continuously, and the steam pressure was maintained through the trial with a variation of not more than $2\frac{1}{2}$ to 3 pounds in either case.

	Spring Garden.	Frankford.
Date of trial	Nov. 24, 25.	Dec. 29, 30.
Duration of trial	24 hours.	26 hours.
Trial began	12 noon.	2 P. M.
Trial ended	12 noon.	4 P. M.
Dimensions and Proportions.		
Type of Boiler—Marine Tubular.		
Number in use	5	3
Diameter of boilers	11 ft. 6 in.	11 ft. 6 in.
Length of boilers	10 ft. 10 in.	10 ft. 10 in.
Number of furnaces	2	2
Type of furnaces: Fox Patent Corrugated.		
Mean diameter of furnaces	3 ft. 7 in.	3 ft. 7 in.
Length of furnaces	8 ft.	8 ft.
Number of tubes in each boiler	188	188
Diameter of tubes	3 in.	3 in.
Length of tubes	8 ft.	8 ft.
Diameter of drum	3 ft. 6 in.	3 ft. 6 in.
Length of drum	12 ft. 6 in.	12 ft. 6 in.
Heating surface of one boiler:		
Two corrugated furnaces	136 sq. ft.	136 sq. ft.
Back box	134 sq. ft.	134 sq. ft.
Tubes	1180 sq. ft.	1180 sq. ft.
Front of boiler	45 sq. ft.	45 sq. ft.
Side and back	56 sq. ft.	56 sq. ft.
Total	1551 sq. ft.	1551 sq. ft.
Superheating surface under drum	46 sq. ft.	46 sq. ft.
Grate surface (width 3 ft. 6 in.; length 6 ft.)	42 sq. ft.	42 sq. ft.
Ratio of water heating surface to grate surface	37 to 1	37 to 1
Total tube cross section area	$7\frac{7}{16}$ ft.	$7\frac{7}{16}$ ft.
Ratio of tube cross section to grate surface	1 to $5\frac{1}{2}$	1 to $5\frac{1}{2}$
Height of stack	100 ft.	100 ft.
Area of stack at base	49 sq. ft.	25 sq. ft.
Average Pressure.		
Steam pressure in boiler by gauge	63 lbs.	$110\frac{1}{2}$ lbs.
Steam pressure at engine	60 $\frac{1}{2}$ lbs.	$107\frac{3}{4}$ lbs.
Absolute steam pressure in boiler	78 lbs.	$125\frac{1}{2}$ lbs.
Atmospheric pressure per barometer	30.005	30.424
Force of draught in inches of water		
Average Temperature.		
Of external air	32° F.	34° F.
Of Fire room	79° F.	80° F.
Of steam	310° F.	344° F.
Of escaping gases	370° F.	343° F.
Of feed water	105.8° F.	108.8° F.
Of water in the pumping main		41° F.
Fuel.		
Total amount of coal consumed	58,962 lbs.	28,954 lbs.
Moisture in coal	Very wet.	Very wet.
Dry coal consumed		
Total refuse in pounds	11,724 lbs.	5,949 lbs.
Per cent. of refuse	21	20.5
Total combustible	47,238 lbs.	23,005 lbs.
Pounds of coal consumed per hour. Total	2,454.2 lbs.	1,113.6 lbs.
Pounds of coal consumed per hour. Per sq. ft. of grate surface	11.7 lbs.	8.8 lbs.
Pounds of coal consumed per hour. Per sq. ft. of heating surface	0.316 lbs.	0.24 lbs.
Pounds of combustible per hour. Total	1,968.2 lbs.	884.8 lbs.
Pounds of combustible per hour. Per sq. ft. of grate surface	9.36 lbs.	7.02 lbs.
Pounds of combustible per hour. Per sq. ft. of heating surface	0.25 lbs.	0.19 lbs.

RESULTS OF CALORIMETRIC TEST.

	Spring Garden.	Frankford.
Quality of steam, dry steam being taken as unity.		
Percentage of moisture in steam	7¾	2⅛
Number of degrees superheated		
WATER.		
Total weight of water pumped into the boilers and apparently evaporated	407,906 lbs.	196,842 lbs.
Water actually evaporated, corrected for quality of steam	375,464 lbs.	190,702 lbs.
Equivalent water evaporated into dry steam from and at 212° F.	428,967 lbs.	219,555 lbs.
Equivalent total heat derived from fuel, in British thermal units	473,293,417	211,834,261
Equivalent water evaporated into dry steam from and at 212° F. per hour	17,873 lbs.	8,444 lbs.
ECONOMIC EVAPORATION.		
Water actually evaporated per lb. of coal from actual pressure and temperature	6.37 lbs.	6.59 lbs.
Equivalent water evaporated per lb. of coal from and at 212° F.	7.28 lbs.	7.59 lbs.
Equivalent water evaporated per lb. of combustible from and at 212° F.	9.08 lbs.	9.55 lbs.
COMMERCIAL EVAPORATION.		
Equivalent water evaporated per lb. of coal with one-sixth refuse at 70 lbs gauge pressure from temperature of 100° F.	6.58 lbs.	6.92 lbs.
RATE OF COMBUSTION.		
Coal actually burned per sq. ft. of grate surface per hour	11.7 lbs.	8.8 lbs.
Consumption of coal per hour, coal assumed with ⅛ refuse. — Per sq. ft. of grate surface	11.3 lbs.	8.42 lbs.
Consumption of coal per hour, coal assumed with ⅛ refuse. — Per sq. ft. of water heating surface	.30 lbs.	.23 lbs.
Consumption of coal per hour, coal assumed with ⅛ refuse. — Per sq. ft. of least area of draught	61.3 lbs.	46.4 lbs.
RATE OF EVAPORATION.		
Water evaporated from and at 212° F. per sq. ft. of heating surface per hour	2.49 lbs.	1.84 lbs.
Water evaporated per hour from temperature of 100° F. into steam of 70 lbs. gauge pressure. — Per sq. ft. of grate surface	80.02 lbs.	59.41 lbs.
Water evaporated per hour from temperature of 100° F. into steam of 70 lbs. gauge pressure. — Per sq. ft. of water heating surface	2.16 lbs.	1.60 lbs.
Water evaporated per hour from temperature of 100° F. into steam of 70 lbs. gauge pressure. — Per sq. ft. of least area of draught	53.31 lbs.	40.35 lbs.
COMMERCIAL HORSE POWER.		
On a basis of 30 lbs. of water evaporated per hour from a temperature of 100° F. into steam of 70 lbs. gauge pressure (= 34½ lbs. from and at 212° F.)	Total H. P. 520	Total H. P. 242
Horse power (builders rating at 10 sq. ft. fire surface and 15 sq. ft. of tube surface per horse power)	565	339
Per cent. developed above rating		

The observations on the quantity of water evaporated were carefully watched by the experts employed by the contractors for Pumping Plant, as the contract required the duty of the plant to be estimated upon a basis of ten pounds of water evaporated, equivalent to one pound of coal.

Respectfully,

JOHN E. CODMAN,
Assistant Engineer.

REPORT

OF

MECHANICAL TESTS

WITH THE

400 TON U. S. TESTING MACHINE,

AT THE

WATERTOWN ARSENAL,

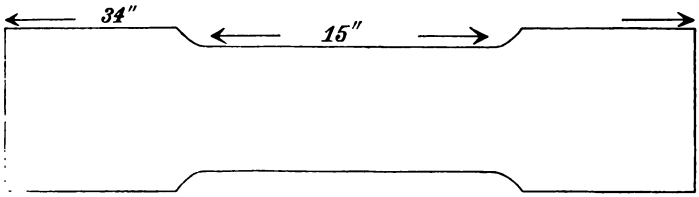
FOR THE

PHILADELPHIA WATER DEPARTMENT.

TESTS MADE BY JAMES E. HOWARD.

TENSILE TESTS OF STEEL BOILER PLATE.

FORM OF SPECIMENS.



No. 3099. MARK ON SPECIMEN, 1120.

Sectional area, 5.621 in. × .602 in. = 3.38 square inches.

Gauged length, 15 inches.

Stem laid off into 1 inch sections.

Applied loads.		In gauged length.		Remarks.
Total pounds.	Pounds per sq. inch.	Elongation.	Set.	
3,380	1,000	0		
16,900	5,000	.0020 in.		
33,800	10,000	.0040		
	1,000	.....	—.0002 in.	
50,700	15,000	.0068 in.		
67,600	20,000	.0091		
	1,000	.....	—.0002 in.	
84,500	25,000	.0120 in.		
	1,000	.....	0	
96,000	....	.0146 in.		
98,000	.....	.0151		
100,000	29.590	.0158	.....	Elastic limit.
101,400	30,000	.0166		
102,000	.....	.0185		
104,000	.....	.0230		
106,000	.....	.044		
108,000	.....	.234		
110,000	.....	.26		
111,540	33,000	.27		
118,300	35,000	.32		
135,200	40,000	.44		
152,100	45,000	.66		
169,000	50,000	.98		
185,900	55,000	1.70 in.		
193,600	57,280	.....	.....	Ultimate strength.
0	0	4.47 in.	—	29.8 per cent.

Elongation of inch sections after fracture: 15 in., .20 in., 27 in., .38 in., (1.02 in., fractured section), .41 in., .31 in., .28 in., .27 in., .24 in., .20 in., .19 in., .17 in., .11 in.

Area at fracture, 4.42 in. × .40 in. = 1.77 square inches.

Contraction of area, 47.6 per cent.

Appearance of fracture, silky, with fine lamination.

Correct: J. E. HOWARD.

No. 3100. MARK ON SPECIMEN, 1121.

Sectional area, 5.623 in. × .602 in. = 3.38 square inches.

Gauged length, 15 inches.

Applied loads.		In gauged length.		Remarks.
Total pounds.	Pounds per sq. inch.	Elongation.	Set.	
3,380	1,000	0		
16,900	5,000	.0018 in.		
33,800	10,000	.0040		
	1,000	.....	0	
50,700	15,000	.0066 in.		
67,600	20,000	.0091		
	1,000	.....	0	
84,500	25,000	.0118 in.		
	1,000	.....	0	
86,000	.....	.0120 in.		
88,000	.....	.0121		
90,000	.....	.0126		
92,000	.....	.0129		
94,000	.....	.0131		
96,000	.....	.0134		
98,000	.....	.0139		
100,000	.....	.0141		
101,400	30,000	.0145		
102,000	.....	.0149		
104,000	30,770	.0151	.....	Elastic limit.
106,000	.....	.0162		
108,000	.....	.239		
110,000	.....	.251		
111,540	33,000	.26		
118,300	35,000	.31		
135,200	40,000	.45		
152,100	45,000	.69		
169,000	50,000	1.04 in.		
185,900	55,000	1.80		
191,450	56,640	.....	.....	Ultimate strength.
0	0	4.36 in.	=	29.0 per cent.

Elongations of inch sections: .10 in., .17 in., .17 in., .20 in., .23 in., .25 in., .35 in., .59 in., (.85 in. fractured section), .35 in., .29 in., .25 in., .22 in., .19 in., .15 in.

Area at fracture, 4.49 in. × 36 in. = 1.62 square inches.
Contraction of area, 52.1 per cent.
Appearance of fracture, silky, with fine lamination.
Took oblique curve across specimen.

Correct: J. E. HOWARD.

No. 3101. MARK ON SPECIMEN, 1116.

Sectional area, 7.502 in. × .752 in. = 5.64 square inches.

Gauged length, 15 inches.

Applied loads.		In gauged length.		Remarks.
Total pounds.	Pounds per sq. inch.	Elongation.	Set.	
5,640	1,000	0		
28,200	5,000	.0018 in.		
56,400	10,000	.0043		
	1,000	.....	0	
84,600	15,000	.0072 in.		
112,800	20,000	.0100		
	1,000	.....	.0003 in.	
141,000	25,000	.0143 in.		
	1,000	.....	.0013 in.	
144,000	.....	.0145 in.		
146,000	.....	.0148		
148,000	.....	.0150		
150,000	.....	.0152		
152,000	.....	.0154		
154,000	.....	.0156		
156,000	.....	.0160		
158,000	.....	.0168		
160,000	28,370	.0172	.....	Elastic limit.
162,000	.....	.0186		
164,000	.....	.0310		
166,000	.....	.234		
168,000	.....	.245		
169,200	30,000	.248		
174,840	31,000	.270		
186,120	33,000	.333 in.		
197,400	35,000	.418		
225,600	40,000	.70		
253,800	45,000	1.02 in.		
282,000	50,000	1.72		
296,800	52,620	.....	.....	Ultimate strength.
0	0	4.96 in.	=	33.0 per cent.

Elongation of inch sections: .11 in., .19 in., .22 in., .28 in., .37 in., .55 in., (1.22 in., fractured section), .46 in., .33 in., .28 in., 24 in., .24 in., .22 in., .17 in., .08 in.

Area at fracture, 5.92 in. × .48 in. = 2.84 square inches.

Contraction of area, 49.6 per cent.

Appearance of fracture, silky, slightly spongy at centre.

Oblique fracture, tore apart from one edge, which showed an opening of .35 in., after fracture.

Correct: J. E. HOWARD.

No. 3102. MARK ON SPECIMEN, 1117.

Sectional area, 7.442 in. × .738 in. = 5.49 square inches.

Gauged length, 15 inches.

Applied loads.		In gauged length.		
Total pounds.	Pounds per sq. inch.	Elongation.	Set.	Remarks.
5,490	1,000	0		
27,450	5,000	.0018 in.		
54,900	10,000	.0040		
	1,000	.....	0	
82,350	15,000	.0066 in.		
109,800	20,000	.0090		
	1,000	.....	0	
137,250	25,000	.0120 in.		
	1,000	.....	.0002 in.	
140,000	.....	.0120 in.		
142,000	.....	.0121		
144,000	.....	.0122 in.		
146,000	.....	.0124		
148,000	.....	.0126		
150,000	.....	.0128		
152,000	.....	.0130		
154,000	.....	.0132		
156,000	28,420	.0134	.....	Elastic limit.
158,000	.....	.0142		
160,000	.....	.195		
164,700	30,000	.203		
170,190	21,000	.234		
181,170	33,000	.292		
192,150	35,000	.363		
219,600	40,000	.57		
247,050	45,000	1.85 in.		
274,500	50,000	1.38		
296,100	53,930	.....	.....	Ultimate strength.
0	0	4.69 in.	=	31.3 per cent.

Elongation of inch sections: .11 in., .17 in., .19 in., .21 in., .21 in., .26 in., .35 in., .42 in., (1.04 in., fractured section), .54 in., .34 in., .28 in., .24 in., .19 in., .14 in.

Area at fracture, 5.82 in. × .47 in. = 2.74 square inches.

Contraction of area, 50.1 per cent.

Appearance of fracture, silky, with slight lamination.

Correct: J. E. HOWARD.

No. 3103. MARK ON SPECIMEN, 1118.

Sectional area, 7.502 in. × .752 in. = 5.64 square inches.

Gauged length, 15 inches.

Applied loads.		In gauged length.		Remarks.
Total pounds.	Pounds per sq. in.	Elongation.	Set.	
5,640	1,000	0	.....	Specimen has warped surface, introducing minus "sets."
28,200	5,000	.0013 in.		
56,400	10,000	.0035		
	1,000	.....	0	
84,600	15,000	.0058 in.		
112,800	20,000	.0080		
	1,000	.....	—.0003 in.	
141,000	25,000	.0100 in.		
	1,000	.....	about —.0015 in.	
144,000	.....	.0100 in.		
146,000	.....	.0102		
148,000	.....	.0106		
150,000	.....	.0109		
152,000	.....	.0112		
154,000	27,300	.0121	.....	Elastic limit.
156,000	.....	.0135		
158,000	.....	.0165		
160,000	.....	.0215		
162,000	.....	.202		
164,000	.....	.213		
169,200	30,000	.231		
174,840	31,000	.252		
186,120	33,000	.297		
197,400	35,000	.351		
225,600	40,000	.56		
253,800	45,000	.89		
282,000	50,000	1.50 in.		
299,500	53,110	.....	.....	Ultimate strength.
0	0	4.82 in.	=	32.1 per cent.

Elongation of inch sections: .10 in., .18 in., .20 in., .24 in., .24 in., .28 in., .31 in. .42 in. (1.18 in. fractured section), .53 in., .34 in., .28 in., .24 in., .16 in., .12 in.

Area at fracture, 5.85 in. × .48 in. = 2.81 square inches.

Contraction of area, 50.2 per cent.

Appearance of fracture, silky, with slight lamination.

Correct: J. E. HOWARD.

F. H. PARKER,
Major of Ordnance Commanding.

Watertown Arsenal, Mass.,
September 28, 1883.

REPORT BY THE CHIEF CLERK

OF THE DETAILED EXPENDITURES OF THE DEPARTMENT, DURING 1884.

PHILADELPHIA WATER DEPARTMENT,

February 1, 1885.

COL. WILLIAM LUDLOW,

Chief Engineer:

SIR:—I have the honor to herewith submit a detailed statement of the expenditures of this department for the year 1884.

The recapitulation attached will show the total amount available during the year, the sub-division of expenditures, the balances merging, and those remaining to the credit of the department at the close of the year.

The business transactions during the year required the issue of seventeen hundred and thirty-two orders for supplies, the examination of thirty-four hundred bills, the preparation of three hundred and forty-eight pay-rolls, and the drawing of twelve thousand seven hundred and thirty-seven warrants.

Respectfully,

J. T. HICKMAN,

Chief Clerk.

Detailed Expenditures of the Department for 1884.

General Appropriation.			Amount appropria'd.	Amount expended.	Amount merging.
An Ordinance making an appropriation to the Water Department for the year 1884, approved December 31, 1883		$813,385 00			
Increased by transfer:					
From Board of Fire Commissioners, Oct. 24	$6,000 00				
From Inspectors of County Prisons, November 25	3,500 00				
From Revision of Taxes, Nov. 25	2,000 00				
From Board of Fire Commiss'ers, November 25	2,500 00				
From Trustees of City Ice Boats, November 25	1,000 00				
		$15,000 00			
Diminished by transfer:					
To refund twice-paid water-rents, Sept. 9	$891 93				
To refund twice-paid water-rents, Oct. 4	3,153 44				
		$4,045 37			
Net increase by transfer		10,954 63			
Net appropriation			$824,339 63		
Item 1. Salaries		$168,944 00			
Diminished by transfer:					
To refund twice-paid water-rents, September 9	$891 93				
To Item 7, October 4	1,500 00				
" 2, November 25	1,100 00				
" 7, November 25	300 00				
" 3, December 30	200 00				
" 7, December 30	400 00				
" 8, December 30	400 00				
Net reduction		4,791 93			
Net appropriation to Item 1			$164,152 07		
Salary of Chief Engineer			$6,000 00	$6,000 00	
" superintendent			3,000 00	3,000 00	
" assistant engineers			8,400 00	6,325 80	
" draughtsmen			4,150 00	4,150 00	
" chief clerk			1,800 00	1,800 00	
" assistant clerk			1,080 00	1,080 00	
" correspondence clerk			1,000 00	1,000 00	
" superintendent's clerk			850 00	850 00	
" pipe recording clerks			1,800 00	1,800 00	
" time clerk			850 00	850 00	
" messenger			600 00	600 00	
" pipe inspector			1,200 00	1,200 00	
" registrar			2,750 00	2,750 00	
" registrar's clerk			1,350 00	1,350 00	
" cashier			1,300 00	1,300 00	
" permit clerk			1,080 00	1,080 00	
" registering clerk			1,080 00	1,080 00	

Detailed Expenditures of the Department for 1884.

General Appropriation.	Amount appropria'd.	Amount expended.	Amount merging.
Item 1, continued.			
Salary of receiving clerks	$2,000 00	$2,000 00	
" general clerks	5,400 00	5,400 00	
" chief inspector	950 00	950 00	
" inspectors	17,100 00	17,068 53	
" messenger	800 00	800 00	
" purveyors	8,880 00	8,880 00	
" purveyor's clerks	3,600 00	2,798 71	
" general foremen	5,634 00	5,459 83	
" foremen of repairs	3,120 00	3,120 00	
" watchmen	2,025 00	2,025 00	
" superintendent of shop	1,500 00	1,500 00	
" clerk to superintendent of shop	850 00	831 73	

Detailed Expenditures of the Department for 1884.

SALARIES OF EMPLOYÉS AT PUMPING STATIONS.	Engineer in Charge.	First Engineer.	Second Engineer.	Assistant Engineers.	Oilers.	Firemen.	Coal Passers.	Storekeeper.	Amount appropria'd.	Amount Expended.	Amount merging.
Fairmount	.....	1	1	.....	4	.....	.....	1	$5,600 00	$5,573 66	
Spring Garden	1	.....	.....	4	6	10	4	1	20,100 00	19,774 50	
Belmont	1	.....	.....	2	2	6	4	1	12,200 00	11,957 78	
Roxborough	1	.....	.....	2	.....	.....	4	2	6,970 00	6,688 08	
Mt. Airy	.....	1	1	.....	.....	.....	.....	2	2,540 00	2,527 45	
Chestnut Hill	1	.....	.....	.....	.....	.....	.....	1	1,410 00	1,410 00	
Frankford	1	.....	.....	.....	1	2	.....	.....	3,250 00	3,250 00	
Kensington	.....	1	1	.....	.....	2	4	.....	7,100 00	6,703 75	
Salary of foreman carpenter									900 00	900 00	
" " bricklayer									950 00	950 00	
" " stonemason									900 00	900 00	
" " rigger									900 00	900 00	

Detailed Expenditures of the Department for 1884.

General Appropriation.		Amount appropria'd.	Amount expended.	Amount merging.
Salary of foreman, laborers		$675 00	$675 00	
" watchmen		8,100 00	8,100 00	
" policemen, with $40 each for uniforms		2,860 00	2,860 00	
" janitor, Spring Garden Hall		675 00	675 00	
" river watchman		750 00	745 84	
" watchman, Spring Garden Hall		675 00	675 00	
" lineman		720 00	720 00	
" telephone operators		720 00	720 00	
" general storekeeper		800 00	363 48	
			$164,119 14	$32 93
Item 2. For regular supplies, including fuel, oil, gas, and small stores	$130,000 00			
Diminished by transfer:				
To Item 8, June 21	$15,500 00			
" 3, Oct. 4	10,000 00			
" 4, " 4	10,000 00			
" 5, " 4	5,000 00			
	$40,500 00			
Increased by transfer:				
From Item 1, November 25	$1,100 00			
From Item 3, November 25	6,800 00			
From Item 11, December 11	390 00			
	$8,290 00			
Net reduction	$32,210 00			
Net appropriation to item		97,790 00		
Blocks and sheaves			3 00	
Brise			15 00	
Chandlery			1,031 71	
Copper measures			3 55	
Gum goods			1,195 03	
Hauling coal, Auxiliary Station, Roxborough			106 70	
Hauling coal, Kensington Station			10 00	
Hauling coal, Mt. Airy Station			694 21	
Hardware			307 78	
Iron fittings			386 80	
Magnetic Blasting Machine			30 00	
Oil cans			6 25	
Packing			201 93	
Paints			261 89	
Polish			49 95	
Scales, etc.			772 82	
COAL FOR OFFICES, SHOP, AND PURVEYORS' DISTRICTS.				
41 tons of stove, at $6.00	$246 00			
85 tons of bituminous, at $5.75	488 75			
113 tons of nut, at $5.75	649 75			
20 tons carried to third floor, at $1.50	30 00			
			1,414 50	
COAL FOR PUMPING STATIONS.				
2 tons, 1990 lbs. bituminous sub-main, at $6 00	$17 97			
4,400 lbs. bituminous sub-main, at. 5 50	12 00			

Detailed Expenditures of the Department for 1884.

General Appropriation.			Amount appropria'd.	Amount expended	Amount merging.
Item 2—Continued.					
15	tons egg, Kensington, at..$4 00	$60 00			
2,392	" pea, Kensington, at.. 2 82	6,745 44			
1,502.15	" pea, Frankford, at.... 2 92	4,388 03			
27.15	" egg, Chestnut Hill, at 4 85	134 58			
985.01	" pea, Chestnut Hill, at 3 20	3,152 16			
1,585.07	" egg, Roxborough, at.. 4 46	7,070 66			
2,616.07	" pea, Roxborough, at.. 2 90	7,587 43			
41.09	" pea, Belmont, at..... 2 65	111 17			
47.01	" pea, Belmont, at..... 3 45	162 32			
4,329.03	" pea, Belmont, at..... 2 89	12,511 25			
229.11	" egg, Belmont, at..... 4 38	1,005 48			
2,517.09	" egg, Spr'g Garden, at.. 4 51	11,353 72			
10,109.19	" pea, Spr'g Garden, at.. 2 95	29,824 33			
			.....	$84,136 59	
	GAS.				
Shop		$59 52			
Mt. Airy		173 76			
Kensington		888 09			
Spring Garden		1,708 42			
Fairmount		1,964 33			
			.....	4,794 12	
	OIL AND TALLOW.				
Albany grease		$6 25			
49½	gals. black oil, at 15c	7 43			
856½	" gasoline, at 19c	162 74			
495	" gasoline, at 18c	89 10			
1,178	" headlight, at 12c	141 27			
404¼	gals. lard, at 66c	266 80			
814	" lard, at 71c	577 95			
294⅔	" paraffine, at 16c	47 15			
101	" red star cylinder, at 40c	40 40			
1,304	" valve, at 49c	638 95			
51	" valve, at 55c	28 05			
352½	" valve, at 59c	207 97			
			.....	2,214 06	
				$97,635 89	$154 11
Item 3. For repairs to machinery, and the conveyance of workmen incident thereto..$45,000 00					
Increased by transfer:					
From Item 2, Oct. 4, $10,000 00					
" 1, Dec. 30, 200 00					
	$10,200 00				
Diminished by transfer:					
To Item 2, November 25.....	6,800 00				
Net increase by transfer		3,400 00			
Net appropriation to Item			$48,400 00		
Chain hoists			.....	50 00	
Hydraulic jacks			.....	328 00	
Repairs to indicators			.....	9 25	
Repairs to jacks			.....	43 22	
Stroke indicator			.....	23 51	
Transportation			.....	561 75	

General Appropriation.										Amount appropria'd.	Amount expended.	Amount merging.
Item 3, continued.												
WAGES.	Fairmount.	Spring Garden.	Belmont.	Roxborough.	Mt. Airy.	Chestnut Hill.	Frankford.	Kensington.	Totals.			
Bricklayers	$287 00	$1,276 37	$916 99	$439 75	$64 75	$103 25	$288 00	$132 50	$3,508 61			
Carpenters	469 75	111 00	36 00						616 75			
Hauling	39 75	330 00	13 00	116 25	62 00	15 50	90 50	41 50	708 50			
Laborers	35 00	462 12	456 24	184 61			388 93	20 12	1,546 02			
Machinists	873 12	4,740 01	1,984 24	1,006 26	174 16	157 22	894 65	304 12	10,133 78			
Painters	300 00	165 00							465 00			
Stonemasons	129 00	142 50		495 50			21 00		788 00			
Totals	$2,133 62	$7,226 00	$3,406 47	$2,242 37	$300 91	$275 97	$1,683 08	$498 24			$17,766 66	

Detailed Expenditures of the Department for 1884.

General Appropriation.	Amount appropria'd.	Amount expended.	Amount merging.
Item No. 3, continued.			
Amounts brought forward		$18,782 39	

MATERIAL.	Fairmount.	Spring Garden.	Belmont.	Roxborough.	Mt. Airy.	Chestnut Hill.	Frankford.	Kensington.		
Asbestos paint		$29 00								29 00
Air valve	$57 30									57 30
Boiler inspection			$64 00		$18 60	$15 80		$47 50		145 90
Block and rope		34 65								34 65
Bricks, lime, and sand		189 40		10 09						199 49
Cement		16 25				3 25				19 50
Coal cars		392 00	98 00	98 00			98 00			686 00
Covering boilers and pipe		390 07		700 15	48 00	97 80	54 30			1,290 32
Donkey pumps		2,201 90		698 40			1,285 25	400 00		4,585 55
Drip pans		7 50	2 50							10 00
Fire brick		352 77	74 60				14 60			441 97
Flue connections		763 79								763 79
Freight				3 57						3 57
Grate bars		919 20	710 20	162 42	61 20	92 01		333 33		2,278 36
Gum gasket and valves		250 14	13 05	37 03	62 20		40 40	15 00		417 82
Hand side rest			15 00							15 00
Hardware	5 50	124 76	57 34	3 84	11 77		62 46			265 67
Hot well tank		132 00								132 00

General Appropriation.									Amount appropria'd.	Amount expended.	Amount merging.
Item No. 3, continued.											
MATERIAL—continued.	Fairmount.	Spring Garden.	Belmont.	Roxborough.	Mt. Airy.	Chestnut Hill.	Frankford.	Kensington.			
Iron and brass fittings	$74 46	$4,615 53	$902 46	$319 12	$264 72	$63 90	$458 42	$3 59		$6,702 20	
Lumber	14 46									14 46	
Leather belting			21 33							21 33	
Machine work	35 00									35 00	
New scale				47 20						47 20	
Packing		548 59	393 40	133 45			42 00			1,117 44	
Repairs to boilers		1,723 58	724 27	1,484 47	145 72	322 75	1,505 58			5,906 37	
" counters			5 88	9 50						15 38	
" engines		3,729 07								3,729 07	
" gate hoist	136 41									136 41	
" scales		103 62		22 20				3 49		129 31	
Steam traps					16 00					16 00	
Shaper		225 00								225 00	
Tar							2 50			2 50	
Towing		14 00								14 00	
Valve		10 50								10 50	
Wire screen		94 18								94 18	
Totals	$323 13	$16,867 50	$3,082 03	$3,729 44	$628 21	$595 51	$3,563 51	$802 91		$48,374 63	$25 37

Detailed Expenditures of the Department for 1884.

General Appropriation.	Amount appropria'd.	Amount expended.	Amount merging.
Item 4. For repairs to buildings, grounds, and reservoirs	$25,000 00		
Increased by transfer:			
From Item 2, October 4	$10,000 00		
" 6, November 25	4,175 00		
" 11, December 30	1,015 00		
Net increase	15,190 00		
Net appropriation to Item	$40,190 00		
Alterations to coal cars		$805 70	
" " shutes		90 00	
Bricks, lime, and sand		1,749 18	
Cement		1,205 30	
Cleaning cesspool		30 50	
Chandlery		526 67	
Fire-brick and clay		94 00	
Forebay gates		350 00	
Forage		503 07	
Force-pump		18 00	
Freight		31 28	
Gas fitting		317 96	
Gas machine		174 00	
Grass seed and plants		37 75	
Gum goods		142 80	
Hardware		818 29	
Harness		126 75	
Hauling ashes		651 32	
Hire of diving apparatus		33 00	
Horse blankets		41 00	
Horse-shoeing		28 70	
Iron fittings		6 33	
Lumber		3,488 98	
Lamps (electric)		151 20	
New track and repairing old		847 98	
Oars and chain		19 98	
Painting		15 00	
Paints, paint oil, and glass		812 68	
Paper hanging		110 65	
Plumbing		449 42	
Professional services (veterinary surgeon)		10 00	
Repairs to roadway		4 25	
" roofs		646 35	
" water-closets		261 68	
Removing dam and dredging		505 50	
Setting gas machine		316 93	
Stone		223 34	
Stoves, etc		22 75	
Telephone rental		1,123 11	
" supplies		20 84	
Wagon, carts, and repairs		382 50	
Window frames and sash		95 97	
Wooden barrows		48 00	
Wages, bricklayers		794 50	
" calciminers		140 00	
" carpenters		4,473 00	
" cement mixer		138 75	
" hauling		800 00	
" laborers		11,776 55	
" painters		2,457 00	
" plasterers		688 51	
" stableman		398 00	
" stonemasons		1,044 00	
" quarryman		60 00	
		$40,109 02	$80 98

Detailed Expenditures of the Department for 1884.

General Appropriation.			Amount appropria'd.	Amount expended.	Amount merging.
Item 5. Maintenance and improvement of the distribution		$135,000 00			
Increased by transfer:					
From Item 2, October 4	$5,000 00				
" " 6, November 25	14,400 00				
" Inspectors County Prison, November 25	3,500 00				
" Receiver of Taxes, November 25	2,000 00				
" Board of Fire Commissioners, November 25,	2,500 00				
" Trustees City Ice Boats, November 25	1,000 00				
Net increase		28,400 00			
Net appropriation to Item			$163,400 00		
Bricks and sand				$60 20	
Brass steam fittings				3,158 70	
Canvas				49 98	
Cement				182 00	
Chain and shackles				142 08	
Chandlery				539 29	
Coke				100 70	
Freight				7 55	
Fire Hydrants				228 00	
Gasoline				2 50	
Gum goods				989 26	
Hauling				99 00	
Hauling pipe				5,654 92	
Hardware				1,146 07	
Hire of boats				45 00	
" of chain				164 54	
" of crab				27 00	
" of diving apparatus				2,510 00	
" of lighters				1,058 00	
Hydraulic jacks				301 80	
Iron fittings				2,589 51	
Iron knees				42 00	
Iron pipe				32,009 29	
Lumber				4,801 94	
Manure				2 00	
Measuring over pipe				1,419 89	
Meters				25,624 94	
Pig lead				5,305 39	
Plumbing				255 25	
Powder (blasting)				1,106 15	
Rent of cellar				50 00	
Repairs to jacks				107 97	
" to pipe				130 93	
" to stop				90 00	
" to tools				190 73	
Stop valve				75 00	
Supporting track				25 40	
Tapping machines				900 00	
Towing				49 00	
Trackage				24 00	
Wharfage				33 68	
White lead				1 50	
Wages, First District				6,949 70	
" Second "				7,311 56	
" Third "				10,334 67	
" Fourth "				14,182 64	
" Fifth "				7,261 96	
" Sixth "				11,034 05	
" buildings, grounds, and reservoirs				4,962 40	
" improvement to distribution				9,528 00	
				$162,866 14	$533 86

Detailed Expenditures of the Department for 1884.

General Appropriation.	Amount appropria'd.	Amount expended.	Amount merging.
Item 6. For supplies and labor at city repair shop $60,000 00			
Diminished by transfer:			
To refund twice paid water rents, October 4..... $3,153 44			
To Item 4, November 25..... 4,175 00			
" 5, " 25..... 14,400 00			
Net reduction..... 21,728 44			
Net appropriation to item.....	$38,271 56		
Brass castings.....		$2,041 96	
Brass steam fittings.....		381 86	
Coke.....		14 00	
Chandlery.....		501 24	
Galvanizing.....		160 32	
Grates.....		7 50	
Gum goods.....		372 82	
Hoist.....		20 25	
Hammer dies.....		45 10	
Hardware, steel bolts, and nuts.....		2,280 35	
Iron.....		1,308 54	
Iron castings.....		9,148 06	
Iron tubing.....		159 87	
Leather.....		10 33	
Lumber.....		402 02	
Machine work.....		301 12	
Malleable castings.....		70 28	
Oil.....		83 79	
Paints.....		19 35	
Plug valves.....		675 00	
Repairs to gauge.....		3 90	
" pump.....		37 15	
Steam-trap.....		26 25	
Varnish.....		40 00	
Wages.....		20,127 62	
		$38,238 68	$32 88
Item 7. For general and incidental expenses, including keep of horse for Chief Engineer, superintendent, and assistant engineers..... $11,941 00			
Increased by transfer:			
From Item 1, October 4..... $1,500 00			
" " 1, November 25..... 300 00			
" " 1, December 30..... 400 00			
Net increase..... $2,200 00			
Net appropriation to item.....	$14,141 00		
Advertising.....		$879 75	
Badges.....		32 50	
Books.....		164 20	
Brass fittings.....		12 55	
Carriage hire.....		105 25	
Chairs, stools, and desk.....		107 50	
Chandlery.....		39 58	
Clocks.....		10 50	
Engineer's supplies.....		1,008 94	
Extra copies Chief Engineer's report.....		194 00	
Frames.....		13 50	
Ground-rent.....		26 26	
Gum goods.....		111 17	
Hardware.....		35 76	

Detailed Expenditures of the Department for 1884.

General Appropriation.	Amount appropria'd.	Amount expended.	Amount merging.
Item 7, continued.			
Ice		$244 60	
Incidentals		846 90	
Iron safes		447 00	
Keep of horse, Chief Engineer		650 00	
" " superintendent and ass't engineers		750 00	
Lumber		112 88	
Meals		426 90	
Maps		18 50	
Messenger and telegraph service		174 92	
Paper hanging		10 1[illegible]	
Plumbing		13 00	
Postage stamps		245 76	
Printing notice		59 60	
Rent of office and cellar		150 00	
Repairs to instruments		67 67	
Stationery		3,997 86	
Traveling expenses (pipe inspector)		240 45	
Transportation		2,632 90	
Type writer and supplies		133 28	
Washing towels		73 50	
Window shades		5 00	
Item 8. For surveys, and expenses in connection therewith, for a future water supply, $10,000 00		$14,042 36	$98 64
Increased by transfer:			
From Item 2, June 21 $15,500 00			
" " 1, December 30 400 00			
Net increase 15,900 00			
Net appropriation to item	$25,900 00		
Brass fittings		3 60	
Blue prints		3 00	
Cement		5 96	
Casks		9 85	
Freight		2 24	
Engineer's supplies		822 87	
Gum goods		14 80	
Hardware		116 77	
Incidentals		2,586 75	
Lumber		127 07	
Maps		218 20	
Oakum		5 50	
Printing notice		3 00	
Rain gauges		197 60	
Repairs to instruments		332 74	
Rent		304 20	
Services of assis't engineers, analyst, and rodman		20,901 00	
Tripod		78 00	
Walnut strips		1 50	
Water registering clock		150 00	
Item 9, contingent expenses $10,000 00		$25,884 65	15 35
Increased by transfer:			
From Item 11, December 30 160 00			
Net appropriation to Item	10,160 00		
Books and binding		89 40	
Horses and carts		664 95	
Incidentals		20 40	
Lumber		17 10	
Messenger and telegraph service		83 94	
Wages		9,217 91	
		$10,093 70	66 30

Detailed expenditures of the Department for 1884.

General Appropriation.		Amount appropria'd.	Amount expended.	Amount merging.
Item 10, for the extension of works	$217,500 00			
Increased by transfer:				
From Item 11, December 30	1,435 00			
Net appropriation to Item		$218,935 00		
Deficiencies of 1883; Ordinance March 22, 1884:				
Advertising	$52 30			
Books	17 20			
Bricks, lime, and cement	5 78			
Coal	5,877 75			
Carriage hire	28 25			
Fire-brick and clay	148 50			
Gum goods	121 89			
Hardware	49 23			
Hauling ashes	388 68			
Hauling coal	111 55			
Ice	196 17			
Iron castings	226 58			
Iron fittings	47 47			
Iron railing	46 45			
Incidentals	166 15			
Lamps	93 69			
Lumber	1,885 88			
Maps	25 10			
Meals	15 45			
Messengers and telegraph service	100 70			
Oil	97 07			
Paints	270 40			
Packing	425 37			
Paving around plugs	519 53			
Plate glass	5 53			
Plumbing	176 03			
Postage	16 44			
Repairs to engine	4,413 60			
Repairs to heater	8 75			
Repairs to instruments	5 90			
Repairs to mains	1,879 22			
Repairs to roofs	933 32			
Sash and frames	287 68			
Services of superintendent of excavation	782 46			
Stationery	509 72			
Stone	53 16			
Telephone rental	375 00			
Transportation	283 00			
Valve	1,250 00			
Wood	7 60			
			$21,904 55	
Base for stand pipe			241 60	
Brass fittings			433 68	
Bricks, lime, and sand			849 78	
Boilers, Spring Garden Station			13,025 00	
Cement			1,787 50	
Chandlery			261 74	
Coal shed, Frankford Station			5,413 00	
Coal shed, Spring Garden station			7,300 00	
Coffer-dam, Fairmount Station			916 55	
Conduit, Spring Garden Station			2,224 15	
Connections for boilers, Spring Garden Station			2,304 94	
Disc for pump			53 00	
Electric plants for Spring Garden Station			6,176 00	
Extra work on boilers, Spring Garden and Frankford Stations			1,484 15	
Gate hoists castings			76 21	
Gum goods			13 50	

Detailed Expenditures of the Department for 1884.

General Appropriation.	Amount appropria'd.	Amount expended.	Amount merging.
Item 10, continued.			
Hardware		$282 58	
Hire of lighter		243 10	
Incidentals		55 60	
Iron		32 85	
Iron beams		1,044 58	
Iron fittings		375 20	
Iron pipe and special castings		81,136 88	
Lift crab		87 00	
Lumber		1,444 15	
Mill work, new store-house, Spring Garden Station		705 00	
New gates, Fairmount Station		684 36	
Oakum		3,6 00	
Paints		74 35	
Portable boiler		400 00	
Repairs to tools		149 68	
Rope		124 28	
Services inspectors, superintending the erection of engines and boilers		1,280 90	
Sheet lead		111 54	
Steel rails		263 50	
Stone		490 00	
Store-house and stable, Spring Garden Station (labor in erection)		1,592 00	
Tar		4 00	
Tin for roof, store-house and stable, Spring Garden station		199 85	
Tolls		10 50	
WAGES.			
Building forebay walls, Spring Garden Station		1,109 88	
Buildings, grounds, and reservoirs		2,404 94	
Cleaning forebay, Spring Garden Station		2,823 96	
" " Fairmount Station		231 00	
Conduit, Fairmount and Spring Garden Stations		10,543 34	
Excavating and blasting Spring Garden Station		574 42	
Fourth District		17,858 75	
Repairing forebay wall, Spring Garden Station		179 24	
Sixth District		11,884 32	
Spring Garden and Frankford improvement		11,465 93	
Third District		1,549 66	
		$218,933 72	$1 28
Item 11. For erecting fire plugs with three attachments.			
Transferred from appropriation to the Board of Fire Commissioners, October 24, 1884.. $6,000 00			
Diminished by transfer:			
To Item 2, December 30 ..... $390 00			
" 4, " 1,015 00			
" 9, " 160 00			
" 10, " 1,435 00			
Net reduction 3,000 00			
Net appropriation to Item	$3,000 00		
Bolts and nuts		74 72	
Brass castings		268 77	
Gum sheet		75 15	

Detailed Expenditures of the Department for 1884.

General appropriation.	Amount appropria'd.	Amount expended.	Amount merging.
Item 11, continued.			
Iron		$29 58	
Iron castings		105 84	
Iron pipe		568 10	
Lead lining		15 00	
Leather		8 25	
Pattern carving		1 80	
Plug valves (gum)		250 00	
" valves (iron)		5 50	
" castings		651 18	
Wages		906 93	
		$2,960 82	$39 18
	Balance Jan. 1, 1884.		Balance not merging
Item 13, of appropriation for 1883. For keeping machinery in good order, transferred from surplus of 1882. Ordinance Nov. 19, 1883...	30 14		
Brass steam fittings		30 14	
Item 15, of appropriation for 1883. For keeping buildings, grounds, and reservoirs in good order, transferred from surplus of 1882. Ordinance November 19, 1883	$78 72		
Repairs to roofs		78 72	
			Amount not merging
Item 19, of appropriation for 1883. For the purchase of pipe and special castings, transferred from surplus of 1882, ordinance October 20, 1883	$24,939 68		
Iron pipe and special castings		20,824 52	
Stop valves		3,800 00	
		$24,624 52	$315 16
Item 21, of appropriation for 1882. For the purchase of two small engines, stand pipe, and boilers for Mount Airy Station, ordinance January 5, 1882	2,753 02		
Force and air pump		160 28	2,592 74
Special appropriations.	Balance Jan. 1, 1884.		
For the purpose of beginning the work of constructing the Cambria reservoir, balances of consolidated water loans, ordinance June 27, 1883	$380 70		
Rent		12 00	
Wages		368 70	
		$380 70	
For the Extension of Works.			
Surplus of 1880 and 1881.			
Ordinances of June 21, 1882, and March 24, 1883....	$152,359 12		
Boilers for Frankford Station		26,680 00	
Boilers for Spring Garden Station		50,650 00	
Conduit for Spring Garden Station		141 75	
Excavation for Spring Garden Station		3,300 00	
Extra work on engine house, Spring Garden		1,442 97	
Carried forward		$82,214 72	

Detailed Expenditures of the Department for 1884.

Special appropriations.	Balance Jan. 1, 1884.	Amount expended.	Balance not merging
Brought forward		$82,214 72	
Hire of tools		278 83	
Pumping engine, Roxborough Station		18,720 00	
Pumping engines, Spring Garden Station		24,800 00	
Repairs to engine, Spring Garden Station		1,261 71	
Services inspectors superintending the erection of engines and boilers		290 22	
Surveys for a future water supply		1,225 00	
Testing boiler plate		5 50	
Use of derrick		92 50	
		$128,888 48	$23,470 64
FOR THE EXTENSION OF WORKS.			
Surplus of 1882.			
Ordinance of March 24, 1883	$61,523 49		
Conduit		$138 00	
Incidentals		34 08	
Lumber		31 81	
New engine house, Spring Garden Station		26,928 00	
Pumping engine, Frankford Station		25,200 00	
Repairs to tools		17 35	
Surveys for a future water supply		347 91	
		$52,697 15	8,826 34
REFUNDS.			
For the purpose of refunding certain twice-paid, over-paid and paid-in-error water rent and pipe laying bills. Ordinance December 31, 1880	180 00	$24 43	155 57
For the purpose of refunding certain twice-paid, over paid, and paid-in-error water rent and pipe laying bills. Ordinance June 16, 1881	523 75	21 50	502 25
For the purpose of refunding certain twice-paid, over-paid, and paid-in-error water rent and pipe laying bills. Ordinance March 10, 1882	116 25	15 50	100 75
For the purpose of refunding certain twice-paid, over-paid, and paid-in-error water rent and pipe laying bills. Ordinance December 11, 1882	376 43	159 78	216 65
For the purpose of refunding certain twice-paid, over-paid, and paid-in-error water-rent and pipe laying bills. Ordinance December 30, 1882	174 28	27 93	146 35
For the purpose of refunding certain twice-paid, over-paid, and paid-in-error water rent and pipe laying bills. Ordinance November 12, 1883	950 87	537 92	412 95
For the purpose of refunding certain twice-paid, over-paid, and paid-in-error water rent and pipe laying bills. Ordinance September 9, 1884	Amount appropria'd. $891 93	529 52	362 41
For the purpose of refunding certain twice-paid, over-paid, and paid-in-error water rent and pipe laying bills. Ordinance October 4, 1884	3,153 44	2,180 69	972 75

Detailed Expenditures of the Department for 1884.

RECAPITULATION.

Available for 1884.

Special appropriations		$248,431 82	
Annual appropriation		824,339 63	
			$1,072,771 45
Expended from annual appropriation for deficiencies of 1883	$21,904 55		
Expended from annual appropriation for surveys	25,884 65		
Expended from annual appropriation for extensions	197,029 17		
Expended from annual appropriation for maintenance	578,440 38		
		$823,258 75	
Expended from special appropriations for extension at Mt. Airy	$160 28		
Expended from special appropriations for Cambria Basin	380 70		
Expended from special appropriations for refunds	3,497 27		
Expended from special appropriations for maintenance	24,733 38		
Expended from special appropriations for extensions	181,585 63		
		210,357 26	
Balance merging	$1,080 88		
" not merging	38,074 56		
		39,155 44	
			1,072,771 45
Expended for refunds	$3,497 27		
" " deficiencies	21,904 55		
" " surveys	25,884 65		
" " extensions	379,155 78		
" " maintenance	603,173 76		
		$1,033,616 01	
Balance		39,155 44	
			1,072,771 45
Balance on hand, January 1, 1885	$38,074 56		

REPORT BY THE REGISTRAR.

PHILADELPHIA WATER DEPARTMENT.
REGISTRAR'S OFFICE.

February 27, 1885.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—I respectfully submit the following Report of the operations of this Office for the year 1884:

The total receipts derived from all sources (paid daily as received into the Office of the City Treasurer) were, - - - - - -	$1,792,486 01
This is an increase over the previous year of -	165,416 85
And over 1882, of - - - - - -	275,581 37
The collection of water rents and penalties for the year 1884 amounted to - - -	1,588,825 33
An increase over the previous year of - -	184,662 72
And over 1882, of - - - - - -	275,389 23
The receipts from delinquent rents and penalties amounted to - - - - - -	22,330 69
A decrease from 1883 of - - - -	57,975 15
And from 1882, of - - - - - -	67,691 50

The large decrease in this item is by reason of closer collections and more prompt payments.

The receipts from fractional rents and other sources amounted to - - - - -	$77,557 40
An increase over the year 1883 of - -	10,469 30
And over 1882, of - - - - - -	28,027 50
The receipts from water-pipe charges amounted to - - - - - - - - - -	71,542 00

An increase over the year 1883, of - -	$25,688 91
And over 1882, of - - - - - -	36,562 48
An Ordinance was passed on March 20, 1884, requiring a fee of 25 cents to be charged on all searches for pipe frontage issued. The receipts from this source amounted to -	461 50
Receipts through the Chief Engineer's Office for old material, fire connections, etc., amounted to - - - - - - -	10,670 89
An increase over 1883 of - - - -	2,155 78
And over 1882, of - - - - -	3,155 01
The amount collected through the City Solicitor's office for pipe frontage, as certified to this Department, amounted to - -	21,098 20
A decrease from 1883 of - - - -	46 21
And from 1882, of - - - - -	322 85

Water-pipe bills to the amount of $24,870.77 were returned to the City Solicitor for lien.

The receipts of the Department in full for the year 1884 as previously estimated by the Chief Engineer to the City Controller were	$1,800,000 00
Actual receipts for the year 1884, - -	1,792,486 01
Difference, - - - - - - -	$7,513 99

The receipts for the last quarter of 1884 on properties that are metered, do not appear in the receipts of 1884, as these payments are not made until after the expiration of the quarter.

The total of these bills is - - - - -	$14,971 81
And had they been paid in 1884, the full receipts for the year would have been - -	1,807,457 82

The large increase of the receipts as noted above, is due in a measure to the enlarged force of Inspectors (which permits the Department to assign them to smaller districts) and the faithful and zealous manner in which they have performed their duties.

The Report shows that more permits have been issued than in any previous year. The work of the Inspectors is very complicated, as they are required to have a fair knowledge of the mechanical and industrial arts, as well as of plumbing and steam fitting, together with ability to estimate the cubical contents of tanks, vats, tubs, etc.

It is due to the clerical force to mention the careful and faithful manner in which they have performed their duties. Owing to the disadvantage under which they work for want of sufficient space they have been at times required to remain at night in order to complete their work. To this they have responded cheerfully.

I would call your attention to the inconvenience occasioned by inadequate room in the Registrar's Office for the transaction of business. Office space being so limited as to render it impossible to accommodate the public satisfactorily during our busy season—the months of March and April—the people are compelled to occupy the yard and street while waiting an opportunity to transact business with this Department—procuring permits, paying bills, etc.—in many instances for several hours at a time. These disadvantages cannot well be obviated unless more suitable quarters are procured.

On account of the increase in business, the books and papers have accumulated to such an extent that we find it impossible to store all in the fire-proofs, and if fire should occur, some of the most valuable records of the Office would be destroyed, causing great inconvenience to the Department, as they could not be replaced without considerable expense.

The annexed itemized tables contain full information of the detailed work of this Office.

Very respectfully,

A. N. KEITHLER,

Registrar.

TOTAL RECEIPTS OF THE WATER DEPARTMENT FOR THE YEAR 1884.

Months.	Delinquent Rents.	Penalties.	Rents for 1884.	Penalties.	Fractional Rents.	Water Pipe.	Water Pipe Searches.	Totals.
January	$1,622 82	$179 52			$2,720 95	$4,314 33		$8,837 62
February	843 00	124 97	$170,283 17		2,525 70	2,842 14		176,618 98
March	934 50	128 52	305,857 04		4,668 74	2,745 41	$2 50	314,336 71
April	4,623 45	297 40	842,663 87		12,298 84	5,189 46	50 00	865,123 02
May	685 39	100 89	44,075 65	$2,169 50	11,553 30	2,963 80	51 00	61,599 44
June	1,193 00	178 02	46,874 32	2,322 37	6,559 20	5,383 94	54 00	62,664 85
July	706 50	103 00	11,447 75	1,630 08	12,231 51	5,390 55	44 25	31,553 64
August	391 50	58 79	17,587 90	2,635 81	14,023 73	18,374 61	40 50	53,112 84
September	3,087 50	460 03	51,867 15	7,756 11	8,467 08	5,311 97	38 00	76,987 84
October	3,234 50	484 71	34,166 33	5,055 78	6,667 30	4,121 43	62 00	53,792 05
November	1,826 15	273 68	6,436 31	943 44	9,703 25	8,082 98	56 50	27,321 31
December	689 50	103 44	2,163 00	284 67	18,742 88	6,721 38	63 75	28,768 62
Totals	$19,837 72	$2,492 97	$1,533,422 49	$22,797 76	$110,162 48	$71,542 00	$461 50	$1,760,716 92

Total receipts through the Chief Engineer's office for the year 1884	10,670 89
" " " " office of the City Solicitor for the year 1884	21,098 20
" " of the Water Department for the year 1884	$1,792,486 01
Receipts as previously estimated by the Chief Engineer	1,800,000 00

Items of Receipts under Head of "Fractional Rents."

Year.	Rents.	Ferrules.	Repaving.	Repairs.	Totals.
1884	$97,097 98	$11,842 00		$1,222 50	$110,162 48
1883	53,021 35	9,596 00	$2,684 00	1,786 75	67,088 10
Increase	$44,076 63	$2,246 00			$43,074 38
Decrease			$2,684 00	$564 25	

RECEIPTS THROUGH THE CHIEF ENGINEER'S OFFICE FOR THE YEAR 1884.

January 29	Henry Snyder	Rent at Fairmount	225 00
February 13	Sarah Burgers	Stone	6 00
" 13	Mrs. Sobenheimer	"	2 00
" 13	John Lewright	"	2 25
March 1	Machine Tool Works	Fire attachment	74 74
April 10	Pennsylvania Railroad Company	Supply "	5 79
" 10	Summers & Co	Old material	409 25
" 15	William Mills	Repairing fire hydrant	14 41
" 16	Francis Brady	Old material	140 41
" 16	Bussenius, Concliffe & Co	" "	100 00
" 18	Joseph H. McClure	" "	42 72
" 19	Summers & Co	" "	93 60
" 22	Joseph H. McClure	" "	111 83
" 25	Bussenius, Concliffe & Co	" "	1,365 72
" 25	James A. Woodfall & Co	" "	81 91
May 5	Summers & Co	" "	248 32
" 7	Joseph H. McClure	" "	295 23
" 19	Lewis Kensil & Co	" "	188 65
" 22	Summers & Co	" "	451 74
" 23	Francis Brady	" "	301 90
" 23	Charles Kelly	Deposit for old material	13 00
" 28	Henry Snyder	Rent at Fairmount	225 00
June 2	E. D. Smith	For penalty	50 00
" 5	Charles Mousley	Old material	105 39
" 12	Summers & Co	" "	514 80
" 12	Mrs. Weatherly	Old lead pipe	1 00
" 23	Summers & Co	" material	477 51
" 26	Philadelphia, Wilmington & Baltimore Railroad Co	Repairs to pipe	16 18
July 2	John S. Bross	For penalty	50 00
" 7	Bussenius, Concliffe & Co	Old material	500 00
" 8	James Webster	For penalty	50 00
" 9	Joseph A. McGuckin	" "	50 00
" 11	A. C. Brown	" "	50 00

RECEIPTS THROUGH THE CHIEF ENGINEER'S OFFICE FOR THE YEAR 1884—*Continued.*

July 11	William J. McCandless	For penalty	50 00
" 11	Nathaniel Bryan	" "	50 00
" 11	George Montjoy	" "	50 00
" 21	Henry Snyder	Rent at Fairmount	225 00
" 30	Richard Walt	For penalty	50 00
" 30	Henry Strodick	" "	50 00
August 6	Patrick Mahoney	Stone	42 40
" 6	Thomas Parker & Co	For penalty	5 00
" 6	James McHenry & Co	" "	5 00
" 6	Robert Kilpatrick	" "	5 00
" 6	T. P. Smart	" "	5 00
" 6	John M. Mack	" "	5 00
" 6	James White	" "	5 00
" 6	Joseph Johnson	" "	5 00
" 6	Dennis Mahoney	" "	5 00
" 6	Oliver Wilson	" "	5 00
" 6	P. C. McEntee	" "	5 00
" 6	R. Walter Peterson	" "	5 00
" 6	George V. Kirst	" "	5 00
" 6	James Patchell	" "	5 00
" 6	William Ballenger	" "	5 00
" 6	Thomas Gannon	" "	10 00
" 6	George W. Eckert & Co	" "	5 00
" 7	R. J. Peoples	" "	5 00
" 7	Alexander Armstrong	" "	5 00
" 7	Henry Mullen Estate	" "	20 00
" 11	Joshua Nuttall	" "	5 00
" 11	Henry Mullen Estate	Repairing pipe	19 31
" 11	Henzler & Flach	For penalty	20 00
" 26	Benjamin L. Collum	Stone	5 60
" 28	William Arrott	For penalty	20 00
" 28	Robert Maxwell	Stone	32 00
" 28	Firth, Foster Bros	For penalty	20 00
" 29	Joseph Dudley	Stone	27 00

RECEIPTS THROUGH THE CHIEF ENGINEER'S OFFICE FOR THE YEAR 1884—*Continued.*

September 2	James A. Woodfall & Bro	Old material	27 35
" 3	A. Purvis & Son	" "	48 18
" 4	Thomas Young	Stone	15 60
" 5	Bussenius, Conclifle & Co	Old material	347 57
" 5	Joseph H. McClure	" "	166 78
" 10	M. Dolan & Bro	" "	635 31
" 12	Joseph H. McClure	" "	466 15
" 16	John M. Sharp	For penalty	50 00
" 24	Vulcanite Paving Company	" "	10 00
October 14	Charles Bartle	Stone	40 00
" 14	John Robinson	"	85 20
" 14	George Barnes	"	34 00
" 17	Warrant	9,466 overdrawn	25
" 22	Warrant	9,399 overdrawn	5 75
" 29		12 empty barrels	8 85
November 3	Daniel Boyer	Stone	47 20
" 6	H. C. Eyre	Repairing pipe	50 10
" 7	Charles Bartle	Stone	28 00
" 12	William Mullery	Gravel	51 00
" 15	John J. Dawson & Bro	Old material	252 77
December 4	Henry Snyder	Rent at Fairmount	225 00
" 11	John Ballinger	For penalty	20 00
" 11	John Long	Fire attachment	59 39
" 11	Charles Taylor	For penalty	50 00
" 13	Walnut Street Presbyterian Church	Motor attachment	68 42
" 13	John S. Baldt & Son	For penalty	50 00
" 13	Ocean Steamship Company	Fire attachment	201 00
" 15	M. & W. H. Nixon	" "	51 69
" 16	Eastern Penitentiary	Repairing pipes	29 05
" 18	William Sellers & Co	Water connection	25 71
" 18	Bryan, Fox & Son	Fire attachment	42 52
" 18	Eastern Penitentiary	Repairing pipe	10 50

RECEIPTS THROUGH THE CHIEF ENGINEER'S OFFICE FOR THE YEAR 1884—*Continued.*

December 16.....	William Sellers & Co.....	Water connection.....	10 50
" 23.....	M. Leinau.....	Fire attachment.....	58 14
" 23.....	Philadelphia Gas Department.....	Removing fire hydrant.....	50 22
" 26.....	Stokes & Parrish.....	Fire attachment.....	83 86
" 27.....	S. B. & M. Fleisher.....	" "	138 74
" 30.....	John Wilde & Bro.....	" "	80 43
		Total.....	$10,670 89

COMPARATIVE STATEMENT OF RECEIPTS FOR THE YEARS 1883 AND 1884.

Year.	Delinquent Rents.	Delinquent Penalties.	Water Rents.	Penalties.	Fractional Rents.	Water Pipe.	Water Pipe Searches.	Chief Engineer's Office.	City Solicitor's Office.	Totals.
1884	$19,837 72	$2,492 97	$1,566,027 57	$22,797 76	$77,557 40	$71,542 00	$461 50	$10,670 89	$21,098 20	$1,792,486 01
1883	69,995 84	10,310 00	1,380,882 17	23,280 44	67,088 10	45,853 09	.....	8,515 11	21,144 41	1,627,069 16
Increase	.....	.....	$185,145 40	.....	$10,469 30	$25,688 91	$461 50	$2,155 78	.....	$165,416 85
Decrease	$50,158 12	$7,817 03	.....	$482 68	.....	.....	.....	.....	$46 21	.....

REVENUES OF THE DEPARTMENT FOR THE YEARS 1880 TO 1884, INCLUSIVE.

Year.	Delinquent Water Rents.	Delinquent Penalties.	Water Rents.	Penalties.	Fractional Rents.	Water Pipe.	Water Pipe Searches.	Chief Engineer's Office.	City Solicitor's Office.	Totals.
1880	$112,728 37	$16,783 11	$1,218,925 66	$19,002 35	$48,038 07	$26,077 90	.....	$4,786 07	$38,015 53	$1,484,357 06
1881	84,591 40	12,627 66	1,256,662 00	19,234 38	53,451 56	47,489 11	.....	5,549 01	29,936 22	1,509,541 34
1882	78,543 01	11,479 18	1,295,419 87	18,016 23	49,529 90	34,979 52	.....	7,515 88	21,421 05	1,516,904 64
1883	69,995 84	10,310 00	1,380,882 17	23,280 44	67,088 10	45,853 09	.....	8,515 11	21,144 41	1,627,069 16
1884	19,837 72	2,492 97	1,566,027 57	22,797 76	77,557 40	71,542 00	461 50	10,670 89	21,098 20	1,792,486 01
Totals	$365,696 34	$53,692 92	$6,717,917 27	$102,331 16	$295,665 03	$225,941 62	$461 50	$37,036 96	$131,615 41	$7,930,358 21

SCHEDULE OF CHARGES AGAINST PUBLIC BUILDINGS AT THE REGULAR RATES.

Wards.	Name.	Location.	Amount.
Fifth	Mayor's office		$15 00
"	Telegraph Department		13 00
"	Office Clerks of Councils		5 00
"	Court of Common Pleas, No. 1		32 00
"	Sheriff's office		4 00
"	Common Pleas, No. 3		18 00
"	Independence Hall	Independence Hall	21 00
"	Council Chambers		6 00
"	Prothonotary's office		20 00
"	Common Pleas, No. 4		6 00
"	" " No. 2		21 00
"	Old Court-house		9 00
"	New "	Sixth street, below Chestnut street	87 00
Ninth	Basement		662 00
"	West end, first floor		85 00
"	Superintendent's office	New City Hall, Broad and Market streets	10 00
"	City Treasurer		18 00
		Amount carried forward..	$1,032 00

SCHEDULE OF CHARGES AGAINST PUBLIC BUILDINGS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward.....	$1,082 00
Ninth.....	City Controller.....		8 00
"	City Commissioners.....		4 00
"	Southeast corner, first floor.....		48 00
"	Headquarters National Guards.....		4 00
"	Commissioner of City Property.....		6 00
"	Commissioners of Fairmount Park.....		8 00
"	Board of Revision.....		4 00
"	Tax Assessor's office.....	New City Hall, Broad and Market streets.....	2 00
"	Delinquent Tax office.....		4 00
"	Northeast corner, first floor.....		48 00
"	Receiver of Taxes.....		16 00
"	Northeast corner, second floor.....		48 00
"	Survey Department.....		13 00
"	Highway "		6 00
"	Southeast corner, second floor.....		27 00
		Amount carried forward..	$1,278 00

SCHEDULE OF CHARGES AGAINST PUBLIC BUILDINGS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$1,278 00
Ninth	Architect's office	New City Hall, Broad and Market streets	6 00
"	Supreme Court		33 00
"	Board of Guardians' office	42 North Seventh street	12 00
Tenth	Cherry street shops	918 Cherry street	53 00
"	Armory State Fencibles	East side Broad, south of Race street	65 00
Eleventh	City Morgue	Northwest corner Noble and Beach streets	14 00
Fourteenth	Spring Garden Hall	Thirteenth and Spring Garden streets	41 00
Seventeenth	Purveyor's office	Frankford avenue and Master streets	5 00
Twenty-second	Town Hall	Northwest corner Germantown avenue and Lafayette street	29 00
Twenty-third	Gas office	Southeast corner Frankford avenue and Ruan street	24 00
Twenty-sixth	Water Department office, stable, and storage yard	Wharton street east of Twelfth street	16 00
"	County Prison	West side Passyunk avenue, from Reed to Dickinson streets	1,294 00
Twenty-seventh	Philadelphia Almshouse		3,333 00
Twenty-ninth	Purveyor's office	Northeast corner Master and Twenty-sixth streets	5 00
		Total	$6,208 00

SCHEDULE OF CHARGES AGAINST FAIRMOUNT PARK AT THE REGULAR RATES.

Name.	Location.	Amount.
West Park	Belmont, including sprinklers for entire Park	$1,148 24
" "	Belmont Mansion	83 00
" "	British Building	18 00
" "	Ohio Building	7 00
" "	Memorial Hall	250 00
" "	Horticultural Hall	98 00
" "	Greenhouse adjoining Horticultural Hall	20 00
" "	Outside grounds	128 00
" "	Sweet Brier Mansion	15 00
" "	Rhode Island Building	9 00
" " jet fountain	Lake west of Belmont avenue, near Elm avenue	6,500 00
" " " "	Catholic Total Abstinence Building, near Elm avenue	1,000 00
East Park, drinking fountain	North front Lemon Hill Mansion	168 00
" " " "	Northeast from Lemon Hill Mansion	112 00
" " " "	Northeast of Sedgley Guard-house	10 00
" " jet fountain	" " "	560 00
	Amount carried forward	$10,126 24

SCHEDULE OF CHARGES AGAINST FAIRMOUNT PARK AT THE REGULAR RATES—*Continued.*

Name.	Location.	Amount.
	Amount brought forward	$10,126 24
East Park, jet fountain	East side forebay	560 00
" " " "	Green street entrance	756 00
" " " "	On lawn east of steamboat landing	735 00
" " " "	On lawn northeast of steamboat landing	735 00
" " trefoil fountain	East of Lincoln monument	2,205 00
" " fish pond	Main drive, near Brown street entrance	1,984 00
" " large fountain	West of Thirty-third street, south side Dauphin street	1,003 00
	Total	$18,104 24

SCHEDULE OF CHARGES AGAINST POLICE STATION HOUSES AT THE REGULAR RATES.

Wards.	Name.	Location.	Amount.
First	Station house, Seventeenth District	South side of Taylor street, east of Passyunk avenue	$62 00
Third	" " Second "	Second street above Christian street	97 00
Fifth	Central Station	Mayor's office, Independence Hall	70 00
"	Station house, Third District	Union street below Fourth street	63 00
Sixth	" " Fourth "	Fifth street above Race street	65 00
Seventh	" " Nineteenth District	734 Lombard street	60 00
Eighth	" " Fifth "	Fifteenth street, east side, south of Walnut street	61 00
Ninth	" " Twentieth "	1519 Filbert street	51 00
Tenth	" " Sixth "	235 South Eleventh street	65 00
Eleventh	" " Seventh "	St. John street below Green street	30 00
Fourteenth	" " Eighth "	1012-14 Buttonwood street	55 00
Fifteenth	" " Ninth "	Northwest corner Twenty-third and Brown streets	48 00
Seventeenth	" " Tenth "	Front street above Master street	58 00
Eighteenth	" " Eleventh "	Girard avenue above East Montgomery avenue	31 00
Twentieth	" " Twelfth "	Northeast corner Tenth and Thompson streets	71 00
		Amount carried forward	$887 00

SCHEDULE OF CHARGES AGAINST POLICE STATION HOUSES AT THE REGULAR RATES—*Continued.*

Wards.	Name.	Location.	Amount.
		Amount brought forward.....	$887 00
Twenty-first.....	Station house, Thirteenth District.....	Station-house alley, between Mechanic and Cotton streets.....	36 00
Twenty-second....	" " Sub "	Northwest corner Twenty-seventh and Highland avenue.....	23 00
"	" " Fourteenth "	North side Lafayette street.....	52 00
Twenty-third.....	" " Fifteenth "	Southwest corner Ruan street and Paul street.....	52 00
Twenty-fourth.....	" " Sixteenth "	Southwest corner Lancaster avenue and Thirty-ninth street.....	64 00
Twenty-fifth.....	" " Twenty-fourth District.....	Southwest corner Clearfield and Belgrade streets.....	19 00
"	" " Sub "	Northwest corner Kirkbride and Richmond streets.....	40 00
"	" " " "	3883 Germantown avenue.....	33 00
Twenty-seventh...	" " Twenty-first "	Southeast corner Woodland avenue and Spruce street.....	63 50
Twenty-eighth.....	" " Twenty-second "	Northwest corner Park and Lehigh avenues.....	94 50
Twenty-ninth.....	" " Twenty-third "	Southwest corner Twentieth and Jefferson streets.....	57 00
Thirtieth.....	" " First "	Fitzwater street below Twentieth street.....	60 00
Thirty-first.....	" " Eighteenth "	2028 Trenton avenue.....	53 00
		Total.....	$1,534 00

SCHEDULE OF CHARGES AGAINST FIRE STATIONS AT THE REGULAR RATES.

Wards.	Name.	Location.	Amount.
First	Fire station, No. 10	818 Morris street	$25 00
Fifth	Truck D Company	319 Union street	21 00
"	Fire station, No. 22	Levant street below Third street	20 00
Sixth	" " No. 8	143 Race street	18 00
"	Truck B Company	321–323 Branch street	12 00
Seventh	Fire station, No. 11	1035 Lombard street	15 00
"	" " No. 1	South street below Nineteenth street	19 00
Tenth	" " and shops, No. 17	Race street, south side, west of Thirteenth street	142 00
Eleventh	" " No. 21	826 New Market street	27 00
Fourteenth	" " No. 26	Hamilton street, between Tenth and Eleventh streets	36 00
Fifteenth	" " No. 18	1903 Callowhill street	15 00
"	Truck A	2132 Fairmount avenue	17 00
Eighteenth	Fire station, No. 16	1106–1108 Montgomery avenue	20 00
Nineteenth	" " No. 15	Howard street and Columbia avenue	15 00
Twenty-first	" " No. 12	4541 to 4545 Main street	17 00
Twenty-third	" " No. 7	22 East Church street	16 00
"	" " No. 14	4612 Frankford avenue	24 00
Twenty-fifth	" " No. 28	Belgrade street twenty feet south of Clearfield street	23 00
Twenty-seventh	" " No. 5	Southeast corner Thirty-seventh and Ludlow streets	24 00
Twenty-ninth	" " No. 27	2202–2204 Columbia avenue	26 00
		Total	$532 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES.

Wards.	Name.	Location.	Amount.
First	Grammar School	Southeast corner Seventh and Dickinson streets	$27 00
"	Weccacoe Primary School	Second and Reed streets	13 00
"	Tasker School	Ninth and Tasker streets	13 00
"	Levin Handy Smith School	Fifth street and Snyder avenue	20 00
"	William Welsh School	Thirteenth and Jackson streets	26 00
"	Henry Clay School	Lancaster avenue, above Reed street	13 00
"	Morris School	Morris street, below Second street	13 00
"	Colored Consolidated School	Dickinson street, below Seventh street	18 00
"	Calhoun "	Tenth street and Snyder avenue	20 00
Second	Geo. W. Nebinger "	Carpenter street, above Sixth street	18 00
"	Wharton "	Fifth street, below Washington avenue	29 00
"	Washington "	Carpenter street, above Ninth street	26 00
"	Watson "	Mary street, below Second street	15 00
Third	Mount Vernon "	Catharine street, above Third street	42 00
"	Fletcher "	Christian street, above Front street	14 00
"	Thomas B. Florence "	Catharine street, below Eighth street	32 00
		Amount carried forward	$339 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$339 00
Third	Lyons School	Catharine street, above Tenth street	13 00
Fourth	Ringgold "	Northeast corner Eighth and Fitzwater streets	18 00
"	Fagen "	Twelfth and Fitzwater streets	21 00
"	Wm. M. Meredith School	Fifth street, above German street	35 00
"	Ralston "	Northeast corner Guilford and Bainbridge streets	15 00
"	Ronaldson "	Fitzwater street, above Sixth street	13 00
Fifth	Horace Binney Grammar School	Spruce street, below Sixth street	77 00
"	James Forten School	Sixth street, above Lombard street	15 00
"	Geo. W. Wharton School	Third street, above Lombard street	26 00
Sixth	No. 1 Primary School	New street, below Second street	9 00
"	Northeast Boys Grammar School	Northwest corner Crown and Race streets	29 00
"	N. E. Secondary School	Crown street, above Race street	10 00
Seventh	Secondary, No. 1, School	409 South Twenty-third street	8 00
"	Secondary, No. 3, "	1119 Pine street, northeast corner Quince street	17 00
"	Southwest "	Northeast corner Seventeenth and Pine streets	22 00
		Amount carried forward	$667 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$667 00
Seventh	Secondary, No. 4, School	415 South Nineteenth street	13 00
"	O. V. Catto "	2028 Lombard street	18 00
Eighth	Hollingsworth "	Locust street, south side, west of Broad street	26 00
"	Locust street "	Northeast corner Locust and Twelfth streets	29 00
"	James A. Garfield "	Southwest corner Locust and Twenty-second streets	10 00
Ninth	Zane street "	711-717 Filbert street	28 00
"	Filbert street "	2015 Filbert street	13 00
"	Keystone "	Nineteenth street, west side, north of Chestnut street	37 00
Tenth	Edward Shippen "	Cherry street, north side, west of Nineteenth street	21 00
"	John Agnew "	Cherry street, south side, west of Eleventh street	20 00
"	Cherry street "	Cherry street, south side, west of Fifteenth street	8 00
"	Northwest "	Race street, north side, west of Fourteenth street	24 00
"	Sergeant "	920 Sergeant street	9 00
Eleventh	Shunk Primary, No. 1, School	East side New Market street above Brown street	9 00
"	Madison Secondary "	East side New Market street above Noble street	19 00
		Amount carried forward	$951 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$951 00
Eleventh	Northern Liberties School	Third street below Green street	19 00
"	Biedeman Primary "	St. John street below Buttonwood street	19 00
Twelfth	Saunders "	Northwest corner Dillwyn and Callowhill streets	16 00
"	Mifflin "	Third property west of 18 North Third street	26 00
"	Rovoudt "	432–436 Maria street	17 00
"	E. M. Paxton "	Noble street below Sixth street	26 00
Thirteenth	Wyoming "	Northwest corner of Sixth street and Fairmount avenue	23 00
"	Adams "	Garden street below Buttonwood street	23 00
"	Warner "	Perth street, north of Parrish street, west side	28 00
Fourteenth	Roberts Vaux "	Wood street between Eleventh and Twelfth streets, north side	29 00
"	Monroe "	Wood street east of Twelfth street	32 00
"	John M. Ogden "	Northeast corner of Twelfth and Wistar streets	26 00
"	Robert T. Conrad "	Melon street east of Twelfth street	25 00
"	Hancock "	Fairmount avenue west of Twelfth street	41 00
"	Spring Garden "	Southeast corner Twelfth and Ogden streets	30 00
		Amount carried forward	$1,331 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$1,331 00
Fourteenth	Central High School	Southeast corner Broad and Green streets	63 00
Fifteenth	Girls' Normal "	Northeast corner Spring Garden and Seventeenth streets	119 00
"	Boys' School of Practice	1619 and 1621 Spring Garden street	41 00
"	Hoffman School	Northeast corner Seventeenth and Wood streets	19 00
"	Thaddeus Stevens School	Northwest corner Seventeenth and Grayson streets	31 00
"	Lincoln "	Southeast corner Twentieth street and Fairmount avenue	71 00
"	A. D. Bache "	Northeast corner Twenty-second and Brown streets	17 00
"	Livingston "	Northeast corner Twenty-third and Shamokin streets	21 00
Sixteenth	Wm. A. Lee "	Howard street below Girard avenue	30 00
"	Martin Landenberger School	Fourth street above George street	27 00
"	George Wolfe "	Charlotte street above Poplar street	20 00
"	Jefferson "	Fifth street above Poplar street	38 00
Seventeenth	Harrison "	South side Master street above Second street	19 00
"	James R. Ludlow "	Northeast corner Master and Lawrence streets	25 00
"	Webster "	East side Hancock street above Girard avenue	16 00
Eighteenth	Douglas "	Southeast corner Edgemont and Huntingdon streets	13 00
		Amount carried forward	$1,901 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES.—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$1,901 00
Eighteenth	Primaries, Nos. 7 and 8	Southwest corner Belgrade and Otis streets	13 00
"	T. K. Finletter School	Montgomery avenue, northeast corner Gaul street	29 00
"	Morris "	Palmer street above Thompson street	16 00
"	George Chandler "	Montgomery avenue above Richmond street	36 00
"	Vaughan "	Marlborough street above Thompson street	26 00
Nineteenth	Price "	East side Howard street, north of Diamond street	21 00
"	Wm. Adamson "	East side Fourth street	25 00
"	Franklin "	East side American street, north of Columbia avenue	12 00
"	Colored consolidated "	West side Cadwallader street (rented)	
"	Wm. H. Hunter "	Southeast corner Dauphin and Mascher streets	16 00
"	Cohocksink "	Northwest corner Montgomery avenue and Fourth street	15 00
"	Cumberland "	Southwest corner Cumberland and Hancock streets	19 00
Twentieth	Park Avenue "	Park avenue above Thompson street	61 00
"	Daniel Webster "	Eleventh street below Thompson street	21 00
"	Penn "	Southeast corner Eighth and Thompson streets	20 00
		Amount carried forward	$2,231 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$2,231 00
Twentieth	Rutledge School	Northwest corner Seventh and Norris streets	27 00
"	James Todd School	Northwest corner Franklin and Norris streets	27 00
"	Primary No. 7 School	1523 and 1531 Mervine street	10 00
"	James Lynd School	Twelfth street, above Columbia avenue	40 00
Twenty-first	Manayunk Grammar School	South side Green lane, below Wood street	17 00
"	Fairview "	Manayunk avenue, below Green lane	47 00
"	Schuylkill Secondary "	Washington street and Jefferson avenue	17 00
"	Roxborough "	Ridge avenue, west side, below Parker street	6 00
"	Washington Primary "	Shur's lane, south side, first house east of Cresson street	13 00
"	Levering "	West side Ridge avenue, below Martin street	7 00
Twenty-second	Chestnut Hill "	South side Highland avenue	19 00
"	Germantown "	Northeast corner Adams and Lafayette streets	30 00
"	C. W. Scheaffer "	Germantown avenue and Wyoming street	24 00
"	Central Primary. "	North side of Centre street	13 00
"	Bringhurst "	Bringhurst street	16 00
		Amount carried forward	$2,544 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$2,544 00
Twenty-second	Rittenhouse School	South side Rittenhouse street	13 00
Twenty-third	Marshall School	Northwest corner Franklin and Sellers streets	11 00
"	Henry Herbert Grammar School	Frankford avenue, 100 feet from the southeast corner of Foulkrod street	25 00
"	White Hall School	Southwest corner Pratt and Tacony streets	19 00
"	Wilmot Public School	One hundred and thirty feet from the southwest corner of Mulberry street	8 00
Twenty-fourth	Norris J. Hoffman School	Northeast corner Fifty-fifth and Vine streets	28 00
"	Jesse George "	Hamilton street above Sixty-third street	28 00
"	Martha Washington "	Forty-fourth and Huron streets	36 00
"	Belmont Grammar "	Forty-first and Oregon streets	28 00
"	Warren "	Thirty-eighth street below Warren street	35 00
"	Mantua "	Thirty-eighth street below Mount Vernon street	29 00
"	Haverford "	3415 Haverford street	28 00
Twenty-fifth	Sherman "	Northeast corner Somerset street and Frankford avenue	17 00
"	Boudinot "	Southwest corner Indiana avenue and "D" street	21 00
"	Henry W. Halliwell Grammar School	Frankford and Allegheny avenues	31 00
		Amount carried forward	$2,901 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$2,901 00
Twenty-fifth	Geo. B. McClellan, No. 1, School	Northwest corner Edgemont and Neff streets	13 00
"	Geo. B. McClellan, No. 2, "	Northeast corner Neff and Thompson streets	30 00
"	Carroll "	1528 Salmon street	14 00
"	Irving "	Bridesburg	13 00
"	Barton "	Frankford avenue and Buckius street	13 00
"	Bayard Taylor "	Sixth and Venango streets	16 00
"	Asa Packer "	Broad and McFerran streets	22 00
Twenty-sixth	Jackson "	Southeast corner Twelfth and Federal streets	40 00
"	Jeremiah Nichols "	Northeast corner Sixteenth and Wharton streets	34 00
"	James Alcorn "	Thirty-fourth and Wharton streets	25 00
"	Landreth Federal "	Southeast corner Twenty-third and Federal streets	17 00
"	James Logan "	Northwest corner Nineteenth and Reed streets	16 00
Twenty-seventh	Newton Grammar "	Southwest corner Thirty-eighth and Spruce streets	34 00
"	Newton Secondary "	3438 Chestnut street	28 09
"	Newton Primary "	3459 Ludlow street	16 00
		Amount carried forward	$3,232 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$3,232 00
Twenty-seventh	Price School	Southwest corner Forty-seventh and Locust streets	19 00
Twenty-eighth	Oakdale School	Eleventh street and Huntingdon avenue	24 00
"	Camac "	Corner Thirteenth street and Susquehanna avenue	43 00
"	Kenderton "	Fifteenth street below Tioga street	28 00
"	T. H. Powers School	Southwest corner Susquehanna avenue and Woodstock street	30 00
"	Bellevue "	Twenty-sixth street and Cumberland avenue	32 00
"	Glenwood Primary School	Ridge avenue above Thirty-second street	16 00
Twenty-ninth	Reynolds "	Southwest corner Twentieth and Jefferson streets	36 00
"	Edward Gratz "	Southeast corner Twenty-third and Jefferson streets	24 00
"	Morris City "	Southwest corner Twenty-sixth and Thompson streets	10 00
"	Muhlenberg "	Southeast corner Master and Forty-seventh streets	22 00
"	Elisha Kent Kane "	Southeast corner Jefferson and Twenty-sixth streets	31 00
"	George G. Meade "	Eighteenth and Oxford streets	49 00
Thirtieth	Wm. S. Pierce "	Twenty-fourth and Christian streets	26 00
"	Curtin "	Southwest corner Twentieth and Catharine streets	16 00
		Amount carried forward	$3,638 00

SCHEDULE OF CHARGES AGAINST THE PUBLIC SCHOOLS AT THE REGULAR RATES—(*Continued*).

Wards.	Name.	Location.	Amount.
		Amount brought forward	$3,638 00
Thirtieth	James Pollock School	Southwest corner Birch and Fitzwater streets	16 00
"	Edwin M. Stanton School	Southeast corner Seventeenth and Christian streets	23 00
Thirty-first	John S. Hart "	York and Memphis streets	29 00
"	Adams "	Adams street above Amber street	21 00
"	Lucretia Mott "	Huntingdon avenue and Sepviva streets	28 00
		Total	$3,755 00

LIST OF CHARITABLE INSTITUTIONS

Which, under the provisions of the Ordinances of June 21, 1878, and June 16, 1881, are charged fifteen per cent. of the regular rates.

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
First	Sisters of St. Francis	505 Reed street	June 7, 1883	$22 00	$5 00
Second	St. Ann Widows' Asylum	906 Moyamensing avenue	June 21, 1878	24 00	5 00
"	Ridgway Library	Broad street, southeast corner Christian street	January 31, 1882	141 00	21 15
Third	Maternity Hospital	730-32-34 South Tenth street	December 21, 1883	12 00	5 00
"	Industrial Home	762 South Tenth street	June 21, 1878	50 00	7 50
"	Southern Home for Destitute Children	Southeast corner Fitzwater and Twelfth streets.	June 21, 1878	154 00	23 10
"	Philadelphia Society for Employment and Instruction of the Poor	714-18 Catharine street.....Special ordinance	March 23, 1878	76 75	5 00
Fourth	Institute for Colored Youth	918-20 Bainbridge street	April 17, 1883	28 00	5 00
"	Bedford Street Mission	619 Alaska street	June 2, 1879 / June 11, 1879	30 50	5 00
Fifth	City Mission	411 Spruce street	April 10, 1883	16 00	5 00
"	Philadelphia Dispensary	127 South Fifth street	April 19, 1881	34 50	5 00
"	Newsboys' Aid Society	251 South Sixth street	September 29, 1881	62 90	9 43
		Amount carried forward		$651 65	$101 18

LIST OF CHARITABLE INSTITUTIONS—(*Continued*).

Ward.	Name.	Location.	When placed on charity list.	Amount Assessed.	Amount charged.
		Amount brought forward.....		$651 65	$101 18
Sixth.....	Apprentices' Library.....	500 Arch street, southwest corner Fifth street...	June 21, 1878..	23 00	5 00
Seventh.....	Howard Hospital.....	1518–20 Lombard street.....	April 10, 1883..	22 50	5 00
"	Pennsylvania Hospital.....	Southwest corner Eighth and Spruce streets.....	.....	574 50	86 18
"	Western Soup Society.....	1613–15 Arch street.....	June 21, 1878..	21 00	5 00
"	Clinton Street Boarding House.....	913–15 Clinton street.....	June 21, 1879.. / Sept'mb'r 30, 1879..	80 00	12 00
"	Deaf and Dumb Asylum.....	Broad street, northwest corner Pine street.....	June 21, 1878..	946 00	141 90
"	Day Nursery.....	2218 Lombard street.....	October 3, 1882..	12 00	5 00
"	Lincoln Institute.....	324 Eleventh street.....Special Ordinance...	March 23, 1873..	106 00	5 00
Eighth.....	Midnight Mission.....	919 Locust street.....	December 21, 1883..	23 00	5 00
"	Philadelphia Library.....	Northwest corner Juniper and Locust streets....	January 31, 1882..	75 50	11 32
"	Jefferson Hospital.....	Sansom street, south side, above Tenth street...	June 21, 1878..	545 50	81 83
"	Union Benevolent Association.....	701 Sansom street.....	February 13, 1883..	66 00	9 90
"	Jefferson College.....	Tenth street, west side, below Sansom street.....	June 21, 1878..	140 00	21 00
"	Children's Hospital.....	207 South Twenty-second street.....	June 21, 1878..	91 00	13 65
"	Historical Society.....	Northwest corner Thirteenth and Locust streets	February 29, 1884..	29 00	5 00
		Amount carried forward.....		$3,406 65	$513 96

LIST OF CHARITABLE INSTITUTIONS—(*Continued*).

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
		Amount brought forward..		$3,406 65	$513 96
Ninth	Women's Christian Association	1605 Filbert street	June 21, 1878..	36 00	5 40
"	Homœopathic Hospital	1116–18 Cuthbert street		29 00	5 00
Tenth	Central Soup Society	709–11 Cherry street	June 13, 1881..	103 00	15 45
"	Indigent Widows' and Single Women's Society	North side Cherry street, E. of Eighteenth street	June 21, 1878.. / June 18, 1879..	61 00	9 15
"	Catholic Home for Destitute Children and Orphan Girls	1718–20 Race street	June 21, 1882..	42 00	6 30
"	Wills' Eye Hospital	1810–24 Race street	June 21, 1878..	125 00	18 75
"	Academy of Natural Sciences	1900 Race street, S. W. corner Nineteenth street.	June 21, 1878..	109 00	16 35
"	Presbyterian Historical Society	1227–29 Race street	June 20, 1882..	17 00	5 00
"	Pennsylvania Institution for the Instruction of the Blind	Northwest corner Race and Twentieth streets..	June 21, 1882..	481 00	72 15
"	Orthopædic Hospital	1701 Summer street, N. W. cor. Seventeenth st..	June 21, 1878..	56 50	8 48
"	Academy of Fine Arts	Northwest corner Broad and Cherry streets.....	June 21, 1878..	276 00	41 40
"	Magdalen Society of Philadelphia	Northeast corner Twenty-first and Race streets.	June 21, 1878..	75 00	11 25
Twelfth	Northern Soup Society	817 North Fourth street	June 21, 1878..	40 50	6 07
"	Home Association	505 North Sixth street	June 21, 1878..	18 00	5 00
		Amount carried forward..		$4,875 65	$739 71

LIST OF CHARITABLE INSTITUTIONS—(*Continued*).

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
		Amount brought forward...		$1,875 65	$739 71
Thirteenth.....	Northern Dispensary.....	606-08-10 Fairmount avenue.....	June 21, 1878..	41 50	6 23
Fourteenth.....	Spring Garden Institute.....	1349-51-53 Spring Garden street.....	October 22, 1883..	45 00	6 75
Fifteenth.....	Preston Retreat.....	N. W. corner Twentieth and Hamilton streets..	June 21, 1878..	121 00	18 15
"	Home Infirmary.....	2208 Brown street.....	July 27, 1878..	23 00	5 00
"	Northern Home for Friendless Children..	N. E. corner Twenty-third and Brown streets...	June 21, 1878..	110 00	16 50
"	Soldiers' Orphans' Home.....	N. E. cor. Twenty-third and Brown sts. (rear)...	June 21, 1879..	82 00	12 30
"	House of Refuge.....	N. W. cor. Twenty-second and Parrish streets...	March 18, 1879..	1,178 42	176 76
"	" " (colored).....	" " " " " "	March 18, 1879..	400 00	60 00
"	Howard Institute.....	1610 Poplar street.....	June 7, 1883..	13 00	5 00
"	" "	1612 " "	June 7, 1883..	16 00	5 00
"	Jewish Foster Home.....	S. W. corner Twenty-fourth and Poplar streets.	June 21, 1878..	46 00	6 90
"	C. Morrison.....	2426 Hare street.....	June 24, 1879..	5 00	0 00
"	St. Vincent Home for Destitute Infants...	N. W. corner Wood and Eighteenth streets.....	June 21, 1878..	101 50	15 23
"	Northern Home Infirmary.....	826 North Twenty-third street.....	November 16, 1880..	11 00	5 00
"	Home for Aged Couples.....	1721-23 Francis street.....	December 5, 1883	14 00	5 00
		Amount carried forward...		$7,083 07	$1,083 53

LIST OF CHARITABLE INSTITUTIONS—(*Continued*).

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
		Amount brought forward...		$7,083 07	$1,083 53
Eighteenth.....	St. Mary's Hospital.....	N. E. cor. Palmer street and Frankford avenue.		53 50	8 03
Nineteenth.....	Episcopal "	N. E. corner Front street and Lehigh avenue...		714 00	107 10
"	Northeastern Soup Society.....	1540 Front street.....		00	5 00
Twenty-second.....	Women's Christian Association.....	4781 Germantown avenue.....	January 31, 1883..	15 00	5 00
"	Young Men's Christian Association.....	5019 " "	January 25, 1882..	77 00	11 55
"	Lutheran Orphans' Home.....	5576 " "	June 21, 1878..	64 00	9 60
"	" Asylum for Aged.....	5580 " "	June 21, 1878..	84 00	12 60
"	Jewish Hospital.....	Cottage avenue.....		209 50	31 43
"	Germantown Hospital.....	East Penn street, west of Chew street.....		92 00	13 80
"	Pauline Home.....	" " second house east of Ross st...	March 4, 1883..	39 00	5 85
"	Little Sisters of the Poor.....	Mill street, fourth house east of Ross street.....	June 21, 1878..	132 00	19 80
"	Jewish Foster Home.....	" first house west of Chew street.....	June 7, 1881..	138 00	20 70
"	Germantown Poor House.....	Rittenhouse street.....	June 21, 1878..	57 00	8 55
Twenty-fourth.....	Working Home for Blind Men.....	3518 Lancaster avenue.....	June 21, 1878..	96 00	14 40
"	Union Home for Old Ladies.....	N. W. corner Lancaster and Girard avenues.....	June 21, 1878..	15 00	5 00
		Amount carried forward...		$8,877 07	$1,361 94

LIST OF CHARITABLE INSTITUTIONS—(*Continued*).

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
		Amount brought forward...		$8,877 07	$1,361 94
Twenty-fourth.....	Presbyterian Hospital.....	S. W. cor. Powelton avenue and Saunders street..	June 21, 1878..	285 00	42 75
"	Pennsylvania Home for Blind Women....	N E.. " " " " " " ..	June 18, 1881..	73 00	10 95
"	Old Men's Home.....	N. W. " " " " " " ..	June 18, 1881..	170 00	25 50
"	Pennsylvania Hospital for Insane(females)	Haverford street, south side.....	June 21, 1878.. / February 17, 1879..	1,064 00	159 60
"	" " " " (males)...	Southeast cor. Haverford and Fiftieth streets.....	June 21, 1878.. / February 17, 1879..	1,045 50	156 83
"	Colored Orphans' Home.....	S. W. cor. Forty-fourth street and Elm avenue...	June 21, 1878..	65 50	9 83
"	House of Good Shepherd.....	Fairmount avenue, west of Thirty-fifth street...	June 21, 1878..	516 00	77 40
"	Philadelphia Home for Infants.....	Westminster street, S. E. corner Markoe street...	June 21, 1878..	88 00	13 20
"	St. John's Orphan Asylum.....	" " north side.....	June 21, 1878..	105 00	15 75
"	Western Home for Poor Children.....	Forty-first street, southeast cor. Baring street ..	April 18, 1882..	44 00	6 60
"	Pennsylvania Homœopathic Hospital for Children.....	Forty-third street, S. W. corner Brown street....	June 21, 1878..	37 00	5 55
"	Colored Orphans' Home.....	Forty-fourth street, S. W. cor. Haverford street..	Special Ordinance... March 23, 1878..	53 00	5 00
"	Baptist Orphanage.....	Forty-fifth street, S. W. cor. Fairmount avenue..	June 21, 1878..	26 00	5 00
Twenty-fifth.....	Old Ladies' Home.....	Frankford avenue, fifth house north of Cemetery	May 31, 1881..	11 00	5 00
		Amount carried forward...		$12,460 07	$1,900 90

LIST OF CHARITABLE INSTITUTIONS—(*Continued*).

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
		Amount brought forward..		$12,460 07	$1,900 90
Twenty-sixth.....	Third Regiment Armory.....	N. E. corner Twelfth and Reed streets.....	May 16, 1882..	50 00	7 50
Twenty-seventh...	University of Pennsylvania.....	N. E. corner Thirty-sixth and Spruce streets.....	June 21, 1878..	1,323 50	198 50
" ...	University of Pennsylvania, Veterinary Department.....	S. W. cor. Thirty-sixth and Pine streets.....	June 21, 1878..	77 00	11 55
" ...	University of Pennsylvania, Biological Department.....	S. side Pine, bet. 37th and Cleveland streets.....	June 21, 1878..	95 00	14 25
" ...	West Philadelphia Industrial School.....	N. W. corner Thirty-ninth and Pine streets.....	June 21, 1878..	118 00	17 70
" ...	Home for Incurables.....	Woodland avenue, east of Forty-eighth street...	January 1, 1883..	141 00	21 15
" ...	Divinity School.....	" " N. E. corner Fiftieth street...	.....	160 00	24 00
" ...	Presbyterian Orphans' Home.....	Woodland avenue, between Fifty-eighth and Fifty-ninth streets.....	July 18, 1878..	128 00	19 20
" ...	Educational Home.....	Forty-ninth st. and Woodland av....Spec'l ordin...	March 23, 1878..	179 50	5 00
Twenty-eighth.....	Baptist Home.....	North Seventeenth street, corner Norris street..	June 21, 1878..	223 00	33 45
"	Odd Fellows' Home.....	" " S. E. cor. Tioga " ..	June 21, 1878..	76 00	11 40
"	Methodist Episcopal Home.....	N. E. cor. Thirteenth street and Lehigh avenue..	June 21, 1878..	190 00	28 50
"	Women's Homœopathic Hospital.....	2135-37 North Twentieth street.....	October 1, 1884..	40 00	6 00
Twenty-ninth.....	Homœopathic Hospital for Children.....	914 North Broad street.....	December 21, 1883..	52 00	7 80
		Amount carried forward..		$15,313 07	$2,305 90

LIST OF CHARITABLE INSTITUTIONS—(*Continued*).

Ward.	Name.	Location.	When placed on charity list.	Amount assessed.	Amount charged.
		Amount brought forward..		$15,313 07	$2,395 90
Twenty-ninth.....	School of Design for Women.....	1346 North Broad street.....	June 20, 1878..	129 00	19 35
"	Little Sisters of the Poor.....	Eighteenth street, E. side, N. of Jefferson street..	June 21, 1878..	182 00	27 30
"	German Hospital.....	S. W. corner Corinthian and Girard avenues.....	June 21, 1878..	134 00	20 10
"	House of Refuge.....	N. W. corner Twenty-second and Poplar streets.	June 21, 1879..	439 00	65 85
"	St. Joseph's Hospital.....	S. E. cor. Seventeenth street and Girard avenue..	June 21, 1878..	422 00	63 30
"	Women's Medical College.....	Northwest corner Twenty-first street and North College avenue.....	June 21, 1878..	110 00	16 50
"	" Hospital.....	Northeast corner Twenty-second street and North College avenue.....	June 21, 1878..	249 50	37 43
"	Girard College.....	South College avenue, north side.....	June 3, 1879..	5,515 28	827 29
"	Union Temporary Home for Children.....	1525 Poplar street.....	June 21, 1878..	69 00	10 35
"	Northwest Soup Society.....	1300 North Nineteenth street.....	June 21, 1879..	11 00	5 00
				$22,573 85	$3,398 37
		Loss of revenue to the city..		$19,175 48	

STATEMENT OF PERMITS ISSUED DURING THE YEAR 1884, BY WARDS.

APPLIANCES.	WARDS.																														Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Aquaria	1												1																			2
Bakeries	2													1			1			1	1		2			2		3	3	1		17
Barber shops	1	1				1		3	3			1	3	2	2		2	1	4	2	2		2	1		4	1		5	1	3	45
Bars	18	4	3	8	12	10	7	11	9	11	6	6	7	6	13	7	5	7	29	10	9	8	6	9	27	25	9	26	6	11	11	236
Basins and sinks in dwellings	11	2		2	9	5	5	85	11	28	1	19	15	15	120	2	5	5	39	80	15	124	17	108	19	23	110	452	210		11	1,548
Basins and sinks in offices, stores, factories, hotels, public build'gs	6	2	1	2	28	52	1	29	55	50	2	2	2	8	7	1	1	1	12	6	4	42	2	10		6	52	5	11	1		401
Baths in dwellings	203	20	6	3	18	3	19	48	15	11	3	15	10	10	111	3	19	67	396	100	65	217	51	288	348	415	115	586	428	39	57	3,689
Baths in public buildings									2													7										9
Bidets								7	2													1		3					2			15
Bottling establishments	1					1							2						2										1			7
Building purposes, number	35	2	1		3	2	2	9	11	5		1	2	2	6		6	20	86	25	74	82	33	82	105	45	38	113	49	5	24	868
Carriages and wagons	1																			2			5					9	11			28
Cut-offs	72	27	10	9	17	27	32	37	28	30	17	7	35	31	60	11	26	35	72	75	12	24	5	47	43	86	27	40	63	127	54	1,186
Half dwellings	2																		1	2					1			2				8
Drug stores	2													1						1	1			3		2	1		1			12
Ferrules, number	306	53	18	12	34	43	150	71	64	58	19	14	43	50	141	32	38	110	605	196	153	306	100	406	511	684	217	849	494	145	119	5,921
Filterers																												1				1
Fountains, counter										1				1					2					2		2			2	2		12
Fountains, garden														3											2		1		1			7
Forges																											1					1
Greenhouses								1												1	1	5	4	1		5	6	6				30
Hatters' planks	6							4	2	2																						14
Hydrants	232	16	5	4	17	2	13	23	3	5	2	12	8	8	70	2	32	84	499	94	180	296	115	382	532	592	201	658	403	46	90	4,626
Hydraulic elevators																				1		1										2
Ice cream saloons																							1									1
Laundries													1		2			1	1	2		1					1					9
Machines for scouring, washing, bleaching, and rinsing	9																		1													10
Milk houses													5							5							2		4	1		17
Motors, beer					2	3		2	5			1			1	1	1	7	5	4	6	1		3		1	2	5	2	1		53
Motors, organ								1											1			3					2	1				8
Photograph galleries								1					1			1	1										1				1	6
Plug permits		1				3			3	2			1	1	2					1	5		5	1	1	1		2	3	1	1	34
Pools in churches																								1								1
Rectifying establishments																									1			1				2
Restaurants and eating saloons					1			1				1	1	1		2	2	1	1			1	1					1		2		16
Screw nozzles	23				1	4			1				3		1				2	2	5	14		7		2	24	3	2			94
Slaughter houses															1				1			1			2			4				9
Stalls in stables	137				1	2		35	8	9	2		5	4	87		5	1	65	33	10	153	18	9	2	134		20	17	4	3	764
Stalls, fish																											1					1
Steam boilers, number	3				3	5		3	5		3		1	1	2	2	3	1	11	3	2	7		2	3	1	2		2	1	2	68
Steam boilers, H. P	36				155	60		150	305		19		3	34	36	70	34	4	538	82	136	150		80	297	3	8		260	3	87	2,550
" " heating, number							1	1		1											1		1	2	3		3					13
Steam engines, number	2	2		2	2	6		2	8	3	2		1	4	4	2		2	6	5	4	3	1	3	2	1	3	4	4	3	3	84
Steam engines, H. P	32	66		18½	29	64		19	100	26	12		3	28	63	23		9	241	86	43	72	10	37	53	5	14	14	7	33	5	1,112½
Steam saws, number																											3					
Street sprinklers																																
Tubs, vats, and tanks	1							2	1		22					4	2		18	10				13								73
Urinals in dwellings														5						4		13						2				24
Urinals in stores, offices, hotels, factories, and public buildings	1			1	14	17		4	16	7		1		1	3				11	1	1	9		4			5	2	4		3	105
Urinal troughs	2				3			1	1		1			1				1														10
Wash-paves	47	5	3		6	6	4	30	16	6	1	13	9	6	97	5	26	40	263	86	13	111	36	172	143	88	89	479	329	21	35	2,185
Wash-paves for watering horses	8	4	3	1	1		4	1	7	3	5	3		8	13	2	14	7	36	11	2	6	11	12	30	14	10	19	7	7	12	261
Wash-tubs (stationary)		2			3			40	20	14		3	3	2	76				1	3	1	68	4	63			24	33	48			408
Water-closets in dwellings,	40	5	3	3	29	9	19	114	31	47	3	41	73	88	195	9	6	23	173	183	13	196	10	378	60	77	209	979	650	26	43	3,735
Water-closets in offices, factories, stores, hotels, public buildings	4	4		5	34	50	2	35	55	11	6	3	1	13	13	1			22	5	2	64		26		11	13		20			400
Watering vessels	11	95	26	6		1					16							1														156
Wool washers																									1							1

ERRATUM: In the column of "Gallons per day," multiply each number by ten.

COMPARATIVE STATEMENT OF REGULAR AND METER CHARGES, 1884.

Ward.	Name.	Location.	Assessed by Regular Rates, 1883.	Assessed by Regular Rates, 1884.	Gallons per day.	Average by Meter Charges, 1884.	Assessed by Regular Rates, 1885.	Horse Power.	Establishment.
First	Furbush, M. A	N. E. cor. Moyamensing avenue and Moore streets	$83 00	$395 00	442	$110 62	$265 00	130	Woolen Mill.
	" "	S. E. cor. Eighth and Mountain streets	185 00	1,800 00	5,248	1,312 00	1,217 00	583	Dye House.
	McCahan, C. & Co	N. W. cor. Otsego and Morris streets	120 00	863 00	154	38 70	681 00	308	Sugar House.
	Rawley, E. H	N. E. cor. Mifflin and Otsego streets	83 00	101 00	569	142 34	95 00	6	Rosin Oil Works.
	Shoemaker, J. L. & Co	1520 South Ninth street	56 00	103 00	667	166 88	75 00	25	Morocco Manufactory.
	Wetherill, S. P. & Co	Cor. Tenth and Dickinson streets	65 00	189 00	598	149 64	125 00	54	Chemical Works.
Second	Arrott, William	S. E. cor. Thirteenth and Carpenter streets	340 00	437 00	1,985	396 40	308 00	129	Woolen Mill.
	Bartol, B. H	1012 Passyunk avenue	164 00	717 00	1,105	276 49	497 00	220	Sugar Refinery.
	Campbell, Elliott & Co	1021–25 South Twelfth street	494 00	823 00	6,256	1,564 17	611 00	212	Woolen Mill.
	Heyl Bros	N. E. cor. Otsego street and Washington avenue	165 00		725	181 47	265 00	130	Sugar House.
	Martin, T	1201 Washington avenue	179 00	195 00	747	186 79	135 00	60	Dye House.
	Williams, J. & Son	S. W. cor. Twelfth and Carpenter streets	219 00	246 00	989	247 37	177 00	69	Woolen and Cotton Mill.
Third	Belrose, Lewis	S. W. cor. Eleventh and Catharine streets	244 00	270 00	392	98 07	186 00	84	Dye House.
Fourth	Horstman, John F	314 Stanley street		32 00	669	167 30	32 00		Wool Washers.
Fifth	Jayne Est	244 Chestnut street	513 71		1,065	266 31	298 00	98	Drugs.
	Tatham Bros	226 & 228 South Fifth street	189 00	475 00	402	100 66	325 00	150	Lead Works.
Sixth	Gillou, Rene	127 North Fourth street	70 00	329 00	730	182 73	151 00	63	Miscellaneous.
	McCambridge, S	523–27 Cherry street	103 00	154 00	232	58 21	119 00	35	Machine Shop.
	Smith, Robert	14 to 20 South Fifth street	474 00	434 00	1,625	406 30	395 00	19	Brewery.
Seventh	Kershaw, R	2030–42 Naudain street	203 50	319 00	644	161 18	258 00	100	Woolen Mill.
	Mitchell, N. C	2417–21 South street	86 00	518 00	684	171 00	348 00	170	Rubber Works.
	Milne, C. J	1822–26 Lombard street	82 00	476 00	429	107 45	324 00	88	Dye House and Woolen Mill.
	Smith, J	1920–26 Pine street	322 00	641 00	862	215 52	444 00	207	Cotton Mill.
Eighth	Aldine Hotel	1914 Chestnut street	1,176 15		2,800	700 00	893 00	58	Hotel.
	Continental Hotel	Ninth and Chestnut streets	309 00		2,617	654 32	1,582 00	87	"
	Kelsey, H. W	1106 Walnut street	223 81		322	80 50	100 00	11	Baths.
	LaFayette Hotel	Broad and Chestnut streets	1,500 00		3,592	898 00	2,050 00	100	Hotel.
	McLaughlin (The Times)	Eighth and Chestnut streets	144 00	240 00	213	53 42	186 00	54	Newspaper.
	Payne, J. A	219 South Broad street	158 00	158 00	800	200 00	171 00		Swimming school.
	Presbyterian Board of Publication	1334 Chestnut street	70 00	163 00	145	36 44	196 00	60 (heating)	Publishing House.

COMPARATIVE STATEMENT OF REGULAR AND METER CHARGES, 1884—*Continued.*

Ward.	Name.	Location.	Assessed by Regular Rates, 1883.	Assessed by Regular Rates, 1884.	Gallons. per day.	Average by Meter Charges, 1884.	Assessed by Regular Rates, 1885.	Horse Power.	Establishment.
Eighth	Underground Electric Company	Rear of 123 South Eleventh street			1,167	$291 84	$650 00	325	Electric Company.
	Wyeth, John & Bro	1412 Walnut street	$173 00	$273 50	1,700	425 00	238 00	68	Chemicals.
Ninth	Brush Electric Light Company	Johnson street, W. of Twentieth street	607 00		3,600	900 00	2,608 00	1,296	Electric Light Company.
	Massey, William	N. W. cor. Tenth and Filbert streets	1,066 00	114 00	3,782	940 60	1,772 80	58	Brewery.
	Milligan, William	1013 Chestnut street	95 99	115 00	210	52 60	85 00		Baths.
	Croft & Allen	1224 & 1226 Market street	100 00	233 00	1,353	338 40	176 00	57	Candy Manufactory.
	Wilbur & Co	1211 & 1213 Clover street		228 00	217	54 43	177 00	76	" "
Tenth	Borgner & O'Brian	234 North Twenty-third street	41 00	100 00	127	31 93	70 00	24	Brick Works.
	Coulter & Lowry	203–07 N. W. cor. Twenty-second street	131 00	210 00	334	83 69	167 00	37	Cloth Finishers.
	Cornelius and Sons	811–21 Cherry street	355 00	420 00	1,898	474 64	320 00	100	Gas Fixtures.
	Helwig	122 Eutaw street	96 00	135 00	640	160 00	95 00	30	Dye House.
	Mellor & Rittenhouse	214–18 North Twenty-second street	218 00	422 00	5,600	1,400 00	389 00	113	Chemicals.
	Maxim Electric Light Company	N. E. cor. Chester and Maple streets		419 00	1,185	296 43	294 00	134	Electric Light Company.
	Newkumet Est	2306 Vine street	221 00	260 00	254	63 74	199 00	31	Brick Works.
	Philadelphia Galvanizing Company	2124 Race street	51 00	86 00	530	132 67	71 00	14	Galvanizing Company.
	Schell, J. & J. B	S. E. cor. Tenth and Vine streets	65 00	77 00	880	220 28	65 00	12	Marble Works.
Eleventh	Baum, Little & Co	123 Margaretta street	96 00	132 00	880	221 41	132 00	23	Morocco Manufactory.
	Betz, John F	333 St. John street	126 00	320 00	2,479	619 81	248 00	72	Malt House.
	Blume & Reiber	700 North Front street	62 00	180 00	1,216	304 00	136 00	44	Skin Dresser.
	Buckius	425 St. John street	37 00	71 00	779	194 83	67 00	4	" "
	Clark, William	422 " "	84 00	153 00	813	203 45	114 00	32	" "
	Cumming & Patterson	131–37 Margaretta street	101 00	121 00	1,138	284 71	148 00	22	Morocco Manufactory.
	Elton & Co	N. W. cor. St. John and Willow streets	40 00	70 00	638	159 66	64 00	6	Skin Dresser.
	Evans, Edw. & Co	427 & 429 St. John street	47 00	69 00	390	97 57	63 00	8	Morocco Manufactory.
	Felton, W. S. & Co	431 " "	47 00	64 00	430	107 53	55 00	9	" "
	Fisher, C. R	151 & 153 Willow street	40 00	93 00	793	198 29	85 00	10	" "
	Frank, Geo. & Son	149 " "	41 00	53 00	432	108 02	50 00	3	" "
	Frank, John & Son	213 " "	40 00	64 00	353	88 44	55 00	9	" "
	Gundelfinger & Unkle	145 Margaretta street	56 00	72 00	484	121 12	65 00	10	Skin Dresser.
	" "	143 " "		64 00			51 00	7	" "
	Hafele, M	157 Willow street	36 00	37 00	89	22 33	37 00	2	Morocco Manufactory.
	Hammer, Alwin	506–14 New Market street	39 00	121 00	480	120 00	99 00	22	" "

Ward.	Name.	Location.	Assessed by Regular Rates, 1883.	Assessed by Regular Rates, 1884.	Gallons per day.	Average by Meter Charges. 1884.	Assessed by Regular Rates, 1885.	Horse Power.	Establishment.
Eleventh	Herman, Frederick	216 Willow street	$40 00	$98 00	144	$36 12	$26 00		Skin Dresser.
	Horn, William H	451 & 455 North Third street	142 00	125 00	546	136 53	81 00	34	Morocco Manufactory.
	Jones, J. & W	430 & 432 North Front street	45 95	73 00	112	28 13	65 00	8	Dye House.
	Keasby & Mattison	328 & 330 " "	152 00	190 00	171	42 92	106 00	45	Chemical Works.
	Martin, P. D	210 & 212 Callowhill street	21 00	34 00	59	14 92	35 00	4	Morocco Manufactory.
	Mathews, M. C	215 Willow street	66 00	129 00	576	144 20	104 00	25	" "
	McCready, Levering & Co	139 & 141 Margaretta street	101 00	65 00	314	78 50	46 00	6	" "
	Meyers, M. N	313 North Third street	11 00	60 00	46	11 77	40 00		Rectifying Estab.
	Smith, E. A	209 & 211 Willow street	31 00	51 00	209	52 41	52 00	4	Morocco Manufactory.
	Sweatman & Co	S. E. cor. Callowhill and New Market streets	107 50	208 00	1,160	290 00	193 00	15	Malt House.
Twelfth	Amer, A. C. & Co	438 North Third street	106 00	126 00	1,029	257 49	111 00	15	Morocco Manufactory.
	Betz, John F. & Son	S. W. cor. York avenue and Willow streets	1,312 00	3,827 24	17,317	4,329 49	3,291 24	268	Brewery.
	Bowman & Smith	429–33 Dillwyn street	105 00	85 00	644	161 18	85 00		Morocco Manufactory.
	" "	440 & 442 " "	105 00	87 00	644	161 18	74 00	13	" "
	Costello & Covey	444 & 446 North Third street	107 00	161 00	895	223 97	137 00	24	" "
	Dungan, Hood & Co	434 & 436 " "	60 00	326 00	1,961	490 36	276 00	50	" "
	Gamble, E. M	427 Dillwyn street	49 00	63 00	338	84 61	53 00	10	Skin Dresser.
	Gibbs, Charles	822 & 824 Lawrence street	96 00	122 00	449	112 44	110 00	12	Hat Manufactory.
	Hammond & Dwyer	424 Dillwyn street	52 00	82 00	632	158 17	77 00	14	Morocco Manufactory.
	Hoyt, H. A	412 & 414 Dillwyn street		121 00	295	73 84	97 00	22	Hat Manufactory.
	Jackson, T	814–20 Lawrence street	174 00	171 00	467	116 97	122 00	49	Woolen Mill.
	O'Callahan, B. F	458–66 North Third street	47 00	214 00	631	157 91	176 00	38	Skiver Manufactory.
	Martin, S	422 & 424 " "	64 00	67 00	290	72 72	53 00	14	Morocco Manufactory.
	Pierson, C. & Son	426 " "	26 00	87 00	76	19 00	77 00	10	Skin Dresser.
	" "	421 Dillwyn street	20 00	135 00	2,189	547 40			Wool Puller.
	Stern, J. & Son	428 North Third street	45 00	55 00	544	136 21	50 00	4	Malt House.
	Stroebel, J	849 & 851 North Fourth street	90 00	170 48	354	88 64	155 48	15	Brewery.
	Stephenson, J. B	439 York street	75 00	158 00	111	27 95	108 00	50	Oil Works.
	Walters, P	321 & 323 Fairmount avenue	168 00	292 00	998	166 36	266 00	26	Brewery.
Thirteenth	Bower, W. H	914 Fairmount avenue	127 50	207 00	290	72 50	152 00	55	Dye House.
	Hance Bros. & White	621–25 Callowhill street	66 00	251 00	415	103 75	168 00	75	Drugs.
	Magee, R	725–31 Vine street	252 00	589 62	1,600	400 00	556 62	33	Brewery.

COMPARATIVE STATEMENT OF REGULAR AND METER CHARGES, 1884—*Continued.*

Ward.	Name.	Location.	Assessed by Regular Rates, 1883.	Assessed by Regular Rates, 1884.	Gallons per day.	Average by Meter Charges, 1884.	Assessed by Regular Rates, 1885.	Horse Power.	Establishment.
Fourteenth	Thompson, L. & Co	N. E. cor. Eleventh street and Ridge avenue	$215 00	$240 00	196	$49 00	$180 00	64	Marble Works.
	" "	N. W. cor. Twelfth and Buttonwood streets	21 00	189 00	495	123 88	100 00	28	Factory.
Fifteenth	Brooke, B. & Co	S. E. cor. Twenty-third and Hamilton streets	155 00	241 00	786	196 94	147 00	52	Soap Manufactory.
	Bergdoll Brewing Company	N. E. cor. Twenty-ninth and Parrish streets	1,098 00	2,696 82	9,078	2,269 56	2,366 82	330	Brewery.
	Clough & Carson	618 North Twenty-fourth street	239 00	382 00	1,067	266 80	298 00	84	Dye Works.
	Conrad, Jacob	N. W. cor. Twenty-seventh and Parrish streets	242 12	266 12	798	199 53	236 12	30	Brewery.
	Culbertson, J. & Son	N. E. cor. Twenty-third and Hamilton streets	165 00	228 00	308	77 00	174 00	54	Dye House.
	Eastern Penitentiary	N. E. cor. Fairmount ave. and Twenty-second street	1,824 00	1,824 00	5,980	1,495 00	1,824 00	121	Prison.
	Erben, Search & Co	S. W. cor. Osprey and Spring Garden streets	609 00	1,033 00	2,800	700 00	713 00	320	Woolen Mill.
	Wood, Wm. & Co	N. W. cor. Twenty-fourth and Hamilton streets	185 00	226 00	275	68 75	154 00	52	Dye House.
	Wright, J. K. & Co	S. W. cor. Twenty-sixth and Hare streets		177 00	136	34 00	127 00	50	Printers' Ink Works.
Sixteenth	Adams & Keene	930–40 St. John street	105 60	170 60	988	247 12	142 00	19	Morocco Manufactory.
	Allen, S	933–41 North Front street	59 00	191 00	1,980	495 00	248 00	36	" "
	Carey, George	934 North Third street	224 00	494 00	387	96 85	457 00	37	Brewery.
	Deglow, R	1036 St. John, or 1033 Canal street	30 00	79 00	114	28 50	64 00	13	Morocco Manufactory.
	Eglinton, J	5–11 Canal street	71 00	71 00	255	63 96	58 00	13	" "
	Flagg, S. G. & Co	1109–19 North Front street	65 00	99 00	333	83 27	72 00	27	Foundry.
	Gamble, Wm. C. & Bro	161 Canal street	35 00	69 00	357	89 40	65 00	4	Morocco Manufactory.
	Gross, C	1116–24 Canal street	21 00	70 00	108	27 07	61 00	9	" "
	Gultz, A	Rear of 142 Edward street	34 00	59 00	40	10 17	51 00	8	Hat "
	Hartley, Fink & Co	1035–39 North Front street	98 00	123 00	1,142	285 50	108 00	15	Morocco "
	Hummell & Sons	972 Canal street	132 00	179 00	761	190 44	143 00	36	Skin Dresser.
	Keene & Coates	943 North Front street	161 00	342 00	88	22 30	272 00	69	Tannery.
	Lea, Samuel & Sons	1142 St. John street	55 00	213 00	432	108 24	112 00	43	Woolen Mill.
	Lottie & Moser	185 & 187 Canal street	24 00	42 00	184	46 00	38 00	4	Silk Dyeing Establishment.
	McNeeley & Co	N. W. cor. Charlotte and Canal streets	169 00	411 00	4,474	1,118 58	371 00	40	Morocco Manufactory.
	Miller, C. W. & Co	171–79 Canal street	137 00	222 00	2,396	599 00	172 00	50	Hair Washer.
	Nevill, J. & Son	1014 & 1016 St. John street	126 00	231 00	1,353	338 34	181 00	40	Morocco Manufactory.
	Schmidt, C	111–21 Edwards street	480 00	811 28	2,953	738 25	704 28	40	Brewery.
	Schutt, F	354 Canal street	36 00	59 00	362	90 50	59 00		Morocco Manufactory.
	Smith, E	927 & 929 North Third street	243 50	479 00	4,320	1,080 24	505 00	120	" "
	Simpson, Ralph	Rear of 20 Richmond street	44 00	45 00	163	40 93	30 00	3	Skin Dresser.
	Whartman & Co	35 & 37 Poplar street	102 00	128 00	424	106 00	156 00	27	Meat Packing House.
	Zimmerman	20 Slossman street	29 00	33 00	132	33 24	33 00		Morocco Manufactory.

Ward.	Name.	Location.	Assessed by Regular Rates, 1883.	Assessed by Regular Rates, 1884.	Gallons per day.	Average by Meter Charges. 1884.	Assessed by Regular Rates, 1885.	Horse Power.	Establishment.
Seventeenth	Arrott, William	S. W. cor. Howard and Jefferson streets		$632 00	3,348	$837 00	$468 00	164	Woolen Mill.
	Buckhalter	1210–18 Charlotte street		104 00	276	69 12	79 00	22	Dye House.
	Craig, A. H. & J	N. W. cor. Jefferson and Randolph streets	137 00	273 00	1,050	262 55	218 00	55	Tannery.
	Delaney & Co	1445 Hancock street	34 00	216 00	976	244 24	198 00	48	Glue Manufactory.
	Dolan, T. & Co	S. E. cor. Oxford and Howard streets		3,766 00	42,844	10,711 20	4,872 00	866	Dye House.
	Dornan Bros	S. W. cor. " "	146 00	291 00	1,771	442 85	217 00	74	" "
	Drueding Bros	431 & 433 Master street	74 00	138 00	346	86 67	95 00	36	" "
	Bower, G	N. E. cor. Second and Jefferson streets	46 00	76 00	241	60 44	60 00	16	" "
	Hacker, J. & Co	N. W. cor. Jefferson and Mascher streets	45 00	79 00	603	150 65	71 00	8	Skin Dresser.
	Hill, T	1514 Hancock street	39 00	82 00	240	60 00	52 00	16	Dye House.
	Kindsvaters	S. W. cor. Oxford and Randolph streets	27 00	89 00	330	81 78	73 00	16	Tannery.
	Kitcherman, C	1230–34 Charlotte street	65 00	133 00	510	127 85	98 00	35	Dye House.
	Knight, G. W	141 Master street	47 00	66 00	230	57 66	50 00	16	Brass Finisher.
	Lafferty, C	1526 & 1528 Hancock street		112 00	439	109 90	94 00	18	Dye House.
	Long Bros. & Co	1533 & 1535 Palethorp street		116 00			68 00		" "
	Long, J. & Co	S. W. cor. Oxford and Palethorp streets		282 00	973	243 44	196 00	86	Cotton Manufactory.
	Ludig & Sons	1503–13 Mascher street	11 00	239 00	96	24 00	158 00	64	Tallow "
	McConnell, J. J. & Co	1214 Canal street	240 00	63 00	788	197 20	70 00		Morocco "
	" "	1220–36 Canal street		440 00			234 00	106	Cotton Spinners.
	Peterson, J	S. E. cor. Randolph and Master streets	124 00	175 00	212	53 00	102 00	22	Tannery.
	Reiger & Getz	1538 Germantown avenue	39 00	69 14	198	49 63	78 14	3	Brewery.
	Schwering, J. & Son	1533–45 Randolph street	143 00	186 00	172	43 00	149 00	31	Skin Dresser.
	Schofield & Branson	217 Jefferson street	221 00	340 00	1,248	312 00	247 00	93	Stocking Mill.
	Tortual & Co	1528 Mascher street	8 00	43 00	55	13 84	33 00		Skin Dresser.
	Volmer, A	S. E. cor. Randolph and Jefferson streets	96 00	103 00	337	82 30	104 00	19	Brewery.
	Zierfuss	1534 Germantown avenue	27 00	51 00	271	67 84	51 00		"
Eighteenth	Becker, H	429–35 Moyer street	138 00	167 00	317	79 32	120 00	47	Woolen Manufactory.
	Burgin & Son	1204 East Montgomery avenue	131 50	251 00	395	98 93	181 00	70	Glass Works.
	Clay, George W	941 East Norris street	25 00	30 00	155	38 87	25 00	5	Dye "
	Derbyshire, W	226 Girard avenue	78 00	73 00	184	46 22	57 00	16	" "
	Dougherty & Downs	1345–49 Frankford avenue	260 00	560 00	408	102 25	384 00	176	Rectifying House.
	Early & White	1514–18 Vienna street	119 00	175 00	936	254 14	139 00	36	Dye House.
	Hamilton, Thomas	1350 " "	113 00	187 00	169	42 44	143 00	44	Wire Works.

Ward.	Name.	Location.	Assessed by Regular Rates, 1883.	Assessed by Regular Rates, 1884.	Gallons per day.	Average by Meter Charges. 1884.	Assessed by Regular Rates, 1885.	Horse Power.	Establishment.
Eighteenth	Hanifen & Co	S. W. cor. Thompson and Savery streets	$181 00	$198 00	115	$28 85	$138 00	60	Hosiery Mill.
	Hasse, G. W	1205 Thompson street	70 00	108 00	204	51 00	82 00	26	Whitening Works.
	Johnson, H	1213 Hanover street	136 00	120 00	868	217 07	95 00	25	Dye House.
	Rogers, Annie & Rose	1410 Savery street	93 00	84 00	196	49 03	68 00	16	" "
	Rohrbacher & Hohrman	1355–65 Salmon street	43 00	134 00	198	49 52	93 00	24	Glass Works.
	Thornton, William	1214–18 Crease street	116 00	279 00	160	40 10	113 00	49	Woolen Mill.
	Thudium, R. C	1051 Frankford road	166 00	200 00	134	33 73	117 00	46	" "
Nineteenth	Arrott, William	1720 North Second street	354 00	547 00	13,260	.....	375 00	166	Woolen Mill.
	" "	1727 and 1729 Phillip street	74 00	81 00		3,315 19	154 00	.....	" "
	Crawford, George	1710–14 Howard street	95 00	122 00	988	247 08	105 00	17	Dye Works.
	Finkenhauer, T	1714 & 1716 Germantown avenue	123 00	123 00	305	76 44	123 00	12	Brewery.
	Forader	1716 Randolph street	45 00	54 00	943	235 92	48 00	6	Morocco Manufactory.
	Gillender & Sons	N. W. cor. Oxford and Howard streets	164 00	380 00	1,256	312 12	281 00	74	Glass Works.
	Gay, John	N. E. cor. Howard and Norris streets	75 00	511 00	2,540	635 28	358 00	153	Woolen Mill.
	Hogg & Metzger	N. W. cor. Second and Huntingdon streets	135 00	.....	1,324	331 10	247 00	86	" "
	Lea, J. & Son	1711 & 1713 Bodine street	191 00	213 00	419	104 87	148 00	65	Cotton "
	Leedom, T	2415–37 Howard street	296 00	338 00	2,907	726 84	262 00	76	Carpet "
	McKee & Co	N. E. cor. Harrison and Howard streets	107 00	189 00	2,111	527 81	211 00	60	Knitting "
	Murphy, J. B	S. E. cor. Cumberland and Fourth streets	245 00	191 00	561	140 36	169 00	82	Woolen "
	Reiger	N. E. cor. Fourth and Cadwallader streets	5 00	74 44	233	58 48	74 44	.....	Brewery.
	Sanquoit Silk Company	S. E. cor. Columbia avenue and Randolph street	77 00	224 00	828	207 16	168 00	56	Silk Manufactory.
	Schuman, C	1724 North Fifth street	65 00	89 00	273	68 36	63 00	12	Skin Dresser.
	Schollenberger & Sons	S. E. cor. Putnam and Mascher streets	171 00	362 00	669	167 40	340 00	108	Oleomargerine Manufactory.
	Schofield & Mason	N. E. cor. Fairhill and Cumberland streets	191 00	306 00	1,093	273 32	397 00	47	Carpet Mill—Dye Works.
	Taylor, T. & Sons	S. E. cor. Howard street and Lehigh avenue	176 00	279 00	1,451	362 85	203 00	76	" "
	Wieman, T. & Son	1732–38 Howard street	79 00	229 00	1,088	272 00	181 00	48	Dye Works.
	Western White Lead Works	1833 Hancock street	107 00	250 00	4,834	1,208 58	178 00	72	Lead "
Twentieth	Alburger, John	S. W. cor. Girard avenue and Franklin streets	166 00	281 50	624	153 75	194 00	68	Soap "
	Bearwood Bros	1640 North Sixth street	.....	401 00	1,470	367 75	276 00	109	Finishing Works.
	Class, Charles	1732 Mervine street	164 00	262 58	2,059	514 97	232 58	30	Brewery.
	Haisch, C	1748 " "	124 00	202 00	534	133 68	222 00	25	"
	Hartranft, S. & Co	939 North Ninth street	180 00	217 00	77	19 43	152 00	68	Flour Mill.

COMPARATIVE STATEMENT OF REGULAR AND METER CHARGES, 1884—*Continued.*

Ward.	Name.	Location.	Assessed by Regular Rates, 1883.	Assessed by Regular Rates, 1884.	Gallons per day.	Average by Meter Charges. 1884.	Assessed by Regular Rates, 1885.	Horse Power.	Establishment.
Twentieth	Hyzer & Lewellyn	952 North Ninth street	35 00	75 00	65	16 48	31 00	10	Fire Brick Works.
	Kasper, C	1703 North Twelfth street		160 80	436	109 00	119 80	28	Brewery.
	Schimmell, J. O	N. E. cor. Eighth and Berks street		260 50	679	169 90	183 00	60	Fruit Pressing Company.
	Schuman, F	1808 & 1810 North Eighth street	88 00	103 00	420	105 28	83 00	20	Kid Manufactory.
	Sullivan, J. & Son	902 Montgomery avenue	102 00	184 00	804	201 00	136 00	48	Dye House.
	Wolters, C	N. W. cor. Eleventh and Oxford streets	595 00	1,086 22	7,516	1,879 23	960 22	126	Brewery.
Twenty-first	Powers & Weightman	School Lane			400	100 00	168 00	40	Chemical Works.
	Wallace, D	4046 Main street	185 50	396 00	225	56 42	263 00	123	Cotton Mill.
Twenty-second	Miller, John C	Ashmead and Wakefield streets	70 00	901 00	762	190 56	753 00	123	Brewery.
Twenty-third	Crankshaw	West Unity street, S. W. cor. of Elizabeth street		104 00	190	47 55	71 00	33	Woolen Mill.
	Erdrick, A	South side Bridge	8 00	98 00	489	122 38	68 00	30	Brewery.
	Grousch	4224-28 Edward street	73 00	165 00	467	116 88	153 38	20	"
	Warder, J	South side Frankford	116 00	166 00	232	58 00	129 00	37	Dye Works.
Twenty-fourth	Aman Bros	3721 Filbert street	59 00	113 00	134	33 70	78 00	35	Planing Mill.
Twenty-fifth	Bridesburg Manufacturing Comp'y	N. E. cor. Richmond and Orchard streets	395 00	1,164 00	245	61 39	736 00	368	Machinery.
	Ennis, G. W. & Co	N. W. cor. Lehigh avenue and Front street	176 00	213 00	1,010	254 52	163 00	50	Carpet Mill.
	Hernig, J	2610 Frankford road	43 00	46 00	668	167 00	46 00		Brewery.
	Houghton, E. T. & Co	240 West Somerset street	146 00	218 00	78	19 58	157 00	61	Oil Works.
	Hamilton, J	East side Howard street	101 00	203 00	160	40 09	95 00	45	Carpet "
	Holmes, Henry	N. E. cor. Trenton avenue and Auburn street		176 00	136	34 13	75 00	35	" "
	Jefford, J. E. & Co	1412 Salmon street	57 00	245 00	277	69 40	161 00	44	Pottery.
	Kramer, Otto	2717 Germantown avenue		172 00	1,464	366 00	144 00	28	Dye House.
	Mantz, Gotleib	S. E. cor. Sixth and Clearfield streets	142 00	331 90	579	144 94	255 90	76	Brewery.
	Martin, James	S. W. cor. Richmond and Tioga streets	501 00	1,009 00	8,036	2,009 00	1,183 00	323	Dye House.
Twenty-sixth	Breed, Creswell & Waltham	S. E. cor. Eighteenth street and Washington avenue.	161 00	229 00	700	150 00	166 00	56	Wall Paper Manufactory.
	Campbell, George W	S. W. cor. Twenty-first street and Washington ave...	552 00	1,243 00	1,770	442 75	913 00	328	Cotton and Woolen Mill.
	" "	S. W. cor. Thirty-first and Reed streets	230 00	659 00	1,309	327 44	473 00	186	Cloth Mill.
	Continental Brewing Company	S. W. cor. Washington ave. and Twenty-first street..	86 00	1,030 00	1,508	377 10	695 00	335	Brewery.
	Cooper, J. W	1720 Washington avenue	271 00	306 00	229	57 45	217 00	51	Furniture Manufactory.
	Greer, J. & Co	S. E. cor. Sixteenth and Reed streets	328 00	526 00	865	216 30	402 00	118	Woolen Mill.

COMPARATIVE STATEMENT OF REGULAR AND METER CHARGES, 1884—*Continued.*

Ward.	Name.	Location.	Assessed by Regular Rates, 1883.	Assessed by Regular Rates, 1884.	Gallons per day.	Average by Meter Charges. 1884.	Assessed by Regular Rates, 1885.	Horse Power.	Establishment.
Twenty-sixth	McDaniel, Harvey & Co	S. W. cor. Sixteenth street and Washington avenue	75 00	333 00	256	64 03	238 00	100	Galvanizing Company.
	Pennypacker, W. G	S. E. cor. Twenty-third street and Washington ave		190 00	800	200 24	190 00	81	Barrel Manufactory.
	Phosphor-Bronze Company	2038 Washington avenue	64 67	242 00	150	37 75	183 00	79	Bronze "
	Wahl & Stewart	N. W. cor. Twenty-fourth and Ellsworth streets	185 50	395 00	326	81 68	271 00	124	Cloth Mill.
Twenty-seventh	Equitable Brick Works	S. E. cor. Walnut and Fifty-sixth streets		292 00	226	56 75	223 00	69	Brick Works.
	Schleicher, Schumm & Co	N. E. cor. Walnut and Thirty-third streets	40 00	178 00	101	25 37	55 00		Gas Engines.
Twenty-eighth	Filemyer, J	2425-31 North Broad street	101 00	162 00	460	115 00	134 00	28	Brewery.
	Gross, L	2419-23 " "	156 00	222 26	315	78 88	163 00	24	"
	Harrison Boiler Works	Seventeenth and Clearfield streets		113 00	144	36 00	75 00	35	Boiler Works.
	Keystone Horse Shoe Works	" " "		165 00	370	92 50	125 00	40	Horse Shoe Works.
	Klopfer	2433 North Broad street	83 00	83 00	318	79 70	81 00		Brewery.
	Stein, J	3365 Ridge avenue	55 00	114 66	364	91 00	96 00	9	"
Twenty-ninth	Baltz, J. & P	N. W. cor. Thirty-first and Thompson streets	429 00	1,258 00	4,390	1,097 76	1,146 00	112	Brewery.
	Bergner & Engel Brewing Company	Thirty-second and Thompson streets	1,539 00	3,000 00	26,850	6,712 51	5,099 00	438	"
	" "	" " "			16,841	4,210 47			" two Ice Machines.
	Beig & Pfender	East side Thirty-third st., 1st house N. of Thompson.	105 00	194 00	440	110 25	167 00	27	"
	Eble & Herter	N. E. cor. Thirty-third and Thompson streets	187 00	656 00	1,108	277 00	698 00	93	"
	Henzler & Flach	Thirty-first and Master streets	26 00	622 98	536	134 00	558 98	64	"
	Jolly, C	East side of Thirty-first street, N. of Master street	51 00	111 00	1,217	304 43	101 00	10	Bottler.
	Muller, H	N. E. cor. Thirty-first and Jefferson streets	349 00	768 62	3,518	879 52	686 62	82	Brewery.
	Poth, F. A	S. W. " " "	522 00	1,607 02	7,168	1,792 00	1,495 02	112	"
	Rothacker & Son	West side of Thirty-first street, N. of Thompson st	127 00	440 62	1,659	414 98	391 62	49	"
	Schemm, P	908-22 West College avenue	245 00	303 88	446	111 64	319 88	7	"
	Shafer, Philip	Thirtieth street, S. of Master street	50 00	101 00	124	31 20	69 00	22	Barrel and Tank Manufactory.
	Shafer & Arnholdt	North side of Thompson street, E. of Thirty-first st.	21 00	365 00	2,550	637 60	327 00	55	Brewery.
	Theis & Wagner	West side of Thirty-second street, N. of Poplar st		763 56	782	195 57	722 56	41	"
Thirtieth	Granless & Son	S. W. cor. Sixteenth and Fitzwater streets	166 00	237 00	411	102 93	115 00	43	Woolen Mill.
	Hagey, J. M	S. W. cor. Sixteenth and Carpenter streets	59 00	93 00	152	38 29	65 00	28	Shoddy "
	Howell Bros	N. W. cor. Twenty-first street and Washington ave.	526 00	706 00	802	200 71	439 50	51	Wall Paper.
	Rosengarten & Son	S. W. cor. Seventeenth and Fitzwater streets	459 00	500 00	2,128	532 00	370 00	130	Chemicals.

COMPARATIVE STATEMENT OF REGULAR AND METER CHARGES, 1884—*Continued.*

NAME.	LOCATION.	Assessed by Regular Rates, 1883.	Assessed by Regular Rates, 1884.	Gallons per day.	Average by Meter Charges, 1884.	Assessed by Regular Rates, 1885.	Horse Power.	ESTABLISHMENT.
Allen, William	2423 Amber street	$181 00	$246 00	1,875	$468 80	$248 00	100	Woolen Mill.
Almy, E. & H. N.	N. E. cor. Kensington ave. and Huntingdon street.	61 00	67 00	1,984	496 20	496 00	132	" "
Arrott, William	N. W. cor. Taylor and Coral streets	105 00	1,028 00	3,217	804 49	764 00	264	Cotton "
Bromley, J. & Bros.	N. E. cor. Front and Jasper streets	552 00	941 00	3,417	854 48	695 00	246	Dye House.
" "	N. W. cor. Adams and Jasper streets	557 00	895 00	1,677	419 37	652 00	243	Woolen Mill.
" "	N. E. cor. York and Jasper streets	361 00	459 00	908	227 25	343 00	116	Dye House.
Bergess, J.	N. E. cor. Amber and Bergess streets	223 00	327 00	2,183	545 85	382 00	58	" "
Brophy, P.	S. W. cor. Emerald and Taylor streets	139 00	140 00	862	215 75	109 00	31	" "
Duffy, J.	2429 & 2431 Emerald street	207 00	285 00	1,346	336 76	211 00	69	" "
Emsley, William	N. W. cor. Adams and Emerald streets	322 00	431 00	2,438	609 61	315 00	116	Woolen Mill.
Fifth and Sixth Sts. P. R. W. Comp'y	Kensington and Cumberland streets	605 00	1,106 00	1,264	316 24	1,134 00	76	Passenger Railway Company.
Foster Bros.	272–88 Taylor and Emerald streets	682 00	1,319 00	15,970	3,992 74	2,432 00	275	Dye House.
Glazier, J. J. & Bro.	119–35 Taylor street	378 00	276 00	1,694	423 59	223 00	53	Woolen Mill.
" "	S. W. cor. Taylor and Jasper streets		198 00			166 00	32	Dye House.
Greenwood	N. E. cor. Huntingdon and Emerald streets	196 00	424 00	1,331	332 92	324 00	100	" "
Kerr, J. H.	E. Huntingdon st., 290 ft. E. of Kensington ave.	95 00	95 00	212	53 00	65 00	30	Woolen Mill.
Kitcherman, C.	S. E. cor. Huntingdon and Jasper streets	356 00	673 00	1,464	367 00	506 00	191	" "
Larimer & Sons	2430 Martha street	207 00	261 00	1,578	394 60	204 00	57	Dye House.
Leavitt, W. A.	N. E. cor. Gaul and Adams streets	96 50	220 00	770	192 56	159 00	57	Glass Works.
" "	N. W. " " "		102 00			84 00	24	" "
Leithead, Robert	N. E. cor. Huntingdon and Collins streets	136 00	198 00	628	157 00	153 00	45	Dye House.
Mair, R. & Sons	S. W. cor. Adams and Amber streets	105 00	165 00	194	48 67	116 00	49	Woolen Mill.
Morgan, S.	220 & 222 E. Huntingdon street	188 00	214 00	156	39 20	185 00	29	" "
Nolan, William	S. E. cor. Huntingdon and Cedar streets	71 00	131 00	1,678	419 58	104 00	27	" " and Dye Works.
Remmy, R. C.	N. E. cor. Cumberland and Commerce streets	74 00	146 00	170	42 75	84 00	20	Pottery.
Straubmiller	N. E. cor. Trenton and York streets	30 00	88 00	376	94 29	76 00	12	Brewery.
Vernon, W.	N. W. cor. Amber and Letterly streets	95 00	147 00	249	62 38	104 00	42	Woolen Mill.
Weisbrod & Hess	S. E. cor. Adams and Holman streets		193 00	630	157 78	177 00	23	Brewery.

COMPARATIVE SCHEDULE OF WATER RATES IN THIRTY-TWO UNITED STATES CITIES.

States.	Names of Cities.	Population.	Number Gallons each day per capita.	Dwellings, each.	Meter Rates per one thousand Gallons.	Engines, Boilers, per Horse-power.	Bars.	Baths.	Basins.	Bakeries.	Barber Shops.	Breweries.	Lawn Sprinkling.	Street Sprinkling.	Fountains.	Slaughter Houses.	Carriages.	Stables, per Horse.		Urinals.	Water-closets.	Wash-paves.		Building Purposes.		Markets.	Fish Stands.	Forges.
																		Private.	Livery.			Private.	Watering Horses.	Bricks.	Stone.			
N. Y.	Albany	101,200		From 20 to 50 ft. front, 1 to 5 stories $4.00 to $21.00	10c.	$3.00		$3.00		Each barrel per day, $2.00 per year			$3.00		$7.00 to $448.00			$3.00	$1.00 and $2.00		$2.00	$5.00		$10c. per M.		Per stall $2.00	$5.00		
Penn.	Allegheny City	86,332	100	1 to 6 rooms, 2 to 6 persons $2.50 to $10.25	15c.			$2.00 to $10.00	$1.50		Each chair, $3.00 to $5.00	Per bbl. 2c.	$2.50 to $12.00		1/8 inch jet $5.00	$15.00 to 30.00	$2.50 to $10.00	$1.50			$2.00 to $10.00	$3.00 to $6.00		7c. per M.	Per perch 4c.				$2.00.
Md.	Baltimore	351,799	60	12 to 22 ft. front $3.00 to $14.00	8c.	$5.00		$2.00 to $10.00					$3.00				$1.50	$1.50			$2.00	$3.00.							
Mass.	Boston	427,900	90	By valuation: Under $1,000 $6.00; Each $1,000 additional 1.00	20c.	12 hours per day, 1 to 10 H.P. $10.00; 10 to 15 " 8.00; Over 15 " 6.00	$5.00 to $50.00.	$5.00		Each barrel per day, $5.00 per year					Each 100 gallons per day $5.00			$2.00	$2.00			$5.00		Per cask of lime 7c.					
N. Y.	Brooklyn	664,100	58	16 to 37½ feet front, 1 to 5 stories $4.00 to $21.00	10½c.		$5.00 to $30.00.	No charge for one. Over one $3.00	$3.00	1c. per barrel	Each basin $3.00				$7.00 to $200.00	$10.00 to $300.00.		$2.50	$2.00		For 1 no charge. Each add. $2.00	$2.00	Must conform to model $10.00	10c. per M.		Per stall, $2.00 to $5.00	$3.00 to $10.00		
N. Y.	Buffalo	166,360	130	Under 25 ft., 1 to 5 stories. To 35 ft. $4.50 to $12.60; 35 to 50 ft. 8.10 to $16.20; 35 to 50 ft. 15.30 to $23.40		$2.00.	$8.34 to $43.34.	1st tub $3.00; Each additional 1.80		Each barrel per day, $4.34 per year								2 stalls $2.40; Each add. 1.50	30 stalls, each $1.67; Over 30, each 1.00	$3.00 up.	1st, $3.00 to $4.20; Each additional, $1.50 to $3.00	30 feet front $1.80		5c.	8c.				
N. J.	Camden	45,000		$5.00.		$3.00 to $4.00.	$5.00 to $10.00.	$3.00 to $9.00.	$1.00 to $6.00.	$5.00 to $10.00.	$10.00.					$3.00 to $50.00.	$1.00.	$1.00.		$2.00 to $4.00.	$2.00 to $6.00.	$3.00 to $5.00.	$10.00.	5 to 13 rooms, $2.50 to $10.00					
Ill.	Chicago	640,400	121	16 to 82 feet front, 1 to 6 stories $3.00 to $29.00	8 to 10c.	$4.00.	No faucet $3.00; With faucet 5.00	No charge for one. Each additional $3.00	No charge for 1st. Each additional $1.00	1c. per barrel	Baths 6.00; Basins $1.50		Automatic $1.00		¾ inch jet $5.00; ¾ " " 5.00			$2.00	$2.00	$1.00 to $1.50	For 1 no charge. Each add. $2.00	$3.00	Not more than eight months $5.00	5c. per M.	6c.	Per stall $1.00	$1.50	$1.50 to $5.00.	
Ohio.	Cleveland	206,500		Hotels $1.25 per room.	62½c. to 12½c.	$2.50.	$6.25 to $31.25.	$2.50 to $12.50.		$6.25 to $18.25.			$1.25 to $6.62.					$1.25	$2.50.	$1.25 to $3.75.	$2.50 to $6.25.	$6.25 to $31.25.							
Ohio.	Cincinnati	273,300	65	From 1 to 15 rooms. $2.00 to $17.00.	9c.			$1.50 to $6.00.	50c. to $2.50.	1½c. per barrel.	Each chair $1.00		3 mills per sq. yd.			50c.		$1.00	$1.00.	$2.50 to $25.00.	$1.50 to $25.00.	$1.50 for 25 feet. Each foot add. 3c.	$10.00.		10c.	3c.			$1.00.
Mich.	Detroit	136,500	144	Per size of families, 3 to 10 persons $5.00 to $10.00; Each additional over 10 75	10c.		$10.00 to $50.00.	$2.00 to $5.00.	Each person 25c.	Each barrel per day, $3.00 per year			$3.00 to $20.00.					$2.00	$2.00.	$2.00.	1 to 10 persons, $3.00 to $5.00	$3 to $10.00.		5c.		Per stall $3.00	$10.00 to $100.00		
Penn.	Easton	12,000	83	With one hydrant $7.00 to $10.00	Under 60,000 per year 40c. 60,000 to 200,000 per year 30½c. 200,000 to 400,000 per year 20c. Over 400,000 per year 16½c.	$3.00.	$6.00 to $20.00.	$3.00.	$1.00.	$6.00 to $20.00.	$6.00 to $20.00.							$3.00.	$3.00.	$2.00.	$4.00.	$3.00.		Per bushel of lime 4c.		$5.00 to $15.00.			
Conn.	Hartford	43,463		5 to 10 persons $5.00 to $10.00	500 gallons per day 30c. 1,000 " " 25c. 2,000 " " 20c. Greater amount, not less than 10c.	$6.00.	$5.00 to $30.00.	$1.00 to $6.00.		$5.00.								$2.00.	$2.00.	$1.00 to $6.00.	$3.00 to $8.00.			4c.	1½c.				
Ind.	Indianapolis	83,099		6 rooms $5.00. Each additional room 1.00	1,000 gallons per day 40c. 4,000 " " 17c. 7,000 " " 12c. 20,000 " " 10c.		$3.00 to $15.00.	$3.00 to $5.00.		Each barrel per day, $3.00 per year	1st chair $6.00; Each additional 2.00			Each cart, $20.00 per month	⅛ inch jet $10.00; ⅛ to 5/8 in., each 8.00			$1.50 to $2.50.			$3.00 to $5.00.	For 50 feet $10.00; Each foot add. 10c.		10c.	3c.				
N. J.	Jersey City	132,174			15c.	$4.00.		$3.00 to $5.00.		1c. per barrel.			$7.00 to $15.00.					$1.00.		$2.00 to $15.00.	$2.00 to $15.00.	$3.00.				$3.00.			
Mass.	Lowell	65,009		6 persons and under $6.00; Each additional person 90	15c.	12 hours per day $4.00	$5.00 to $25.00.	Public, $10. Private, each person 50c. Not less than $2.00	No charge for 2. Over 2, each 50c.	Each barrel per day, $3.00 per year	4 chairs or less, $5.00; Each additional 1.00		$3.00 to $10.00.					1st $4.00; Each add. 2.00	$2.00. No stable less than $25.00.		$4.00 to $10.00.	$3.00.		Per cask of lime 4c.		$6.00 to $15.00.	$6.00 to $15.00.	$6.00 to $15.00.	1st $3.00 Each add. 1.50
Ky.	Louisville	130,659			6 to 15c.		$3.00 to $45.00.	$2.50 to $5.00.	50c. to $1.50.	1c. per barrel.			$1.00.		$5.00 to $100.00.			$1.25	$1.50.	$1.50 to $5.00.	$3.00 to $10.00.	$5.00.				$5.00 to $15.00.			
Wis.	Milwaukee	142,400	106	1 to 16 rooms $4.00 to $14.00	First 25,000 feet 20c. Next 25,000 " 13½c. Next 50,000 " 10½c. Next 400,000 " 9½c. Next 500,000 " 8½c.	Boilers, per square foot of fire surface 30c. Engines $4.00	$10.00 to $50.00.	$3.00 to $15.00.	No charge for 1st. Each additional $1.00	$5.00 to $50.00.	1st chair $5.00; Each additional 2.00		$5.00 to $10.00.		$10.00 to $100.00.			$2.00.	$1.00.	$5.00 to $10.00.	1st $3.00; Each add. 2.00	Self-closing $3.00		6c.				$3.00.	
N. J.	Newark	152,800	60	1 family $6.25; 2 families 10.00; 3 families 14.00; Each family additional 3.00	15c.	$5.00.	$3.00 to $10.00.	$5.00.		Each barrel per day, $3.00 per year	Each chair $2.50		$2.50.			50c.	$2.00 and $2.50		1st $2.50; Each add. 1.50	1st $2.50; Each add. 1.50	$1.00 to $2.50 for street. Additional for each street, 25c.		10c.	Per yard 2½c.				
Conn.	New Haven	68,000	100	1 family $8.00; 2 families 16.00	Under 1,000 per day 30c. 1,000 to 2,000 " 25c. 2,000 to 5,000 " 20c. 5,000 to 10,000 " 15c.	10 H.P. and under $6.00; Under 100 8.00; Over 100 9.00	$25.00.	1st tub $3.00; Each additional 2.00		Each barrel per day, $3.00 per year	$6.00 and over.				¾ inch jet $20.00; 1 " " 40.00			1st $6.00; Each add. 2.00			1st $3.00; Each add. 2.00	For 25 ft. or under, $3.00. Each additional foot, 8c.		5c.		$6.00.			
N. Y.	New York	1,341,400		To 16 ft., 1 to 5 stories $4.00 to $8.00; 25 to 50 ft., 1 to 5 " 10.00 to 14.00; 37 to 50 ft. 14.00 to 18.00	12½c.	Under 10 H.P. $10.00; 10 to 15 " 7.00; Over 15 " 5.00; 60 to 80 H.P. $5.00; 80 to 120 " 4.00; Over 120 " 3.00	$10.00 to $25.00. No faucet $5.00	1st, no charge. Over one, each $3.00		Each barrel per day, $3.00 per year						5c. per head.		2 horses $6.00; Each add. 2.00	Each horse to 30 $1.50; Over 30, each 1.00	1st, no charge. Each add. 2.00	For 1 no charge. Each add. $2.00			10c.					
N. J.	Paterson	56,266																											
Penn.	Philadelphia	933,900	70	Without hydrant, one room on floor $2.50; All others 5.00	8c.	$2.00.	$10.00 to $50.00.	$3.00 to $6.00.	$1.00 to $3.00.	$3.00.	1st basin $3.00; Each additional 1.00	Per bbl. 2c.	$5.00.	$3.00 and $6.00 per square per month.	$6.00 to $75.00.	$5.00 to $100.00.	$1.00.	$1.00.	$1.00.	$1.00 to $100.00.	$1.00 to $100.00.	$3.00.	With self-closing ball cock $10.00.	5c.	2c.	Per stall 25c.	$5.00.	$1.00.	
Penn.	Pittsburg	204,300	186	1, 2, and 3 rooms $3.50 to $6.00; Each room to 10 1.00; Each room over 10 50	To 1,000,000 20c. To 2,000,000 8c. Exceeding 2,000,000 5c.	Not exceeding 10 H.P. $2.50; (Over 10 H. P. from water evaporated from fuel basis.)	With water, $20.00 to 30.00; Without, 10.00 " 20.00	Cold $2.50; Hot and cold, for 1 4.00; Over 1 3.00	1 in bath room free. Others $2.00		Each $7.50.	Under 10,000 bbls. 3c. 10,000 to 30,000, 2½c. Over 30,000 2c.	$18.00.	Cart cap'ty 250 gals., $18 per M. Cap'ty 500 gals., $33 per M.	⅛ in. to ¾ in. jet, $8.00 to $50.00	$15.00 to $100.00	$2.00 and $3.00.	$2.50.	$3.00.	Self-closing $1.50; All others 3.00	Self-closing $3.00; Others 4.00	Each family. $3.00	Hydrant, $20.00. No trough allowed, with wash-pave screw $8.00	10c.	5c.				1 and 2 forges, $6.00; Each add. 4.00
R. I.	Providence	122,500	33	Faucet for one family $6.00; Each additional faucet 2.00; No house to be more than 40.00	15 to 20c.		$10.00 to $50.00.	1st $3.00; Each additional 1.00	1st 3.00; Each additional 1.00	Charge per barrel not to exceed $8.00 per year				Two horses and cart per week, $12.00; One per week, $6.00	¾ in. to ¾ in. jet, $10.00 to $40.00			1st horse $4.00; Each add. 2.00	Each stall 1.50; No stable less than 4.00	Self-closing only $3.00; Each add. 2.00	Approved stop, 1st $5.00; Each add. 3.00	To be used 1 hour per day $5.00		Per cask of lime 8c.		$8.00 to $30.00.	$10.00 to $50.00		
Penn.	Reading	46,052	50	$5.00.	Manufacturers 10½c. Others 21c.	High pressure $2.75	1st class $10.00; 2d class 5.00	$2.00 and $3.00.		$3.00.	1st 3.00; Each additional 1.00					50c.		$1.00.		$1.00.	$2.00.	$3.00.	$10.00.	5c.	2c.				1st $3.00; Each add. 1.00
N. Y.	Rochester	103,800	60	By valuation: $1,500 to $5,000 $2.50 to $3.50; 5,000 to 10,000 4.00 to 5.00; 10,000 to 18,000 5.00 to 5.50; More than one family, each 2.00	1,000 gallons per day 13c. 30,000 " " 8c. 60,000 " " 5c.	$3.00.	$5.00 to $40.00.	1st $2.00; Each additional 1.00		Each barrel per day, $3.00 per year	1st chair $3.00; Each additional 1.50				⅛ in. to ¾ in. jet, $3.00 to $12.00			$1.50.	$1.00.	$1.00 to $3.00.	$2.00 to $4.00.	50 ft. or less $3.00; Over 50 ft., 5c. p. ft. " 100 ft., 3c. "		5c.	2c.	$4.00 to $15.00.	$5.00 to $40.00.		
Mo.	St. Louis	367,300	71	1 family, 2 to 26 rooms, $3.00 to $13.00; More than one family, for each person 50	1,000 gallons per day 20c. 5,000 " " 20c. 25,000 " " 15c. For manufacturers—all 12½c.	Per fire surface at 40c. per square foot	$25.00 to $100.00.	Cold $3.00; Hot and cold 6.00		Each oven $10.00 to $50.00	1st chair $10.00; Each additional 2.00	Per bbl. 5c.		For block of 500 feet $10.00	4 hours per day $25.00	5c. per head.	$2.00.	$3.00.	$2.00. No stable le s than $25.00	$5.00 to $10.00.	10c. per ft. of hose			5c.			$3.00.	
N. Y.	Troy	59,831	100	$5.50 to $6.00.	100,000 gallons per quarter 20c. 250,000 " " 17½c. 500,000 " " 15c. 750,000 " " 10c.	1 to 5 H.P. $3.50; 5 to 10 H.P. 3.00; Over 10 H.P. 2.50		$3.00.		$7.00 to $12.00.	$4.00.	Per bbl. ½c. to 1c.						$2.00 to $6.00.	Each $1.50.		$2.00.		25 feet front $3.00; 50 feet front 5.00	7c.	6c.				
D. C.	Washington	204,300	165	2 stories, 16 feet front $3.30; Each story additional 1.10; Each foot additional 28	10c.	$3.00.	$15.00 to $50.00.	$4.00.		$3.00 to $15.00.	$6.00 to $12.00.				⅛ in. jet, 3 hours per day $5.00; ¼ " " 20.00; 1 " " 150.00	$5.00 to $20.00.		$1.50.	75c.		$3.00 to $10.00.			3c.		Per stall 50c.			
Del.	Wilmington	49,000	103	1 room on first floor, 2 stories high $3.00 to $3.75; All others 5.00	10c.	High pressure engines $2.00; Low pressure H.P. for boiler 4.00	$5.00.	$3.00.	$1.00.	$3.00.	1st basin $3.00; Each additional 1.00				⅛ in. to ¾ in. jet, $6.00 to $32.00	$5.00.	$1.00.	$1.00.	$1.00.	$2.00.	$2.00.	30 minutes per day $2.00		5 and less, each $1.00 per bldg; Each add. 50c.					
Mass.	Worcester	68,000	50	6 persons or less $6.00; 6 to 10 persons 8.00; Each additional family 3.00	1,000 gallons per day 25c. 5,000 " " 20c. 10,000 " " 15c.			1st $5.00; Each additional 3.00	No charge for 2. Each additional $2.00									1 horse $3.00; 2 horses 5.00; Each add. 1.50			1st $4.00; Each add 2.00	$4.00	"	Per cask 6c.		$5.00 to $50.00.			

STATEMENT BY WARDS OF THE NUMBER AND KIND OF PREMISES AND APPLIANCES ON THE GENERAL BOOKS OF THE WATER DEPARTMENT, JANUARY 1, 1885.

APPLIANCES.	WARDS.																														Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Aquaria	1					5			4		1		1		2				1	1		1							6			23
Bakeries	63	48	42	31	30	21	43	29	22	22	32	24	35	35	54	45	40	40	66	63	11	21	9	32	36	54	16	46	56	40	47	1,153
Barber shops	41	36	15	28	49	32	24	33	51	15	23	20	21	25	39	23	25	29	60	41	24	16	21	35	25	31	14	24	38	31	38	927
Bars	206	160	111	232	275	279	143	162	199	169	202	156	153	145	258	157	164	177	374	238	129	76	83	197	214	253	87	183	185	167	229	5,763
Basins and sinks in dwellings	139	39	132	61	227	235	2,107	3,175	1,339	1,835	43	523	955	771	5,988	115	88	113	296	2,438	250	1,502	165	1,799	101	264	2,229	2,988	5,056	138	104	35,115
" " in offices, factories, hotels, and public buildings	53	63	42	37	2,316	3,036	139	1,980	1,811	705	220	192	278	302	467	109	77	90	347	224	66	258	47	393	64	58	454	140	451	133	137	14,699
Baths in dwellings	3,863	1,439	916	623	900	477	2,651	2,688	1,168	2,271	453	1,018	2,049	2,139	5,080	751	735	1,683	4,802	6,171	745	2,533	636	5,244	2,210	3,775	2,145	5,394	7,230	2,794	2,417	77,010
" in public buildings			19		13	52	67	191	53	60	4	7	3		29	1			20	5	1	54		94			46	16	68	28		831
" foot							1						1											2			1					5
Beam houses											8	3																				11
Bidets					1	1	41	169	43	24			10	2	80	1				17	4	29		25		3	16	1	17			484
Bottling establishments	1	4		2	2	5	1	1	1	2	1	4	2	3	2	2	1	2	2	4	1		2	1	2			3	4	2	2	59
Brick yards, gangs of men																									12	22	16	15				65
Breweries, number	1		3	2		2			1		4	5	1	1	5	7	11	2	8	7	1	1	3	1	5	1		5	14	1	2	94
Cars (steam and horse)															33			33	40					133	23		28	157	80		129	656
Carriages and wagons	53	47	34	91	55	26	97	296	252	254	40	111	251	246	483	54	58	112	200	364	116	212	107	351	45	111	192	164	238	92	60	4,812
Coloring rooms											5	5				3																13
Condensers									1															1								2
Dash wheels						2					1	1				1													1			6
Dwellings without water	124	303	155	199	87	420	112	21	53	27	128	64	44	860	28	209	19	597	51	1	758	207	996	552	801	19	154	472	98		89	7,648
Half " " "	220	869	843	984	488	276	774	308	170	584	689	539	397	422	767	973	1,318	560	548	393	117	42	84	128	308	88	97	85	86	228	270	13,655
Drug stores	26	16	12	14	13	13	20	23	23	18	6	11	19	22	29	8	11	18	32	36	8	15	10	23	9	21	14	28	35	25	16	574
Dry dock			1																													1
Engines on railroads		5			1										31				43	18		1			6		2				7	114
Filterers									1						1														1			3
Fountains, counter	5	1	4	1	1	8	9	7	7	9		2	6	6	5	3	2	2	4	11	1	5	2	8	2	3	8	6	16	5	1	150
" garden	3	2	3		3	3	7	19	12	7	1	5	8	11	48	2		8	4	16	8	32	5	30	5	3	36	9	28	11	4	333
Forges	5	1	8	3	9	27			13	3	6	5	5	28	237	7		88	7	40		7	27	12	24	11	63	15	7	5	18	681
Furnaces	8			4			1		22		4	9	2		10		8		6					4						2		80
Gas works									1						1	1					1				1	1						6
Glass "																			3	1					1					1	1	7
Green houses	17						1	13	1	3		1		1	3	2	1	8	3	8	26	102	31	34	59	29	124	48	23	13	2	553
Grindstones					5	11				2				1		23			11	1			13					2				69
Hatters' planks	7				12	9		4	2	2		11	3			6	3		10											2	71
Hydrants	9,055	4,587	2,599	2,385	2,901	2,691	4,706	3,494	2,498	3,684	1,942	2,119	3,254	3,092	8,350	2,562	2,858	4,952	9,145	8,429	2,840	4,057	2,038	8,537	5,911	7,837	2,977	6,876	8,715	5,526	6,281	146,898
Hydraulic elevators						2		1	5	3									2			1										14
Ice cream saloons	7	8	1	5	2	1	6	7	7	6	4		5	1	10	9		10	16	4	2	2	2	6		1	3	7	3	1	1	137
Ice machines															1					1						1			3			6
Laboratories								1		1		1						1										1		1		6
Laundries	10	6	7	9	12	6	12	4	18	8	3	6	7	7	8		3	2	4	13	1	3	1	6	2	2	3	1	16	5	7	192
Machines for scouring, washing, bleaching, and rinsing		1	1		2	2		4		3	1					8	6		16			4			49	4	2				33	136

APPLIANCES.	WARDS.																													Total.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Malt houses											1	1			1		1	1		2						1			4			12
Milk "	11			1			2						5							5				2			2		4		1	33
Motors, beer	3	1	5	7	16	19	10	14	8	4	2	8	6	3	6	5	7	11	17	17	9	4		8		4	4	9	12	30	3	252
" organ							1	3	1	1				1	1	2			1	1	1	6		1			3		1			24
Photograph galleries		2		2	5	3	1	10	19	3	6	1	7	1	6	1	4	1	5	5	1	3	2	1	2		4		1		2	98
Pools in churches		1	1		2			1	1	3			1	2	2	1		3		4	2	3		4	1		2	2	6		2	44
Premises with water	9,055	4,587	2,599	2,385	2,901	2,691	4,706	3,494	2,498	3,684	1,942	2,119	3,254	3,092	8,350	2,562	2,858	4,952	9,145	8,429	2,840	4,057	2,038	8,537	5,911	7,837	2,977	6,876	8,715	5,526	6,281	146,898
" without water	344	1,172	998	1,183	575	696	886	329	223	611	817	603	441	1,282	795	1,182	1,337	1,157	599	394	875	249	1,080	680	1,109	107	251	557	184	228	359	21,303
Rectifying establishments				1		1													1						1			1				5
Restaurants and eating saloons	10	7	2	11	25	80	8	23	59	12	23	4	21	14	7	10	4	3	13	22	1	3	2	16	1	9	11	10	7	8	9	435
Screw nozzles	134	62	50	54	183	274	128	233	163	169	143	106	162	142	336	151	153	286	241	290	188	212	125	394	111	66	221	234	286	91	174	5,562
Shot towers		1																														1
Slaughter houses	17										2	1	2	6	1		6		11	12	5	3	3	23	15	3			6	1	10	127
Soap boiling establishments	1		1								1									1											1	5
Stand-pipes for watering engines									1		2		3	1				2						2	2				2			15
Stalls in stables	1,411	780	199	465	166	353	844	877	1,052	1,079	374	455	528	796	2,390	539	524	1,645	1,287	1,368	430	838	540	2,153	903	1,198	1,013	1,373	1,379	727	1,694	29,390
" in market			144		80	235	209		1,076		289			146	388				208	175	50			293		222			1,071	152	50	4,788
" country	4		14	114	97	27	10	32	92	32	238	127	108	28	152	129	12		101	347	1		147	12	76	13		66	206		12	2,197
" fish			1		9	3	1		6		3				2				2	2				3			1		14	2		49
Steam boilers, number	54	43	10	13	81	216	17	85	113	53	61	37	26	36	157	79	58	60	154	48	45	63	56	37	75	55	33	31	67	24	113	2,000
" " H. P.	1,750	1,174	218	383	1,587⅔	3,408	1,108	1,232	2,523	792	1,031	773	322	978	5,026	1,997	2,071	1,716	4,327	1,226	2,593	1,394	1,318	683⅓	2,416	1,494	542	440	2,601	752	3,253	51,129⅙
" " heating, number				4	36	27	5	17	32	5			6	1	15	3			3	4	4	10	1	12	3	3	8	3	8	3		213
" " " H. P.					359	254	46	237	214	207			464	24	3				140					50	50			33				2,081
Steam engines, number	50	20	8	6	52	132	7	32	83	26	30	17	14	25	41	37	22	28	87	62	10	52	26	30	30	22	20	19	28	23	52	1,091
" " H. P.	651	334	179	50	518	1,274	151	354	2,147	475	216	379	74	353	680	656	377	554	1,691	584	160	455	246	188	565	357	215	152	213	190	431	14,869
Steam saws, number								4																			3					7
Swimming baths								2	1																							3
Tubs, vats, and tanks	21	15	2		88	68	41	9	50	21	169	388	302		109	165	369		167	42	13	67	51	31	71	18	2	47	11	28	172	2,537
Turbine wheels								1																								1
Urinals in dwellings				3	3	2	13	55	10	6			1	7	8	3	2		2	6	1	23		5		1	9	13	17			190
" in stores, offices, factories, hotels, and public buildings	9	9	4	6	553	654	23	325	395	92	20	29	68	55	94	17	6	7	51	29	15	47	10	52	2	13	47	10	84	26	9	2,761
Urinal troughs	2				3	7		1	1		1			1				1														17
Vats, lime											14						25															39
" tan											21	3																				24
Vinegar establishments											1																					1
Wash-paves	1,391	649	482	268	577	390	1,387	1,589	854	1,442	225	625	1,295	1,466	3,753	466	412	858	2,796	1,385	404	1,097	495	2,638	903	1,461	1,449	4,156	5,364	1,651	1,245	46,173
" for watering horses	21	11	9	4	13	4	11	2	15	9	15	8	5	11	26	10	28	37	61	20	6	12	13	26	43	18	20	34	13	10	27	542
Wash-tubs, stationary	4	13	24	6	47		622	1,528	397	489	178	3	3	152	996	396	78	10	53	529	44	723	4	577	12	48	810	263	946	54	10	9,020
Water-closets in dwellings	289	149	176	132	358	217	1,902	2,937	960	1,848	65	615	1,519	1,329	5,206	188	93	129	707	3,335	185	1,925	86	3,195	220	372	2,686	4,546	4,863	634	175	40,741
" " in offices, stores, factories, hotels, and public buildings	13	70	43	18	1,899	3,214	95	1,423	1,852	642	186	153	242	260	612	83	91	48	402	181	61	273	41	309	30	60	234	74	583	150	175	13,517
Wool washers		1		1			1											1	5			4			1	7		1				22

REPORT

BY THE

GENERAL SUPERINTENDENT

OF THE

OPERATIONS IN CONNECTION WITH THE STATIONS, BUILDINGS, GROUNDS, AND RESERVOIRS, DURING 1884.

PHILADELPHIA WATER DEPARTMENT.
OFFICE OF THE GENERAL SUPERINTENDENT.

March 2, 1885.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—I submit, herewith, the Report of the work on the Buildings, Grounds and Reservoirs, and the Pumping Machinery of the Department for the year 1884.

Although a great deal of work was accomplished in 1883 in order to bring this branch of the Department into good condition, much remained to be done in 1884, and the work is even now in many respects, incomplete.

The Winter months gave time for overhauling most of the Engines and Boilers, so that the Summer of 1884 could be met with confidence that so far at least as the Pumping Machinery was concerned, an abundant supply of water could be furnished. When this had been done, attention was more especially directed to improving the condition of the Buildings and the adjacent grounds.

I desire to say that the employés at the Stations, and connected with other work under my supervision, deserve praise

for their continued efforts to promote the interest of the Department.

Before closing I would invite attention to the following statement showing the reduction in the running expenses of the Works during the last two years. The cost of raising water 100 feet per million gallons was $6.66 in 1882, $6.51 in 1883, and $5.54 in 1884; and I am confident that whilst maintaining a thorough efficiency of the Stations at all times, still further reductions can be made.

Respectfully,

J. J. de KINDER,
General Superintendent.

FAIRMOUNT STATION.

BUILDINGS AND GROUNDS.

The wooden bulkheads across the archways of the old Nos. 2 and 6 breastwheels were removed, the single archways altered into double archways, and wrought iron gates with gun metal facings fitted in front of each. The coffer-dams which had been built in the fall of 1883 in front of these archways to permit of the work mentioned being done, were removed. The timber bulkhead built on the north side against the bridge of the forebay (for the purpose of cleaning it) was removed after clearing the forebay of some two thousand cubic yards of mud, besides a lot of old decayed iron mains used at one time for delivering water from the old breastwheels. The old coal sheds near the forebay (so long a disgrace to that part of the Park) were removed, and the grounds cleared of all débris and leveled off with good soil with a view of properly grassing it in the coming spring.

The old cap-log in this part of the forebay was removed and a new yellow pine cap-log substituted; a new float of white

and yellow pine was built for service across the mouth of the forebay; the old boiler was removed from the pump house near the forebay, said house thoroughly repaired and painted, and made suitable for the purpose of testing and fitting water meters. A small building over the north wheel house was fitted for a carpenter shop. The Mansion House received a thorough overhauling; new floors were put in, the walls plastered, the rooms painted and papered, the window-sashes and roof repaired, and the ladies' water closets removed and new ones substituted.

The galleries and floors of both wheel houses were repaired where necessary, and will be further overhauled as soon as the needed repairs to the wheels are completed. All vaults and cellars in and around the wheel houses were cleaned and white-washed, the inside walls of the wheel houses received two coats of white-wash, and the iron beams and girders were scraped and painted. The wood work of the stand-pipe was repaired and the whole structure painted. The inside lining of the reservoir was repaired in several places. The gravel walks were kept in order and the grounds in general kept in neat condition as far as possible, although with little satisfaction, since the building of an intercepting sewer through the grounds made it impossible to preserve a neat appearance. The sewer now being completed, I expect to have all that requires being done about the Station finished before the coming summer.

The river walls were replastered with hydraulic cement, and the flash boards on the dam kept in repair.

Machinery.

Seven Turbine Wheels:—

No. 1. Erected in 1851; capacity per revolution 122 gallons, or 2,000,000 gallons per day.

Nos. 3, 4, and 5. Erected in 1867; capacity of each per revolution 461 gallons, or 6,000,000 gallons per day.

Nos. 7, 8, and 9. Erected in 1862; capacity of each per revolution 325 gallons, or 4,500,000 gallons per day.

No. 1 Turbine. This wheel requires re-cogging, the cylinder re-boring, a new plunger, the guides and crossheads refitted, and the brasses and gibs overhauled. Only slight repairs were made to this wheel.

No. 3 Turbine. Of this wheel the main shaft is broken, and the machinists are now engaged in removing it prior to substituting a new shaft.

The following repairs were made: Both cylinders re-bored, and plungers provided with brass rings to fit the cylinder. All valves were overhauled and fitted to seats; the guides and crossheads replaned; new gibs made, and new cogs are being made.

No. 4 Turbine. Main shaft was re-lined, new crank pins fitted, and all valves overhauled.

No. 5 Turbine. Brasses were refitted and all valves overhauled. An entire new set of cogs are being made for this wheel.

No. 7 Turbine. Four new blades were put in wheel; the old step replaced by a new one; the main shaft re-lined; both pump cylinders re-bored, and two new plungers fitted; all valves and seats overhauled; guides and crossheads planed; brasses fitted; new gibs made, and spur wheels re-cogged.

No. 8 Turbine. Main shaft was re-lined; new crank pins fitted; both cylinders re-bored and new plungers made; one pump cylinder arranged to work one end as air-pump for experimental purposes in connection with the aëration of the water supply; guides and crossheads were re-planed; new gibs fitted; the spur wheels re-cogged; brasses fitted, and valves and seats overhauled.

No. 9 Turbine. Main shaft was re-lined; pump cylinders re-bored; new plungers fitted; all valves overhauled; guides and crossheads planed; gibs renewed, and all brasses refitted.

As soon as the summer, with its accompanying low stages of the river, permits, Nos. 1, 4 and 5 Wheels will be overhauled, the same as Nos. 7, 8 and 9. The entire pumping plant of this Station will then be in good condition.

FAIRMOUNT STATION.

1884.	Running Time of each Turbine in Hours.							Gallons Pumped by each Turbine.							Total Gallons Pumped each Month.	Average Pumpage per day.	Oil.	
																	Castor.	Engine.
	No. 1.	No. 3.	No. 4.	No. 5.	No. 7.	No. 8.	No. 9.	No. 1.	No. 3.	No. 4.	No. 5.	No. 7.	No. 8.	No. 9.			Quarts.	Quarts.
January	.....	157	183	181	655	637	656	.....	44,751,575	53,204,010	48,223,827	161,188,300	156,396,500	160,133,025	623,897,237	20,125,717	6	90
February	177	302	302	296	492	600	587	17,241,528	81,451,785	83,701,004	75,730,314	110,623,825	136,236,100	128,691,225	633,675,781	21,850,882	3	120
March	295	687	744	740	447	588	577	28,841,410	187,248,058	204,217,468	194,216,534	98,905,950	134,351,100	132,402,400	980,182,920	31,618,804	4	116
April	649	412	702	713	612	660	658	64,204,086	110,147,652	193,347,088	188,241,052	123,422,325	140,998,975	138,429,525	958,790,703	31,959,690	11	95
May	638	643	742	739	737	718	739	62,507,798	153,073,206	195,150,520	184,038,115	149,847,100	146,747,900	151,735,675	1,043,100,314	33,648,397	37	169
June	260	719	702	557	304	410	420	25,307,924	180,926,826	180,160,644	138,195,353	62,689,575	83,823,350	87,079,850	758,183,522	25,272,784	9	122
July	464	402	739	732	513	388	540	44,657,490	100,184,520	184,518,477	172,048,427	101,439,650	73,578,050	101,001,550	777,428,164	25,078,328	7	121
August	551	.....	686	738	653	391	605	53,470,526	.....	166,161,457	164,468,665	125,084,700	43,662,775	111,286,175	664,134,298	21,423,687	8	116
September	133	.....	647	595	234	.....	181	12,691,050	.....	157,928,458	133,576,133	48,160,125	.....	34,054,800	386,410,566	12,880,352	2	78
October	91	.....	734	655	.....	75	149	8,524,140	.....	177,616,385	148,577,073	.....	13,491,725	26,032,175	374,241,498	12,072,306	21	79
November	671	.....	713	675	234	539	126	62,244,400	.....	179,515,705	161,693,445	39,716,625	97,514,300	19,445,725	560,130,200	18,671,006	69½	33½
December	728	.....	738	637	682	714	735	68,802,754	.....	195,222,436	144,772,901	128,412,700	136,313,775	141,407,825	814,932,391	26,288,142	8	142
Totals and averages	4,657	3,322	7,632	7,258	5,563	5,720	5,973	448,493,106	857,783,622	1,970,743,652	1,753,781,839	1,149,490,875	1,163,114,550	1,231,699,950	8,575,107,594	23,429,255	185½	1,284½

SPRING GARDEN STATION.

Buildings and Grounds.

Two four-feet iron mains were laid parallel in a trench, connecting the bottom of the forebay with the river. This involved more labor than was anticipated, owing to the fact that the soil between the forebay and the river is open and interlaced with timber from old structures, thereby making numerous passages from the river to the forebay, and making it impossible to control the height of water in the forebay by means of gates on the river side. Whilst this work of laying the mains was in progress, some 3,000 cubic yards of mud were removed from the bottom of the forebay.

The inlets to Nos. 4, 5, 6, 7 and 8 Engines at the old Station were thoroughly cleaned, and each inlet provided with a double set of screens on the forebay side.

The inlets for the Nos. 9 and 10 Engines in the new Station were constructed at the same time, and the same also provided with suitable screens. The work was completed on January 26, and the water again let into the forebay.

The four-foot wooden trunk, which had been constructed to keep the engines at the old Station going while the work enumerated was being executed, was then removed. The coping of the forebay wall was raised 16 inches. The roadway on either side of the forebay, for a distance of about 200 feet, was dug out to a depth of 2 feet, and filled to a depth of 14 inches with stone obtained from the rock north of the forebay, part of which was removed by blasting, in 1883, to allow the construction of the new engine-house.

An iron railing is in course of construction around the forebay, and a bridge 12 feet wide (on iron girders) across it. This means of communication is greatly needed in order to facilitate the hauling of ashes, moving of machinery under repairs, etc.

New coal bunkers, capable of containing 1,500 tons of coal,

were built, the coal tracks from the bunkers to the different boiler rooms were laid straight, with intercepting turn-tables. The difference between the old tracks and the new ones is apparent when it is considered that one person attends to the supplying of coal to the furnaces, whereas previously it took four men and often the entire watch.

The railroad car tracks were entirely renewed from the switch on the main road to the end of the coal bunkers, the rails being steel, and weighing 60 pounds to the yard. The supporting piers of this track were all rebuilt, and nine new piers built to permit of tracks being continued out to the boiler house of the new pumping station. In front of the old station the entire area was repaved, and drains laid to carry the surface and roof water into the sewer south of the forebay.

The grounds around the forebay, and between the river front and the driveway in front of the station, are being leveled off and covered with a layer of garden soil preparatory to grassing it. The wall on the river side, facing the wall of the old conduit, was taken down and rebuilt from the water-line up, and the iron gate overhauled and put in repairs. New stone facing was built on the river side for the two 48-inch inlet mains, and new iron gates with lifting screws, etc., put in position. The river wall along the front of the property is being relaid, and will probably be finished by the end of April.

The contractors are working on the removal of the projecting point of rock between the entrance to the tunnel and the new pumping station. The open sewer along the south side of the forebay was covered over with timber (the planking from conduit used in the forebay during the winter) and finally covered with stone and earth and sodded over. Although this did not prevent the sewage from working itself into the forebay, it removed at least the universal complaint of stench around the station. The stone retaining-wall south of the old station, along the foot of the hill, was continued 100 feet farther north.

The city has deposited a large quantity of loose soil on this high ground without protecting the slopes, thereby forcing us to build this retaining-wall or take the chances of having the roadway around the east side of the station made impassable and the area in front of No. 8 engine house filled with mud at each successive rain storm.

After the sale and removal of No. 5 engine, new floors were laid and the walls repaired or renewed as required. The galleries were also put in thorough repair and new steps made leading to No. 6 engine room. Every part about the buildings was thoroughly cleaned, the walls, cellars and under side of floors white-washed and such alterations and repairs made as the roof trussing, after the removal of No. 4 engine, required.

The engineers' dwelling on the hill north of the old station was removed, and a building containing a general storeroom, oil cellars, rigging loft and stable was constructed.

The old stand-pipe back of the old station was removed and the base closed in with a wrought iron cap.

Three carts, one wagon, and four horses were purchased, with the necessary outfit of harness, etc., enabling us to haul away the ashes from the Spring Garden and Belmont Pumping Stations at times least interfering with the driving through the Park, and to ensure the prompt delivery of stores and material whenever required at the different Stations, and at the same time affording a better opportunity of controlling the quality of goods furnished by the different contractors.

The coal scales were repaired and renewed as required, and a roof and continuous shed are in course of construction, covering the railroad track over the coal bins, in order to protect the coal from the weather. The necessary traps and drain pipes are being laid to catch the surface water from the hills adjoining the coal bins, and lead it to the adjacent sewer. The space under the coal bins has been arranged for the storage of tools, such as hoisting derricks and crabs belonging to the Department, and for which no provision had previously been made.

From the stone of the base of the old stand-pipe which was taken down, a retaining wall has been built for the side slope of the driveway south of the property.

The work yet required to be done, in addition to finishing the work now in course of completion, consists of the following: The building of small wagon shed north of the storehouse, for the carts and wagons; a small blacksmith's shop, adjoining the shed, to enable us to make small immediate repairs; removing of the old mortar from the east walls on the outside of the old station, and pointing the same, as was done on the west wall the year previous, and the terracing of grounds east of the old station, after the Purveyor has completed the work to the mains now in progress.

An intercepting trap, covered with iron grating, provided with the necessary drains, will be constructed between the area of No. 8 Engine-house and the retaining wall of the adjoining high ground, to carry off the surface drainage from the terrace mentioned and the roadway leading to the Reading Railroad tracks.

The coffer-dam placed in the river in the fall of 1883, for the purpose of enabling the laying of the two 48-inch mains connecting the forebay with the river, was removed.

Machinery (Old Station).

Five Engines:—

No. 4. Overhead Cornish; erected in 1854; capacity, 350 gallons per revolution, or 5,000,000 gallons per day. Lift, 120 feet. Removed in May.

No. 5. Side-lever Cornish; erected in 1869: capacity, 510 gallons per revolution, or 6,500,000 gallons per day. Lift, 120 feet. Removed in May.

No. 6. Simpson Compound: erected in 1872. Capacity, 500 gallons per revolution, or 8,000,000 gallons per day. Lift, 120 feet.

No. 7. Rotative Compound, Cramp & Sons; erected in 1877; capacity, 830 gallons per revolution, or 22,000,000 gallons per day.

No. 8. Compound Duplex, Worthington; erected in 1881; capacity, 560 gallons per revolution, or ten million to eleven million gallons per day.

No. 6 Engine (Simpson). The flanges of the high-pressure cylinder were refaced and a false flange fitted (the acid of the tallow and other cheap lubricants formerly used having corroded the flanges to such an extent as to render it impossible to make a tight joint); both the high and low pressures overhauled, the steam valves ground in; brasses refitted and stuffing boxes repacked; cylinders and steam connections covered with Hanmore's patent covering.

This engine did very good service during the entire summer season, and requires but little overhauling. As soon as this is accomplished the cylinders will be lagged with walnut.

No. 7 Engine (Cramp). This engine ran from December 31, 1883, until September 14, 1884, making a run of 259 days consecutively, except on two occasions, when the clearing of the pumps (of small fish, principally eels) rendered a stoppage necessary. I doubt whether any pumping engine in the world, of the same size and capacity as this, could show a better record, notwithstanding the fact that no opportunity was given last year to readjust main bearings or connecting rod brasses. This work is now being done. The plungers are also being overhauled, and metallic steam stuffing boxes will take the place of the old ones, and cylinders, pistons, valves, etc., will be examined.

I have to say, in connection with this, that the long continued run was only possible with the present improved screens (constructed last winter). In 1883 we could not run 48 hours without having valves or springs and valve stem destroyed by the action of *débris* of all kinds, especially barrel bungs from the adjacent breweries, which through the adjoining sewer found their way into the river and on through the forebay and the holes in the imperfect wooden slatted screens into the pump chambers.

Whilst the Purveyor of the District is re-arranging the de-

livery mains back of the old Station and we are obliged to lie still for some time in consequence, I am taking advantage of the opportunity to overhaul all the engines and boilers at one time.

No. 8 Engine (Worthington). This engine has been in almost continuous service for over two years. The fact that we had only two engines, Nos. 7 and 8, capable of feeding the higher levels made it necessary to keep one always saddled ready for action, to take the place of the other in case of a sudden stoppage. This fact also made it impossible to overhaul either engine even if standing still, and only such work was done as would permit of starting up almost at once, if required.

On the final stoppage of the engines at this Station (November 22), No. 8 was taken apart and examined, and here again the use of tallow in previous times showed its effect,—the low-pressure cylinder, especially, being badly pitted or corroded. The cylinders and steam-chests had been covered with dry hair felt laid on loose. This had burned away, and nothing was left of it but a heap of dust, whilst the inside of the lagging was completely carbonized by the excessive heat.

The following work is being done to this engine: The low-pressure cylinders are being rebored, new springs made for low-pressure pistons, low-pressure cylinder heads fitted with stuffing-boxes in centre to receive $4\frac{1}{2}$ inch rods to be connected with low-pressure pistons; steam valves are being overhauled, cross-heads fitted with brass slippers, new valve stems in pumps, air pump and connections overhauled, etc.

When all the required work is completed, the cylinders, valve chests, etc., will be covered with Hanmore's patent covering, and the lagging will be renewed. I expect to have her in first-class running order by the end of March.

The donkey pumps were formerly located against the boiler room walls, so that it was impossible to get at them. Again, they were small, requiring them to be run at a very high speed when in use, causing excessive wear and tear and breakdowns.

Only the largest one was retained,—a Worthington Duplex (10½ inch × 8 inch × 10 inch) which was placed on a suitable foundation away from the wall, in the northeast boiler room and in the place of the smaller ones. A Worthington Duplex (12 inch × 10¼ inch × 10 inch) was placed in the south boiler room, covered in for protection against dust and ashes. Either pump is sufficiently large to feed all of the 21 boilers at this Station with ease.

The smaller donkey pumps are being overhauled and stored for future use at the smaller Stations.

The steam pipes have all been taken down, and will be repaired or renewed where required, provided with expansion joints and traps and re-arranged,—doing away with more than one-half of the pipes.

A large steam drum obtained from the old condemned cylinder boilers at the Roxborough Pumping Station was put in the basement of the No. 7 engine room, and connected with the hot wells of the different engines. It supplies the donkey pumps, takes the drips from all the steam pipes in the building, and serves as a heater in the winter for the eastern part of the building.

An electric light engine with a capacity of 100 lights, furnished by the Edison Electric Light Company, has been placed in position at this Station, and occupies part of the floor space where No. 5 engine previously stood.

The use of gas for any and all purposes was discontinued on September 18, and the pipes and fixtures removed.

Arrangements are being made to place a small engine in the workshop near the buildings, and also some additional light tools. This will enable us to do a great deal of repairing work connected with this Station, on the spot, thus saving the time required in sending it away, which when overhauling an engine is especially valuable.

Boilers (Old Station.)

Twenty one Boilers:—

Nos. 1, 2, 3, 4, 5, and 6 are cylinder boilers, built by Neafie & Levy, erected in 1869.

Nos. 7, 8, 9, 10, and 11 are tubular boilers, built by I. P. Morris, erected in 1870.

Nos. 12 to 21, inclusive, are tubular boilers, built by Hilles & Jones, erected in 1881.

The cylinder boilers, from Nos. 1 to 6, inclusive, were cleaned, bridge wells were repaired and furnaces arranged with pea coal bars. These boilers, which are old and unfit for continuous service, were not used during 1884, but kept in readiness for immediate use if necessary. The tubular boilers from Nos. 7 to 11, inclusive, were cleaned; several crown sheets which were found blistered were taken out and replaced by new ones, and rivets and seams were caulked. The feedwater valves were removed from the back to the front of the boilers where they could be watched properly. The feedwater pipes were re-arranged, and by leading them through the uptakes before entering the boilers, exposing a pipe surface of about one square foot per horse power of boilers to the escaping heated gases, the temperature of the feedwater is increased about 40° Fahr.

This same change was made in the feedwater appliances of the tubular boilers from Nos. 12 to 21, inclusive. The latter boilers were also cleaned. The upper row of tubes of each one of these boilers was removed to allow of a better steam circulation. The water gauges were changed to suit a water level 15 inches lower than carried previously. The tubular boilers were all filled with surface blow appliances, the bridge and division walls repaired, and the furnaces arranged for pea coal grate bars.

The consumption of pea coal is now the same as that of egg coal previously, notwithstanding the fact that a difference

SPRING GARDEN STATION.

1884.	Running Time of each Engine in Hours.			Gallons Pumped by each Engine.			Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. in.			Gallons raised 100 feet per pound of coal.
												Cylinder.	Engine.				
	No. 6.	No. 7.	No. 8.	No. 6.	No. 7.	No. 8.	Gallons.	Gallons.	Tons.	Lbs.		Qts.	Qts.	No. 6.	No. 7.	No. 8.	
January	2½	638½	306¼	1,188,500	429,235,330	159,989,200	590,413,030	17,110,098	861	967	17	200½	171	49	79	59	517
February	.....	689¾	187¾	.....	481,451,460	96,023,760	577,475,220	19,912,939	763	1,479	16	140¼	58¼	.....	81	58	599
March	.....	705½	36¼	.....	435,405,550	17,825,920	453,231,470	14,620,370	608	286	19	126	49¾	.....	84	83	643
April	.....	704½	15½	.....	445,259,310	6,701,520	451,960,830	15,065,361	686	677	22	108	49½	.....	84	86	568
May	.....	703½	88¼	.....	544,852,670	41,900,880	586,753,550	18,927,534	791	561	22	147¾	91	.....	80	69	603
June	191½	7.8¾	435¼	75,648,500	564,141,870	233,815,680	873,606,050	29,120,202	1,144	606	26	221½	118½	51	77	53	536
July	.....	733¾	186¾	.....	561,904,190	93,526,720	655,430,910	21,142,933	887	1,054	24	129	68½	.....	77	53	558
August	.....	735¾	254¾	.....	589,763,970	90,202,560	679,966,530	21,934,404	900	1,959	22	153½	56½	.....	74	53	547
September	523½	314¾	483¼	195,079,500	248,413,190	227,240,160	670,732,850	22,357,762	921	1,029	20	235	125	52	74	54	454
October	706¼	351	351	268,069,000	250,818,530	166,568,080	685,455,610	22,111,471	977	152	20	305½	216½	52	70	54	426
November	564½	466¼	220¾	209,634,500	360,042,380	98,171,360	667,848,240	22,261,608	1,010	1,768	20	226	169½	54	72	73	451
December	.....	.....	.....	.....	.....	.....	.....	.....	57	1,286	20	3	.....	.....	.....	.....	.....
Totals and averages	1,991¼	6,762	2,566¼	749,620,000	4,911,288,450	1,231,965,840	6,892,874,290	18,832,990	9,610	624	21	1,996	1,174	51	78	63	537

of 10 per cent. in favor of the evaporative qualities of the egg coal exists, but the benefit of this change is shown conclusively.

The boilers are now being scaled and cleaned. They will be examined and such repairs made as deemed necessary. The old tubular boilers (from Nos. 7 to 11 inclusive) are hardly worth the expense of a renewal of all the crown sheets which they really need. I would recommend the replacing of them in the near future by a battery of internally fired return tubular boilers.

The brick chimneys of this Station require repairing. This will be done as soon as the weather permits. The floors of the several boiler rooms are now being relaid and put into first-class condition.

NEW SPRING GARDEN STATION.

The engine and boiler houses were completed by the contractor, Mr. Thomas Gamon, on June 9, 1884. The erection of the engines and boilers subsequently, the running of electric light wires, making of steam and water connections, etc., leave some work still to be done. The boiler room floors will be completed, gangways built over the boilers to give access to the stop and safety valves, closets built for the engineers and firemen, the floors of the engine rooms planed and the office furnished, etc.

In connection with this station I would suggest that all the stop valves on the mains near to and controlled at the station, be arranged for opening and closing by means of hydraulic appliances. This, in fact, should be the case at all the stations. A great deal of valuable time (often hours) is lost in waiting for the necessary force of men required to raise the stops, while it takes from 10 to 20 minutes to do the work afterwards. With

the proper hydraulic appliances this could be effected by one man in one-tenth of the time.

Machinery.

Two Engines:—

No. 9 Engine. Worthington Compound Duplex, erected in 1884 and put in service on July 1. Capacity, 851 gallons per revolution, or 15,000,000 gallons per day. Lift, 165 feet.

No. 10 Engine. Worthington Compound Duplex, erected in 1884, and put in service on August 5. Capacity, 851 gallons per revolution, or 15,000,000 gallons per day. Lift, 165 feet.

These engines were officially tested on November 20, but the bursting of a pumping main a few hours after commencing the test compelled a postponement of it until November 25, when the test was finally concluded.

There are two Worthington Duplex Donkey Pumps (14in. x 10½ in. x 10 in.), each capable of feeding all the boilers at this station with ease.

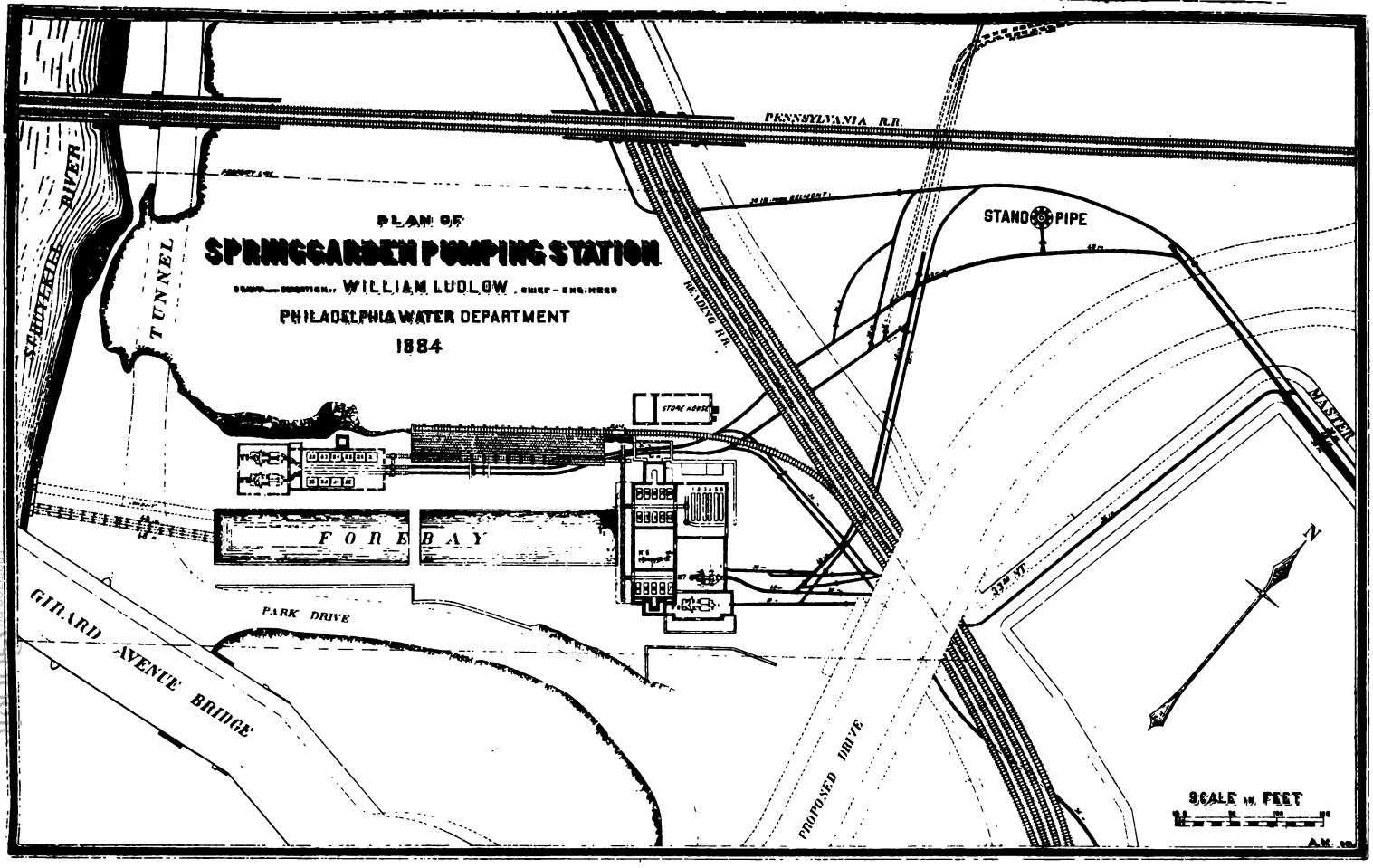
Boilers.

Ten steel return tubular marine boilers, built by the Edge Moor Iron Co., of Wilmington, Del. The first four were under steam on June 24, 1884; the fifth and sixth on August 27, 1884; the seventh and eighth on September 5, 1884; and the ninth and tenth on October 21, 1884.

An Electric Light Engine of 100 lights capacity, furnished by the Edison Electric Light Co., is situated in a separate room built at the southeast corner of the boiler room, and this together with the electric light engine in the old house have been arranged to furnish light for either station and for the coal bins, etc., as circumstances demand.

SPRING GARDEN STATION.

1884.	Running Time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. in.		Gallons raised 100 feet per pound of coal.
										Cylinder.	Engine.			
	No. 9.	No. 10.	No. 9.	No. 10.	Gallons.	Gallons.	Tons.	Lbs.		Quarts.	Quarts.	No. 9.	No. 10.	
January														
February														
March														
April														
May														
June	73¼	.....	36,451,463	.....	36,451,463	9,112,866	49	2,023	19	8½	4⅛	52	.....	390
July	437½	.....	257,950,679	.....	257,950,679	8,320,989	340	353	20	66¾	32⅞	52	.....	405
August	101¾	564	62,662,910	340,884,212	403,547,122	13,017,649	514	392	19	124	54½	79	54	466
September	371½	652	203,336,139	381,327,061	584,663,200	19,488,773	906	129	19	174½	52¼	78	66	465
October	430¾	420¾	246,994,131	234,118,421	481,112,552	15,519,760	791	151	20	150½	65	77	77	488
November	211¾	52¼	126,509,107	34,840,107	161,349,214	5,378,307	314	783	17	69½	36½	78	65	396
December	292	566¼	177,262,616	344,927,740	522,190,356	16,844,850	888	731	20	170	65	73	70	428
Totals and averages	1,918½	2,255¼	1,111,167,045	1 336,097,541	2,447,264,586	11,653,641	3,804	92	19	763¾	310¼	70	66	434


PLAN OF
SPRINGGARDEN PUMPING STATION
WILLIAM LUDLOW
PHILADELPHIA WATER DEPARTMENT
1884
SCHUYLKILL RIVER
TUNNEL
PENNSYLVANIA R.R.
READING R.R.
STAND PIPE
STONE HOUSE
FOREBAY
PARK DRIVE
GIRARD AVENUE BRIDGE
PROPOSED DRIVE
MASTER
N
SCALE IN FEET

BELMONT STATION.

Buildings and Grounds.

But little work required being done at this station during 1884. The new shed over the coal bins is in course of construction. The buildings are in thorough condition, and the appearance of this station is everything that can be desired.

Machinery.

Three Engines:—

No. 1. Duplex Compound, Worthington; erected in 1870. Capacity, 300 gallons per revolution, or 5,000,000 gallons per day. Lift, 216 feet.

No. 2. Duplex Compound, Worthington; erected in 1871. Capacity, 312 gallons per revolution, or 5,000,000 gallons per day. Lift, 216 feet.

No. 3. Duplex Compound, Worthington; erected in 1873. Capacity, 485 gallons per revolution, or 8,000,000 gallons per day. Lift, 216 feet.

The engines, in particular Nos. 1 and 3, have been overhauled and put in as good condition as possible, the previous use of inferior lubricants having corroded the cylinders and valve-faces very badly. The pumps were overhauled and new valves and valve stems put in where required. Brasses and all moving connections were adjusted and stuffing boxes repacked.

These engines have given entire satisfaction during 1884, and will require but trifling adjustments to put them in condition for the service required in 1885.

Boilers.

Fifteen Boilers:—

Nos. 1 to 8 inclusive are cylinder boilers, erected in 1870, by Neafie & Levy.

Nos. 9 to 15 inclusive are tubular boilers, erected in 1881, by Hilles & Jones.

All the boilers were scaled and cleaned; the bridge and division walls repaired, and furnaces arranged for pea coal grates.

The joints and rivets of the cylinder boilers Nos. 1 to 8 inclusive, were caulked in many places. These boilers are old and will require new crown sheets to make them safe, and I would suggest that no more repairs be made to them than are absolutely necessary to render them serviceable for another year, at the expiration of which time I would recommend that they be condemned and a battery of new boilers be substituted.

The crown sheets of No. 12 tubular boiler were renewed; the upper row of tubes from each of the tubular boilers removed and surface blow appliances attached. The water level was lowered 15 inches, the gauges altered to suit this level, and the feed-water arrangements fitted the same as was done with the tubular boilers at the Spring Garden Station.

The boilers are undergoing a thorough cleaning to prepare for this year's service. The hat-flanges on steam domes will be rivetted in place instead of bolted as at present, and of one (No. 7 Cylinder Boiler) the crown sheets will be partially replaced by new ones.

The mains north of the engine house were re-arranged to better suit the requirements of the station. The coal car tracks in the boiler house and the cars will be arranged, before Summer, the same as those at Spring Garden Station—the cars and trucks being already made. An underground telephone wire connecting the station with the Belmont Reservoir was laid in September, and has worked very satisfactorily.

The submerged main which had been repaired in the Spring of 1883 (having been found to have opened in one of the joints) gave out in December of the same year and was permanently repaired in the Summer of last year.

The following is a general description of the manner in which it was repaired and the means employed for effecting such repairs, from material obtained by the removal of the temporary bridge across the Spring Garden forebay, the coffer-dam in the river in front of the Spring Garden property, etc.:

A rectangular bottomless box was made, of the following general dimensions: thirty-one feet long, ten feet wide and twenty-five feet high, outside measurement. It was built in three horizontal sections; the lower section was ten feet high and was built on the east river bank on skids. the ends being left open to a height of seven feet from the bottom. The framing was built of 12 in. x 12 in. yellow pine, lined with three inch tongued and grooved spruce planking on the outside (horizontally), and with three inch tongued and grooved spruce on the inside (vertically). Upon its completion it was launched into deep water and held up by two small scows lashed to it, one on either side. The second section was then built on top of this, planked on the outside in the same way as the lower section. After firmly securing both sections together, the structure was lowered into position over the broken part of the main, when the third or upper section was added. To insure an even bottom for the coffer-dam to rest on, the bottom of the river was leveled off as much as possible by a submarine diver. Two sills, each of 12 in. x 12 in. yellow pine, were made to rest on either side of the enclosed main, and against the vertical or inner sheathing of the lower section, by means of guides built in each corner of the coffer-dam. Each sill had an 8 in. x 8 in. yellow pine vertical post secured to it by means of an iron bolt through a slack mortise. Short timbers were then laid across the coffer-dam, and by means of chain slings and lifting screws the main was partially raised from its bed and the coffer-dam partially forced into the bottom. The sills mentioned were lowered into place, and 8 in. x 8 in. guide posts secured by $\frac{3}{4}$ in. blunt bolts to the corner posts of the structure. The floor was then put in place by a diver. It was made up of white pine pieces six inches thick and eight inches wide, previously fitted together. As the material was very dry, the floor became quite tight after having been in place a few days.

The ends of the lower sections, which had been left open to straddle the main, were then planked over and covered with canvass. Three sets of timbers, each set composed of three

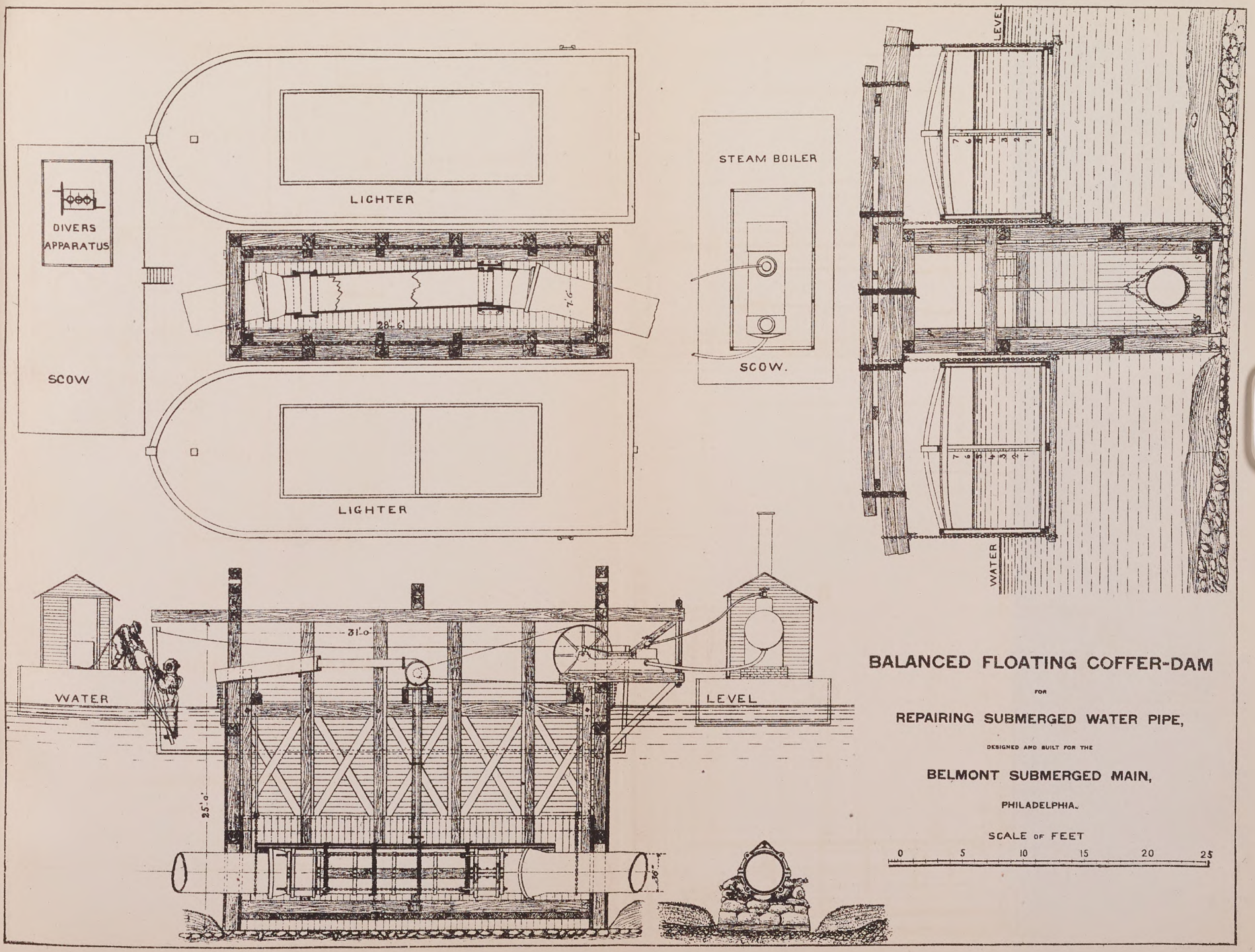
pieces of yellow pine twelve inches square, were then laid across the coffer-dam and two lighters were lashed to them, one on either side of the coffer-dam. An eight inch cataract pump driven by a 12 in. x 16 in. cylinder engine—the steam to which was furnished through a rubber hose from a boiler on a small lighter—completed the outfit.

(The timber used in the construction of the dam was obtained from the Spring Garden Pumping Station where it had been used during the erection of the new pumping station, and the pumping plants had also been used at Spring Garden to keep the forebay dry whilst the process of removing the mud was going on.)

Bench marks were then established, one in each lighter, one against the side of the coffer-dam, and one on a pier of the adjacent railroad bridge which crosses the river. The amount of water necessary to overcome the buoyancy of the coffer-dam was then pumped into the lighters, and the repairs to the main immediately begun. The work was very laborious owing to the fact that during its progress two heavy freshets occurred in the river,—the water levels in the lighter requiring constant changing, either to preserve their counteracting weight to the increasing buoyancy of the coffer-dam as the river rose, or to prevent excessive strain on their supporting timbers as the river fell.

The accompanying sketch shows the peculiar condition of the main when it was exposed to view after pumping out the dam.

As the sketch shows, part of two sections were removed by cutting, after which a straight piece of 36-inch pipe was lowered into place. This was connected with the section on the west side by means of an outside sleeve, and on the east side by an inside sleeve and an outside one made in two pieces. Lead joints were then made in the ordinary manner except that an opening was left at the bottom between the pipe and the sleeve at one end, to allow such water as leaked through the remaining joints to run into the coffer-dam. This opening was after-



BALANCED FLOATING COFFER-DAM

FOR

REPAIRING SUBMERGED WATER PIPE,

DESIGNED AND BUILT FOR THE

BELMONT SUBMERGED MAIN,

PHILADELPHIA.

SCALE OF FEET

0 5 10 15 20 25

BELMONT STATION.

1884.	Running Time of each Engine in Hours.			Gallons Pumped by each Engine.			Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. in.			Gallons raised 100 feet per pound 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	136	606½	20½	29,910,000	144,971,736	7,426,805	182,308,541	5,880,721	354	1,179	15	39⅝	36⅝	95	94	94	497
February	163½	489¼	22½	36,328,800	117,885,768	8,306,595	162,521,163	5,604,178	334	248	15	69⅜	29⅞	95	94	94	476
March	151	401	126½	33,592,200	94,945,656	43,515,655	172,053,511	5,551,081	375	117	15	82	29¾	95	94	94	444
April	384¼	302¾	35	84,198,000	71,660,160	11,847,580	167,705,740	5,590,191	374	839	17	83⅜	40⅛	95	94	94	435
May	674	9½	95¼	154,216,800	2,077,296	31,096,260	187,390,356	6,044,850	448	871	19	80½	38⅛	96	96	96	412
June	.....	415½	292¾	.....	97,783,296	101,326,200	199,109,496	6,636,983	424	140	20	71½	35⅛	.....	94	94	453
July	192	155½	397¾	41,720,700	36,461,568	136,902,405	215,084,673	6,938,215	463	235	16	78¼	41	94	94	94	448
August	127	114	499	27,839,700	26,467,584	164,873,810	219,181,094	7,070,358	435	1,691	19	76½	38¼	94	94	94	485
September	58	113¼	611¾	11,355,000	26,399,568	193,461,165	231,215,733	7,707,191	459	1,192	19	68¼	36½	94	94	94	486
October	89½	313½	426½	19,785,900	71,750,640	135,913,490	227,450,030	7,337,098	495	30	20	75¾	29½	94	94	94	443
November	150	382	285½	32,879,700	89,587,992	96,752,165	219,219,857	7,307,329	520	457	20	68¾	30¾	94	94	94	407
December	194½	401	112½	44,751,300	96,297,552	41,901,090	182,949,942	5,901,611	433	1,125	20	67¼	26¾	94	94	94	407
Totals and averages	2,319¾	3,703¾	2,925½	516,578,100	876,288,816	973,323,220	2,366,190,136	6,465,000	5,117	1,404	18	861⅜	412⅜	95	94	94	449

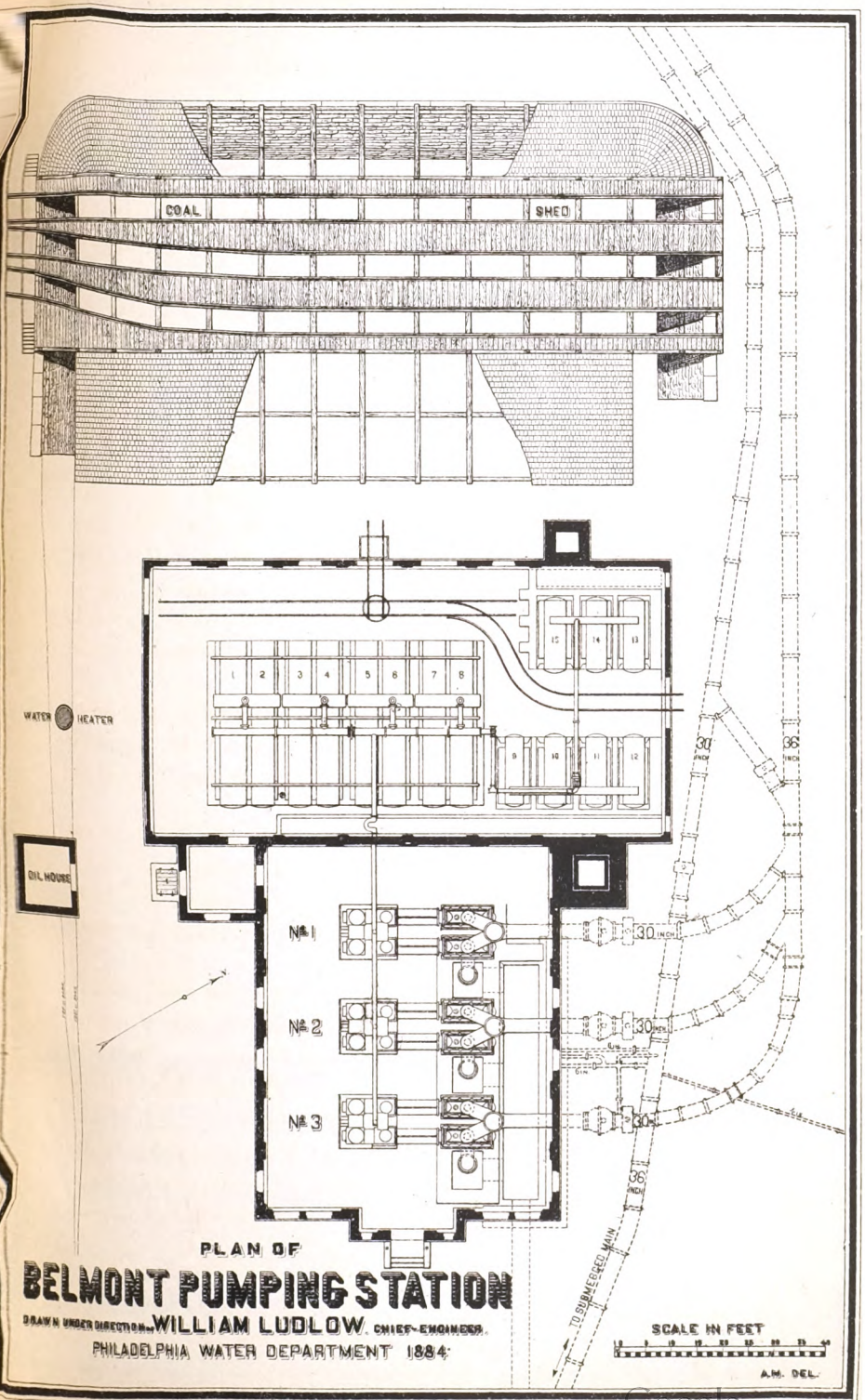
wards filled with cold lead wedges. Heavy iron bands were then bolted in place on either side of each sleeve, hard up against them, to prevent the possibility of the lead moving. Four additional iron bands were bolted around the straight piece of intercepting pipe—the lugs of all the bands being in one horizontal plane. Short pieces of yellow pine timber were then driven in between the successive lugs, and two heavy iron bands, one on the outside of each sleeve, were screwed together by means of bolts and chains to prevent any motion in the future in the repaired part of the main. A steel rail was then laid lengthwise over the whole, and the repaired part lashed to it in four places. This was done to prevent a strain on the lead while the coffer-dam was being removed and before it could be provided with the necessary support. With this completed, the coffer-dam was removed in the manner in which it had been put in place, namely, by taking away one section at a time—the loose floor having previously been ballasted to retain it in place, to serve as a platform for carrying the stone, etc., for the main to rest on.

The bed upon which it now rests is composed of large stone, upon which were placed bags partly filled with hydraulic cement, which upon hardening, naturally fit the shape of the pipe exactly.

Several other leaks were found near the eastern shore, one section having a long crack in it. No difficulty, however, was met in making these perfectly tight by means of iron bands secured in the same way as is done under similar circumstances on dry land.

The main has been in service whenever the water could be spared from the Belmont Basin, and the stoppage of engines at the Spring Garden Pumping Station required it. Successive tests with the pressure gauge at the Belmont Station have shown it to be in first-class working condition.

The building of a double arch at Fountain Green by the Fairmount Park Commisssion caused an accident to the main, seven lengths of which fell in on the night of June 28, but

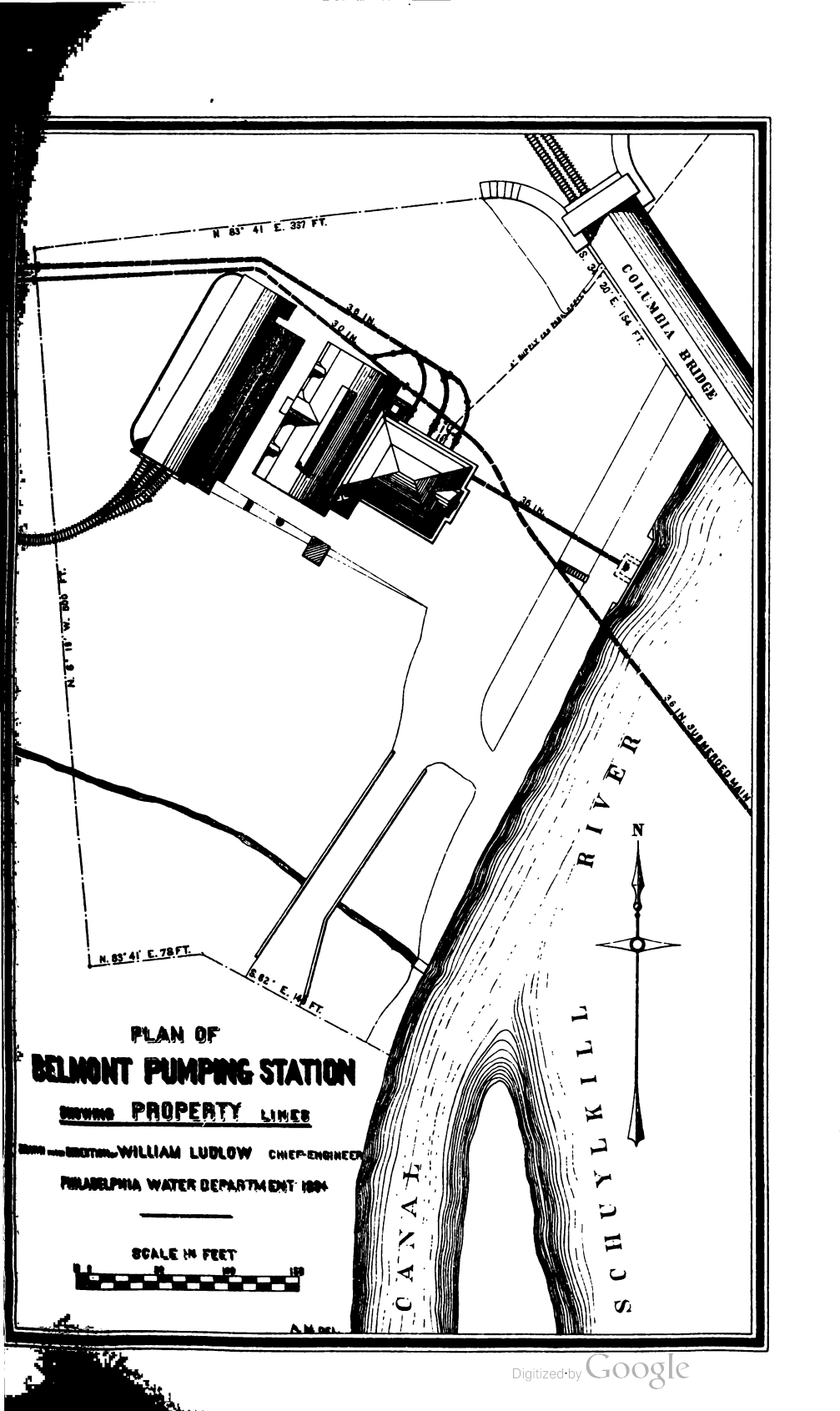


PLAN OF

BELMONT PUMPING STATION

DRAWN UNDER DIRECTION OF WILLIAM LUDLOW, CHIEF-ENGINEER.

PHILADELPHIA WATER DEPARTMENT 1884.



on account of the repairs to the submerged main not having been completed, the main was empty, otherwise the consequences would have been disastrous to the railroad near by. Temporary trestles were immediately erected, and the main, resting on these trestles, was repaired, allowing it to be used during the construction of the archways.

ROXBOROUGH.

Buildings and Grounds.

The floor of the north engine house was completed in May. A work-shop, store-room, and dressing-room were built for the employés at the Station. The boiler-house was entirely repaved, windows were built in on the west side, and the interior of the house and cellars whitewashed. The grounds were cleared and trimmed, brick water-closets built and roofs painted. The appearance of the Station at present is all that can be desired.

Machinery.

Three Engines.—

No. 1. Cornish overhead beam, Birkinbine, erected in 1869; capacity, 159 gallons per revolution, or 2,250,000 gallons per day; lift, 346 feet.

No. 2. Duplex Compound, Worthington, erected in 1872; capacity, 295 gallons per revolution, or 5,000,000 gallons per day; lift, 346 feet.

No. 3. Duplex Compound, Worthington; erected in 1884; capacity, 411 gallons per revolution, or 7,500,000 gallons per day; lift, 346 feet.

No. 1 Engine did no service whatsoever, and could be dispensed with.

No. 2 Engine has had very little done to her, as it was the only engine to be relied upon prior to the completion of No. 3

(the last new one). Preparations are making to give her a thorough overhauling as soon as the work now being done to the engines at the Spring Garden Pumping Station is completed.

No. 3 Engine was put in service on January 29; the official test was made on June 3. It has since been in almost constant use, and works very satisfactorily.

Boilers.

Seven Boilers.—

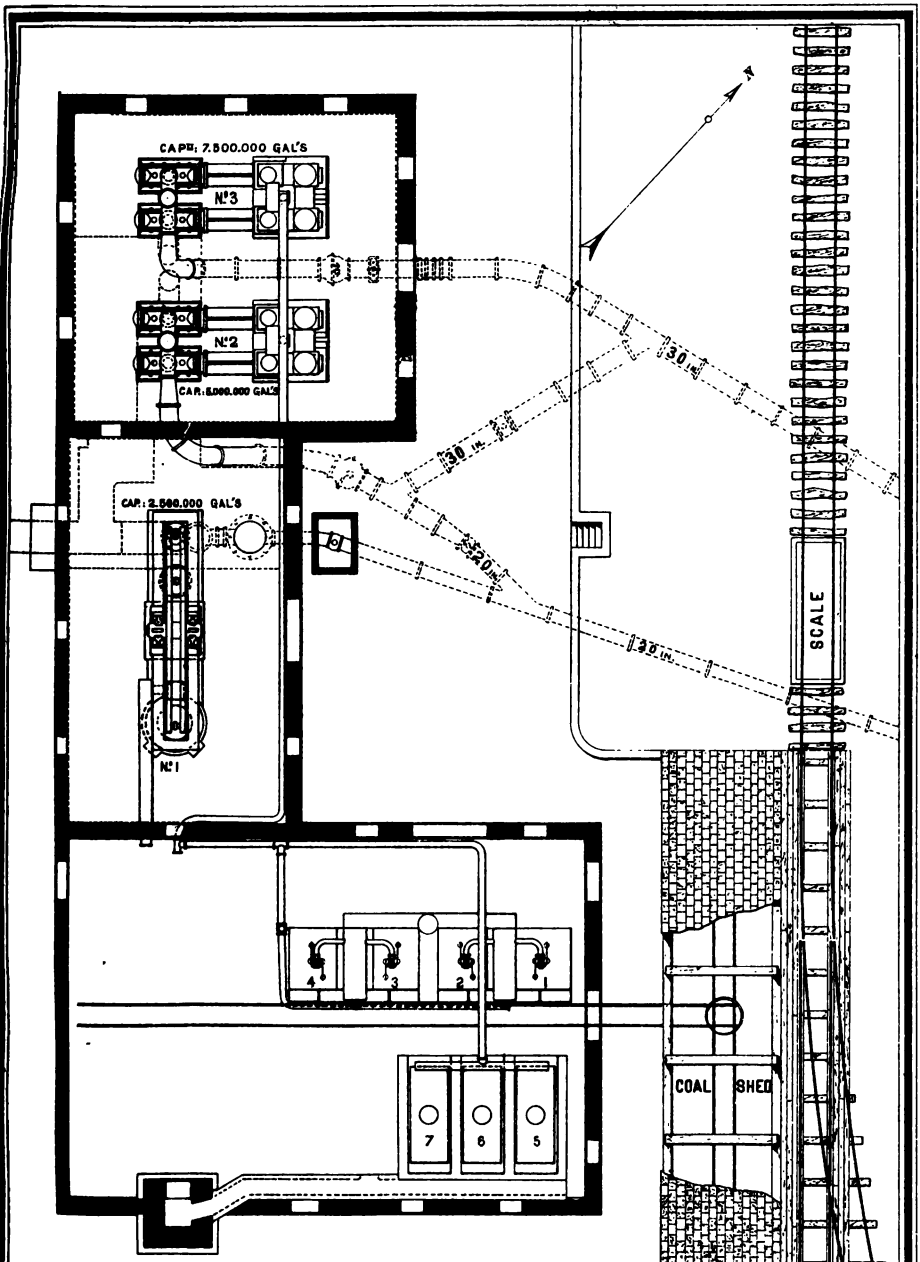
Nos. 1 to 4, inclusive, return tubular marine boilers, erected in 1885 by Neafie & Levy. (Transferred from the Frankford Pumping Station.)

Nos. 5 to 7, inclusive, tubular boilers, erected in 1882, by James Moore.

The old cylinder boilers, Nos. 1 to 8, inclusive, erected in 1867, were condemned, removed, and sold, and four marine tubular boilers (formerly in use at the Frankford Station) were substituted. These boilers are covered with Hanmore's patent covering, and connected with an iron smoke-stack erected at this station in the summer, and obtained from Belmont Station, where it had been stored for some time. All boilers, including the two remaining tubular boilers erected in 1882, were thoroughly cleaned, and the bridge walls of the last two repaired, and all the furnaces arranged for pea coal grate bars. The joints of the main steam pipes were renewed, and a new donkey feed engine $12'' \times 8'' \times 10\frac{1}{4}''$, was substituted for the one which was worn out. Repairs were made to the remaining one.

New iron floor plates were laid between the boilers, the coal tracks into the boiler room were repaired and partially renewed, new railroad coal scales erected, and the coal scales from the bins to the boiler house overhauled and put in thorough repair.

Nos. 1 and 2 boilers are at present being cleaned, and bridge and division walls will be repaired as required.



PLAN OF

ROXBOROUGH PUMPING STATION

SCALE IN FEET

DRAWN UNDER DIRECTION OF WILLIAM LUDLOW CHIEF-ENGINEER.

PHILA WATER DEPT

1864

ROXBOROUGH STATION.

1884.	Running Time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. 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.		Quarts.	Quarts.	No. 2.	No. 3.	
January	509¼	19	110,640,635	4,929,123	115,569,758	3,728,057	420	862	19	115¼	20¼	148	148	418
February	249½	196½	54,376,170	48,930,372	103,306,542	3,562,260	394	1,699	17	64	26¾	148	148	398
March	393½	101	88,943,385	21,432,828	110,376,213	3,560,523	380	660	19	94¾	27¼	148	148	441
April	330	143½	72,002,715	28,948,374	100,951,089	3,365,036	334	1,824	17	110	30¾	148	148	458
May	401	89½	87,184,890	20,473,143	107,658,033	3,472,839	354	1,385	24	110½	33½	148	148	461
June	47½	496½	10,936,830	111,937,494	122,874,324	4,095,811	410	713	25	113	62¾	152	150	462
July	235	271½	52,438,020	63,541,011	115,979,031	3,741,259	393	2,097	28	105½	43	152	152	459
August	.....	502	.....	119,826,639	119,826,639	3,865,375	369	2,220	24	123	37½	.....	152	505
September	.....	526	.....	127,305,606	127,305,606	4,243,520	398	426	23	145	33	.....	152	499
October	.....	496	.....	118,432,938	118,432,938	3,820,396	404	1,745	26	120	35¼	.....	152	457
November	66	376½	14,643,210	92,568,708	107,211,918	3,573,731	375	130	25	120	29	150	152	445
December	.....	389	.....	103,511,172	103,511,172	3,339,071	367	1,474	24	94½	27	.....	152	447
Totals and averages.	231¾	607	491,165,855	861,837,408	1,353,003,263	3,696,729	4,598	1,795	23	1,315½	406	149	150	451

ROXBOROUGH AUXILIARY STATION.

The floor in the engine-house was renewed, the windows and roof repaired, the plaster removed from the stone foundation of the stand-pipe, and the joints pointed with hydraulic cement, the building whitewashed inside and painted where needed, the old fencing removed, and the grounds put in good condition.

MACHINERY.

The pumps being but seldom used require very little attention and are in good condition.

The boiler, which was overhauled in 1883, continues in good order. It was covered in the Fall with Hanmore's patent covering. The furnace was arranged for pea coal grate in the early part of the Spring.

Roxborough Auxilliary Station.

1884.	Running Time.	Total gallons pumped during the month.	Average gallons per day.	Coal.		Percentage of ash.	Lubricating and Cylinder Oil.
	Hours.			Tons.	Lbs.		Quarts.
January	49	626,850	20,221	8	130	11	5¾
February	55	791,100	27,278	6	1,560	11	4¼
March	44½	648,000	20,903	4	2,050	7	3
April	48	885,820	29,517	3	1,330	10	2⅝
May	35½	476,842	15,382	3	1,295	7	2¾
June	55½	732,600	24,407	3	1,730	10	5¼
July	48½	576,180	18,587	3	425	7	5⅛
August	69	877,960	26,886	4	1,940	10	6¼
September	73½	873,180	28,813	4	1,150	7	9
October	73¾	1,056,814	34,091	5	1,486	17	6¼
November	56½	801,255	26,841	6	1,082	14	5¼
December	55	769,417	24,820	8	2,222	20	5¾
Totals and averages	663½	9,060,018	24,754	64	720	11	61⅝

MT. AIRY.

Buildings and Grounds.

Two windows were placed in the cellar wall, the roof repaired, the station supplied with gas, the boiler house whitewashed, and small repairs made to the engine house floor.

Engines.

A surface condenser was supplied to No. 1 Engine and attached to its pumping main (there being thus no loss of water for condensing purposes), and an air pump and feed pump placed in position and worked by the main engine. In consequence of this arrangement the coal consumption has been reduced to about one-half.

Both Nos. 1 and 2 Engines' steam pipes have been covered with Hanmore's patent covering. Arrangements are making to connect the No. 1 Engine with the surface condenser above referred to, to allow of either engine being worked in connection with this condenser.

The pump valves of No. 2 Pump were altered, making the engine now work perfectly smooth.

Boilers.

The crown sheets of Nos. 1 and 3 were repaired in the early part of the year, and the bridges and division walls overhauled. They were scaled and cleaned several times during the year and are in good condition. The back wall of the boiler house shows signs of cracking and will soon require rebuilding. Considering the fact, however, that the building was once a schoolhouse, it is at best, a second-hand affair, and I would suggest the propriety—in the near future—of building a more substantial structure. I think this will be cheaper in the end than the continual patching which an originally poor structure always requires.

The material being on hand at the Station, arrangements will be made this spring to rebuild the coal shed and store-

MOUNT AIRY STATION.

1884.	Running Time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. in.		Gallons raised 100 feet per pound of coal.
										Cylinder.	Engine.			
	No. 1.	No. 2.	No. 1.	No. 2.	Gallons.	Gallons.	Tons.	Lbs.		Quarts.	Quarts.	No. 1.	No. 2.	
January	321½	410	10,839,925	15,218,850	26,058,775	840,605	70	1,346	11	60¾	14⅛	39	33	134
February	456	240	16,662,300	8,899,700	25,562,000	881,448	69	862	10	82¼	10⅝	34	31	129
March	663	81	24,161,575	2,992,275	27,153,850	875,930	80	2,057	21	73¼	9¾	34	33	116
April	427	318	14,571,975	11,559,200	26,131,175	871,039	74	489	15	60½	7½	33	33	119
May	60	684	2,096,925	24,964,075	27,061,000	872,936	69	678	23	64½	8	36	33	133
June	714	.....	24,153,075	.....	24,153,075	805,102	81	922	27	79	7⅞	43	.....	131
July	665	79	22,076,000	2,710,375	24,786,375	799,560	72	1,747	29	30	7¾	35	36	124
August	298	446	10,150,875	16,917,625	27,068,500	873,177	69	1,641	27	20	8	42	54	197
September	455	262	17,077,500	10,177,775	27,255,275	908,509	83	1,124	28	27¾	7¾	63	63	211
October	203	54	7,605,975	20,609,650	28,215,625	910,181	70	63	29	25¾	8⅜	63	62	258
November	33	687	1,270,150	26,621,850	27,892,000	929,733	59	899	28	21½	14⅛	45	54	258
December	12	732	458,225	27,383,850	27,842,075	898,131	54	994	29	24½	15	38	38	200
Totals and averages	4,307½	3,993	151,124,500	168,055,225	319,179,725	872,076	855	1,622	23	569¾	118⅞	42	43	168

PLAN OF

MOUNT AIRY PUMPING STATION

DRAWN UNDER DIRECTION OF WILLIAM LUDLOW CHIEF-ENGINEER,

PHILADELPHIA WATER DEPARTMENT

1884

TOTAL CAPACITY OF RESERVOIR: 4390000 GALLONS

house, which now constitute a shell with very little framing, devoid of all bracing, and with innumerable openings, leaving the coal and stores almost unprotected.

CHESTNUT HILL.

Buildings and Grounds.

The reservoir (or so-called dam) was emptied, and about 100 cubic yards of mud and slush were removed. A wall was built across the inlet to this reservoir, reaching within four feet of the coping, to allow the water to settle before entering the reservoir from the adjacent basin.

The grounds were kept in repair, and the work of building coal sheds, so necessary at this Station, was begun. These will be completed some time during this year. Nothing has been done to the tower, as the more important stations required all the time and means. Preparations are making, however, for the necessary repairs this year. Iron beams will be substituted for the questionable timber now supporting the tank on the tower, whilst the surrounding wood work and the roof will also be repaired or renewed, and painted.

New coal scales have been placed in the boiler room.

Boilers.

The crown sheets of No. 2 Boiler were repaired and one new sheet substituted. Tubes were caulked, smoke box, bridge walls and lining repaired, and furnaces arranged for pea coal bars.

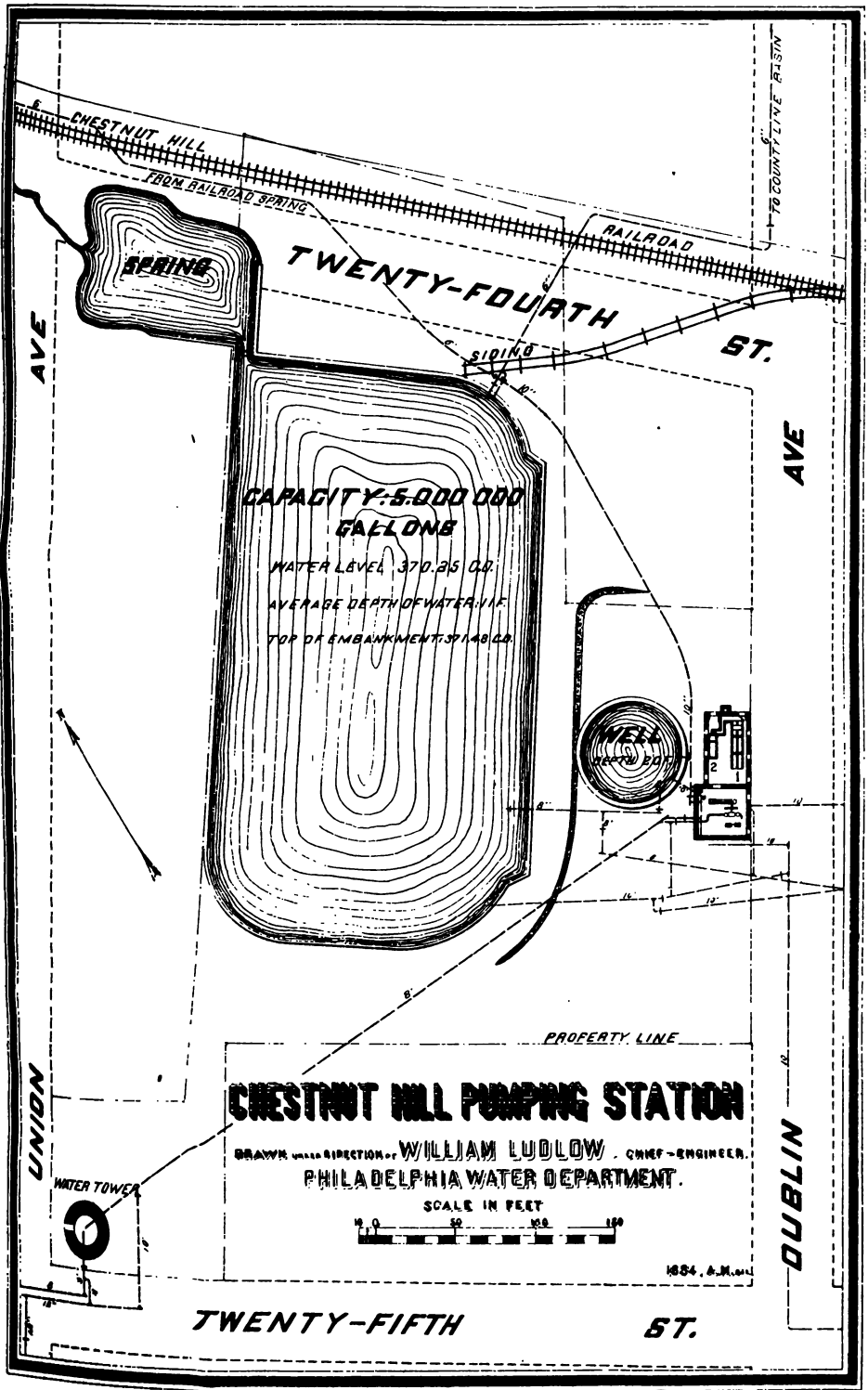
No. 3 Boiler is in good condition. Nos. 1 and 2 are well-nigh worn out, and it will probably be necessary to replace them some time next year by a new one.

Engines.

The wear and tear due to the light service of the machinery at this Station being slight, the attendant repairs are but

CHESTNUT HILL STATION.

1884.	Running Time of each Engine in Hours			Gallons Pumped by each Engine.			Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. in.			Gallons raised 100 feet per pound 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	64¼	67½	.....	1,407,000	2,632,500	.....	4,039,500	130,307	21	1,160	18	13¾	13¾	54	54	.....	104
February	24	90¾	.....	504,000	3,519,750	.....	4,023,750	138,750	21	860	19	14½	14½	54	54	.....	101
March	30¼	109½	.....	635,250	3,724,500	.....	4,359,750	140,637	22	2,020	19	15½	15½	54	54	.....	105
April	103½	63¾	.....	2,079,000	2,525,250	.....	4,604,250	153,475	23	1,404	19	15	15	54	54	.....	108
May	50¾	136	.....	1,065,750	5,304,000	.....	6,369,750	205,476	28	2,086	20	15⅞	15⅝	54	54	.....	122
June	12	33¾	272½	252,000	1,335,750	3,181,802	4,769,552	158,985	31	1,997	16	9¼	9¼	54	54	54	83
July	.....	.....	744	.....	.....	8,636,680	8,636,680	278,603	32	1,106	22	15½	15½	.....	.....	54	147
August	.....	.....	744	.....	.....	7,235,332	7,235,332	233,398	25	1,150	20	10½	10½	.....	.....	54	157
September	.....	.....	720	.....	.....	7,562,958	7,562,958	252,099	24	1,893	19	12⅛	12⅛	.....	.....	54	169
October	12	.....	732	151,200	.....	6,687,746	6,838,946	220,611	23	1,416	19	15½	15½	54	.....	54	165
November	.....	.....	720	.....	.....	6,381,440	6,381,440	212,715	24	998	18	15	15	.....	.....	54	147
December	.....	.....	744	.....	.....	6,842,160	6,842,160	220,715	25	1,563	17	15½	15½	.....	.....	54	148
Totals and averages	296¾	501¼	4,676½	6,094,200	19,041,750	46,528,118	71,664,068	195,804	306	1,978	19	167¾	167¾	54	54	54	130



trifling, and consist of re-making joints, packing stuffing boxes, etc.

A small old engine, unfit for use, was removed and a Worthington duplex donkey pump ($14'' \times 10'' \times 10\frac{1}{4}''$) put in its place.

FRANKFORD.

Buildings and Grounds.

An entire new floor was laid in the engine house, a part of the east wall of the boiler room was removed and altered—moving the doorway to the centre of the front and permitting the laying of the coal tracks closer to the boilers. The old unsightly coal bin was removed and a new one of 1,000 tons capacity built; the fencing was taken away from around the building and substituted for the old fence on the north boundary line of the property.

A cellar was dug and bricked up on the southwest corner of the engine house and a gas machine put in place. Gas pipe and fixtures were laid through the boiler house, and the station furnished with gas in November.

A cellar was constructed in the fire room, and iron steps leading into it surrounded with brass railings. This was for the purpose of receiving the Donkey Engines, whose removal from the engine house was made necessary by the erection of the new Corliss Pumping Engine.

A storeroom, workshop, closets and bathroom for the employés were built. The coal car tracks from the bins to the boiler room were renewed and laid with intercepting turn-tables, and new scales were put in. The wharf was used for unloading stone from the House of Correction for the purpose of repairing the Bridesburg Pike.

Machinery.

No. 1 Engine has had but little done to it, although it requires a thorough overhauling. The time could not be spared for this however, as there was no engine to take its place.

No. 2 Engine:—A Horizontal Corliss Compound Rotative, erected in 1884. Capacity 183 gallons per revolution, or 10,000.000 gallons per day. Put in service August 5. Officially tested December 31.

Boilers.

In the Spring, the last two remaining boilers were removed to Roxborough, and four Steel Marine Tubular Boilers built by the Edge Moor Iron Co., of Wilmington Del., for a working pressure of 100 lbs., were substituted.

The donkey feed engines were overhauled, one condemned, and a new one (12 in. x 7 in. x 10 in.) substituted. The boiler room floor was entirely laid in concrete, with new iron floor plates in front of the boilers. The boilers were made ready for steam on July 18.

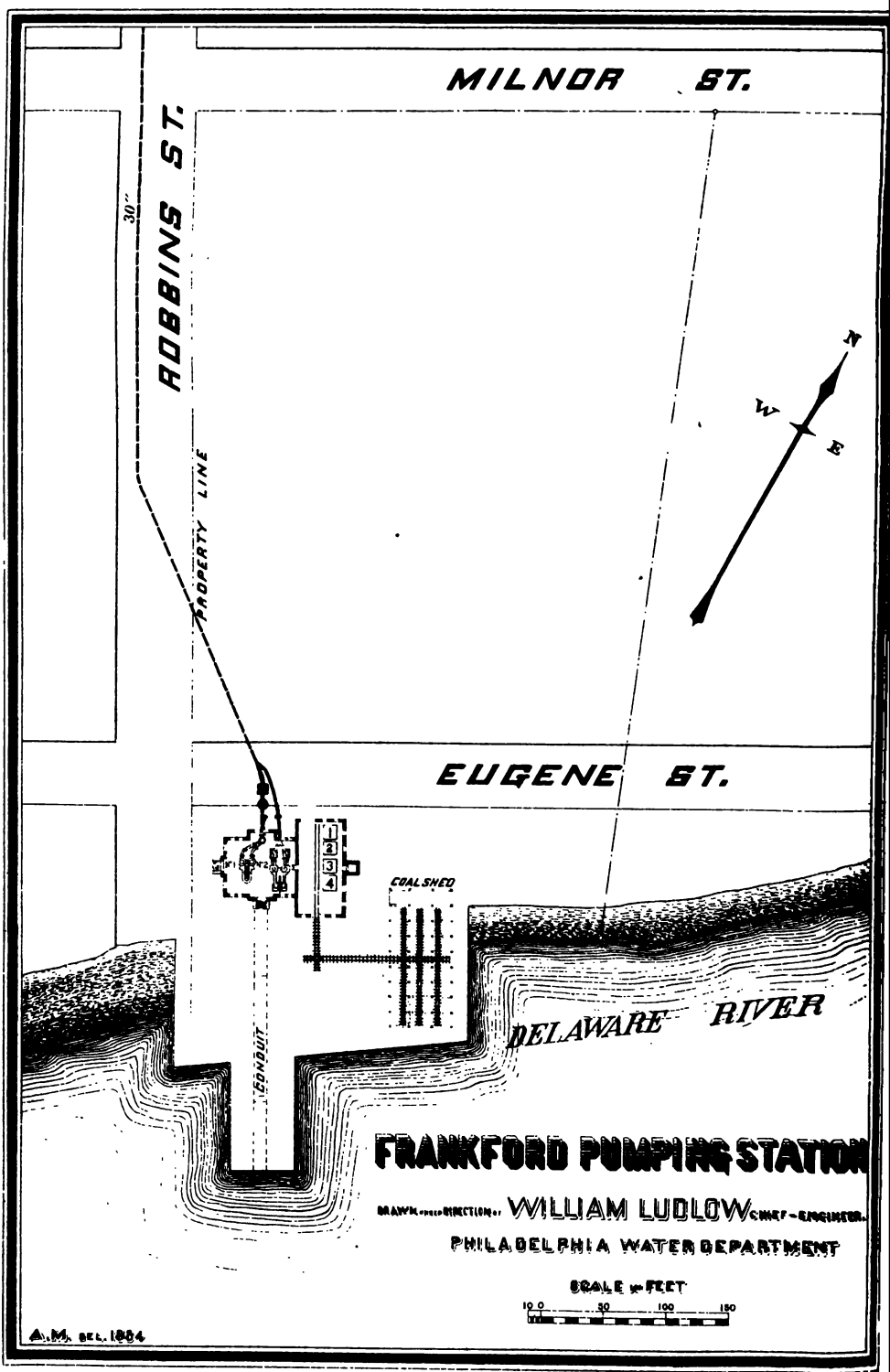
Small repairs and alterations, such as generally follow the erection of new machinery, are now being made, and I expect before Summer to have the entire station and its surroundings in splendid condition.

Repairs were made to the Frankford and Wissinoming trestles supporting the pumping main, but were brought to a standstill in the early part of November for want of funds. As soon as the weather permits, these repairs will be completed.

KENSINGTON.

Buildings and Grounds.

In view of your intention to close this station at an early date, as little as possible was done to it. It is however in fair condi-



FRANKFORD STATION.

1884.	Running Time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. per sq. in.		Gallons raised 100 feet per pound of coal.
										Cylinder.	Engine.			
	No. 1.	No. 2.	No. 1.	No. 2.	Gallons.	Gallons.	Tons.	Lbs.		Quarts.	Quarts.	No. 1.	No. 2.	
January	239¼	.....	79,613,709	.....	79,613,709	2,568,184	143	612	17	27	13½	77	.....	459
February	175¼	.....	55,464,759	.....	55,464,759	2,641,176	98	1,261	18	18	9	76	.....	439
March	196¾	.....	70,191,204	.....	70,191,204	2,264,233	112	1,810	17	22½	11¼	76	.....	486
April	186¼	.....	59,465,277	.....	59,465,277	1,982,176	98	1,312	17	24	11	76	.....	473
May	249¼	.....	79,704,942	.....	79,704,942	2,571,127	131	920	16	25	12½	76	.....	464
June	197½	.....	67,909,725	.....	67,909,725	2,263,657	130	849	15	22	11	77	.....	413
July	226¾	.....	75,418,626	.....	75,418,626	2,432,859	135	1,135	15	30	15	76	.....	431
August	151¼	79	53,554,425	22,898,607	76,453,032	2,466,227	123	680	15	43	20½	77	75	486
September	182	131¼	65,723,403	12,255,327	77,978,730	2,599,291	120	1,872	17	45	22½	77	76	569
October	177	31½	62,973,987	9,827,649	72,801,636	2,348,439	118	860	17	54	24	77	75	484
November	183½	.....	64,747,962	.....	64,747,962	2,158,265	111	1,110	17	44	12	77	.....	441
December	85½	79	30,354,756	28,223,175	58,577,931	1,889,611	111	1,782	17	52½	21½	78	83	424
Totals and averages	2121¼	2351¼	765,122,775	73,204,758	838,327,533	2,290,512	1,442	763	17	407	184¼	77	77	457

KENSINGTON STATION.

1884.	Running time of each Engine in Hours.		Gallons Pumped by each Engine.		Total Pumpage of each Month.	Average Pumpage per Day.	Coal.		Percentage of Ash.	Oil.		Mean Water Pressure and Mean Suction Lift in lbs. 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.		Quarts.	Quarts.	No. 2.	No. 3.	
January	.....	740½	.....	202,237,644	202,237,644	6,523,795	213	2,014	17	65	16	.....	56	544
February	.....	694	.....	191,091,747	191,091,747	6,589,370	195	753	17	55	14	.....	56	562
March	.....	740	.....	200,155,263	200,155,263	6,456,621	229	755	17	72	18	.....	56	502
April	.....	716	.....	198,155,349	198,155,349	6,605,178	240	993	21	81	18	.....	56	474
May	.....	742	.....	222,422,781	222,422,781	7,174,928	252	1,571	23	89	24	.....	56	506
June	125	698	19,196,460	220,622,430	239,818,890	7,993,963	280	2,191	24	112	39	56	56	476
July	348¼	696½	57,778,050	226,620,030	284,398,080	9,174,132	387	2,046	31	79½	43½	58	58	436
August	253	717	38,272,650	232,464,834	270,737,484	8,793,467	333	630	28	59¾	41⅛	58	58	484
September	.....	703	.....	234,940,629	234,940,629	7,831,354	253	661	25	56	10½	.....	58	552
October	.....	690¾	.....	233,605,806	233,605,806	7,535,671	264	883	24	56	10	.....	57	517
November	.....	597	.....	182,403,081	182,403,081	6,080,103	215	149	25	48	7⅛	.....	57	496
December	.....	592½	.....	162,541,386	162,541,386	5,243,271	213	1,245	24	48	6¾	.....	57	466
Totals and averages	726¼	8,327¼	115,247,160	2,507,260,080	2,622,508,140	7,165,323	3,080	454	23	821¼	248	57	57	501

tion, having been put in complete order in 1883; still, the removal of Nos. 1 and 2 Engines during the Summer necessarily required certain alterations in the steam and water connections, etc. If continued this year the floors should be repaired.

Engines.

Nos. 1 and 2 Engines were condemned, removed and sold.

No. 3 Engine (Worthington; capacity 6,000,000 gallons per day) has worked satisfactorily during the whole year, and requires at present the usual overhauling due to the wear and tear of a year's work.

Boilers.

The necessary repairs were made to the bridge walls and linings, and some of the boilers were scaled and cleaned. A new donkey pump (6 in. x 2½ in. x 6 in.) was put in place, and such alterations in steam and water connections made as the removal of the old engines rendered necessary. What remains of the old stand-pipe in front of the building is in bad condition, and will be entirely removed some time this month.

RESERVOIRS.

For want of funds, no reservoirs were cleaned with the exception of the supply reservoir, or so-called dam at Chestnut Hill Station, and as it would be money wasted to make permanent repairs until the mud has been removed, only such work was done as could not be avoided.

Fairmount Reservoir.

Repairs were made to the brick lining on the west side of the basin, the inside slope was cleaned of vegetable matter, and the gravel walks were continued in good order. By the bursting of the service main at the southeast corner on September 4th, the entire basin emptied itself, allowing an opportunity to

inspect the inner slopes, inlets and gate valves in the division banks, every part of which was found to be in a wretched condition.

Some of the division banks had been built of timber and had rotted. I would suggest the removal of these and substituting therefor, stone work, from at least three feet below the ordinary water level. I would also suggest that the station be supplied with electric lights, and that arc lights be distributed around the reservoir. I think this would be not only welcome to the thousands of people who make this a resort during the hot summer nights, but would also enable the Department police to preserve better order.

The stone retaining-wall on Twenty-fourth street requires pointing.

Spring Garden.

Nothing whatsoever has been done to this reservoir. It is the dirtiest one of all, and until the mud is removed there is no use of putting up new fences or sodding the banks, of both of which it is badly in need.

Corinthian.

Nothing has been done to this reservoir. The mud must be removed, and in this case also, until such is done, it will be money wasted to build new fences or attend to the sodding of the slopes.

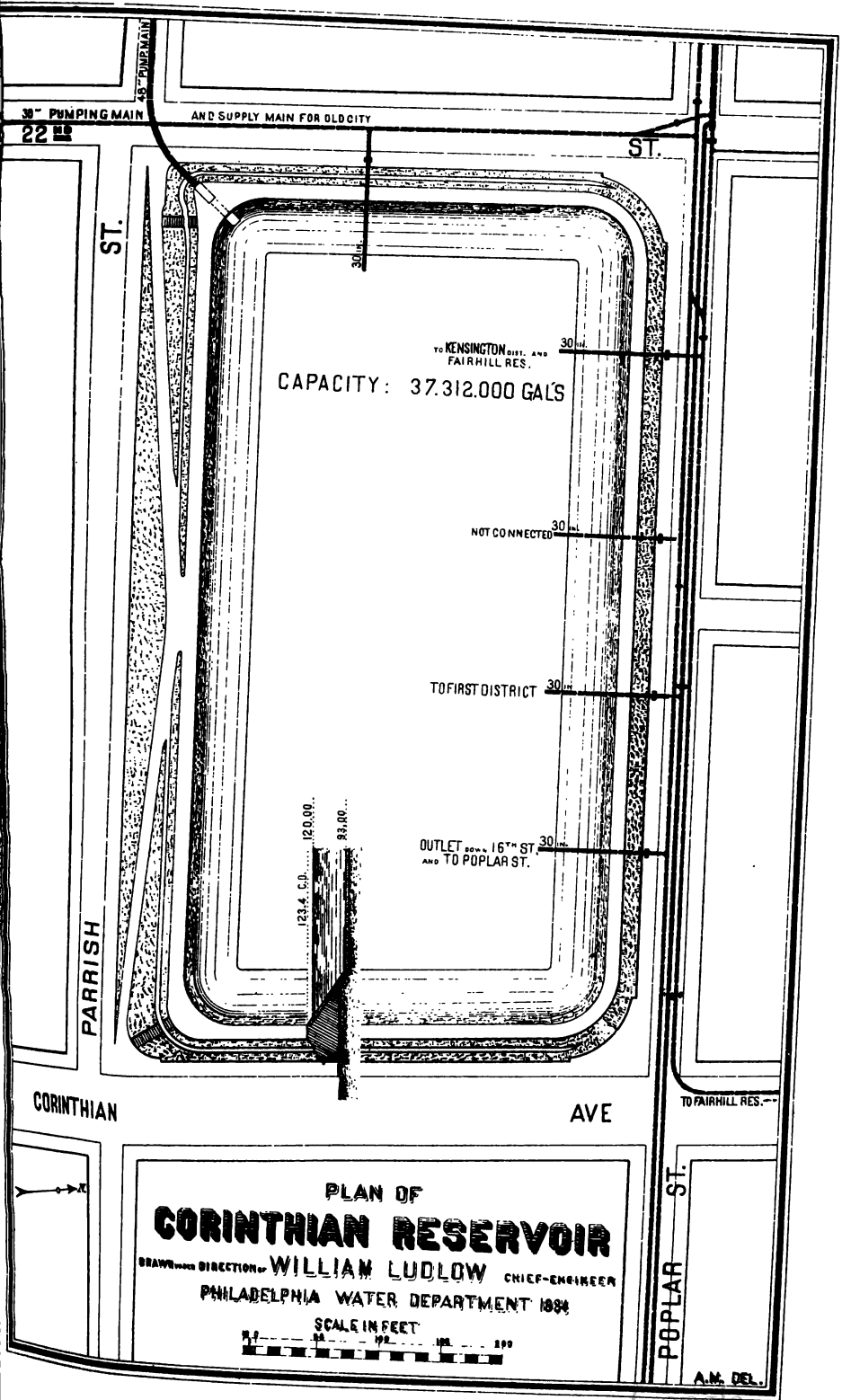
Belmont.

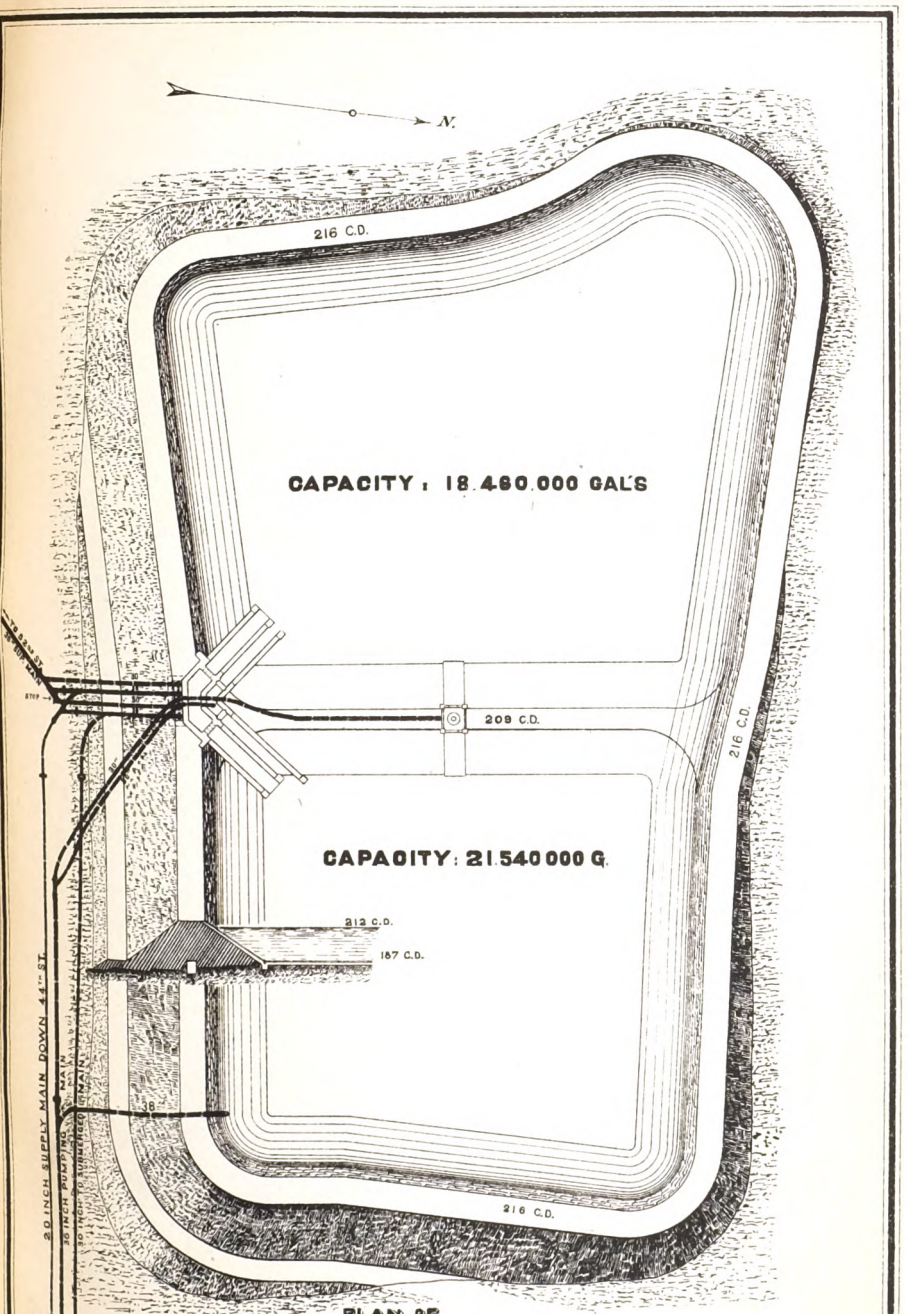
This reservoir is in good condition. The inside lining was kept clean and the grass on the outer slope attended to.

A new watch-house was built, and the gravel walks kept trimmed.

Roxborough.

Nothing has been done to this except such repairs to the riprapping and outside walk as were immediately needed. The reservoir requires cleaning and new fencing, and the riprapping on the inner slopes repairing.





PLAN OF

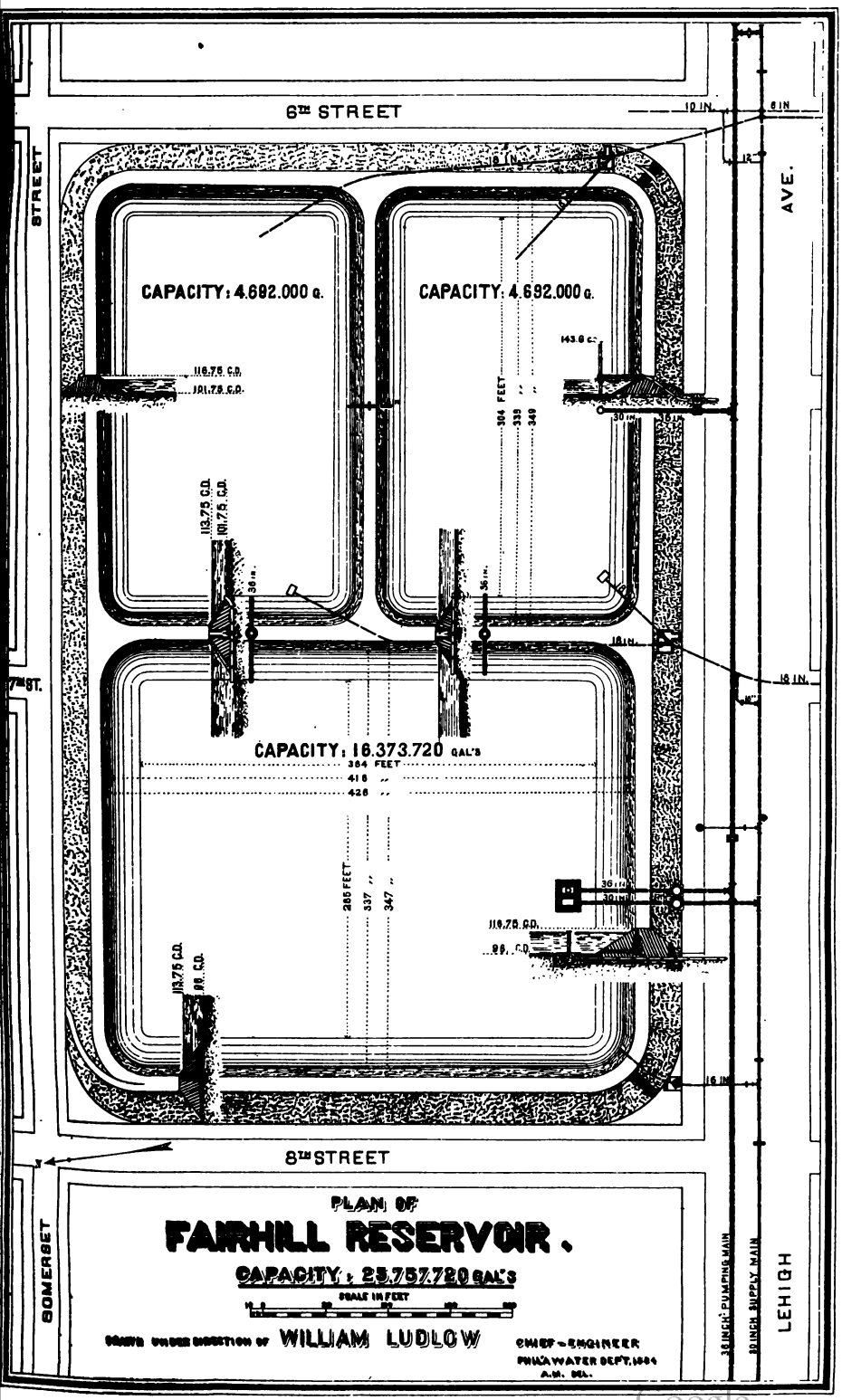
GEORGE'S HILL RESERVOIR.

CAPACITY: 40 MILLIONS GALS

SCALE IN FEET

DRAWN UNDER DIRECTION OF WILLIAM LUDLOW CHIEF-ENGINEER

PHILA WATER DEP'T
1864



PLAN OF

FAIRHILL RESERVOIR.

CAPACITY: 25.757.720 GAL'S

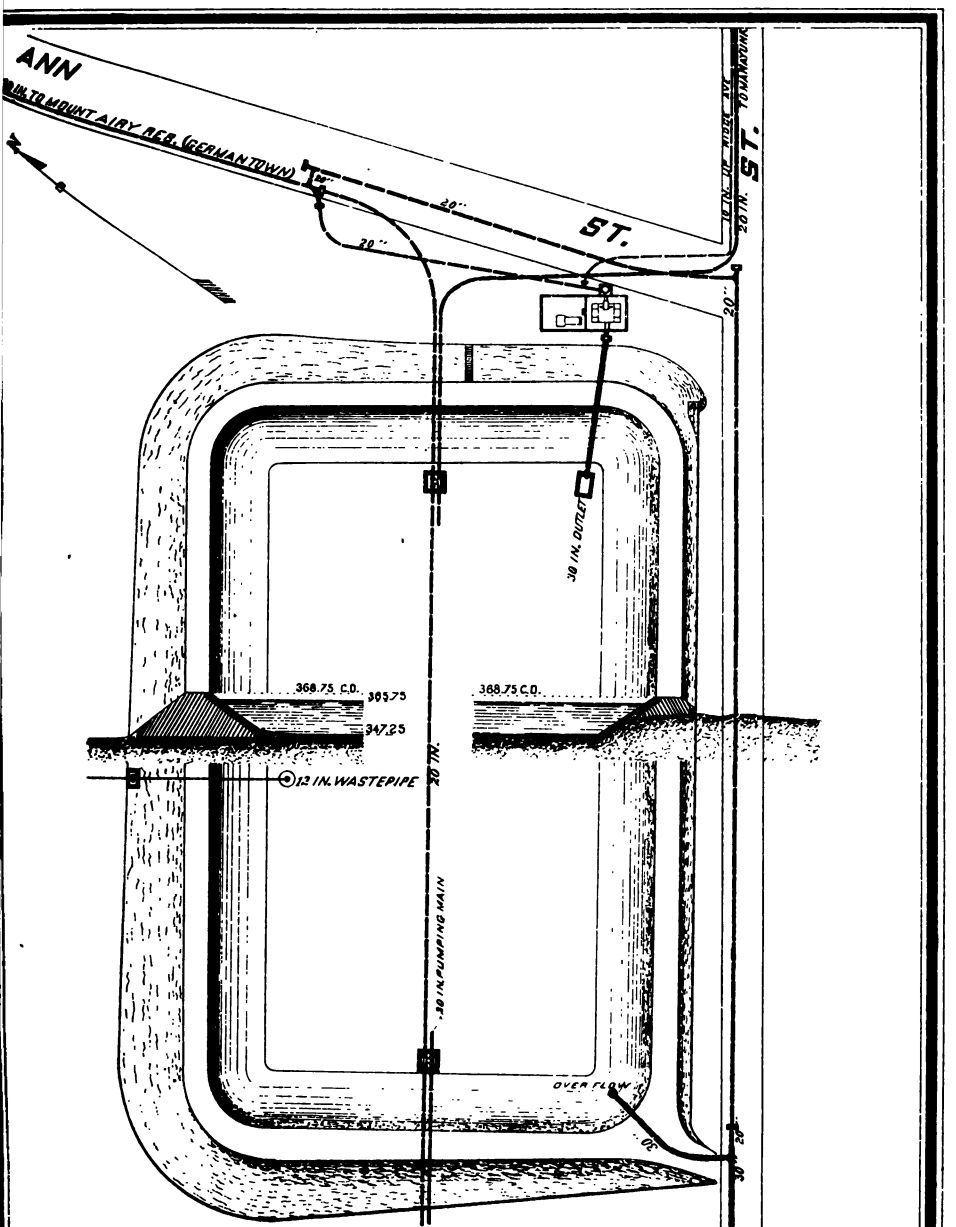
SCALE IN FEET

0 50 100 200 300

DRAWN UNDER DIRECTION OF WILLIAM LUDLOW CHIEF-ENGINEER

PHILA WATER DEPT. 1894

A.M. BEL.



PLAN OF

NORTHBOROUGH RESERVOIR

CAPACITY: 11,771,700 GALLONS

MAIN UNDER DIRECTION OF WILLIAM LUDLOW CHIEF — ENGINEER.

PHILADELPHIA WATER DEPARTMENT

SCALE IN FEET

10 0 50 100 150

A.M. DEC. 1884

Mount Airy.

This reservoir requires cleaning and fencing,—nothing having been done to it either.

Wentz Farm.

This reservoir requires a new fence. I should say, in connection with this, that the last wind storm in December destroyed a large part of the existing fencing on every one of our reservoirs with the exception of Fairmount and Fairhill.

Fairhill.

This reservoir needs overhauling. The slopes and gravel walks are kept in good order.

I would here renew my suggestion of last year, that a fence be erected along the top of the outer slope.

The use of Egg coal was discontinued and Pea coal substituted at the different stations on the following dates:

Spring Garden, March 23, 1884.
Belmont, March 20, 1884.
Roxborough, April 26, 1884.
Roxborough Auxiliary, October 14, 1884.
Mount Airy, April 19, 1884.
Chestnut Hill, March 22, 1884.
Frankford, May 12, 1884.
Kensington, March 25, 1884.

TOTAL GALLONS PUMPED DURING 1884.

1884.	Fairmount.	Spring Garden.	Belmont.	Roxborough.	Roxborough Auxiliary.	Mount Airy.	Chestnut Hill.	Frankford.	Kensington.	Total.	Average per day.	Percentage of Pumpage.	Maximum Gallons for one Day.	Minimum Gallons for one Day.	Total Steam Pumpage.
January	623,897,237	590,413,030	182,308,541	115,569,758	626,850	26,058,775	4,039,500	79,613,709	202,237,644	1,824,765,044	58,863,388	7.16	69,295,876	51,504,203	1,200,867,807
February	633,675,781	577,475,220	162,521,163	103,306,542	791,100	25,562,000	4,023,750	55,464,759	191,091,747	1,753,912,062	60,479,726	6.88	70,906,612	46,163,058	1,120,236,281
March	980,182,920	453,231,470	172,053,511	110,376,213	648,000	27,153,850	4,359,750	70,191,204	200,155,263	2,018,352,181	65,108,135	7.92	70,900,078	54,621,939	1,038,169,261
April	958,790,703	451,960,830	167,705,740	100,951,089	885,820	26,131,175	4,604,250	59,465,277	198,155,349	1,968,650,233	65,621,674	7.72	72,597,778	56,089,914	1,009,859,530
May	1,043,100,314	586,753,550	187,390,356	107,658,033	476,842	27,061,000	6,369,750	79,704,942	222,422,781	2,260,937,568	72,933,469	8.87	95,686,444	66,034,084	1,217,837,254
June	758,183,522	910,057,513	199,109,496	122,874,324	732,600	24,153,075	4,769,552	67,909,725	239,818,890	2,327,608,697	77,586,957	9.13	90,061,266	62,951,334	1,569,425,175
July	777,428,164	913,381,589	215,084,673	115,979,031	576,180	24,786,375	8,636,680	75,418,626	234,398,080	2,415,689,398	77,925,464	9.47	89,421,596	65,563,575	1,638,261,234
August	664,134,298	1,083,513,652	219,181,094	119,826,639	817,960	27,068,500	7,235,332	76,453,032	270,737,484	2,468,967,991	79,644,129	9.68	90,261,457	63,736,685	1,804,833,693
September	386,410,566	1,255,396,050	231,215,733	127,305,606	873,180	27,255,275	7,562,958	77,978,730	234,940,629	2,348,938,727	78,297,958	9.21	94,607,153	67,101,805	1,962,528,161
October	374,241,498	1,166,568,162	227,450,030	118,432,938	1,056,814	28,215,625	6,838,946	72,801,636	233,605,806	2,229,211,455	71,910,047	8.74	83,746,249	62,873,381	1,854,969,957
November	560,130,200	829,197,454	219,219,857	107,211,918	805,255	27,892,000	6,381,440	64,747,962	182,403,081	1,997,989,167	66,599,639	7.84	78,946,832	52,570,981	1,437,858,967
December	814,932,391	522,190,356	182,949,942	103,511,172	769,417	27,842,075	6,842,160	58,577,931	162,541,386	1,880,156,830	60,650,216	7.38	73,727,609	54,069,426	1,065,224,439
Totals and averages	8,575,107,594	9,340,138,876	2,366,190,136	1,353,003,263	9,060,018	319,179,725	71,664,068	838,327,533	2,622,508,140	25,495,179,353	69,658,969	100.00	.....	.....	16,920,071,759
Increase over 1883	.....	2,028,140,706	.....	.....	2,808,648	216,998,115	3,830,418	.....	278,155,945	210,222,102	385,113	.....	.....	4,432,261	1,392,211,237
Decrease from 1883	1,181,989,135	.....	742,470,303	21,626,468	.....	.....	.....	373,625,824	.....	.....	.....	.....	4,644,545	.....	.....

RUNNING EXPENSES OF THE PUMPING STATIONS DURING 1884.

Stations.	Salaries of regular employés at the stations.	Coal.			Oils.		Lighting Stations.			All repairs to machinery and boilers.	Packing and small stores.	Total expense.	Total gallons pumped.	Lift, in feet, including suction and friction.	Number of gallons pumped 100 feet high, friction and suction included.	Cost of raising water 100 feet per million gallons, suction and friction included.	Percentage of work done at each pumping station.
		Tons.	Price per ton.	Cost.	Lubricating, cylinder, and castor. Gallons.	Cost.	Gas.	Oil.	Electric light.*								
Fairmount	$5,573 66				367½	$272 90	$1,964 33	$5 25		$2,795 33	$959 29	$11,570 76	8,575,107,594	100.0	8,575,107,594	$1 35	21.99
Spring Garden	19,774 50	Egg 2,050	$4 95	$10,147 50	1,061	622 29	1,708 42	39 96	$157 32	24,432 08	1,720 40	94,915 01	9,340,138,876	163.9	15,311,994,579	6 19	39.26
		Pea 11,366	3 20	36,371 20													
Belmont	11,957 78	Egg 904	4 38	3,959 52	318½	199 96		13 05	728 63	6,827 07	575 07	36,222 41	2,366,190,136	216.2	5,115,703,074	7 09	13.12
		Pea 4,214	2 89	12,178 46													
Roxborough	6,688 08	Egg 1,470	4 46	6,556 20	430½	233 42		82 96		5,971 81	524 23	29,145 30	1,353,003,263	345.0	4,667,861,257	6 36	11.96
		Pea 3,128	2 90	9,071 20				17 40									
Roxborough auxiliary		Egg 143	5 43	233 49	15½	10 54		2 06			5 88	333 24	9,060,018	80.0	7,248,014		00.02
		Pea 21	3 87	81 27													
Mount Airy	2,527 45	Egg 264	5 68	1,499 52	172¼	91 45	173 76	9 74		929 12	35 06	7,647 83	319,179,725	97.8	312,157,771	24 50	00.80
		Pea 591	4 03	2,381 73													
Chestnut Hill	1,410 00	Egg 58	4 85	281 30	83¾	49 49		8 19		871 48	10 08	3,427 34	71,664,068	124.2	89,006,772	38 51	00.23
		Pea 249	3 20	796 80													
Frankford	3,250 00	Egg 492	4 28	2,105 76	147¾	82 11		6 14		5,246 59	166 99	13,648 51	838,327,533	177.1	1,484,678,061	9 02	3.81
		Pea 950	2 92	2,774 00				16 92									
Kensington	6,703 75	Egg 581	4 32	2,509 92	267¼	144 16	888 09	4 92		1,301 15	386 15	18,985 32	2,622,508,140	131.1	3,438,108,172	5 52	8.81
		Pea 2,499	2 82	7,047 18													
Totals and averages	$57,885 22	28,880	3 39	$97,995 05	2,864	$1,706 32	$4,734 60	$206 59	$885 95	$48,374 63	$4,383 15	$215,895 72	25,495,179,353	152.2	39,001,865,294	$5 54	100.00

* Including interest on plant, depreciation of value, etc.

REPORT

ON THE

OPERATIONS IN CONNECTION WITH THE

DISTRIBUTION SYSTEM

DURING 1884.

BY JOHN L. OGDEN, *Assistant Engineer in Charge.*

PHILADELPHIA WATER DEPARTMENT.
March 4, 1885.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—The following Report of the operations in connection with the distribution system during the year 1884 is respectfully submitted:

Eighty-three thousand eight hundred and sixty-two feet, or nearly 16 miles, of cast iron water-pipes of the following sizes were laid:

4-inch	2,308 feet	16-inch	15,919 feet
6 "	43,775 "	20 "	123 "
8 "	834 "	30 "	3,808 "
10 "	366 "	36 "	2,952 "
12 "	12,983 "	48 "	794 "

This added to that of previous years makes a total of 800 miles 4,257 feet now in service.

The above does not include pipes used for repairs and relays, amounting to 7,280 feet, nor does it represent the work performed which includes the lowering, raising, shifting, etc., of 10,799 feet, in all a total of 101,941 feet or nearly 20 miles of pipe handled.

The removal of the old stand pipe and two disabled engines at the Spring Garden Pumping Station, the contemplated raising of the roadbed of Thirty-third street to pass over the tracks of the Reading Railroad by a bridge, and the complicated manner in which the old mains were laid made it advisable while laying the pumping mains from the two new 15-million gallon Worthington Engines to relay those from the old engines. Plans were therefore prepared by which the arrangement of the mains was simplified, and at the same time the engines were enabled to pump to any desired point of distribution without interfering with each other. This work has been but partially accomplished owing to the necessity for using all the engines during the warm weather. It is progressing as rapidly as possible and will be completed early in 1885.

Seven hundred and forty-three feet of 48-inch, 2,374 feet of 36-inch, and 1,413 feet of 30-inch pipes were used in making these changes.

For the purpose of supplying with Schuylkill water that section of the city now depending on the Kensington Station, the 30-inch main on Ninth street was continued north from Dauphin street to Lehigh avenue, a distance of 2,258 feet, and a 36-inch pipe laid on Lehigh avenue, from Ninth street to the Fairhill Reservoir, a distance of 576 feet. This, with some changes made at the Corinthian avenue and Spring Garden reservoirs, will enable the Department to pump direct from the Spring Garden Station to the Fairhill Basin and the Kensington District, which is now supplied with objectionable Delaware water.

That part of the City east of Sixth street and north of Vine, in which are a large number of manufacturing establishments, has received an increased supply of water by means of a 16-inch main laid on Poplar street, from Broad to Front street, a distance of 6,675 feet. The water was turned on September 2, since which time no general complaint of a scarcity of water has been received from this District.

The work on the 16-inch supply main for Germantown has

been progressing during the year, some portions of its line on Green street have not been graded, and deep rock excavations have been necessary in many places which have retarded the work. Nine thousand two hundred and one feet of 16-inch and 6,687 feet of 12-inch pipes have been put in the ground, leaving 1,719 feet yet unfinished.

The re-arrangement of the pumping mains at the Belmont Station has been completed. The three engines are connected with the 36-inch pipe which is now used exclusively as a pumping main.

The 30-inch, formerly the rising main from No. 1 Engine, has been connected with the submerged main so that the water now passing through it is drawn from the reservoir and no longer pumped direct into the pipe as heretofore. The new arrangement works satisfactorily, and the joints have remained tight. Under the old arrangement constant repairs and re-caulking were necessary.

The 12-inch pipe on Ridge avenue, for increasing the supply of water to the Falls village, has been delayed by rock excavation, which occurs along almost the entire line. Four thousand nine hundred and twenty-eight feet have been completed, leaving 3,000 yet unfinished.

Forty-seven thousand eight hundred and fifty-nine feet of supply pipes have been laid for which frontage is collected. Various dead-ends have been connected, and private, fire, motor and supply attachments made. One hundred and forty-seven new fire hydrants and 324 new valves put in and sundry connections and drains at the works constitute the principal part of the new work done, which represents a total of 7,135,948 pounds of cast iron pipes handled.

Repairs.

The repairs to fire hydrants, gate-valves and mains have been of about the same number and character as in previous years.

New Fire Hydrants.

A new design for a fire hydrant has been prepared, and 50 completed ready to put in the ground early next spring. By a proviso in the ordinance making the appropriation, the positions of these are to be designated by the Fire Commissioners.

The new hydrant has a six-inch connection with the main, a 6-inch stand-pipe and two steamer and one hose nozzle, and is designed to be placed on large pipes, or at the intersection of small pipes, and so far as practicable, at or near the street corners.

The most recent form of hydrant used by the Department is represented in the accompanying drawing.

Drills.

Five thousand nine hundred and forty-five service attachments have been made, about half of which were corporation cocks inserted by means of tapping machines. Some difficulty was experienced at first with the latter owing to their imperfect construction, but the drillers have generally succeeded in overcoming their imperfections and are now pleased with their work. The old style of ferrules has been abandoned.

Relays.

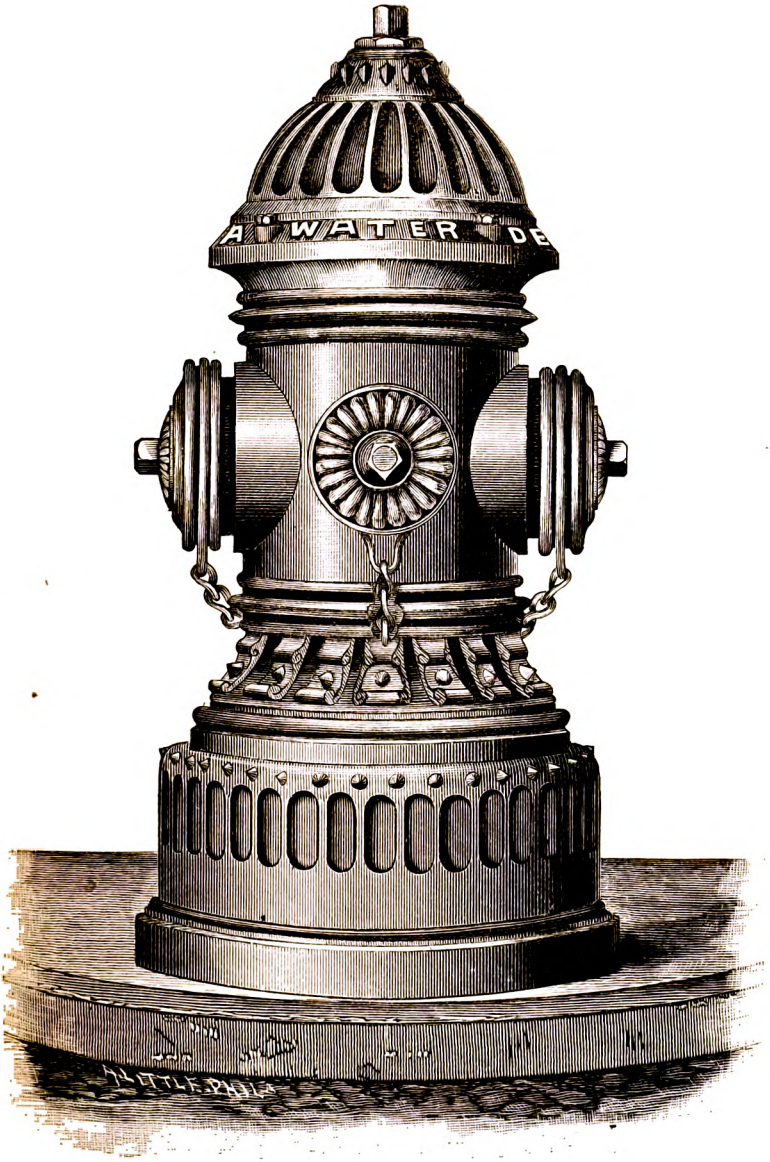
Five thousand nine hundred and fifty-six feet of pipes of various sizes have been taken up, and 687 feet cut off and left in the ground; most of which were three and four-inch pipes for which six-inch have been substituted.

About 1,400 feet of the above were relaid at Chestnut Hill, in accordance with an ordinance of Councils, dated April 5, 1884.

The changing of street grades at various places has necessitated the lowering or raising of 2,387 feet of pipe.

Cable Railway.

The construction of the Cable Railway on Columbia avenue, Seventh street, Franklin and Market streets, has given this



PHILADELPHIA WATER DEPARTMENT
FIRE HYDRANT.

Department considerable trouble, and necessitated the shifting of a large quantity of pipe on Columbia avenue and Market streets, and the removal of several gate valves which were directly in the line of the cable tubes.

In most streets the water pipes are laid in the centre, and where covered by the cable tubes and accompanying concrete, the difficulty of detecting leaks will be greatly increased as the water will no doubt follow the underside of the tube for a considerable distance before appearing on the surface.

The attachment of ferrules for private supply will be a work of much difficulty and will require the excavation of a large space under the tubes to give sufficient room for the driller to work. For the purpose of making repairs, an excavation must be made on both sides of the track, thus completely blocking the street. Where sewers occur in close proximity to the pipe, drilling and repairing will be almost an impossibility. For the convenience of this Department the pipes should be moved from beneath the tracks.

As directed by an ordinance of Councils dated July 28, 1884, water pipes were laid for the supply of the Pennsylvania State Agricultural Societies' Exhibition Grounds, at Sixteenth and Huntingdon streets. The following sizes were used:

1,185 feet of 4-inch cast iron.	1,334 feet of 1-inch wrought iron.
2,689 feet of 2-inch wrought iron.	50 feet of ¾-inch wrought iron.

Water was supplied free of charge to the above and to the International Electrical Exhibition at Thirty-second street and Lancaster avenue, in accordance with an ordinance approved June 17, 1884.

The Trustees of the Philadelphia Gas Works have laid a ten-inch water pipe in Passyunk avenue from the twenty-inch main at Broad street to Schuylkill avenue, a distance of 9,750 feet. Suitable branches were left at each street crossing, and the necessary gate valves, and nine fire hydrants were located along its line.

By a proviso of the ordinance of November 15, 1883, au-

thorizing the work to be done, this pipe when finished became the property of the city and is now in charge of this Department.

The tank in Chestnut Hill Tower was cleaned on Thursday, May 29, 1884, by the Purveyor of the Germantown District. The sediment (which was seven inches deep at the sides and four inches in the centre) was removed, and the sides and bottom of the tank scraped and washed out with clean water.

District Yards.

I desire to invite attention to the changes that have been made within a few years in the location of the Purveyor's yards, for the storage of material required in the laying of water-pipe.

The yard for the Second Purveyor's District was formerly located at Thirty-fifth and Aspen Streets, West Philadelphia. This lot was sold and the material removed to Thirty-eighth street and Woodland avenue. The sale of the latter lot to the University of Pennsylvania leaves us without a yard for this District and no place to store the materials on hand, which must shortly be removed

The yard for the Third Purveyor's District has been so reduced in area by the erection of the police station and the sale of the Old Kensington Hall, that it is no longer suitable for the purpose, and the Department is dependent upon private property owners for the storage of pipes.

The Fourth District Yard, formerly on Corinthian avenue below Parrish street, was, upon the sale of that ground, removed to Corinthian avenue above Poplar street. This lot has been sold to the German Hospital and the material removed to Twenty-sixth and Master streets, where the Purveyor's Office is now temporarily located in very inconvenient quarters.

At Manayunk there is no pipe yard, and the Purveyor of that district is obliged to leave his materials on the street, the railroad sidings, or on property of private citizens who sometimes kindly consent thereto.

The First District Pipe Yard on Wharton street between Eleventh and Twelfth, a very good location, has been so contracted by the Armory and Parade Ground of the Third Regiment, and the erection of a public bath-house that it is scarcely large enough for the purpose. The sheds used for the storage of small tools and perishable materials were torn down to make room for the bath-house. The tools, etc., were placed temporarily in sheds belonging to the Highway Department, who have recently notified us that they desire to occupy them. This leaves the Department almost entirely without storage room for the pipes and fittings we are obliged to have on hand.

METERS.

The frame building at Fairmount in which a small Worthington engine was formerly in position, was fitted up for testing and inspecting meters.

A six-inch connection was made to the twelve-inch pumping main, and run inside what was the boiler room, thence continued around the side to a wrought iron tank resting on a Fairbank scale of 8,000 pounds capacity. The tank is five feet in diameter and six feet in height, sufficient to measure over one hundred cubic feet. Valves are arranged so as to pass a six-inch or smaller stream of water directly into the tank or through the meters to the tank where it is weighed.

Each meter can be tested separately or a number connected together, the same water passing through all before being weighed. The rate of each meter is recorded for future reference.

The following table shows the meters purchased and set during the year and the number in use at present :—

GENERAL SUMMARY OF METER OPERATIONS DURING 1884.

Size.	In use Jan. 1, 1884.			In stock Jan. 1, 1884.			Purchased.					Received on trial.					In use Jan. 1, 1885.							In stock Jan. 1, 1885.						Condemned.			
Style of meter.	Crown.	Marsland.	Total.	Crown.	Undine.	Total.	Crown.	Worthington.	Union.	Keystone.	Total.	Equitable.	Keystone.	Union.	Worthington.	Total.	TOTALS.	Crown.	Worthington.	Union.	Keystone.	Marsland.	Equitable.	Total.	Crown.	Worthington.	Union.	Keystone.	Equitable.	Total.	Marsland.	Undine.	Total.	TOTALS.
½ inch...	3	.....	3	20	.....	20	10	.....	.....	.....	10	10	.....	.....	.....	10	43	18	.....	.....	.....	.....	.....	18	15	.....	.....	.....	10	25	.....	.....	.....	43
¾ " ...	4	.....	4	16	.....	16	60	.....	.....	25	85	11	.....	.....	1	12	117	72	.....	.....	13	.....	2	87	8	1	.....	12	9	30	.....	.....	.....	117
1 " ...	12	7	19	37	.....	37	85	25	.....	.....	110	10	.....	2	.....	12	178	120	17	.....	.....	4	3	144	14	8	2	.....	7	31	3	.....	3	178
1½ " ...	1	6	7	31	.....	31	60	2	25	.....	87	.....	4	.....	.....	4	129	86	2	23	2	4	.....	117	6	.....	2	2	.....	10	2	.....	2	129
2 " ...	6	6	12	20	1	21	110	2	.....	.....	112	.....	.....	.....	.....	.....	145	128	1	.....	.....	4	.....	133	8	1	.....	.....	.....	9	2	1	3	145
3 " ...	5	10	15	12	.....	12	25	3	.....	.....	28	.....	.....	.....	.....	.....	55	32	3	.....	.....	8	.....	43	10	.....	.....	.....	.....	10	2	.....	2	55
4 " ...	2	.....	2	11	.....	11	6	.....	.....	.....	6	.....	.....	.....	.....	.....	19	14	.....	.....	.....	.....	.....	14	5	.....	.....	.....	.....	5	.....	.....	.....	19
6 " ...	.....	1	1	2	.....	2	2	.....	.....	.....	2	.....	.....	.....	.....	.....	5	4	.....	.....	.....	.....	.....	4	.....	.....	.....	.....	.....	.....	1	.....	1	5
Total...	33	30	63	149	1	150	358	32	25	25	440	31	4	2	1	38	691	474	23	23	15	20	5	560	66	10	4	14	26	120	10	1	11	691

One hundred and nineteen meters were removed for various causes, as follows:

Crown meters, injured by steam	7
" " registering gear broken	9
" " pistons expanded	13
" " frozen and broken	15
" " defective	2
" " pistons broken by stones	3
" " pistons broken by loose metal lining	3
Union " frozen and broken	1
" " injured by being struck with hammer	2
Keystone " pistons binding	17
" " frozen and broken	3
Equitable meters, frozen and broken	1
" " stopped on centre	27
Worthington meters, pressure insufficient to move them	5
Marsland " corroded and condemned	11
Total	119

Most of the above can be easily repaired with the exception of the Marsland, which have been in use a number of years and are considered worn out.

All meters in some measure retard the flow of the water, so that it is necessary to use a size larger than the supply pipe to insure a good flow. The fact of a meter being in position in a building makes the owner careful of the plumbing, prevents waste both from leaks and careless use, and makes him provident when drawing water for any purpose. Meters invariably register in favor of the consumer, the percentage of which increases by continued service.

COMPLAINTS.

Three thousand six hundred and sixty-nine complaints of leaks were received during the year, the examination into the cause of which resulted as follows:

Leaky hydrants	2,324
" service-pipes	698
" wash paves	142
" spigots	9
" Water-closets	3
" horse-troughs	4
Surface water, etc. (not leaks)	489

Nearly 75 per cent. were hydrants leaking at the cock. It is impossible to estimate the waste thus occasioned, besides the inconvenience attending the filling of cellars, the damaging of foundation walls, and the endangering of the lives of those who are obliged to live in the dampness caused by this nuisance. The stop-cock is soon worn loose, and as the waste will allow the water to soak through the ground, no attention is paid to it until some neighboring cellar is flooded. It is time some improvement was made in this direction and the old style of hydrant discontinued.

The greatest number of complaints of short supply of water were received from West Philadelphia and that part of the city below South street. Complaints were also received from citizens residing in the vicinity of Nineteenth and Walnut and of Nineteenth and Spring Garden streets.

The high ground of the Twenty-fourth and the Twenty-seventh Wards was but poorly supplied during the summer, and residents justly complained of their inability to obtain water on the second floor in many of the houses. When the rapid increase of these wards is considered—the erection of over 5,000 houses during the last ten years with no increase in the water-supply (which is now as then furnished, by one 20-inch pipe)—the cause of the short supply is apparent and a new main should be provided for at once.

The lower part of the city, below South street, was in some locations almost entirely without water. In the eastern part (First and Second Wards) some relief was given by shutting off the water from some establishments which were pumping directly from the mains. In the western part (Twenty-sixth and Thirtieth Wards) no relief could be given without shutting down the manufacturing establishments which were draining the pipes.

To give relief to this section two things are necessary,—a 20-inch main on Gray's Ferry road and an additional 30-inch supply main from Fairmount Reservoir.

Tioga, owing to the small pipe through which it is supplied, is poorly protected from fire,—one engine being sufficient to draw all the water from the mains. In case of a break in the pipes (which occurred twice during the summer) the district would be without water.

Some other localities, one of which is the high ground on Spring Garden street, about Eighteenth, are also short of water. These isolated districts can only be relieved by a re-arrangement of the distribution.

Respectfully,

JOHN L. OGDEN,

Assistant Engineer.

IRON SERVICE AND SUPPLY MAINS LAID IN 1884.

FIRST DISTRICT.

Comprising the First, Second, Third, Fourth, Twenty-sixth, and Thirtieth Wards.

Street.	Location.	Size in inches.	Distance in feet.
	Supply Pipes.		
Bancroft street,	from Dickinson to north house line of Tasker	6	425
Caernarvon street,	from Tasker north	6	25
Delaware avenue,	from Queen south	6	38
Effingham street,	from Dickinson to Tasker	6	450
Ernest street,	from Twenty-eighth street west	6	156
Field street,	from Eleventh to Twelfth	6	423
Gerritt street,	from Twentieth to Twenty-first	6	545
Hanley street,	from Reed street north	6	128
Hicks street,	from 159 feet south side house line of Dickinson to Reed	6	634
Lawton street,	from Mifflin to Moore	6	450
Long street,	from McKean	6	21
McKean street,	from Ninth to Tenth	6	446
Mole street,	from 159 feet south side house line of Dickinson to Reed	6	626
Porter street,	from Twenty-eighth street west	6	173
Queen street,	from west house line of Delaware ave. east	6	26
Tiernan street,	from 148 feet south side house line of Dickinson to Dickinson	6	173
Tasker street,	from Caernarvon to east house line of Twentieth	6	137
Taylor street,	from Effingham street, west	6	12
Twenty-eighth street,	north house line of Shunk, north	6	617
	Total		5,505
	Supply connections (private).		
Twelfth street,	east side, 70 feet south of Wharton, for public bath house	4	15
Fire hydrant connections		4	48
" "		6	179
	Total		227

Street.	Location.	Size in inches.	Distance in feet.
Repairs, general		3	2
" "		4	19
" "		6	123
" "		10	4
Total			148
Repairs, new stops put in.			
Dickinson, west house line of Fifteenth		6	3
Moyamensing avenue, east side, 2 feet south of Morris		6	12
Reed street, east house line of Sixteenth		6	3
Sixth street, south house line of Tasker		6	2
Total			20

Recapitulation of First District.

	Purposes for which used.		Sizes—Inches. 3	4	6	10	Total feet.
New pipe or feet added.	Supply pipes				5,505		5,505
	Supply connections (bath-house)			15			15
	Fire hydrants connections			48	179		227
	Total	feet		63	5,684		5,747
		pounds		1,197	176,204		177,401
Pipe used, but adding nothing to feet in the ground.	Repairs, general		2	19	123	4	148
	Repairs, new stops put in				20		20
	Total	feet	2	19	143	4	168
		pounds	30	361	4,433	220	5,044
Total handled		feet	2	82	5,827	4	5,915
		pounds	30	1,558	180,637	220	182,445

SECOND DISTRICT.

Comprising the Fifth, Sixth, Seventh, Eighth, Ninth, Tenth, Twenty-fourth, and Twenty-seventh Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply pipes.		
Chancellor street, from 152 feet west of west house line of Thirty-second street west	6	279
Chester avenue, from east house line of Forty eighth street west	6	280
DeKalb street, from Locust to Walnut	6	421
" " from Fairmount to Aspen	6	396
Hoadly street, from Woodland avenue southeast	6	301
Smedley street, from Thirty-third to Thirty-fourth	6	414
Total		2,091
Fire connections (private).		
Chestnut street, north side, 125 feet west of Thirtieth street, Stokes and Parrish	4	26
Crown street, east side, 237 feet north of house line of Race	4	15
Delaware avenue, east side, 128 feet south of Vine; Pennsylvania Railroad	4	30
Second street, east side, 102 feet north of Walnut; Chamber of Commerce	4	9
	6	1
Twenty-fourth street, from Vine south; Nixon's Paper Mill	4	12
	6	3
Thirty-third street, east side, 48 feet north of Lancaster avenue; Electric Light Company	6	93
Total		189
Supply connections (private).		
Woodland avenue, southeast side, 219 feet south of Fifty-eighth; Belmont Cricket Grounds	4	26
Merrick street, east side, 17 feet north of house line of South Penn Square, for City Hall	6	68
South Penn Square, 17 feet west of west curb line of Juniper, for City Hall	6	60
Total		154

Street. Location.	Size in inches.	Distance in feet.
Motor connections (private).		
Walnut street, north side, 234 feet east of house line of Fortieth; Walnut Street Presbyterian Church	4	24
Fire Hydrant connections	4	40
" " "	6	187
Total		227
Repairs, general	4	58
" "	6	339
" "	8	4
" "	10	3
Total		404
Repairs, new stops put in.		
Chancellor street, west side of Thirty-second	4	3
New street, east side of Third	4	3
Arch street, east side of Ninth	10	3
" " west side of Ninth	10	3
" " east side of Seventh	10	3
" " west side of Seventh	10	3
Seventh street, south side of Race	6	2
Race street, east side of Seventh	6	3
Franklin street, 5 feet 6 inches north from centre of Race	4	2
Second and Union streets, intersection stop	6	9
Total		34
Taken up.		
Crown street, from Race to Vine	3	633
Gothic street, from Front to Second	3	396
Total		1,029
Relaid.		
Crown street, from Race to Vine	6	682
Gothic street, from Front to Second	6	454
Total		1,136

Street	Location.	Size in inches.	Distance in feet.
	Lowered.		
Chester avenue,	between Forty-sixth and Forty-seventh	6	353
South Penn Square,	from centre of Broad, west	10	121
Fire hydrant connection		6	25
	Total		499
	Pipe shifted.		
Market street,	between Nineteenth and Twentieth	6	141
" "	from Tenth to Thirteenth	20	1,476
	Total		1,617

Recapitulation of Second District.

	Purposes for which used.	Sizes—Inches. 3	4	6	8	10	20	Total feet.
New pipe, or feet added.	Supply pipes			2,091				2,091
	Fire connections (private)		92	97				189
	Supply " "		26	128				154
	Motor " "		24					24
	Fire hydrant connections		40	187				227
	Total.... feet		182	2,503				2,685
	Total.... pounds		3,458	77,593				81,051
Pipe used, but adding nothing to feet in the ground.	Repairs, general		58	339	4	3		404
	" new stops put in		8	14		12		34
	Taken up	1,029						1,029
	Relaid			1,136				1,136
	Lowered			378		121		499
	Shifted			141			1,476	1,617
	Total.... feet	1,029	66	2,008	4	136	1,476	4,719
	Total.... pounds	15,435	1,254	62,248	168	7,480	234,684	321,269
	Total handled... feet	1,029	248	4,511	4	136	1,476	7,404
	Total handled... pounds	15,435	4,712	139,841	168	7,480	234,684	402,320

THIRD DISTRICT,

Comprising the Eleventh, Twelfth, Sixteenth, Seventeenth, Eighteenth, Nineteenth, Twenty-third, Thirty-first, and part of the Twenty-fifth Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply Pipes.		
Cambria street, from Third to Fourth	6	286
Charter street, from Trenton avenue to Amber	6	442
Darien street, from Huntingdon north	6	270
Firth street, from Eighth west	6	146
Fourth street, from Cambria south	6	94
Glenwood street, from Second to Fifth	6	1,744
Huntingdon street, from Eighth to Ninth	6	281
Hutchinson street, from Lehigh avenue north	6	213
Hutchinson street, from Somerset north	6	113
James street, from Edgemont to Thompson	6	243
Marshall street, from York to Cumberland	6	549
Marshall street, from Venango south	6	169
Mercer street, from Ann to Neff	6	431
Ninth street, from Huntingdon north	6	37
Ninth street, from Lehigh avenue south	6	277
Orianna street, from Cambria south	6	94
Orkney street, from Somerset to Cambria	6	551
Orkney street, from York to Cumberland	6	549
Potter street, from dead end, 229 feet northeast, Leamy street northeast	6	15
Potter street, from Lehigh avenue south	6	180
Wishart street, from 138 feet west, Frankford avenue west.	6	332
Total		7,016
Fire connections (private).		
Adams street, south side, 125 feet west of Emerald; Firth & Bro	4	19
Third street, east side, 313 feet north of Somerset; Folwell & Bro	4	17
Hope street, west side, 232 feet north of Montgomery avenue; Thomas E. White	4	9
Total		45
Supply connections (private).		
Howard street, east side, 152 feet 6 inches south of Oxford street; Thos. Dolan & Co	4	14
Second street, west side, 338 feet north of Columbia avenue; Ontario Mills	4	19
Total		33

Street. Location.	Size in inches.	Distance in feet.
Fire hydrant connections	4	14
" " "	6	202
Total		216
Supply mains.		
Poplar street, from Front to Sixth	16	2,991
Ninth street, from 114 feet south of south curb line to north side Lehigh avenue	30	176
Lehigh avenue, north side, from west of Ninth to 513 feet 8 inches east of east house line of Ninth street	36	546
Lehigh avenue, from 36-inch main to connection with reservoir	36	30
Total		3,743
Drains and Connections at Stations.		
Frankford Station, discharge pipe	12	129
" " drain pipe	6	6
" " pumping main	30	44
Kensington " blow-off pipe	4	197
Total		376
Cross Connections.		
Second street, from east to west side, below Poplar	6	67
Repairs general	4	58
" "	6	331
" "	10	3
Total		392

Street.	Location.	Size in inches.	Distance in feet.
	Repairs, new stops put in.		
Thompson and Monmouth.	"Barton."	6	$14\frac{5}{6}$
Cumberland street, south side, at east house line of Richmond		6	3
York street, 3 feet west of west house line of Fifth		6	$2\frac{2}{3}$
" "	south side, at east house line of Tulip	6	$3\frac{1}{2}$
Poplar and Front streets.	"Dividing stop."	10	$9\frac{1}{2}$
" "	New Market streets. " "	6	$9\frac{1}{2}$
" "	Second streets. " "	6	$9\frac{1}{2}$
" "	St. John " " "	6	$9\frac{1}{2}$
" "	Third " " "	10	$9\frac{1}{2}$
" "	Fourth " " "	6	$9\frac{1}{2}$
" "	Fifth " " "	6	$9\frac{1}{2}$
" "	Randolph streets " "	6	$9\frac{1}{2}$
" "	Sixth " " "	10	$9\frac{1}{2}$
	Total		109
	Relaid.		
Beach street, across Canal street, former site of Cohocksink creek		6	83
Tacony street, under Pennsylvania Railroad bridge, Frankford		6	69
Oxford street, south side, 2 feet west of east house line of Howard street supply connection; Thos. Dolan & Co.		6	7
	Total		159
	Raised.		
Third street, from 82 feet north of Somerset north to Cambria		6	446
Fire hydrant connection		4	15
	Total		461
	Taken up.		
Second street, east and west sides south of Poplar		4	19
Lehigh avenue, north side, opposite stop house at reservoir		36	59
Mascher street, west side, 60 feet north of Putnam street; fire connection		4	18
	Total		96
	Cut off and Left in the Ground.		
Tacony street, under Pennsylvania Railroad bridge, Frankford		6	58

Recapitulation of Third District.

Purposes for which used.	Sizes—Inches.							Total feet.
	4	6	10	12	16	30	36	
Supply pipes		7,016						7,016
Fire connections (private)	45							45
Supply " "	33							33
Fire hydrant connections (private)	14	202						216
Supply mains					2,991	176	576	3,743
Drains and connections at Stations	197	6		129		44		376
Cross connections		67						67
Total..... feet	289	7,291		129	2,991	220	576	11,496
Total..... pounds	5,491	226,021		9,288	329,010	73,040	243,072	885,922
Repairs, general	58	331	3					392
Repairs, new stops put in		81	28					109
Taken up	37						59	96
Relaid		159						159
Raised	15	446						461
Total..... feet	110	1,017	31				59	1,217
Total..... pounds	2,090	31,527	1,705				24,898	60,220
Total handled feet	399	8,308	31	129	2,991	220	635	12,713
Total handled pounds	7,581	257,548	1,705	9,288	329,010	73,040	267,970	946,142

FOURTH DISTRICT.

Comprising the Thirteenth, Fourteenth, Fifteenth, Twentieth, part of the Twenty-eighth, and part of the Twenty-ninth Wards.

Street.	Location.	Size in inches.	Distance in feet.
	Supply Pipes.		
Bailey street,	from Montgomery to Ridge avenue	6	562
Bambrey street,	from 192 feet south of Girard avenue to Girard avenue	6	178
Buttonwood street,	south side, from Broad east	10	286
Carlisle street,	from north to south side Diamond	6	73
Cambridge street,	from Fifteenth west	6	201
Columbia avenue,	from east to west side P. R. R bridge	6	103
Deacon street,	from Girard avenue to Stiles	6	255
Eighteenth street,	from north to south side Diamond	6	75
Euclid street,	from Broad to Fifteenth	6	449
Fifteenth street,	from Montgomery to Berks	6	559
Fifteenth street,	from north to south side Diamond	6	64
Fifteenth street,	from Indiana to Allegheny	6	1,130
Fifteenth street,	from Norris north	6	127
Henrietta street,	from 28 feet east of Twenty-first to Twenty-first street	6	28
Judson street,	from Montgomery to Berks	6	556
Lambert street,	from south side Diamond to Susquehanna	6	573
Lorain street,	from Green to Wallace	6	371
Master street,	from Twenty-fifth west	6	477
Perth street,	from Oxford to Columbia avenue	6	527
Seventeenth street,	from north to south side Diamond	6	60
Seventeenth street,	from Cumberland north	6	798
Sixteenth street,	from north to south side Diamond	6	63
Sharswood street,	from Twenty-fifth west	6	223
Stewart street,	from Twenty-fifth west	6	227
Twentieth street,	from north to south side Diamond	6	78
Twenty-sixth street,	from south side Master north	6	44
Twenty-ninth street,	from south house line Norris to south house line Ridge avenue	6	142
Uber street,	from north to south side Diamond	6	73
Van Pelt street,	from north to south side Diamond	6	64
Woodstock street,	from north to south side Diamond	6	56
Wright street,	from Twenty-first to Twenty-second	6	459
Wright street,	from Twenty-fifth west	6	200
York street,	from west curb line Twenty-sixth to Twenty-seventh	6	444
Total			9,525

Street. Location.	Size in inches.	Distance in feet.
Pumping Mains at Spring Garden Station.		
For No. 7 Engine, from north side R. R. R. to stand-pipe to Thirty-third and Master streets	48	743
For No. 8 Engine, from north side R. R. R. to connect with Belmont main near stand-pipe	30	245
From No. 9 Engine to No. 7 Main	36	746
From No. 9 Main to near Thirty-third and Reading R. R.	36	347
From No. 9 Main connection to run to East Park reservoir	36	42
From No. 9 Main northwest to connect with Belmont main	30	185
From No. 10 Engine to No. 7 Main	36	777
From No. 10 Main to Thirty-third and west side R. R. R.	36	464
From No. 10 Main northwest to connect with Belmont main	30	85
From Belmont main to east side Con. R. R. bridge and south side R. R. R. to west side stand-pipe to Thirty-third and Master streets	30	898
Total		4,532
Supply mains.		
Nineteenth, from north side to south side Diamond street.	20	82
Taney and Mt. Pleasant streets	48	35
Taney and Thompson streets	30	68
Twenty-eighth street, from 118 feet north Mt. Pleasant street north	48	16
Poplar street, from Sixth to Broad streets	16	3,684
Ninth street, from Dauphin street north	30	2,082
Total		5,967
Dead ends connected.		
Herbine with Fifteenth street	6	18
Lemon with Eleventh street	4	23
Total		41
Fire connections (private).		
Twenty-fourth street, north side, 61 feet north of Vine street, for John Lang	4	19
Motor connections (private).		
Wallace street, south side, 118 feet west of Tenth street	4	19

Street. Location.	Size in inches.	Distance in feet.
Supply connections (private).		
Hamilton street, north side, 79 feet east Twenty-fifth st...	4	36
Hamilton street.....	6	6
Hamilton street, south side, 190 feet east Seventeenth st...	4	15
State Fair grounds.....	4	1,185
Thirty-first street, west side, 38 feet north of Jefferson.....	4	20
Total	.....	1,262
State Fair grounds { Wrought-iron pipe, laid by Meter Department. }	¾	50
	1	1,344
	2	2,689
Fire hydrant connections.....	6	294
Drains and connections at works.		
Fairmount, on walk east of forebay.....	6	21
" " " "	12	5
" at carpenter shop.....	6	8
" draw-off.....	12	12
" connection to fountain.....	4	25
Spring Garden, drain.....	20	36
" " draw-off from Nos. 9 and 10.....	10	20
" " drain, south side Spring Garden forebay..	6	350
" " blow-off new engine house.....	6	11
" " blow-off and drain.....	6	464
" " exhaust pipe.....	4	43
" " drain.....	16	43
" " "	4	142
" " blow-off No. 9 and 10.....	6	130
Total.....	.....	1,310
Drain on Pumping main.		
Thirty-third and Master streets.....	6	66
" " " "	8	3
Total.....	.....	69
Repairs, general.....	3	2
" "	4	17
" "	6	73
" "	10	20
" "	36	8
Total.....	.....	120

Street.	Location.	Size in inches.	Diameter in feet.
Repairs, submerged main		36	12
	Repairs, cut out to put in new stops.		
Green street, north side, 112 ft. east of 9th, for R R.R. Co.		4	
Eleventh and Lemon		10	10
Poplar street, west of Corinthian avenue		30	3
Thompson street, west of Twenty-sixth		30	5
Total			18
	Repairs, taken up.		
Fairmount forebay		16	550
Spring Garden Station (Belmont main)		30	550
" "	pumping main	48	62
Belmont reservoir, supply main		30	92
" Station, submerged main		30	73
" " " "		36	95
" "	pumping main, 1, 2, and 3 engines	30	123
" " " "	to Belmont reservoir	36	111
" "	drain	4	35
" " "		6	220
" "	blow off	10	36
" " "		12	24
"	main, at Fountain Green	30	72
Total			2,043
	Relaid.		
Spring Garden Station, pumping main		48	62
Belmont reservoir, supply main		30	92
Belmont Station, submerged main		30	73
" " " "		36	95
" "	pumping main, 1, 2, and 3 engines	30	123
" " " "	to Belmont reservoir	36	111
" "	drain	4	35
" " "		6	220
" "	blow-off	10	36
" " "		12	24
"	main, at Fountain Green	30	72
Total			943

Recapitulation of Fourth District.

	Purposes for which used.	Sizes—Inches. 3	4	6	8	10	12	16	20	30	36	48	Total feet.
New pipe, or feet added.	Supply pipes			9,239		286							9,525
	Fire connections (private)		19										19
	Motor " "		19										19
	Supply " "		1,256	6									1,262
	Dead ends connected		23	18									41
	Fire hydrant connections			294									294
	Pumping mains									1,413	2,376	743	4,532
	Supply "							3,684	82	2,150		51	5,967
	Drains and connections at Stations		210	984		20	17	43	36				1,310
	Drains on pumping main			66	3								69
	Total feet		1,527	10,607	3	306	17	3,727	118	3,563	2,376	794	23,038
	Total pounds		29,013	328,817	126	16,830	1,224	409,970	18,762	1,182,916	1,002,672	464,490	3,454,820
Pipe used, but adding nothing to feet in the ground.	Repairs, general	2	17	73		20					8		120
	" submerged main										12		12
	" new stops put in					10				8			18
	Taken up		35	220		36	24	550		910	206	62	2,043
	Relaid		35	220		36	24			360	203	62	943
	Total feet	2	87	513		102	48	550		1,278	432	124	3,136
	Total pounds	30	1,653	15,903		5,610	3,456	60,500		424,296	182,304	72,540	766,292
	Total handled feet	2	1,614	11,120	3	408	65	4,277	118	4,841	2,808	918	26,174
	Total handled pounds	30	30,666	344,720	126	22,440	4,680	470,470	18,762	1,607,212	1,184,976	537,030	4,221,112

GERMANTOWN DISTRICT,

Comprising the Twenty-second and parts of the Twenty-fifth and Twenty-eighth Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply pipes.		
Ashmead street, from Germantown avenue to Wakefield..	6	904
Baynton street, from 305 feet south Wister south.....	6	326
Bowman street, from Hancock to Evans.....	6	798
Chelten avenue, from east to west side Green.....	10	60
Chestnut Hill avenue, from southwest from Thirtieth.....	6	235
Duval street, from Adams street southwest.....	6	304
Garfield street, from Germantown avenue to Wakefield...	6	911
Haines street, from dead end, 178 feet east of Wilson, northeast.....	6	390
Highland avenue, from 4-inch dead end, east of Twenty-ninth to west side Thirtieth.....	6	544
Laurel street, from Germantown avenue northeast.....	6	452
Meehan street, from three feet east Musgrove to Chew.....	6	677
Nicetown lane, from Cottage street southwest.....	6	404
Norton street, from Green southwest.....	6	9
Ontario street, from Twentieth to Twenty-first.....	6	529
Queen street, from south to north side Philadelphia and Germantown Railroad (Pennsylvania Railroad)....	6	62
Queen street, from 54 feet 8 inches northeast Wissahickon avenue to Wissahickon avenue.....	6	55
Rex avenue, from 276 feet northeast of Thirtieth street to Thirtieth.....	6	276
Seventeenth street, from Venango south.....	6	37
Sharpnack street, from Musgrove to Chew.....	8	708
Thirtieth street from Willow Grove northwest.....	6	1,209
Thirtieth street, from Union avenue to Chestnut Hill avenue.....	6	1,918
Venango street, from Seventeenth to Eighteenth.....	6	446
Willow Grove avenue, from centre of Thirtieth southwest.	6	245
Willow Grove avenue, from 249 feet southwest Thirtieth, southwest.....	8	123
Willow Grove avenue, from 357 feet 9 inches southwest Thirtieth to Thirty-fifth.....	6	2,509
Wissahickon avenue, from Manheim street northwest.....	12	411
York road, or Twelfth street, from Tioga to Angle..... ...	6	181
Total.....	.....	14,723

Street. Location.	Size in inches.	Distance in feet.
Supply mains.		
Manheim street, from Germantown avenue to Green	12	754
Green street, from Manheim to Tulpehocken	12	5,933
Green street, from Tulpehocken northwest (above Upsal).	16	2,429
Green street, from 335 feet south Carpenter to Carpenter..	16	335
Carpenter street, from Green to McCallum	16	675
McCallum street, from Carpenter to Allen's lane	16	2.564
Allen's lane, from McCallum to Mount Airy reservoir	16	3,198
Total		15,888
Cross connections.		
Wissahickon avenue and Manheim street	6	13
Green street and west Maplewood	6	19
Green street and east Maplewood	6	9
Allen's lane and Emlen	6	26
Green street and Rittenhouse	6	4
Green street and Walnut lane	6	5
Total		76
Fire connections (private).		
Nicetown lane; Geo. W. Blabon & Co	6	
Chelten avenue, 330 feet 6 inches west of Germantown avenue; Workingmen's Club	2	
Fire hydrant connections	4	50
" " "	6	709
Total		759
Connections at Stations.		
Mount Airy reservoir	20	5
Drains.		
Willow Grove	4	1½
Green street and Rittenhouse	6	7
Germantown avenue and Cresheim Creek	4	36½
Germantown avenue and Cresheim Creek	6	12
Allen's lane and Emlen	6	26
School House lane and west Pulaski avenue	4	6
Total		89

Street.	Location.	Size in inches.	Distance in feet.
Repairs, general		3	42
" "		4	22
" "		6	36
" "		8	43
" "		10	9
Total			152
	Repairs, new stops put in.		
Germantown avenue, northwest corner Manheim		10	3
Tulpehocken street and Green		10	
Chestnut Hill pumping station		6	2
Allen's lane, on fire hydrant connection in front of engine house		4	
Total			5
	Taken up.		
Spring House pike, from 504 feet northwest New, northwest		3	547
" " " " 40 ft. 8 in. southeast of northwest side Chestnut Hill avenue to house line northwest side New		4	323
Johnson street		3	78
Penn street		3	66
Queen street		3	55
School lane		3	131
Thorp's lane		3	988
York road		3	96
Total			2,788
	Relaid.		
Johnson street, northwest of Green		3	24
" " from east to west side Green		6	54
Penn street, from east to west side Green		6	66
Queen street, east from Wissahickon avenue		6	55
Spring House pike, from 504 feet northwest New northwest		6	548
Spring House pike, from north house line of New northwest		6	504
Spring House pike, 40 ft. 8 in. southeast of northwest side Chestnut Hill avenue to house line northwest side New		6	323
Spring House pike to house line northwest side New		4	10
School lane, from Germantown Railroad (Penna. R. R.)		6	86
Thorp's lane, from York road west		6	988
Cedar lane, from Mill to Locust		6	486
York road, from Thorp's lane south		6	96
Total			3,240

Street. Location.	Size in inches.	Distance in feet.
Lowered.		
Thirtieth street, south, Abington	6	291
Germantown avenue and Cresheim, at Bridge	10	42
Boynton avenue, from Wister south	6	70
Total		403
Pipe Raised.		
Queen street and Wissahickon avenue	6	125
Seventeenth and Ontario	6	46
Total		171
Cut off and left in the ground.		
Cedar lane	3	486
Shifted.		
Queen street, from 170 ft. 6 in. northeast Wissahickon avenue southwest	6	116
Private pipe laid by Pennsylvania Railroad Company.		
Oakland place, from Duval southeast	6	188
Fire hydrant connection	4	14
Evergreen avenue, from Germantown avenue to Twenty-eighth	6	1,305
Twenty-eighth street, from Evergreen avenue northwest	6	124
Willow Grove avenue, southeast side 177 ft. 6 in. southwest Thirtieth	4	12
Total		1,643

Recapitulation of Germantown District.

	Purposes for which used.	Sizes—Inches. 3	4	6	8	10	12	16	20	Total feet.
New pipe, or feet added.	Supply pipe			13,421	831	60	411			14,723
	Supply mains						6,687	9,201		15,888
	Fire hydrant connections		50	709						759
	Cross connections			76						76
	Drains and connections at Stations		44	45					5	94
	Total... Feet		94	14,251	831	60	7,098	9,201	5	31,540
	Total... Pounds		1,786	441,781	34,902	3,300	511,056	1,012,110	795	2,005,730
Pipe used, but adding nothing to feet in the ground.	Repairs, general	42	22	36	43	9				152
	Repairs, new stops put in			2		3				5
	Taken up	2,465	323							2,788
	Relaid	24	10	3,206						3,240
	Lowered			361		42				403
	Raised			171						171
	Cut off and left in the ground	486								486
	Shifted			116						116
	Total... Feet	3,017	375	3,892	43	54				7,861
	Total... Pounds	45,255	6,745	120,652	1,806	2,970				177,428
	Total handled Feet	3,017	449	18,143	874	114	7,098	9,201	5	88,901
	Total handled Pounds	45,255	8,531	562,438	36,708	6,270	511,056	1,012,110	795	2,188,158

MANAYUNK DISTRICT.

Comprising the Twenty-first and part of the Twenty-eighth Wards.

Street. Location.	Size in inches.	Distance in feet.
Supply pipes.		
Adams street, from Terrace to 3 feet east of west house line, Manayunk avenue	6	319
Bolton street, from east side of Ridge avenue southwest	6	456
Chestnut street, from southeast of Walnut to Walnut	6	10
Clearfield street, from west house line Nicetown lane to Thirty-fourth	6	1,123
East street, from Terrace northeast	6	110
Fountain street, from Smick southwest	6	137
High street, from Walnut northwest	6	13
Jefferson street, from 16-inch main on Ridge ave. southwest	12	430
Mansion street, from west house line Ripka to Jefferson	6	438
Mitchell street, from east side Levering to Martin	6	307
Ogle street, from 169 feet northwest of Fountain northwest	6	73
Parker street, from Ridge avenue southwest	12	323
Pechin street, from 169 feet southeast house line Shur's lane to Kingsley	6	39
Ripka avenue, from Mansion southwest	6	25
Ridge avenue, from 544 feet south side house line Clearfield northwest	12	4,928
Smick street, from Fountain southeast	6	25
Terrace street, from 96 feet 8 inches northwest Markle northwest	6	60
Walnut street, from High to Chestnut	6	183
Total		8,999
Pumping main.		
No. 3 engine	30	25
Cross connections.		
Ridge road, opposite north curb line James	6	10
" " north house line Spence	6	10
" " 26 feet southeast Indian Queen lane	6	10
Total		30

Street. Location.	Size in inches.	Distance in feet.
Fire connections (private).		
Ridge avenue and Norristown Railroad	4	38
Robeson street, 128 feet west of Main street	4	26
Total		64
Fire hydrant connections	4	67
" " "	6	91
Total		158
Drains.		
Ridge avenue, 359 feet south east James	4	7
Abbotsford avenue, 221 feet northeast Penna. R.R. bridge	4	15
Roxborough Station, exhaust pipe	12	58
Total		80
Repairs, general	4	6
" "	6	16
" "	10	10
Total		32
Repairs, new stops put in.		
River road, 378 feet northwest Fountain	6	4
Relaid.		
Abbotsford avenue, east of Pennsylvania and Chestnut Hill Railroad	3	152
Abbotsford avenue	4	16
" "	6	33
" " across Pennsylvania and Chestnut Hill Railroad	6	125
Abbotsford avenue	4	20
Total		346
Repairs, stops taken out.		
River road, north house line Fountain	6	6

Street. Location.	Size in inches.	Distance in feet.
Lowered.		
Mitchell street, north Riley	6	84
Ridge avenue, south Cinnaminson and opposite Prospect	20	79
" " opposite Sumac	6	72
Sumac street, east of Ridge avenue	6	278
Grape, between Wood and Tower	6	240
Washington street, southwest of Main st. across the canal	6	100
Total	.....	853
Cut off and left in the ground.		
Abbotsford avenue, from Pennsylvania Railroad bridge	3	201
Shifted.		
River road	6	36

Recapitulation of Manayunk District.

	Purposes for which used.	Sizes—Inches. 3	4	6	10	12	20	30	Total feet.
New pipe, or feet added.	Supply pipes			3,318		5,681			8,999
	Pumping mains							25	25
	Cross connections			30					30
	Fire " (private)		64						64
	Fire hydrant connections		67	91					158
	Drains and connections at Stations		22			58			80
	Total.... feet		153	3,439		5,739		25	9,356
	Total.... pounds		2,907	106,609		413,208		8,300	531,024
Pipe used, but adding nothing to feet in the ground.	Repairs, general		6	16	10				32
	" new stops put in			4					4
	" stops removed			6					6
	Lowered			774			79		853
	Relaid	152	36	158					346
	Cut off and left in the ground	201							201
	Shifted			36					36
	Total.... feet	353	42	994	10		79		1,478
	Total.... pounds	5,295	798	30,814	550		12,561		50,018
	Total handled... feet	353	195	4,433	10	5,739	79	25	10,834
	Total handled... pounds	5,295	3,705	137,423	550	413,208	12,561	8,300	581,042

RECAPITULATION, BY DISTRICTS.

	Districts.	3 in.	4 in.	6 in.	8 in.	10 in.	12 in.	16 in.	20 in.	30 in.	36 in.	48 in.	Total. Feet.	Total. Pounds.
New pipe or feet added.	First	.....	63	5,684	.....	.....	.....	.....	.....	.....	.....	.....	5,747	177,401
	Second	.....	182	2,503	.....	.....	.....	.....	.....	.....	.....	.....	2,685	81,051
	Third	.....	289	7,291	.....	.....	129	2,991	.....	220	576	.....	11,496	885,922
	Fourth	.....	1,527	10,607	3	306	17	3,727	118	3,563	2,376	794	23,038	3,454,820
	Germantown	.....	94	14,251	831	60	7,098	9,201	5	.....	.....	.....	31,540	2,005,730
	Manayunk	.....	153	3,439	.....	.....	5,739	.....	.....	25	.....	.....	9,356	531,024
	Total... feet	.....	2,308	43,775	834	366	12,983	15,919	123	3,808	2,952	794	83,862	
	Total... pounds	.....	43,852	1,357,025	35,028	20,130	934,776	1,751,090	19,557	1,264,256	1,245,744	464,490	.....	7,135,948
Pipe used, but adding nothing to feet in the ground.	First	2	19	143	.....	4	.....	.....	.....	.....	.....	.....	168	5,044
	Second	1,029	66	2,008	4	136	.....	.....	1,476	.....	.....	.....	4,719	321,269
	Third	.....	110	1,017	.....	31	.....	.....	.....	.....	59	.....	1,217	60,220
	Fourth	2	87	513	.....	102	48	550	.....	1,278	432	124	3,136	766,292
	Germantown	3,017	355	3,892	43	54	.....	.....	.....	.....	.....	.....	7,361	177,428
	Manayunk	353	42	994	.....	10	.....	.....	79	.....	.....	.....	1,478	50,018
	Total... feet	4,403	679	8,567	47	337	48	550	1,555	1,278	491	124	18,079	
	Total... pounds	66,045	12,901	265,577	1,974	18,535	3,456	60,500	247,245	424,296	207,202	72,540	.....	1,380,271
Total handled	feet	4,403	2,987	52,342	881	703	13,031	16,469	1,678	4,086	3,443	918	101,940	
	pounds	66,045	56,753	1,622,602	37,002	38,665	938,232	1,811,590	266,802	1,688,552	1,452,946	537,030	.....	8,516,219

Total, 83,862 feet, or 15 miles and 4,662 feet added to the distribution.

RECAPITULATION OF WORK ON THE WATER PIPES.

Classified in sizes and arranged according to the use made of them.

	Purposes for which used.	3 in.	4 in.	6 in.	8 in.	10 in.	12 in.	16 in.	20 in.	30 in.	36 in.	48 in.	Total feet.
New pipe, or feet added.	Pumping main and connections									1,438	2,376	743	4,557
	Supply " "						6,687	15,876	82	2,326	576	51	25,598
	" pipes			40,590	831	346	6,092						47,859
	Dead ends connected		23	18									41
	Fire connections (private)		220	97									317
	Motor connections "		43										43
	Supply " "		1,330	134									1,464
	Fire hydrant connections		219	1,662									1,881
	Drains and connections at Stations		473	1,035		20	204	43	41	44			1,860
	Drain on pumping mains			66	3								69
	Cross connections			173									173
	Total.... feet		2,308	43,775	834	366	12,983	15,919	123	3,808	2,952	794	83,862
	Total.... pounds		43,852	1,357,025	35,028	20,130	934,776	1,751,090	19,557	1,264,256	1,245,744	464,490	7,135,948
Pipe used, but adding nothing to feet in the ground.	Repairs, general	46	180	918	47	49					8		1,248
	" submerged main										12		12
	" new stops put in		8	121		58				8			190
	" stops removed			6									6
	Taken up	3,494	395	220		36	24	550		910	265	62	5,956
	Relaid	176	81	4,879		36	24			360	206	62	5,824
	Lowered			1,513		163			79				1,755
	Raised		15	617									632
	Cut off and left in ground	687											687
	Shifted			293					1,476				1,769
	Total.... feet	4,403	679	8,567	47	337	48	550	1,555	1,278	491	124	18,079
	Total.... pounds	66,045	12,901	265,577	1,974	18,535	3,456	60,500	247,245	424,296	207,202	72,540	1,380,271
	Total handled... feet	4,403	2,987	52,342	881	703	13,031	16,479	1,678	5,086	3,443	918	101,941
	Total handled... pounds	66,045	56,753	1,622,602	37,002	38,665	938,232	1,811,590	266,802	1,688,552	1,452,946	537,030	8,516,219

FIRE HYDRANTS, BY WARDS,

And the diameter of the pipes to which they are connected.

Wards.	Sizes of Pipes in Inches.											Total.
	3	4	6	8	10	12	16	18	20	30	36	
First	5	105	186	3	.....	.....	1	.....	.....	.....	.....	300
Second	33	42	93	5	3	1	2	.....	1	.....	.....	180
Third	11	7	68	5	15	.....	.....	.....	.....	.....	.....	106
Fourth	21	13	54	2	11	.....	.....	.....	.....	.....	.....	101
Fifth	6	10	50	36	23	2	.....	.....	.....	.....	.....	127
Sixth	8	11	68	9	10	.....	.....	.....	.....	2	.....	108
Seventh	11	5	101	.....	8	16	14	.....	.....	.....	.....	155
Eighth	12	2	95	.....	12	18	8	.....	2	.....	.....	149
Ninth	5	5	89	.....	19	11	5	.....	1	3	.....	138
Tenth	11	10	77	3	13	11	.....	.....	1	1	.....	127
Eleventh	.....	14	44	1	16	.....	.....	.....	.....	.....	.....	75
Twelfth	.....	13	39	.....	24	1	2	.....	.....	.....	.....	79
Thirteenth	.....	18	71	.....	16	3	.....	.....	.....	.....	.....	108
Fourteenth	.....	14	63	.....	19	5	1	.....	.....	2	.....	104
Fifteenth	1	57	173	.....	27	5	2	.....	3	2	.....	270
Sixteenth	.....	21	41	.....	22	.....	.....	.....	.....	.....	.....	84
Seventeenth	1	25	54	.....	8	2	.....	.....	.....	.....	.....	90
Eighteenth	.....	37	76	.....	23	.....	.....	.....	.....	.....	.....	136
Nineteenth	.....	64	186	.....	9	.....	.....	4	.....	.....	1	264
Twentieth	.....	60	144	.....	5	7	.....	.....	.....	2	.....	218
Twenty-first	.....	20	185	.....	10	3	3	.....	5	.....	.....	226
Twenty-second	32	66	254	14	32	13	15	.....	2	.....	.....	428
Twenty-third	.....	3	108	.....	.....	.....	.....	.....	5	.....	.....	116
Twenty-fourth	14	22	301	20	26	49	.....	.....	3	.....	.....	435
Twenty-fifth	.....	20	281	3	19	9	.....	.....	.....	.....	2	334
Twenty-sixth	3	56	197	.....	1	5	.....	.....	2	.....	.....	264
Twenty-seventh	.....	16	107	84	21	32	.....	.....	.....	.....	.....	260
Twenty-eighth	.....	4	284	.....	2	19	.....	.....	2	1	.....	312
Twenty-ninth	.....	24	164	1	19	2	9	.....	.....	4	1	224
Thirtieth	3	34	130	.....	2	4	1	.....	.....	.....	.....	174
Thirty-first	.....	42	149	.....	4	.....	.....	.....	.....	.....	.....	195
Totals	177	840	3,932	186	419	218	63	4	27	17	4	5,887

FIRE HYDRANTS, BY PURVEYORS' DISTRICTS,

And the diameter of the pipes to which they are connected.

Purveyors' Districts.	Sizes of Pipes in Inches.											Total.
	3	4	6	8	10	12	16	18	20	30	36	
First	76	257	728	15	32	10	4	.....	3	.....	.....	1,125
Second	67	81	888	152	132	139	27	.....	7	6	.....	1,499
Third	1	239	948	4	123	15	2	4	5	.....	3	1,344
Fourth	1	177	810	1	88	33	12	.....	5	11	1	1,139
Germantown	32	66	341	14	34	15	15	.....	2	.....	.....	519
Manayunk	.....	20	217	.....	10	6	3	.....	5	.....	.....	261
Totals	177	840	3,932	186	419	218	63	4	27	17	4	5,887

STATEMENT OF THE NUMBER OF FIRE-PLUGS, BY DISTRICTS AND WARDS,

During 1884, and total previous thereto.

	First District.					Second District.					Third District.						Fourth District.						Germantown.				Manayunk.			Total.
	Wards.				Total.	Wards.				Total.	Wards.					Total.	Wards.					Total.	Wards.			Total.	Wards.		Total.	
	1	2	3	26		6	8	24	27		12	18	19	25	31		14	15	20	28	29		22	25	28		21	28		
Prior to 1884	.....	.....	.....	.....	1,106	.....	.....	.....	.....	1,492	.....	.....	.....	.....	.....	1,326	.....	.....	.....	.....	.....	1,117	.....	.....	.....	463	.....	.....	248	5,752
During 1884	6	1	1	12	20	3	2	7	3	15	2	1	6	9	1	19	2	1	3	16	3	25	47	1	8	56	7	6	13	148
Totals	.....	.....	.....	.....	1,126	.....	.....	.....	.....	1,507	.....	.....	.....	.....	.....	1,345	.....	.....	.....	.....	.....	1,142	.....	.....	.....	519	.....	.....	261	5,900
Taken out in 1884	.....	.....	.....	.....	1	.....	.....	.....	.....	8	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	13
Total in city	.....	.....	.....	.....	1,125	.....	.....	.....	.....	1,499	.....	.....	.....	.....	.....	1,344	.....	.....	.....	.....	.....	1,139	.....	.....	.....	519	.....	.....	261	5,887

Number of attachments for fire purposes previously reported	264
Made during 1884, First District	0
Second "	6
Third "	3
Fourth "	1
Manayunk District	2
Germantown "	2
Total	278

ATTACHMENTS, ETC., MADE BY THE PURVEYORS,

In accordance with permits issued by the Registrar, arranged by months.

Months.	Service Attachments.						Shut-Offs by Permit.					Miscellaneous.				
	Size.															
	½ inch.	⅝ inch.	¾ inch.	1 inch.	2 inches.	Total.	To re-drive ferrules.	To draw ferrules.	To transfer ferrules.	For repairs.	Total.	Ferrules drawn for leak.	Ferrules drawn and plugged.	Duplicate ferrules drawn.	Ferrules re-driven.	Total.
January	45	3	.....	1	.....	49	7	5	.....	4	16	9	7	.....	8	24
February	47	2	.....	5	2	56	14	1	.....	14	29	15	3	.....	20	38
March	280	4	9	10	.....	303	10	1	1	47	59	5	10	.....	7	22
April	415	8	8	10	.....	441	10	7	5	57	79	8	13	.....	17	38
May	388	13	7	9	.....	417	11	5	7	45	68	12	12	2	28	54
June	440	14	7	13	1	475	9	4	2	63	78	12	5	.....	14	31
July	483	16	6	13	1	519	12	1	3	55	71	9	10	.....	7	26
August	689	20	3	14	1	727	14	.....	4	58	76	8	9	.....	11	28
September	715	21	10	17	.....	763	3	1	1	62	67	6	27	.....	11	44
October	804	52	18	16	.....	890	16	15	.....	75	106	7	20	.....	10	37
November	723	29	14	17	2	785	14	9	7	63	93	13	66	11	22	112
December	500	3	2	15	.....	520	26	14	2	34	62	18	18	4	24	64
Totals	5,529	185	84	140	7	5,945	146	63	32	577	818	122	200	17	179	518

ATTACHMENTS, ETC, MADE BY THE PURVEYORS,

In accordance with permits issued by the Registrar, arranged by Purveyors' Districts.

Districts.	Service Attachments.						Shut-offs by Permits.					Miscellaneous.				
	Size.					Total.	To re-drive ferrules.	To draw ferrules.	To transfer ferrules.	For repairs.	Total.	Ferrules drawn for leak.	Ferrules drawn and plugged.	Duplicate ferrules drawn.	Ferrules re-driven.	Total.
	½ inch.	⅝ inch	¾ inch.	1 inch.	2 inch.											
First	1,206	7	2	4	.....	1,219	8	4	1	121	134	24	35	.....	34	93
Second	738	63	51	60	3	915	.....	.....	5	104	109	3	102	.....	28	133
Third	1,507	15	3	33	.....	1,558	60	29	14	162	265	44	46	6	62	158
Fourth	1,483	92	22	30	3	1,630	63	13	6	167	249	48	3	11	31	93
Germantown	394	8	5	11	1	419	4	9	3	16	32	.....	6	.....	17	23
Manayunk	201	.....	1	2	.....	204	11	8	3	7	29	3	8	.....	7	18
Totals	5,529	185	84	140	7	5,945	146	63	32	577	818	122	200	17	179	518

Repairs to Mains, Stops, and Fire Hydrants, and Stops Taken Out During 1884.

Districts.	Repairs to Mains.	Stops.		Fire Hydrants.	
		Repaired.	Taken out.	Repaired.	Taken out.
First	59	624	.....	981	1
Second	62	904	8	743	8
Third	163	478	1	581	1
Fourth	101	332	.....	876	3
Germantown	50	58	.....	51	.....
Manayunk	42	404	.....	408	.....
Totals	477	2,800	9	3,640	13

Account of New Stops and Fire Hydrants for 1884.

Districts.	Stops.			Fire Hydrants.
	Two-way.	Barton Four-way.	Total.	
First	29	.....	29	20
Second	34	1	35	16
Third	54	2	56	19
Fourth	67	.....	67	25
Germantown	112	.....	112	54
Manayunk	25	.....	25	13
Totals	321	3	324	147

NUMBER OF VALVES RAISED IN THE DIFFERENT DISTRICTS DURING THE YEAR 1884.

Also in each year since 1875.

Districts.	3-inch Barton.	3-inch.	4-inch.	6-inch.	8-inch.	10-inch.	12-inch.	16-inch.	20-inch.	30-inch.	36-inch.	Totals.
First	.....	.....	2	5	.....	.....	.....	.....	.....	.....	.....	7
Second	.....	7	3	9	1	1	1	1	3	3	.....	29
Third	.....	.....	4	10	.....	.....	.....	.....	.....	.....	.....	14
Fourth	.....	.....	4	47	.....	3	1	.....	.....	3	1	59
Totals for 1884	.....	7	13	71	1	4	2	1	3	6	1	109
" " 1883	.....	4	27	88	.....	8	.....	1	.....	1	1	130
" " 1882	1	14	25	58	1	5	1	.....	.....	1	.....	106
" " 1881	.....	15	44	90	.....	5	7	.....	.....	.....	.....	161
" " 1880	.....	7	23	47	.....	8	1	.....	.....	1	.....	87
" " 1879	.....	9	16	60	1	3	2	.....	.....	1	1	93
" " 1878	.....	27	22	100	.....	3	1	.....	1	1	.....	155
" " 1877	.....	12	6	50	.....	1	.....	.....	1	.....	.....	70
" " 1876	.....	3	17	49	.....	3	.....	.....	1	.....	.....	73
" " 1875	.....	17	55	120	4	12	2	4	1	2	.....	217
" " 1874	.....	13	32	111	6	6	3	3	.....	.....	.....	174
Totals for 11 years	1	128	280	844	13	58	19	9	7	13	3	1,375

TABULAR STATEMENT OF WORK CONNECTED WITH THE DISTRIBUTION,

For the five years 1880 to 1884, inclusive.

Years.	Pipe.										Additional stops.	Additional fire hydrants.	Fire hydrants in use.	Meters in use.	Service Attachments.					
	Extensions.		Repairs and relays.		Total pipe handled.		Total amount in use.		Total amount handled.											
	Feet.	Pounds.	Feet.	Pounds.	Feet.	Pounds.	Feet.	Pounds.	Feet.	Pounds.					½ in.	⅝ in.	¾ in.	1 in.	2 in.	Total.
1880.....	23,085	844,946	9,557	262,826	32,642	1,107,772	3,927,623	192,816,906	4,164,768	200,136,708	138	70	5,358	34	2,687	118	49	89	.....	2,943
1881.....	56,616	2,832,623	3,832	199,649	60,448	3,032,272	3,984,239	195,649,529	4,225,216	203,168,980	249	144	5,502	42	3,166	137	59	121	.....	3,483
1882.....	56,860	5,396,165	7,740	484,092	64,600	5,880,257	4,041,099	201,045,694	4,289,816	209,049,237	312	120	5,622	45	3,169	110	76	129	.....	3,484
1883.....	63,215	3,048,645	12,605	675,420	75,880	3,724,065	4,104,314	204,094,339	4,365,696	212,773,301	281	130	5,752	63	4,576	97	71	133	.....	4,877
1884.....	83,862	7,135,948	18,079	1,380,271	101,941	8,516,219	4,188,176	211,230,287	4,467,637	221,289,520	324	147	5,809	560	5,529	185	84	140	7	5,945

REPORT

ON THE

OPERATIONS OF THE SHOP

DURING 1884.

PHILADELPHIA WATER DEPARTMENT,
January 10, 1885.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—I submit the following statement of the operations of the Cherry street shop, for the year ending December 31, 1884.

Respectfully,
JAMES F. NEALL,
Superintendent of the Shop.

GENERAL STATEMENT OF MATERIAL AND LABOR.

DEBIT.

To stock on hand January 1, 1884		$12,154 55
520,223	lbs. cast iron castings	9,699 30
15,182¼	" brass castings	2,310 75
1,004	" malleable castings	70 28
5,143	" steel, assorted	456 87
75,433	" wrought iron	2,309 97
179	tons coal	1,029 25
180	bushels coke	14 00
7,012	feet lumber, assorted	419 67

Bolts, nuts, washers, and rivets	1,044 73
Rubber, rings, valves, and assorted gum	1,372 97
Wrought iron pipe and fittings	131 39
Hardware	934 11
Hauling	120 00
To railroad tickets	203 75
To chandlery	56 99
To sponge cloth	72 00
To wages paid hands	31,343 57
To paints and oils	285 31
To machinery	499 45
To leather	10 33
To brass fittings	242 52
To gauges and repairs to same	93 65
To galvanizing	160 32
To miscellaneous	31 00
To gasket	353 72
To gas	59 62
To ice	40 05
To lead (for Second District)	39 48
	$65,559 60

CREDIT.

By repairs and supplies to First District	$4,149 38	
" " " Second "	5,171 83	
" " " Third "	3,898 05	
" " " Fourth "	10,569 27	
" " " Fifth "	1,337 37	
" " " Sixth "	6,113 70	
		$31,239 60

TO FAIRMOUNT STATION.

Repairs to machinery	$2,192 47	
Buildings and grounds	560 72	
Pumping water	172 12	
		2,925 31

TO SPRING GARDEN STATION.

Repairs to machinery	$2,482 35	
" " boilers	3,422 04	
Buildings and grounds	791 30	
Extension	3,251 45	
Pumping water	108 75	
		10,055 89
Store-house	854 74	854 74

To Belmont Station.

Repairs to machinery	$936 69	
" " boilers	1,021 72	
Buildings and grounds	366 78	
Electric engine	8 54	
Pumping water	453 00	
		$2,786 73
Repairs to submerged main	1,479 39	1,479 39
To general buildings and grounds	139 77	139 77
Improvements, Cherry street shop	327 63	
Repairs to tools, gas, hauling, etc	1,207 40	
		1,535 03

To Roxborough Station.

Repairs to machinery	498 16	
" " boilers	1,117 41	
Buildings and grounds	99 69	
		1,715 26

To Frankford Station.

Repairs to machinery	428 49	
" " boilers	1,032 62	
Buildings and grounds	397 32	
		1,858 43

To Kensington Station.

Repairs to machinery	236 51	
" " boilers	89 43	
Buildings and grounds	4 25	
Pumping water	147 75	
		477 94

To Chestnut Hill Station.

Repairs to machinery	$47 90	
" " boilers	30 63	
Buildings and grounds	22 25	
Pumping water	130 00	
		230 78

To Mount Airy Station.

Repairs to machinery	$458 62	
" " boilers	89 60	
Buildings and grounds	35 73	
Pumping water	64 00	
		647 95

To Water Meters.		
Supplies	797 55	
Wages	752 89	
		1,550 44
To Surveys.		
Supplies	100 93	100 93
To Main Offices, 13th and Spring Garden streets	176 02	176 02
To Machinery (tools for 3-way plug)	139 01	139 01
To Distribution.		
Repairs and supplies	355 03	355 03
To Fixed Patterns.		
Repairs to patterns and patterns for 3-way plug	408 30	408 30
To sale of old metals	818 32	818 32
To sale of 5,173 ferrules, at 50 cts	2,587 40	2,587 40
Stock on hand January 1, 1885	10,964 93	10,964 93
Total amount of credit		73,047 20
Less total amount of debit		65,559 60
Balance to credit		7,487 60

INVENTORY OF STOCK ON HAND, JANUARY 1, 1885.

17	4-inch	square-top	screws,	O. S.,	at	$2 25	$38 25
11	6-inch	"	"	"	"	2 50	27 50
4	8-inch	"	"	"	"	3 25	13 00
9	10-inch	"	"	"	"	4 50	40 50
5	12-inch	"	"	"	"	5 00	25 00
16	16-inch	"	"	"	"	6 50	104 00
12	20-inch	"	"	"	"	8 25	99 00
1	30-inch	"	"	"	"	10 25	10 25
3	36-inch	"	"	"	"	22 00	66 00
							$423 50

26	4-inch	square-top	screws,	N. S.,	at	$2 25	$58 50
48	6-inch	"	"	"	"	2 50	120 00
6	8-inch	"	"	"	"	3 25	19 50
8	10-inch	"	"	"	"	4 50	36 00
5	12-inch	"	"	"	"	5 00	25 00
4	16-inch	"	"	"	"	6 50	26 00

2	20-inch " " " " 8 25.....	16 50		
2	30-inch " " " " 10 25.....	20 50		
3	36-inch " " " " 22 00.....	66 00		
				388 00
63	4-inch socket screws, at $1 50.....	$94 50		
63	6-inch " " " 1 75.....	110 25		
45	8-inch " " " 2 00.....	90 00		
27	10-inch " " " 2 25.....	60 75		
27	12-inch " " " 2 50.....	67 50		
				423 00
12	3-inch spindles, at $1 50.....	$18 00		
25	4-inch " " 1 50.....	37 50		
23	6-inch " " 1 75.....	40 50		
8	8-inch " " 2 00.....	16 00		
18	10-inch " " 2 25.....	40 50		
17	12-inch " " 2 50.....	42 50		
				195 00
4	4-inch bands, at $2 15.....	$8 60		
6	6-inch " " 2 15.....	12 90		
12	12-inch " " 7 50.....	90 00		
5	20-inch " " 10 50.....	52 50		
				$164 00
55	valve rods, complete, at 80 cts. each.....	$44 00		
168	caulking and gasket irons, at 50 cts. each.....	84 00		
6	drills, assorted, at 60 cts. each.....	3 60		
1	doz. handled chisels, at 60 cts. each.....	7 20		
8½	" chisels, assorted, at 35 cts. each.....	35 70		
1	15-pound sledge, at $2.25.....	2 25		
4	caulking hammers, at $1.14 each.....	4 56		
446	wood plugs, at 50 cts. each.....	223 00		
				404 31
9	doz. pick handles, at $1.30 per doz.....	$11 70		
4	" axe handles, at $1.88 per doz.....	7 52		
12	" hammer handles, at 38 cts. per doz.....	4 56		
500	lbs. gasket, at 7 cts. per lb.....	35 00		
12	stub end straps, at $8.00 each.....	96 00		
				154 78
68	pairs cross heads, with nuts, at $2.50.....	$170 00		
12	" " " without nuts, at 75 cts.....	9 00		
66	" plug monkeys, complete, at $3.28.....	216 48		

22	plug monkey screws, at $1.00	22 00	
285	brass plugs, assorted, at 50 cts	142 50	
109	plug nuts, finished, at $1.00	109 00	
17	6-inch stops, at $25.00	425 00	
2	20-inch " at $95.00	190 00	
11	fire hydrants, O. S., at $28.00	308 00	
1	" " case, O. S., at $7 50	7 50	
50	6-inch 3-way fire hydrants, at $40.00	2,000 00	
50	goose necks for 3-way fire hydrants, at $4.50	225 00	
1	12-inch stop, at $45.00	45 00	
			3,869 48
	2 sets gearing for derrick	$75 00	
	4 street keys, at $5.25	21 00	
	5 hydrant " at $2.25	11 25	
30,499	lbs. iron castings, at .0187 cts	570 33	
17,921	" wrought iron, at 2¼ cts	403 22	
1,254	" cast steel, at 10½ cts.	131 67	
721	" machine steel, at 4½ cts	32 44	
35	" malleable castings, at 7 cts	2 45	
1,264	" iron forgings, at 10 cts	126 40	
4,078	" unfinished brass, at 14 cts	570 92	
3,863	" finished " at 30 cts	1,158 90	
150	" rolled " at 20 cts	30 00	
27	" brass spring wire, at 30 cts	8 10	
			3,141 68
	Finished stop sides and valves	167 45	
	300 feet lumber (assorted), at 6 cts	18 00	
	186 lbs. Babbitt metal, at 35 cts	65 10	
1	6-inch globe valve	75 00	
	Hardware	244 26	
	Bolts and nuts	497 46	
	Chandlery	13 91	
	Paints (75 lbs white lead) at 6 cts	4 50	
	1 doz. brass pump springs, at 50 cts. each	6 00	
	150 pure gum joint rings, at 70 cts	105 00	
	266 pure gum valves, at $2.25	598 50	
	1 gross sponge cloth	6 00	
			1,801 18
			$10,964 93

Stop-cocks, Boxes, Frames and Covers, Fire-hydrants, Cases and Gasket, delivered from Cherry Street Shop during 1884, to the Purveyors' Districts.

Districts.	4-inch stop-cocks.	6-inch stop-cocks.	8-inch stop-cocks.	10-inch stop-cocks.	12-inch stop-cocks.	16-inch stop-cocks.	20-inch stop-cocks.	30-inch stop-cocks.	36-inch stop-cocks.	Frames and covers.	Fire-hydrants.	Cases.	Boxes.	Gasket, Bales.	Extra covers.
First	.....	38	.....	1	.....	.....	.....	.....	.....	110	25	122	.....	2	.....
Second	9	22	2	1	1	.....	2	.....	.....	102	54	53	35	6	.....
Third	3	35	.....	2	.....	.....	.....	.....	.....	139	31	74	.....	9	12
Fourth	17	43	12	22	9	4	.....	6	3	84	.....	49	.....	13	.....
Germantown	2	96	.....	.....	2	2	2	.....	.....	132	29	65	.....	24	.....
Manayunk	2	15	.....	.....	6	.....	.....	.....	.....	15	.....	15	.....	4	.....
Sp. Garden Station	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Water Meters.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
	33	249	14	28	18	6	4	6	3	582	139	378	35	59	12

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ARTICLES MANUFACTURED DURING 1884.

21	4-inch stop cocks, at $22 00		$462 00
264	6-inch " " " 25 00		6,600 00
14	8-inch " " " 30 00		420 00
28	10-inch " " " 40 00		1,120 00
18	12-inch " " " 45 00		810 00
7	16-inch " " " 70 00		490 00
6	20-inch " " " 95 00		570 00
6	30-inch " " " 190 00		1,140 00
3	36-inch " " " 360 00		1,080 00
138	fire hydrants, " 28 00		3,864 00
50	" " 6 in. 3-way	at 40 00	2,000 00
379	" hydrant casings, O. S.,	" 7 50	2,837 50
588	frames and covers	" 3 90	2,293 20
50	goose necks, for 3-way plugs	" 4 50	225 00
4,966	ferrules, at 50 cts		2,483 00
			$26,394 70

REPORT

OF A

SANITARY SURVEY

OF THE

SCHUYLKILL VALLEY

By Dana C. Barber, *Assistant Engineer.*

Philadelphia Water Department,
February 28, 1885.

Col. William Ludlow,
Chief Engineer:

Sir:—I have the honor to submit the following report of a Sanitary Survey of the Schuylkill Valley made by me, under your direction. Its basis is the special preliminary survey made by me in December, 1883 and January, 1884, from which were compiled the statistics of pollution published in your last annual report. The work of this investigation during the past year has consisted chiefly in a more thorough and complete examination of the special sources of pollution, particularly of the large towns, where much time was spent in studying the natural facilities for house-drainage—for few of the towns have any sewers, and none a complete sewerage system.

Nearly all the manufactories in the valley have been revisited and the first report verified, supplemented or corrected. Some of the mills in operation at the time of the first inspection were closed at the second visit, while some new ones had

started in the meantime and many slightly changed their rate of production. But in general there was little change either way, and the drainage arrangements remained in almost every case exactly the same.

The second (last) survey was made in the opposite direction from the first, *i. e.*, going up the valley instead of down, so that, since most of the summer and early fall was occupied in the proposed future supply watersheds and in investigations of the pollution of the Schuylkill within the city, but little was done in the portion above the city until late in the fall, and the field work was not finished till January 20; while some special investigations within the city have been made since that date.

For convenience of comparison the same method of division and other arrangement is used in this as in the first report. The whole valley is divided into seven districts each of which ends just above the the principal towns on the river, generally at a pumping station, as most of the towns draw their supply from the river and above their own pollution.

First, or Pottsville District.

Beginning at the upper end, the first and largest district comprises the whole valley above Reading, having an area of about 657 square miles and a population of about 91,000. This district (which, from its principal town, I have styled the Pottsville district) is naturally sub-divided into four parts: the Schuylkill proper above its confluence with the Little Schuylkill, the Little Schuylkill, the Schuylkill below the Little Schuylkill, and Maiden's creek. The first two are rough mountainous regions, containing but little arable land or any industry other than coal mining.

The principal river pollution comes from the mine water, which contains large amounts of sulphuric acid, and from the drainage of towns that have been built up by the mining industry. According to Mr. Edwin F. Smith, Chief Engineer of the Schuylkill Canal, the acidity of the water has been de-

creasing since the year 1868, and is, in his opinion, now only about one-third of its former strength at Pottsville, on account of the gradual transfer of mining operations to the other side of the mountain, draining into the Susquehanna, though in the last three years much acid has come from the washing of old dirt piles for the recovery of the fine coal.

The largest town in the first or upper district is Pottsville, situated on the right bank of the Schuylkill, about 100 miles above Fairmount dam by way of the river, and 600 feet above sea level. It is the seat of Schuylkill County, the centre of trade for the surrounding country, and has a population of about 15,000.

The Pottsville water-works, owned by a stock company, derive their supply from streams on Broad Mountain, in the old red sandstone overlapping the coal formation. An impounding reservoir, eight miles north of the town (in west end of Ryon township) and 800 feet above it, with earth dam 35 feet high, covers 70 acres, and has a capacity of about 300,000,000 gallons. Several small streams are taken in on the aqueduct route, so that the exact consumption is unknown. They supply an estimated population of 25,000, including Palo Alto, Port Carbon, and St. Clair, and the collieries and locomotives of the Philadelphia and Reading Railroad Company, and extensive rolling mills and shops, and estimate the total supply as high as 4,000,000 or 5,000,000 gallons per day. The distributing reservoir, of 6,000,000 gallons capacity, is not high enough to supply the whole town, and a part is therefore supplied directly from the aqueduct.

The town is favorably situated on quite steep slopes for easy and thorough drainage. Norwegian creek, flowing through the town, is arched over through the thickly-settled portion, and has numerous lateral branches. Probably three-fourths of the population has direct drainage for wash-water, either by separate sewer connection or through street gutters and inlets. Over 300 water-closets are supplied with the public water, and the Secretary and Engineer of the Water Company

(Mr. William D. Pollard) estimates that 95 per cent. of them have sewer connection. Probably many houses on the line of the sewers and creek (where it is arched over) have privies over the same, but no estimate of their number was obtained. Almost all houses not near the creek or sewers have good surface drainage, and most of the streets are thoroughly washed into the river by every heavy rain.

Besides the domestic drainage there are the following sources of pollution in Pottsville:

Coal and Iron Company's repair shops, having privies for 900 men over Norwegian creek.

Pottsville Iron and Steel Company's shops, having privies for 400 men over the same creek.

Ulmer's Packing House, on east branch of Norwegian creek, one mile from the river, employing 30 men and slaughtering 300 hogs and 10 cattle per week, discharging all waste into the creek; using 25,000 gallons of water per day.

Gas works, on Norwegian creek about seven-eighths of a mile from the river. Product from 40,000 to 70,000 cubic feet per day, from naphtha, causing considerable tarry waste.

One large brewery (Yuengling's) and one or two small ones having direct drainage to the river.

Small glue factory just above the pork-packing house, discharges small amount of waste from beef legs.

Small soap works drained by sewer to Norwegian creek.

Within four or five miles of the borough of Pottsville, there is an additional population of about 20,000. The principal towns included are the following:

Minersville, four miles west of Pottsville, on West Branch of Schuylkill. Population 5,000. Water supply; no sewers, but good surface drainage.

Cressona, on same stream, near confluence with Schuylkill, four miles south of Pottsville. Population 1,500. No public water supply.

Schuylkill Haven, east of Cressona, on Schuylkill river at head of canal-boat navigation. Population about 3,000. No

public water supply at present but water works in process of construction, to be completed next spring, from streams five miles distant, beyond Cressona, giving head of 235 feet. Small gas works (supplying Cressona also) and small rolling mill, but no other special sources of pollution discovered. Good surface drainage for greater part of the town.

Palo Alto, on Schuylkill, east of Pottsville. Population about 2,000. Water supply from Pottsville company. Situated on steep banks and has good surface drainage to river. Privies over the river for 150 men in shops.

Port Carbon, on Schuylkill at mouth of Mill creek, two miles northeast of Pottsville. Population 2,500. Water supply from Pottsville company. Situated on steep slopes and has good surface drainage to river.

St. Clair, on Mill creek, two miles above Port Carbon. Population about 4,000. Water from Pottsville company. Situated on nearly level ground, affording very little direct drainage into the stream.

The valley of the Schuylkill above Pottsville, extending about 15 miles northeast, or nearly to Tamaqua, is a mining region containing a number of other towns, smaller than those mentioned above, in which there is no special pollution except the sulphuric acid from the coal mines. The valley below Pottsville, as far as Port Clinton, where the Little Schuylkill enters, is sparsely populated except in the towns named above, though containing considerable grazing and some farming land.

The valley of the Little Schuylkill is very rugged and contains no villages of note except Tamaqua, near the head of the valley, 20 miles above Port Clinton and 800 feet above the sea level. It is a mining town of 6,500 inhabitants, with a water supply from a stream flowing through farming country in old red sandstone, overlapping coal formation. Two storage reservoirs, having combined capacity of over 50,000,000 gallons; consumption not known. The houses are scattered over a small plateau and on gentle slopes to the surrounding hills. The main street is drained by a partly-covered natural water-

course in the rear of the buildings on one side and by a private sewer on the other side. Perhaps 50 houses have complete drainage and one-third of the whole population direct drainage for wash water. The only special sources of pollution discovered were a small gas-works and two small slaughter-houses.

The Little Schuylkill apparently brings more acid water than the Schuylkill proper, for while fish are occasionally found in the river above the mouth of the latter, none are found below until it receives the Tulpehocken Creek, at Reading, 23 miles distant.

The valley of the Schuylkill between Port Clinton and Reading is a farming and grazing country, containing but few villages or manufactories near the river. Hamburg, on the left bank of the Schuylkill, 80 miles above Fairmount, is the only notable town. It has a population of about 2,500, without a public water supply or drainage facilities except an open shale soil over clay, with gentle slope towards the river. The navigation canal intercepts this drainage, as well as that from the farm lands below, and allows opportunity for subsidence before discharging into the river ten miles below Hamburg.

At Shoemakersville, 75 miles above Fairmount, a tannery, which last year used 2,000 hides, 100 bushels of lime, 60 bushels of hen manure and 360 tons of bark, draining into a small creek 20 rods from the river, will do nothing this year.

Maiden's Creek, entering from the left, about 70 miles above Fairmount, drains a large area of farming country, partly in a limestone region, but though bringing lime-water into the Schuylkill sufficient to remove considerable of the sulphuric acid (by depositing sulphate of lime), the river water still remains too acid for fish to live in it.

No special sources of pollution were found in the Maiden's Creek watershed except the following:

Rolling mill at Maiden's Creek Iron Works, three miles from the river, uses two barrels of oil on the rolls.

Tannery at Trexler Station, Albany township, near the creek, 19 miles from the river, used 1,000 hides, 50 bushels of

lime, 30 bushels of hen manure and 180 tons of bark last year, but will do very little this year. Tannery in Grimsville, Greenwich township, near branch of creek, 15 miles from the river, uses 1,750 hides, 87 bushels of lime, 52 bushels of hen manure and 315 tons of bark per year.

Tannery in Kutztown, Manatawny township, on branch of creek, 14 miles from the river, uses 1,500 hides (estimated), 75 bushels of lime, 45 bushels hen manure and 270 tons of bark per year.

Tannery in Berkeley, Ontelaunee township, near the creek, one mile from the river, uses 1,200 hides, 60 bushels of lime, 36 bushels of hen manure and 216 tons of bark per year.

The *Second* or *Reading District*, comprising the watershed from the northern boundary of Reading to (but not including) Manatawny creek—just above Pottstown—contains about 400 square miles and has a population of about 95,000. It is almost entirely a farming region containing very few other sources of pollution except from the city of Reading, the largest town in the valley above Philadelphia, situated on the left bank of the Schuylkill about 60 miles above Fairmount dam, at an elevation (foot of Penn street) of 181 feet above sea level. It is the seat of Berks County and the centre of trade for the surrounding country, has extensive iron works, numerous hat factories and various other lesser industries, with a rapidly growing population, now estimated at 53,000.

The water works are owned by the city. The sources of supply are small streams from a sandstone region above the town. The total reservoir capacity is about 150,000,000 gallons and the daily consumption about 5,000,000 gallons.

There is only one public sewer in the city, and that merely takes the place of the lower portion of a natural brook, yet on account of unusually good facilities for gutter drainage and the common practice of thus disposing of domestic wash water, probably three-fourths of all the waste water of the city passes directly to the river. And although no water-closet

connections with the one sewer or the other natural stream are allowed, it is almost certain that much fæcal matter reaches the river by the following peculiar arrangement. A regulation of the Board of Health requires all privy wells and cesspools to be dug 20 feet deep unless rock or water is encountered at a less depth, but does not require them to be water tight; they are almost invariably walled up with loose stone. Cavernous limestone underlies the city and is within 20 feet of the surface under nearly half of the built-up portion, and fissures are commonly found on or near the surface of the rock. As it has been observed that those vaults or wells which reach one of these fissures do not fill up nearly as soon as others, if at all, such natural outlets are sought in digging privy wells in order to avoid the trouble and expense of cleaning them out. It is, moreover, not unusual to find running streams of water through these fissures and these also are sought, to a less extent, for natural sewers. These streams come from the hill back of the town, soaking down through coarse sand and gravel at the foot of the hill and coming up as springs in the river bed.

Throughout the city cesspools and privy wells are seldom cleaned until they become full and new wells are sometimes dug instead of emptying the old ones, though this is forbidden by the Board of Health. Of the 9,000 privy vaults and cesspools in the city only about 520 were cleaned last year. The contents are removed to farms outside the city at a distance from streams.

The total death-rate of the city was about 18 per 1,000 during the year 1883 and about 19 per 1,000 in each of the three years previous. Nearly one-fourth (exactly one-fourth if still-births are excluded) of all the deaths in 1883 were from zymotic diseases, 41 being from scarlet fever, of which 187 cases were reported during the year. During last fall (1884) there was an unusual prevalence of diphtheria, 273 cases and 60 deaths being reported from October 1 to December 6.

The special sources of pollution at Reading comprise two gas-works, five tanneries, one soap-works, several slaughter-

houses, two paper mills, one woolen mill, nine hat factories, five breweries and two malt houses, several rolling mills and hardware works, besides many others of such a character that the pollution is very slight.

The Reading Gas Company, having works near the canal at the foot of Fifth street, produce from 60,000 to 200,000 cubic feet per day, using crude petroleum—five or six gallons to one thousand cubic feet. This was considered, at the time of my first inspection (December, 1883), one of the worst sources of pollution at Reading. Scarcely any attempt was made to utilize or destroy the great quantity of waste which went directly to the river by a pipe under the canal. This waste-pipe leaked badly under the canal, causing much annoyance to the navigation company, whose Chief Engineer (Mr. Edwin F. Smith) finally devised a method of burning the waste, which the gas company have recently adopted. An old boiler shell is fitted, in an upright position, to the mouth of the waste-pipe in the river, projecting several feet above the ordinary water-level, about 25 feet from the shore. The waste products are thus retained in the iron cylinder and set on fire every day, except when it storms or the water overflows the receptacle, as it had been doing for a week or more at the time of my last inspection (January 16, 1885). The waste then all runs off, and at other times much escapes through a leak in the pipe, so that the arrangement is at present by no means a complete abatement of the nuisance. It is designed to remedy these defects in the spring. I could get no estimate from the Superintendent of the quantity of waste which formerly was discharged into the river, but from comparison with other gas-works below I estimate it to have been over 150 gallons per day on the average—of a thick, black, pulpy matter—or over 250 gallons per day in winter.

The Philadelphia & Reading Railroad Company's gas-works on North Sixth street near Greenwich street (on a small stream, about a mile from the river) use naphtha or refined coal oil, producing about 65,000 cubic feet per week. The

waste from these works is comparatively small, but is sufficient to cause a decided tarry odor several hundred feet away.

At Winter & Goetz's tannery, on the canal, at the corner of Island and Front streets, the waste liquid from treating 120 dozen sheepskins and 25 dozen calfskins per week runs directly into the canal. The principal animal waste comes from soaking the skins in water for two or three days. More or less waste also comes from the use of ten bushels of lime, 200 lbs. of salt and 400 lbs. of alum per week, also small quantities of aniline dyes and a variable number of eggs, sometimes as many as 100 dozen per day. Forty workmen use privies over an earth pit 15 feet from the canal. As the water from the canal enters this vault considerable pollution probably results.

Ruth & Co., 547 South Fourth street, manufacture glove kid, using 40 dozen sheepskins per week. It is claimed that the only waste discharged into the canal (by separate sewer) is the water in which the skins have been soaked. This is a new factory, started last August.

De Long Bros., Ninth and Muhlenburg streets, tan 5,000 cattle hides and 1,250 calfskins per year, using 1,000 tons of oak and chestnut bark, 200 bushels of lime and 100 bushels of hen manure. The hides are kept in pits filled with water for eight months, the water being changed every day for the first few days, then at gradually increasing intervals,—ten, twenty and thirty days. All waste water (about 4,000 gallons per day) passes directly into a brook, half a mile from the river.

Henry Kerper tans 2,000 hides per year at Second and Chestnut streets, using 100 bushels lime, 60 bushels hen manure and 360 tons bark. Waste water by sewer to canal.

George F. Winter, at Second and Front streets, tans 1,250 hides per year, but claims to discharge no waste into the sewer. Probably the usual proportion of animal matter reaches the canal by the sewer from Kerper's tannery.

The slaughter-houses of Reading are mostly at a distance from the river or water-courses and drain liquid waste into

wells in the earth, so that, unless these have outlets through the cavernous limestone before mentioned, there can be but little pollution from this source. The blood is generally caught and removed with the offal for fertilizer. The principal slaughter-house draining into the river is that of Rader & Thompson, Second and Court streets, on the line of the public sewer. They claim to discharge no waste into the sewer except wash water. A small hog-slaughtering house on Maple street drains blood as well as waste water into the creek close by. The manure pile, which also receives the solid waste, drains into the creek.

In December, 1883, the Reading Soap and Candle Works, W. K. Leman, proprietor, Second and Washington streets, were using 75,000 to 100,000 lbs. of grease per year, 27,000 lbs. caustic soda, 20,000 lbs. sal soda, 350 lbs. of rosin, 100 lbs. oil of sassafras, and 5 lbs. of citronella, producing 150,000 lbs. hard soap and 20,000 lbs. of candles per year, and discharging about 7,000 gallons of spent lye (alkali strength 3° to 5°) into the sewer, or 19 gallons per day. At the last inspection (January 16) the workmen in charge said they were not doing more than half as much then.

The lower mill of the Bushong Paper Company, limited, on the canal at Bingaman and Canal streets, use about 5,000 lbs. of domestic rags per day, with 15 bushels of lime, 550 lbs. chloride of lime, and 1,000 lbs. of wood pulp. All waste matters, including sewage from 60 operatives, discharged into canal; 400,000 gallons water used per day.

Another mill of the same company, on the canal at the foot of Court street, uses 4,000 lbs. of rags, 800 lbs. of lime and 450 lbs. of chloride of lime. Water closets used by 35 operatives in this mill discharge into the canal, as well as all other waste.

J. G. Leinbach & Company's woolen mill, on North Fourth street, near Buttonwood, scours 500 lbs. of wool per day, and uses 24 lbs. soda ash, 31 lbs. of rosin soap, 30 lbs. extract of logwood (liquid), 3 lbs. chrome, 3 lbs. oil of vitriol, 2½ lbs.

cutch and 1½ lbs. blue vitriol per day; also trifling amounts of aniline and other dyes.

Hendel, Bro., Sons & Co., Fifth street, below Laurel street, are the largest manufacturers of wool hats in Reading, producing 1,000 dozen a week, or about 1,700 per day. They use about 90 lbs. of hard soap, 10 to 15 lbs. of blue vitriol, 3 barrels of logwood and smaller amounts of other dye stuffs and chemicals per day; also scour a little wool—from 50 to 100 lbs. a day. The waste water runs 700 feet in street gutter to canal.

It was found so difficult to obtain reliable statistics from the eight other hat factories in Reading that time was taken only to obtain the products, which aggregate (including the one above mentioned) about 10,000 hats per day [average for every day in the year]. The relative quantities of soap and dye stuffs used in the other factories probably do not vary much from the figures given above. Most of them are situated near a creek flowing through the lower portion of the city and the waste water runs to the creek in the street gutters. When not colored by dye stuffs, the waste water (which I have estimated to be about 300,000 gallons per day) from fulling the hats, is slightly soapy and is turbid from short wool fibres.

Peter Barbey's lager beer brewery, Hockley lane and River road, produces about 25,000 barrels of beer per year. Waste water from rinsing barrels and vats, and cleaning generally, runs in gutter to canal, two or three hundred feet distant.

The Lauer Brewing Company, limited, produce about 30,000 barrels of lager beer annually at Third and Walnut streets. Waste water runs through box culvert 500 feet to public sewer. A porter and ale brewery, with malt-house connected, at Third and Chestnut streets, owned by the same company, produce 10,000 barrels per year. Waste runs by special sewer (draining also two tanneries mentioned above) to canal.

W. P. Deppen's Spring Garden Brewery, Chestnut street, near Tenth, produces 15,000 barrels of beer, porter and ale per year. A malt-house in the rear, belonging to the same

man, produces 25,000 bushels per year. Waste water from both places runs in street gutter a quarter of a mile to a creek entering the river at the foot of South street.

Keller & Schäffer's Keystone Brewery, between Fourth and Ash streets, below Elm street, produces about 8,000 barrels of lager beer per year. Waste water by special connection to public sewer.

M. K. Graeff's malt-house, west of Ninth street, below Muhlenburg street, produces 35,000 to 40,000 bushels a year. Water in which grain has been soaked runs to creek near by.

The Reading City Passenger Railway Company's stables, on Miner street above Willow, occupied by 40 or more horses, have stall drainage by terra cotta pipe to street gutter, 600 feet from creek near river. No other stables in the city have direct drainage.

William McIlvaine & Sons' rolling mill, on Laurel street east of Seventh, use 25 barrels of suet and petroleum per year on rolls; drainage into creek flowing through the yard where much of the waste oil is caught and retained till heavy rains. Privies for 150 men over the same creek; only 75 men employed at time of last inspection (January 16, 1885). Several other iron works and rolling mills cause slight pollution, from the rolls and laborers' baths.

The Penn Hardware Works, on the canal between Spruce and Pine streets, formerly had privy for 200 operatives close to the canal wall from which most of the fæcal matter entered the river. This was abandoned just before last inspection (Dec. 12) and a new one constructed 120 feet back, over a pit reached by the canal water; hence probably some pollution by filtration.

The Reading Stove Works, Orr, Painter & Co., on the canal between Spruce and Chestnut streets, have privies over earth vaults near the canal; water passes through the intervening earth and removes more or less of the polluting matters; those most used require cleaning every year. Bath water (from 250 men) discharged into canal.

H. S. Getz & Co's marble mills, on the Canal, near foot of Second street, have water-closets for 13 men connected with sewer from Lauer's brewery and Kerper's and Winter's tanneries.

Eckert & Co's fire-brick works, on canal just below preceding, have privies over canal wall for perhaps 20 men. [Works closed at time of inspection.]

McIlose & Co's fire-brick works, on canal near foot of Fourth street, have privy for 50 men over leaching well ten feet from canal; requires cleaning every two years, but probably causes considerable river pollution.

Besides the above, situated so near the canal or creeks as to permit more or less direct pollution by fæcal matter, the following large establishments have partial privy drainage through the limestone fissures previously referred to. At the Philadelphia and Reading Railroad Company's machine-shops, Seventh street, between Spruce and Franklin, so much of the privy waste escapes from the vaults that one requires cleaning only once in five years, and the other only once in ten years, though the two are used by 1,000 men. At the car-shops of the same company, Sixth and Centre streets, the privies formerly were self-cleaning, but now are not entirely so; about 850 men are employed here. The spectacle works of T. A. Wilson & Co., Second and Washington streets, are in the cavernous limestone district and the privies will probably never require cleaning. Two hundred operatives are employed here where the wash (bath) water goes directly to the public sewers or culvert, with which the privies were at first connected, but afterward cut off to comply with Board of Health regulation forbidding water-closet connections. The cesspool receiving the drainage of the water-closets at the Philadelphia and Reading Railroad depot has a clear outlet to the river, as was shown at the time of its construction, when the full head of a fire hydrant was turned into it for twenty-four hours without filling it.

Tulpehocken creek, entering the Schuylkill opposite Reading, drains a large area of farming country in a limestone region

and brings down enough limestone water to complete the reduction of the acid, in part effected by Maiden's creek, so that the water below Reading is generally good (so far as acidity is concerned). Above the Tulpehocken the Schuylkill water is too acid to be used in boilers. The only special sources of pollution discovered in the Tulpehocken watershed are the following:

Paper-mill of the Bushong Paper Company (limited), near the mouth of the Tulpehocken; uses 5,000 lbs. jute per day, with about 800 lbs. of lime and 450 lbs. of chloride of lime.

Van Reed's paper-mill, five miles from the Schuylkill, uses about 2,000 lbs. of paper rags and some wood pulp.

Tannery in Bernville, on branch of North Kill creek, 15 miles from the Schuylkill, tans 2,000 hides and uses 100 bushels of lime, 60 bushels hen manure, and 360 tons bark.

Tannery in Jefferson township above Bernville, 18 miles from the Schuylkill, tans 1,200 hides and uses 60 bushels of lime, 36 bushels hen manure, and 215 tons of bark.

Another in Womelsdorf, Heidelberg township, near the Tulpehocken, about 24 miles from the Schuylkill, does the same amount as the preceding. Both the latter are on very small brooks and probably no pollution reaches the river.

Small woolen mill in Wernersville, Lower Heidelberg township, on Spring creek, about 18 miles from the Schuylkill, scours perhaps 12 lbs. of wool per day.

The following establishments contributing to river pollution are in the immediate vicinity of Reading:

Cyrus Erence's neats foot oil and tallow factory, in Exeter township, four miles east of Reading, receives all the dead animals from that city. During the year 1883 there were 72 horses, 7 cattle, 16 sheep, 104 cats, 85 dogs, 54 pigs, besides numerous chickens, geese, etc. The carcasses are boiled to obtain the oil and all the liquid waste runs to a creek nearly seven miles from the river. Bones and butcher's offal are received from other sources, over 100 tons of dry bones being shipped from this place during a year.

Next door to the above is Joseph Levan & Co.'s glue factory. During the winter and early spring about 150 tons of beef legs are treated with oil of vitrol (100 lbs. a day), and during the late fall and late spring 200 tons of scraps of hides are used, with one or two bushels of lime to each ton. The establishment is a local nuisance, but comparatively little animal matter reaches the water course. The proprietor estimated about 400 gallons per day of waste liquid from washing the beef legs and 1,000 gallons of lime water per day from the hide stock. Most of this runs by a small brook to the creek above mentioned.

A mile above on the same creek, Louis Kraemer & Co.'s woolen mill scours 27 lbs. of wool per day, and uses 5 lbs. soda ash, 3 lbs. bichromate of potash, 40 lbs. extract of logwood, 10 lbs. chipped logwood and smaller amounts of various other dye stuffs.

A short distance below the glue factory above mentioned, on Antietam creek is A. J. Brumbach's cotton and woolen mill, scouring nearly 300 lbs. of wool per day and using over 200 lbs. of extract of logwood and smaller quantities of fustic, hyperric, etc. Fifty operatives use privies over the stream.

Opposite Reading, near the river, is G. W. Alexander & Co.'s hat factory producing about 700 hats per day and using a great variety of dye stuffs, generally in small quantities; and in Mohnsville, Cumru township, about six miles from the Schuylkill, by a small creek, are six or seven more hat factories producing perhaps 3,000 hats per day.

Between Reading and Pottstown (about 20 miles) there are almost no sources of pollution except from agriculture. The greatest is at Birdsboro, half way between the two towns, where about 20 houses have indirect washwater drainage into Hay creek, over which E. & G. Brook's nail works have privies for 400 men. Though having a public water supply (by 12-inch pipe from a small stream one or two miles distant and 170 feet above the town) and a population of perhaps 2,000 this

town has no other sources of direct pollution, most of the houses being situated at a distance from the river or any tributary. In the extreme lower end of the second district, just above the mouth of the Manatawny creek, the Warwick Furnace and Rolling Mill has privies for 60 men over the stream, though the manager thought that not more than 30 or 40 used them.

The *Third*, or *Pottstown District*, comprising the valley from just above Manatawny creek to the pumping station of the Phœnixville water works, an area of about 150 square miles, has a population of about 25,000. The river valley is narrow between these points and consists principally of good farming land.

Manatawny creek, the principal tributary in this district, drains a rougher country with poorer soil and sparse population. Boyertown, partly in this (Manatawny) and partly in the Perkiomen watershed, has a population of 1,200 or 1,300. It has a water supply (used by about two-thirds of the population) from Ironstone creek, half a mile from the town, half by gravity and half by pumping; consumption not known. The town has but little direct drainage except into the iron mines which underlie a part of it, whence the filtered water is pumped into Ironstone creek. The following small manufactories of a polluting character are in the Manatawny watershed:

Small woolen mill at Friedensburg, Oley township, about 18 miles from the river; custom work—perhaps 2,000 pounds of wool per year.

Wren's cotton and woolen mill, in Colebrookdale township, between Boyertown and Colebrookdale station, on Ironstone creek, eight miles from the river; mixed shirtings and blankets, mostly from cotton; uses 15 lbs. soap, 1 lb. oil of vitriol and 1 lb. cochineal per day besides small quantity of concentrated black dyes.

G. B. Conrad's "Oley" paper mill, Oley township, 14 miles from the river, uses about 2,500 pounds of paper rags per day.

Brewery, producing 5,000 barrels a year, on the creek, two miles from the river.

Glasgow Iron Co.'s rolling mill and puddling furnace, a short distance above the preceding; uncertain quantity of oil from the rolls passes directly into the stream; privies for 140 men on the bank.

The greatest pollution from this district is from the borough of Pottstown, situated on the left bank of the Schuylkill just below the mouth of Manatawny creek, 40 miles above Fairmount dam and 150 feet above sea level. Population about 5,000 or, including suburbs, 9,000. Seat of several large iron works and centre of trade for surrounding country. The water works, owned by a private company, draw their supply from the river near the lower end of the town. The water is generally considered bad, especially in summer, when most people resort to wells for drinking water. An association of physicians recently urged the water company to take the supply from above the town, but at last accounts this had not been favorably considered. Probably on account of the unsatisfactory quality the amount supplied is quite small for the population—less than 200,000 gallons per day.

Three natural water courses through the town drain wash water from about two-fifths of the entire population, mostly through the street gutters; and, according to a recent inspection by two resident physicians (Drs. Kellar and Saylor) water-closet drainage from over one hundred houses is discharged into two of these streams, one of which is culverted through the built-up portion of its course. The Philadelphia and Reading Railroad station water-closets also drain to the river. Moreover, the night soil is taken to steep slopes just outside the town whence much fæcal matter is probably washed into the streams.

The special sources of pollution within the town are few. The gas-works (owned by private company—same owning water-works) produce from 15,000 to 30,000 cubic feet per day from coal; tar sold, and but little waste to river, except

ammonia water. The Philadelphia Bridge Works, below the intake of the water-works, have privies for 400 men over cesspools in made ground; probably some river pollution by percolation after high water.

J. Trinley's fertilizer factory, below Limerick station (about 34 miles above Fairmount), on small creek one-fourth mile from river, grinds 500 tons of bones per year, and mixes the dust with prepared manure; process mostly dry, causing no river pollution; some waste, however, from boiling fresh bones before grinding, and from dead animals from the surrounding country. Complaint is made that animals having died of contagious diseases are used there, and the liquid waste drained into the stream, but the proprietor's representative claimed that they were very careful not to take such material. The proprietor sold in 1883 one thousand tons of fertilizers, mostly in the Schuylkill valley, including 150 to 200 tons of other makes.

At Royer's Ford, a village of 700 or 800 inhabitants, situated on the left bank of the Schuylkill, in Limerick township, 32 miles above Fairmount, a stone culvert under a row of houses on the main street drains wash-water from perhaps 20 houses and a dozen water-closets, including that of the hotel. The Spring City Gas Company's works at the same place, near the river, produce about 8,000 cubic feet per day, for the supply of both Royer's Ford and Spring City (on the other side of the river). The gas is made from naphtha, with considerable waste of heavy hydrocarbons. Buckwalter & Co.'s stove foundry, near the river, above the bridge, has one privy over a small stream, used by a dozen men. Bath-tubs, used every day by 70 sweaty men (60 moulders), discharge into the same stream.

Spring City, a village of 1,500 to 1,800 inhabitants, opposite Royer's Ford, contributes but little direct pollution, except from the manufactories named below, the houses being scattered and generally distant from streams. Perhaps one-half the population have fairly good surface drainage.

The American Wood-Paper Company's mill, on the canal above the bridge, produces about seven tons of wood pulp per day, using 80 bushels of lime, 2,000 lbs. soda ash, 2,000 lbs. chloride of lime, 100 lbs. alum, and a little coloring matter. Seventy-five workmen use water-closets draining into the canal.

Yeager & Hunter's stove foundry, near the canal in the lower part of the village, has privies for about fifteen men over the water.

The Fourth or Phœnixville District, embracing an area of about 520 square miles, with 65,000 inhabitants, extends from the Phœnixville pumping station to the upper boundary of Norristown. The main river valley is narrow between these points and by far the larger portion of the area is drained by the Perkiomen, entering the Schuylkill from the north, about 25 miles above Fairmount. The source of greatest pollution is the borough of Phœnixville, on the right bank of the Schuylkill, 28 miles above Fairmount and 110 feet above sea level. The population is estimated at 7,500, mostly living back from the river, on both sides of French Creek, which thus receives most of the drainage. The water supply (works owned by the borough) is pumped from the Schuylkill above the town and is generally considered to be of good quality, except sometimes in winter, when, owing to the peculiar formation of the river just above the pumping station, broken ice accumulates under the surface ice and collects a great quantity of organic impurities, more or less of which are drawn in by the pumps in certain conditions of the river. The consumption is about 500,000 gallons per day. The upper portion of the town, north of French Creek, has one arched culvert taking wash water only from perhaps 800 people. The main part of the town, south of the creek, has two natural watercourses, one of which is arched over for a quarter of a mile or more and the other for a short distance. Both receive gutter drainage from a population of perhaps 1,500, besides complete drainage from some 15 houses. A few privies are also placed

over the upper culvert near the canal, so that perhaps 150 people have water closet drainage into the two streams, including the 25 operatives of Griffin, Smith & Co.'s pottery works on the lower culvert.

The death-rate of the borough, as calculated by a local physician, ranges from 19 to 23 per 1,000, the principal diseases being, in summer, diarrhœa and malaria, and in winter pneumonia, scarlet fever, diphtheria and a peculiar affection of the bowels known there as "winter cholera," which may have some connection with the foul condition of the water supply referred to above.

The most serious special pollution in the town is the privy drainage of the Phœnix Iron Company, which has extensive works along the creek entirely through the town. Eight hundred men use privies over race ways or other arrangements providing direct water carriage to the creek, and 800 more use privies over leaching wells which high water enters by percolation.

The Phoenixville Gas Works producing about 12,000 cubic feet in winter, from crude petroleum, wastes a large quantity of thick, pulpy matter (said by the Superintendent to be eighteen gallons a day) to the river by a special pipe. At the mouth of this water pipe was a large accumulation of viscid tarry matter which had not been carried away by the water at the time of the last inspection (Nov. 20, 1884.)

No other special sources of pollution were discovered in Phoenixville except two or three small slaughter-houses in the extreme upper part of the town, one of which drains all blood and casts much offal into a small branch of French creek. French creek drains a farming country in which no special pollution was discovered besides a small paper mill—J. Frederick Sheeder's—near the southern boundary of East Vincent township, eight miles from the river, producing three tons of binders', trunk, album, and box board, from old paper rags.

Pickering creek, entering the Schuylkill a short distance

below Phoenixville, from the right, also drains a farming country containing a few small manufactories, as follows:

J. W. P. Ingraham's woolen mill, in Charlestown village, five miles from the river, uses about 2,000 pounds of fulling soap per year in fulling blankets, and about the same quantity of scouring soap; no wool scouring or dyeing.

John Rees, Jr.'s paper-mill, near the above, uses about 1,000 lbs. of old paper per day during ten months of the year, to make binders' board. Near the above are two lead mines which have not been worked lately.

B. F. Williams' paper-mill, on small branch of Pickering creek, about three miles from the river, in Schuylkill township, makes about one ton per day of binders' board from old paper.

On the creek, just below the entrance of the above brook, is a small creamery, which evidently gives little or no pollution; waste liquid (cheese whey) taken by the farmers bringing milk to feed to hogs.

Only that portion of the Perkiomen valley below Schwenksville is included in the present report, the portion above that point being comprised in the proposed future supply watersheds on which I have submitted a special report, including also the Skippack creek, above Evansburg. There are but few manufactories in this lower portion, and little pollution, except from the farming land which occupies most of the territory.

At Schwenksville, the largest village in this lower portion, about eleven miles from the Schuylkill, a few houses have very imperfect surface drainage to the creek. The only manufactory having any drainage of a foul character is a creamery, from which the amount of waste reaching the creek is very small, most of it being taken by farmers.

At Grater's Ford, nine miles from the Schuylkill, about a dozen houses on top of a steep bank of the creek cast rubbish of various sorts down the bank and about half of them have privies on the bank. Just below the above a small brook enters the creek, which receives, four or five miles above, the drainage of a small tannery near Limerick Square. It uses

about 400 hides and 1,200 calfskins, 300 bushels lime, 18 bushels hen manure and 100 tons bark.

At Rahn's Station, eight miles from the Schuylkill, a small fur hat factory, using per day 50 lbs. chipped logwood, 3 lbs. fustic, 2 lbs. oil of vitriol and trifling amounts of cudbear, hyperinc and other dyes, drains into the Perkiomen, about 800 feet distant, by a small stream which also receives the privy waste from the operatives, perhaps twenty in number.

Casselberry's tannery, at Evansburg, on a small tributary, one mile from the Perkiomen and seven miles from the Schuylkill, tans 500 hides and 2,200 calfskins per year, using 44 bushels lime, 27 bushels hen manure and 150 tons of bark.

In the valley of the main river below the Perkiomen are the following sources of pollution:—

Palm Paper Co.'s mill, at Valley Forge, 23 miles above Fairmount, formerly used rags, but now use jute bagging (old sacks), 2,700 lbs. per day, with 270 lbs. wood pulp, 10 bushels lime, 300 lbs. chloride of lime and 75 lbs. alum. Water closets for 14 operatives discharge directly into the stream.

At Port Kennedy station, Upper Merion township, 21 miles above Fairmount, the hotel has privies beside a creek entering at that point, which also receives considerable pollution from the general surface drainage of a population of nearly 500.

Abraham's paper mill, at Merion station, 19 miles above Fairmount, on Crow Creek, near the river, uses 2,000 lbs. of old paper per day in making cardboard. No chemicals are used in making cardboard or binders' board, except copperas, about 12 quarts to the ton.

The Fifth, or Norristown District, extending from the upper boundary of Norristown to the pumping station of the Conshohocken water works, is the smallest of the seven, having an area of only 30 square miles and a population of 20,000. There is no pollution in this district other than from agriculture, except from the towns of Norristown and Bridgeport,

situated opposite each other on the Schuylkill, about 16 miles above Fairmount dam.

The borough of Norristown, on the left bank, has a population of about 14,500. It is the seat of Montgomery county, is a trading centre for the farmers for several miles around, especially from the north and northwest, and has considerable manufacturing.

The water works, owned by a private company, draw their supply from the Schuylkill, pumping continuously for six days in the week from that division of the river flowing to the right or on the farther side of Barbadoes island, opposite the town, in order to avoid the pollution entering that part of the river adjacent to the town above the pumping station. The reservoir, two miles from the river and 211 feet above it, has a capacity of 12,000,000 gallons. The daily consumption is from 800,000 to 1,000,000 gallons. The quality of the water is generally considered satisfactory.

Two natural streams, Stony Creek through the upper part and Saw Mill Run through the lower, afford good surface drainage for the greater portion of the town. There are also several sewers, as follows: Four-feet brick sewer in Marshall street, from George street to Stony Creek, about 1,300 feet, takes only surface water from street gutters and possibly waste water direct from a few houses (50 on the line), probably no water closets connected. Three-feet sewer in Main street, from Swede street (summit of grade) to Stony Creek, about 2,000 feet; perhaps 35 houses connected, a few having water closets. Also, in same street, from same point, 1,550 feet in opposite direction, to river, receiving water closet drainage of Mill street station, Philadelphia & Reading Railroad, and a few cesspools; about 90 houses on the line, most of them connected for wash water only. Three-feet sewer in De Kalb street, from below Main street, about 750 feet to mill race, 400 feet from river; about 20 houses, including two or three hotels and some cesspools connected, also water closets of Pennsylvania Railroad station.

Saw Mill Run receives gutter drainage from at least 150 houses, in addition to many beside it which drain into it more or less wash water through their backyards, which also contain privies near the banks. An old race from this creek to a flour mill on the river receives considerable backyard drainage, wash water, stable washings, etc. Besides the houses on the lines of the sewers to Stony Creek about 200 have gutter drainage to it directly.

I regret having been unable, on account of the absence of any Health Board or official registration, to procure full and definite statistics of disease and death in this town. According to a local physician the undertakers report 390 deaths during the past year. If there were as many deaths the rate per 1,000 would be 27 (assuming a population of 14,500), but the number probably includes some bodies of persons dying elsewhere. Still I judge the death-rate to be very high, especially from zymotic and infantile diseases. One physician reports having attended 50 cases of typhoid fever in 1884.

In addition to the extensive domestic drainage, the following establishments in Norristown drain foul waste matter into the river or its tributaries:

Slemmer Bros.' Montgomery Oil Works (for refining petroleum), in lower end of town, about 1,000 feet from the river, formerly caused much pollution, but in rebuilding, after destruction by fire, in November, 1883, greater pains were taken to prevent this. The works were again partially burned in September, 1884. At both times considerable oil escaped into the river. The waste liquid is now intercepted by six successive traps (large settling tanks), from which accumulations are removed to pits, six feet deep or more, 200 feet from the river, and covered with ashes. Beyond the settling tanks the waste flows a quarter of a mile through ditches and meadows, so that but little oil ordinarily reaches the river. Probably considerable is washed in by heavy rains, which clean out the channels. About 2,500 gallons of crude oil is used per day,

of which the proprietor thinks not more than one per cent. goes to waste.

Another small oil refinery some distance below the preceding had been idle for a long period at both times of inspection.

More oily waste was running into the river from the Norristown Gas Works (supplying also Bridgeport) than from the oil works at the time of my last inspection (September 22, 1884). About 30,000 cubic feet per day was then being produced from coal. In the preceding winter the product was from 75,000 to 80,000 cubic feet per day and they were then using benzine.

Beener's slaughter house, between Cherry and Barbadoes streets, has a sewer to Stony Creek for liquid waste from slaughtering two or three cattle and ten hogs per week. Two or three other slaughter houses of about equal capacity on Carson alley have a sewer to Saw Mill Run, which also drains surface water from an area containing about 50 houses.

Samuel J. Long, hide and tallow dealer, Markley and Lafayette streets, handles 80–100 hides, 280 sheepskins and 75–120 calfskins per week. The cellar where these are packed in salt, drains by separate sewer into Stony Creek, which also receives much animal matter from the rendering of 25 barrels of tallow per week at the same place.

The county prison, usually containing about 60 inmates, has a special sewer for all liquid waste to Saw Mill Run at Arch and Penn streets.

Bullock's woolen mill, on Saw Mill Run, about one-eighth of a mile from the river, when running to its full capacity, scours 875 lbs. of wool per day and uses 66 lbs. hard soap, 70 lbs. nitrate of iron, 7 lbs. iron liquor, 40 lbs. extract of sumac, 10 lbs. alum, 4 lbs. oxalic acid, 86 lbs. chipped fustic and 2 gallons of ammonia, also irregular and variable quantities of salt, blue vitriol, oil of vitriol, hyperinc, Lima wood, madder, chrome and barwood; sewage from 450 operatives has water carriage to river. At the time of last inspection the average consumption of wool was said to be only about 215 lbs. a day, or one-fourth the full capacity, and at that

time only eight workmen used water closets draining into the creek.

J. & J. Shaw & Co.'s woolen and cotton mill, on Saw Mill Run, one and a half miles from the river, uses 67 lbs. extract logwood, 17 lbs. soda ash, 10 lbs. oil of vitriol and 5 lbs. cutch per day. The dye water flows several hundred feet through a meadow before entering the stream and is thereby slightly purified.

J. Morton Brown & Co.'s woolen and cotton mill, on Barbadoes street near Airy street, when using wool, scours about 860 lbs. a day, with 43 lbs. soda ash and 17 lbs. dyers' bar soap. Also uses regularly, on the average, 43 lbs. extract logwood, besides an unknown quantity of chipped logwood and some aniline dyes. Waste water runs in ditch 500–600 feet to Stony Creek.

The Washington Woolen Mill, near the river, in the upper part of the town, scours 430 lbs. of wool per day and uses 4 lbs. potash, 4½ lbs. soda ash, 8½ lbs. bichromate of potash, 21 lbs. blue vitriol and 75 lbs. extract logwood. Waste water runs to river by pipe. Privies for 85 operatives beside a small brook flowing past the mills. Contents said to be removed to farm, but probably some pollution.

M. L. Cresson & Co.'s Ford street mill, near lower end of town, 300 feet from river, uses 10 lbs. soda ash, 24 lbs. extract logwood, 8 lbs. bichromate of potash and 25 lbs. copperas per day. Dye water enters stream from the oil works and runs one-fourth mile in ditch to river.

John & James Hunter's cotton mill, on the river at De Kalb street, has water closets for 130 operatives discharging into the river, and William Simpson & Son's Wyoming Mills, at the foot of Swede street, have the same arrangement for 150 operatives.

A shirt factory, 600 feet from Stony Creek, half-mile from the river, uses 1½ barrels of soap and 1 barrel of starch per day, in washing and starching new cloth. Waste water runs over surface of ground and in small ditch to creek.

The Eagle Iron Works, on the river, in the lower part of town, have privies for 60 men on the river bank. Excrements reached only by high water, but washed in by heavy rains.

James Hooven & Sons' rolling mill, near the river above the bridge, uses 3,000 lbs. tallow and some other grease on the rolls in a year. Sewer to the river for waste water and grease.

Stony Creek Rolling Mill, at mouth of Stony Creek, uses 1,000 lbs. of grease per month, also 30 lbs. of cylinder and engine oil per day. Privies for 150 men on bank of creek. Excrement falls near low water line and is partially washed in by the stream from the rolls, which flows into the creek under the privies.

Scheidt's brewery, Marshall and Barbadoes street, produces 3,000–4,000 barrels of lager beer per year. Waste water by sewer to Stony Creek.

The Pennsylvania tack works, on Stony Creek, one-third mile from river, use 1 gallon oil of vitriol per day, most of which runs into the creek.

The Star Glass Works, near the river, in the extreme lower end of town, have privies for 75 men on the top of the river bank, 75 feet from the water. Pollution only at times of heavy rain-fall.

In the outskirts of the town, one mile north of the centre of population, is the State Hospital for the Insane (southeast district of Pennsylvania), containing a population of about 1,200. Heretofore the water closet sewage, amounting to 60,000 gallons per day, has been treated (by precipitation and filtration) for the recovery of the solid fertilizing constituents, which were removed, in the form of sludge, by pumping and gravity, to a distant part of the farm, while the partially purified liquid was discharged into a small branch of Stony Creek, together with the remaining 140,000 gallons of waste water (including all kitchen-sink grease), to which no purification process was applied. The decomposing organic matter adhering to the sides of the brook as it flowed past the Hospital station of the Stony Creek Railroad caused an almost intolerable

stench at the time of my last inspection (September 23, 1884). Arrangements are now being made to utilize the sewage by sub-surface irrigation.

Stony Creek, after receiving the hospital drainage and the Norristown sewage from the various sources indicated above, was the most grossly polluted tributary of the Schuylkill in the whole valley, above Dobson's Run.

In Bridgeport, opposite Norristown, a borough of about 2,000 inhabitants, the houses are scattered, there is no water supply and comparatively little domestic waste water reaches the river. About 20 houses along the canal, below the bridge, drain into the canal more or less directly, and most of them have privies near the canal bank. The principal pollution from the town is from the following manufactories:

Lee's woolen mill, in the extreme lower end of town, scours about 10,700 lbs. of wool per day and uses 2,830 lbs. of soft soap, 50 lbs. extract logwood, 14 lbs. alum, 8 lbs. copperas, 8 lbs. blue vitriol, 14 lbs. chrome, 360 lbs. soda ash, 145 lbs. sal soda, 3 lbs. aniline dyes and 14 lbs. oil of vitriol per day. Seven hundred operatives use water closets discharging into a stream to the canal.

Worral & Ratcliff's cotton and woolen mill, on canal nearly opposite railroad station, scours 100 lbs. wool per day and uses 50 lbs. extract of logwood, 6 lbs. blue vitriol and a small quantity of catechu. Seventy operatives use privies over the canal.

A yarn mill, opposite the above, was scouring 214 lbs. wool per day on January 2, 1884. At the time of last visit (October 2, 1884) it had been closed for several weeks. The waste water ran through gutter and ditch, 150 to 200 feet, to canal.

Smith's Cloth Factory, near the canal, in the upper end of town, contemplated starting a dye-house; no pollution at time of last visit (October 1, 1884).

H. McInnes' Paper Mill, on the canal, opposite the railroad station, uses 6,000 lbs. of jute butts and bags (cotton bales,

etc., mostly imported), 850 lbs. chloride of lime, the same quantity of lime, and 21 lbs. soda ash per day. Five operatives use water-closets discharging into the stream, and 23 use a privy over a leaching vault beside the canal wall.

Dager & Cox's Paper Mill, near canal, above De Kalb street bridge, was using 3,430 lbs. of jute bagging, 8,000 lbs. jute butts, 3,000 lbs. chloride of lime, 550 lbs. lime, and 34 lbs. soda ash per day on January 2, 1884. At time of last inspection (September 29, 1884) the works were being re-built (having been destroyed by fire), with one-third greater capacity; jute butts to be used chiefly hereafter.

At J. B. Horn's Packing House, on the canal, below the De Kalb street bridge, 7 cattle per week in summer and 100 hogs per week in cold weather (October to May) are slaughtered, and all liquid waste discharged into the canal.

The Sixth, or Conshohocken District, though a little larger than the Norristown (38.5 square miles), has a smaller population (about 16,000). It extends from the Conshohocken Water Works Pumping Station to the Roxborough Pumping Station of this Department. The principal pollution is from Conshohocken and its tributaries,—Gulf Creek and Mill Creek.

The borough of Conshohocken, population 5,000 to 6,000, is situated on the left bank of the Schuylkill, 12 miles above Fairmount dam, and 60 feet above sea level. The water works, owned by a private company, draw their supply from the river, opposite the upper end of the town, near the entrance to the upper canal lock, the mouth of the intake being eight feet from the tow-path, and half-way between the surface and bottom at ordinary low-water. The reservoir is about 200 feet above the river, and has a capacity of 1,300,000 gallons, which is so large in proportion to the daily consumption (65,000 to 100,000 gallons), that the pump is run only 40 to 60 hours per week, at any time when the water is clearest, except Monday. The pumping-engine boilers are cleaned of scale every three months.

The town contains no sewers, and on account of the houses being scattered but little house drainage reaches the river. About 150 houses have more or less direct gutter drainage to the canal, and the Philadelphia and Reading Railroad Station has water-closets discharging into the same. There is little other pollution, except from the following manufactories:

The Albion Print Works, below the bridge, between the river and canal, use the following materials in bleaching, dyeing, and printing 40,000 yards of cloth per day: 85 lbs. aqua fortis, 200 lbs. muriatic acid, 300 lbs. oil of vitriol, 280 lbs. extract log wood, 390 lbs. bar wood, 9 lbs. alum, 33 lbs. extract citron bark, 4 lbs. bar tin, 3 lbs. antimony, 195 lbs. bichromate potash, 16 lbs. blue vitriol, 13 lbs. sulphate of copper, 6 lbs. catechu, 57 lbs. extract sumac, 281 lbs. gambier, 128 lbs. indigo, 95 lbs. indigo auxiliary (zinc powder), 42 lbs. brown sugar of lead, 4 bushels lime, 4 lbs. litharge, 2 gallons iron liquor, 3 lbs. aniline dyes, 6 lbs. white soap, 483 lbs. soda ash, 83 lbs. sal soda, 105 lbs. sumac, ¾ lb. tin crystals, 1 lb. yellow prussiate of potash, 240 lbs. oxalic acid, 1 lb. tartaric acid, 14 lbs. aniline oil, 3 lbs. chlorate of potash, 72 lbs. chloride of lime, and 185 lbs. sulphur. Two hundred operatives use privies over the stream or on the bank.

Samuel Fulton's Furnace, near the mouth of Plymouth Creek, has privies for 200 men over the bank of the creek; excrement reached by ordinary high water. At a small cinder-crushing works, just above the preceding, and owned by the same man, about a dozen men use a privy on the bank of the creek.

J. Wood & Bros.' Iron Works (smaller shop), between the river and canal, just above the bridge, have a privy over a raceway direct to the river, used by 20 men.

Alan Wood & Co.'s Schuylkill Iron Works, near the canal in the lower portion of the town, waste considerable tar into the canal from their private gas works which make 2,000 cubic ft. of gas per day, from rosin and coal. These iron works

also use 150 lbs. of sulphuric acid per day for one-third of the time and waste some oil from the rolling mill.

The Conshohocken Cottonade Mill, just above the preceding, uses 120 lbs. extract of logwood, 15 lbs. of bluestone and 16 lbs. soda ash per day besides small quantities of other dyes. Waste water flows through an earth ditch several hundred feet to the canal.

The Schuylkill Woolen Mills, near the preceding, use 50 lbs. extract of logwood, 10 lbs. soda ash, 10 lbs. bluestone, 12 lbs. cutch and 8 lbs. extract of bark per day. Waste water runs through box-culvert 200 ft., then over the ground 400 ft. or more to the canal, being entirely absorbed and evaporated in dry weather.

At West Conshohocken the houses are scattered and very little domestic drainage reaches the river. The principal pollution from this point is the drainage of the two following mills:

Bullock's worsted mill, on the river just above the bridge, scours nearly 5,000 lbs. of wool and 500 yds. of cloth per day, using 400 lbs. best suet and tallow soap; also, in the dye-house, 43 lbs. sumac, 30 lbs. chipped logwood, 14 lbs. copperas and 29 lbs. of all other dye stuffs per day. Privies over leaching vaults near the river bank for 366 operatives.

James Hall's carpet factory, on a small stream, near its mouth, in the lower end of the village, uses 100 lbs. chipped logwood, 21 lbs. copperas, 14 lbs. scouring soap and 14 lbs. soda ash per day. About 3,000 gals. of water from spring on hill used per day in dyeing and scouring. Privies on bank of stream—partly over it—for 43 operatives.

Gulf creek, entering the river just above West Conshohocken, drains the following mills:

Bullock's woolen mill, about one-fourth mile from the river, scours 2,000 lbs. of wool per day and uses 820 lbs. chipped logwood; also 55 lbs. of other dye stuffs of which I could not obtain estimate in detail. Privies for 300 operatives partly over pits in the earth and partly over streams—perhaps two-

thirds directly to the river. Seven tenement houses below the mill have privies over the stream, which had a filthy appearance at the time of my last inspection (Sept. 19, 1884).

McFarland's mill, 1½ miles from the river, uses 100 lbs. extract of logwood per day, besides smaller quantities of other dye stuffs. Privies for 125 operatives over raceway, direct to the creek.

About three-fourths of a mile from the river a dozen houses have privies on the banks—six being near enough to the creek to be reached by high water.

At Spring Mill Station, one mile below Conshohocken, seven houses have privies on the banks of a small stream, and about 20 houses drain in wash water more or less directly.

Mill creek, entering from the right, just below Rose Glen Station, eight miles above Fairmount, drains the following mills:

Stelwagon's paper mill, about one-eighth mile from the river, uses 1,700 lbs. jute butts, 8½ bushels lime, 86 lbs. chloride of lime, 130 lbs. alum, and 21 lbs. rosin per day, when running, and has privies for 14 men over the stream. When last inspected (September 9, 1884,) it had been idle for some time.

A woolen carpet yarn factory three-eighths of a mile from the river; 15 operatives use a privy on the bank of the stream, reached by high water.

Another mill just above the preceding, which had been idle for a long time, has privies over the race-way, used by 60 operatives when in operation.

At a carpet yarn factory, one mile from the river, 50–60 operatives use privies over the stream.

W. C. Hamilton & Sons' Riverside paper mill, on a creek near the river, at Lafayette Station (Norristown Branch of P. & R. R. R.), nine miles above Fairmount dam, uses about 9,000 lbs. of cloth rags per day—cotton and linen worn-out garments, one-fifth foreign and four-fifths domestic. The foreign rags were from Germany at the time of last inspection

(September 6, 1884.) The rags are boiled under a pressure of from 40 to 50 lbs. for ten hours, with 2,200 lbs. caustic lime; then washed and bleached with 440 lbs. chloride of lime. About one-half million gallons of water are used per day. Privies for 100 operatives discharge into the stream. Above the mill, one house has its privy over the stream, two on the bank, and several others near it. This mill is only one-and-a-half miles above the Roxborough Pumping Station, of this Department, and is the worst case of pollution between Manayunk and Conshohocken.

In the upper portion of Philadelphia, on streams entering the river near Shawmont and Princeton Stations, several houses drain wash water and cast garbage into the stream, and two or three privies also discharge into them.

The Seventh, or Manayunk District, comprising all the territory draining into the Schuylkill, between Flat Rock and Fairmount dams, or between the highest and lowest pumping stations of the department, has an area of about 75 square miles, and a population of 50,000, of which 20 square miles and 40,000 population are within the city limits. The valley of Wissahickon creek contains almost the whole of the remaining 55 square miles; this is a farming region with no large villages. The greater portion of the district, even of that part within the city limits, is rural and sparsely inhabited; the bulk of the population occupies a comparatively small territory, chiefly on the steep slopes of Manayunk, and the house drainage of this part of the city, with the manufactory refuse from the extensive mills along the river and canal at that place, and on a small tributary stream at the Falls, constitute the principal pollution. Three special reports on the pollution within this district were made by me during the past year, and published in the Appendix to the Journal of Councils, as follows: On June 21, 1884, a "Report on the quantity and kind of solid refuse along the banks of the Schuylkill river, between Flat Rock Dam and the Wissa-

hickon creek" (Appendix No. 204 to the Journal of the Common Council); on July 3, 1884, a "Report of an investigation of the sources of pollution of Wissahickon creek" (Appendix No. 210 to the Journal of the Common Council); and on September 4, 1884, a "Report on the pollution of the Schuylkill river, between Flat Rock and Fairmount dams" (Appendix No. 120 to the Journal of the Select Council).

The present report combines these three reports with additional information obtained from subsequent investigations.

There are three public sewers in Manayunk, as follows: Through Baker street (from just above Belmont avenue, or Green lane) to Gay street, to Levering street, to Main street, to the river just below Levering street, with branches up Main and Gay streets, down Cresson street, and down Main and up Grape streets—about 2,600 feet in all; through Lyceum avenue (from Pechin street) to Wood street, to Cotton street to the river, with branch up Mechanic to Cresson—about 3,500 feet; and through Main street, from Robeson to Shurs' lane—about 1,330 feet. Besides these a private sewer on the course of a natural brook enters the Baker street sewer just above Oak street, and a natural stream along the upper side of Shurs' lane is used as a sewer by several mills, making in all nearly two miles of sewers which discharge into the Schuylkill at Manayunk. These sewers receive not only the street washings and surface drainage from the greater portion of the most densely populated part of this district, but domestic waste water from more than 1,000 houses (occupied, probably, by over 5,000 persons), either by direct connection or through the street gutters and inlets (beside many others at such a distance from regular channels that most of the water is absorbed or evaporated), and water-closet drainage from about 65 houses, including the city police station, with 25 officers and an average of 7 or 8 lodgers, and many liquor saloons, representing a population of probably over 500 persons who have water-closet drainage into the river through the sewers of Manayunk.

In addition to the above number of houses (1,000) having

wash-water drainage into the river through the sewers, about 300 drain into a brook entering the canal at the foot of Leverington street, and 100 more into other brooks in the upper and lower portions of Manayunk, and into the river and canal directly.

More than thirty mills or other manufacturing establishments in Manayunk drain into the river, more or less completely. About half of them are located on the river-bank, and the remainder quite near it or on small tributary streams. The most common, as well as the most dangerous pollution from these manufactories is the privy or water-closet waste, which, in more than half of the whole number (at the time of my last inspection, in August), discharged directly into the stream. The establishments having such arrangements last summer employ, when running at full capacity, over 2,300 persons. The largest, however, has not been in operation for about a year, and the next largest for six months, while the third largest was ordered by the Court to stop the practice (and is reported by the Board of Health to have done so), so that the number of mill-operatives having water-closet drainage into the river at the beginning of the year was reduced to something less than 800.

After excrementitious matter, the most common pollution is from dyeing yarn and cloth, and scouring wool and woolen goods.

The following is a list of the several establishments having foul drainage into the river at Manayunk, with a brief account of each:

The uppermost is the American Wood Paper Company's mill, situated between the river and canal, about six miles above Fairmount dam. Wood pulp only is made, the following quantities of raw materials being used per day:* 34 cords of wood (mostly poplar), 21,000 lbs. of lime, 12,000 lbs. of soda ash, 4,300 lbs. of chloride of lime, and 70,000 gals. of water. The liquid waste—weak solutions of lime, chlorine

* Average for every day (including Sundays), when running at full capacity.

and soda, with the juice of the wood—is discharged directly into the river, and the solid refuse, chiefly waste lime, is dumped on the river bank above the mill, whence much is washed away by high water. The privies are over vaults (said to be tight), 75 ft. from the canal.

Just below the preceding are Nixon's Flat Rock Paper Mills, using 10,000 lbs. of domestic cotton rags, 16 cords of wood, 10,000 lbs. of lime, 1,700 lbs. of soda ash, 2,140 lbs. of chloride of lime and 2,000,000 gals. of water per day. All the liquid waste runs directly into the river with no purification. Formerly the solid waste also was dumped into the river, together with the ashes from 20,000 tons of coal per year, near the evaporating house, some distance below the mills, but since the first of last summer this solid refuse has been taken to waste land above the mills, between the river and canal, which is reached only by the highest water. The water-closets discharge into leaching brick vaults, about 100 ft. from the river. As there is a constant, though slow, passage of water through the ground from the canal to the river, probably some river pollution results.

Next below is a woolen mill belonging to James M. Preston. The principal pollution is from the dye-house, using 137 lbs. of extract of logwood, 34 lbs. of soda ash and 34 lbs. of blue vitriol per day. Privies for 250 operatives are over leaching vaults within 75 ft. of either the river or canal (some within 15 ft.) so that some pollution of this character is probable.

A. Bacher & Co.'s cotton mill is just below the preceding. In dyeing cotton yarn the following materials are used, the waste from which discharges into the river after running a short distance over the earth: $\frac{2}{3}$ lb. of anilines, 3 lbs. of bluestone, 47 lbs. of catechu, 8 lbs. of chrome, 3 lbs. of copperas, 7 lbs. of indigo, 10 lbs. of extract of logwood, $1\frac{2}{3}$ lbs. of madder, 10 lbs. of soda ash, and 3 lbs. of sumac per day, besides smaller amounts of other stuffs. Until last fall the privies used by about one hundred and forty operatives were on the river bank, down which the excrements drained and were

washed by rains, causing considerable dangerous pollution. The arrangement was then slightly improved by a vault (not tight) under the privies, and it was agreed to have the contents removed. The ash heaps back of the mill contained much vegetable waste matters, dye stuff sacks and casings, paper rags, etc., until washed away by the winter freshets.

The new mill of John and James Dobson, beside the canal, a short distance below the preceding, was claimed to cause no pollution last summer. During the winter of 1883–4 it did the dyeing for the "Rock Hill Mill" of the same firm in West Manayunk, using the following quantities of materials per day: 1 lb. of anilines, 2 lbs. oxalic acid, 3 lbs. ammonia, 21 lbs. alum, 7 lbs. black dye, 77 lbs. chloride of lime, 7 lbs. blue-stone, 11 lbs. bi chromate of potash, 10 lbs. copperas, 2 lbs. crystals of tin, 8 lbs. camwood, 1 lb. extract of quercitron bark, 60 lbs. extract of logwood (solid), 8 lbs. extract of fustic, 4 lbs. extract of sumac, 22 lbs. extract of indigo, 18 lbs. Glauber's salts, 153 lbs. chipped logwood, 16 lbs. limewood, 22 lbs. madder, 2 lbs. oil of vitriol, 36 lbs. sal soda, and 82 lbs soda ash. The dyeing is now done on the other side of the river (outside the city), as will be noted again below.

Just below the preceding is a private corporation gas works (producing during the winter from 50,000 to 60,000 cubic ft. per day for the supply of the mills on the island) which is the source of some, but apparently not very great pollution. The gas is made from benzine by Prof. Low's process, and the superintendent claims that there is no waste. From an inspection of the outlet to the river it appears to be very small in amount.

Another mill belonging to James M. Preston, situated beside the canal just below the preceding, has privies for 100 operatives over leaching vaults six or eight feet from the raceway, which causes, without doubt, considerable pollution.

The "Pekin Mills," just below the preceding and the first on the island above the bridge at the foot of Leverington street, are claimed to cause no pollution, the operations consist-

ing simply of weaving, and the privy vaults being 50 ft. or more from the canal and cleaned two or three times a year.

Several mills are located on a natural stream entering the canal just below Leverington street, as follows:

Stafford & Co., Church and Wood streets, manufacturers of blankets and carpet yarns, had until last summer, privies for 40 operatives over the stream. They have since been removed to stone-lined vaults, at a distance from the stream, but some solid waste—wool dust, etc.—still drains into the brook above the mill.

Andrew Wilson's packing box factory had a privy over the same stream, a short distance below, at the time of my last general inspection, in August.

At Fitzpatrick & Holt's "Canton Mills" (cotton and woolen yarns), over the same brook, at High and Leverington streets, the dye-house waste from 267 lbs. extract logwood, 47 lbs. soda ash, 33 lbs. blue vitriol, 17 lbs. catechu, 3 lbs. chrome and ½ lb. aniline per day, discharges directly into the stream, and previous to last fall the privies for 300 employés were over chutes leading to the same, but since the Court ordered this nuisance abated the Board of Health Inspector reports that tight cesspools have been provided.

Beside the canal, but draining into the river, nearly opposite the mouth of the above stream, is Stelwagon's paper mill, another establishment which was charged in court last fall with polluting the water supply. Formerly all waste from this mill, solid as well as liquid, was discharged directly into the river or thrown down the bank, whence it was washed away. This filth was of the worst character, since the product is coarse wrapping and roofing paper, in making which the rags are not boiled, and much coarser, dirtier stock is used than in the other mills above. The raw material consists of three tons of cloth rags (colored), nearly two tons of shoddy waste and over one ton of paper rags. The solid waste dumped on the bank consisted of materials too coarse to be used, as hats, shoes, corsets, mats, &c., shoddy dust too fine to use and the heavy solids

which fall to the bottom of the machines in which the rags are reduced to pulp. The water closet drainage of 24 men was also allowed to run into the river.

Some time after the order of the Court to abate this nuisance the following changes were made: A dusting machine was introduced, through which all the cloth rags were said to be passed, thus removing much of the dirt which adhered to them only loosely, catch basins were placed in the bottom of the machines to intercept the heavy solid wastes, the waste shoddy-dust and other material unsuitable for use was said to be burned in a furnace provided with a blower, and privies were built over a tight vault. Nevertheless, but little change was noticeable in the character of the effluent stream, of which I collected a sample on January 24 and forwarded to Dr. A. R. Leeds, analyst.

Carlyle Greaves' dye house, a small custom place, just below the preceding, uses about 50 lbs. chipped logwood per day on the average, 10 lbs. Glauber's salts and unknown amounts of other dyes very irregularly, the waste from which goes directly to the river.

The "Crompton Mills," beside the canal, next below, are occupied by J. A. Campbell & Bro. (formerly by Morris & Ott), cotton and woolen yarn spinners, having 12 operatives, and using 43 lbs. extract logwood, 9 lbs. soda ash and 9 lbs. blue stone per day, also other dyes in small quantities and irregularly; Shaw, Ferguson & Bowen, using same materials, but one-third more, and having about 18 operatives; Ripley & Co., weavers, having 53 operatives, but no dye-house; and Watson, weaver, having five operatives. One or two of these firms have dye-houses on the river bank; but the waste water is partially settled and filtered before entering the river, by first flowing into a small basin, enclosed by a stone wall and having an overflow. The water-closet drainage of all the above operatives (88) is discharged into the river. A considerable quantity of shoddy dust, and waste material is dumped on the river bank, just below the dye-houses, probably from these mills.

George Grebe's Blanket Mill, opposite the preceding, on the river bank, scours 137 blankets per day, using 34 lbs. of soap and 9 lbs. soda ash. All waste, including water-closet discharges from 16 operatives, goes directly into the river.

The "Wabash Mill," of James M. Preston, at the lower end of the river road on the island between the river and canal, usually employs about 180 hands in the manufacture of flannels and blankets. When in full operation between 150 and 200 blankets are scoured per day with 43 lbs. of fulling soap and 7 lbs. of soda ash, all waste going directly to the river. Small quantities of mill waste were dumped on the bank, or into the river, back of the mill, and the operatives' privies were over the raceway, from the canal to the river, at the time of my last inspection (August 15, 1884.) Since then the Court ordered the cessation of this pollution, and at about the same time the mill was stopped and has ever since been idle. The Medical Inspector of the Board of Health reports that no change has been made in the drainage arrangements.

The mills of the Winpenny estate, a short distance below the preceding, have been idle for a long time.

A small quantity of refuse has been deposited on the bank from the "Eagle Mill" of Sevill Schofield, Son & Co., between the river and canal, just above the West Manayunk bridge; but there appears to be no regular pollution of note from this place.

The "Ripka Mills" (owned by the estate of R. Patterson), situated on the island between the river and canal, below the bridge to West Manayunk, have been idle since early last fall. It is not known when they will start up. When in full operation they employ about 500 persons, all of whom use water-closets discharging directly into the river. In the manufacture of ginghams and dress goods they dye 1,370 lbs. of cotton yarn per day, and use for coloring 1 lb. aniline dyes, 5 lbs. muriate of antimony, 52 lbs. catechu, 62 lbs. chloride of lime, 7 lbs. chrome, 1 lb. copperas, 1 lb. fustic, 13 lbs. indigo, 3 lbs. indigo auxiliary, 19 lbs. iron liquor, 19 lbs. extract of logwood,

6 lbs. madder, 40 lbs. oil of vitriol, 19 lbs. soda ash, 75 lbs. extract of sumac, 21 lbs. muriate of tin, and 1 lb. turmeric—the waste of all which goes directly into the river.

The river bank in the rear of these mills presents a neater appearance than at any other place at Manayunk. Only ashes are deposited there, and these are leveled, covered with earth, and sodded, year by year.

The City Fire Department Station on the north side of Main street, a short distance above the West Manayunk bridge, had water closet drainage to the canal for 12 men until last fall, when a tight well was substituted.

William McMaster's livery stables, on Main street, below Belmont avenue, have partial indirect drainage into the Main street gutter, and thence to the sewer; also a public urinal near the stable office.

Serwazi & Co., bottlers of weiss beer, porter, ginger ale, and mineral waters, at 131 Grape street, wash between 60 and 80 dozen bottles per day, and discharge all waste-water into the sewer.

At Taylor Spink's shoddy works, on Cresson street below Gay street, the operatives' water closets drain into the street sewer, as also small quantities of dye water. On January 10, 1884, about 20 workmen were employed.

Liebert & Obert's brewery, on Oak street, above Baker street, producing from 35,000 to 40,000 bbls. of beer per year, drains into a culvert back of the brewery. A privy for six workmen is placed directly over the culvert. Sixteen dwellings on the same street have privies over the same culvert.

The water closets at the Philadelphia and Reading (Norristown branch) Railroad Station at Manayunk drain into the river by sewer, and also the City Police Station House, between Cotton and Mechanic, Cresson and Main streets. The latter is occupied by 25 officers and men and had on February 6, 1885, an average of seven or eight lodgers. The same branch of the street sewer running to the Police Station House

receives water closet drainage from several private dwellings on Main street.

The next manufactory below the Ripka Mills, above mentioned, is the Schuylkill Paper Mill, owned by George McDougal, between the canal and river near the foot of Levering street. On January 12, 1884, the foreman stated that the following quantities of materials were used per day, on the average: 1,700 lbs. cotton rags, 3,430 lbs. wood pulp, 366 lbs. chloride of lime, and 43 lbs. soda ash. During the past summer the mill was not in operation and the upper part underwent reconstruction. Back of this part, on June 19, 1884, was a pile of old sackings and mattings, rotten rags, etc.,—foul in appearance—containing about 80 cubic yards, and about 250 yards of waste lime, within reach of high water. Back of the lower portion was about 80 yards of waste lime and a large pile (10,000 yds.) of ashes. At present the reconstructed portion is operated by W. J. Elliot, for the manufacture of manilla wrapping paper. Only jute is used and this is boiled with lime, so that the river pollution is much less serious than formerly. The following is a list of the average quantities of materials used per day: 6,000 lbs. jute, 20 bushels lime, 500 lbs. chloride of lime and 200 lbs. of alum. The privy drainage which formerly discharged into the river is now retained in dry wells.

Next below is the large cotton mill of the A. Campbell estate, which has been idle for a year past. When in operation it employs 700 operatives. The most serious pollution is from the water-closet wells or cesspools, which have an overflow directly to the river. The dye-house waste is more or less filtered by passing through the ash bank behind the mill. The principal pollution from this source is at times of freshet, when the water enters the cellars under the dye-houses and probably removes much of the accumulated deposit. The following list of the principal materials used per day was obtained from the Superintendent on January 10, 1884: 7 lbs. alum, 2 gallons oxy-muriate of antimony, 10 lbs. blue vitriol, 68 lbs. catechu,

66 lbs. chloride of lime, 9 lbs. chrome, 11 lbs. copperas, 6 lbs. fustic (extract), 41 lbs. indigo, 22 lbs. indigo auxiliary, 2 gallons black iron liquor, 52 lbs. lime, 7 lbs. chipped logwood, 55 lbs. extract logwood, 8 lbs. oil of vitriol, 12 lbs. soap, 6 lbs. soda ash, 81 lbs. sumac (bag), 34 lbs. sumac (extract), 15 lbs. tallow and 222 lbs. starch. Back of the mill is a long regular bank of ashes, reached by high water, but hardly in the river channel, and above the mill, near the canal, reached only by very high water if at all, is a deposit of some 70 or 80 cubic yards of chipped logwood.

Sevill Schofield, Son & Co. are the largest woolen manufacturers draining into the Schuylkill above Dobson's Mills at the Falls. At their "Economy Mills," between the river and canal, just above the lower end of the latter and on the river side of the canal, and at the "Blantyre Mills," between Main street and the canal below Cotton street, about 25,000 lbs. of wool were scoured daily, in August, 1884, with 50 lbs. of soap and an equal quantity of soda ash, and all the waste from this process goes directly into the river or canal.

In scouring cloth the following process of recovering the waste products and keeping them out of the river is employed: The scouring machines are emptied into wooden gutters, through which the waste is washed into wooden tanks in an adjoining room and below the level of the floor of the scouring room. In these tanks it is treated with oil of vitriol, causing the oils to separate from the pulp (woolen fibres), and then put in coarse filtering bags of matting for removing the water, which comes out quite clear and tasteless. The oily pulp is next placed under presses and the oil extracted, to be used over again in making soap. The mats (waste solids) are taken away to farms for manure. Thirty barrels of oil per week are thus saved and 6,000 lbs. of manure. The rinsings of the scouring machines are discharged into the river directly, and this, the proprietor claims, is the only pollution from the process. The solid waste from privies is removed to farms, but the urine is caught in barrels and used in wool scouring. In

the dye houses, which discharge directly into the river or canal, the following were average quantities of materials used per day, on January 10, 1884, besides smaller amounts of many others: 143 lbs. chipped logwood, 85 lbs. of extract of logwood, 43 lbs. extract of sumac, 40 lbs. hypernic, 8 lbs. fustic, 11 lbs. blue vitriol, 23 lbs. oil of vitriol, 12 lbs. catechu, 7 lbs. chrome, 13 lbs. copperas, 2 lbs. anilines, 86 lbs. soda ash and 7 lbs. scouring soap.

Back of the "Economy Mills" was, in June, 1884, an extensive (artificial) bank of ashes mixed with small quantities of various sorts of mill waste—principally chipped logwood and other solid waste from the dye houses, and teasels (burrs used in dressing woolen cloth) with wool clinging to them, also small quantities of wool-dust and rags. But these were washed away, apparently by the winter freshets, and the bank at this date is nearly free from organic refuse, except some old lumber, which is to be burned. A small quantity of tin scraps, old oil cloth, old hats, shavings, etc., was found in June beside the abutment of the tow-path bridge, just below the "Economy Mills," but probably dumped there by others than the mill owners. They were removed during the winter, probably by high water.

A small cemetery above Cresson and Penn streets is favorably situated for drainage into the river through the street gutters, being on a side hill and having its lower sides cut down for street and railroad, and unprotected by sod.

Below the lower canal locks, on the river bank, is J. D. Heft & Son's Yarn Mills. A little scouring is done, but the principal pollution is the sewage from 60 operatives, and the dye-house waste from 177 lbs. of extract of logwood, 67 lbs. of soda ash, 50 lbs. catechu, 43 lbs. indigo, 26 lbs. anilines (principally scarlet), 17 lbs. blue stone, and between 100 and 200 lbs. per day of other dye stuffs. [Average quantity per day in January, 1884.]

The mill of David Wallace & Son, just below the preceding, when visited on January 12, 1884, was said to scour a little wool—33 lbs. a day—and do some dyeing, using 35 lbs. of

extract of logwood, 17 lbs. blue vitriol, and small amounts of other dye stuffs. The waste from both of these processes goes directly to the river.

The four following mills on Shur's lane drain into the river through the street gutter, or natural streams, which are covered in the lower portion :

Rice & Bean, manufacturers of woolen spun yarns, on the northwest side of Shur's lane, above the railroad, dye about 1,000 lbs. per day, using 96 lbs. of extract of logwood, 14 lbs. soda ash, 14 lbs. blue vitriol, 1 lb. chrome, and small quantities of anilines. All sewage, including excrements from 30 operatives, goes to the river (about 800 feet) by a culvert having a steep grade. (Last inspection in August, 1884.)

Morris & Ott have recently started a new mill just above the preceding, but it is not yet fully in operation. Privies for 19 operatives are over the same brook, above mentioned; but it is designed to dig a vault as soon as the spring opens and abolish the old arrangement.

J. Leach & Bro., manufacturers of cotton and woolen goods, on the northwest side of Shur's lane, about one-third mile from the river, dye 600 lbs. of cotton per day, using 70 lbs. of extract of logwood and a little chipped logwood, 18 lbs. vitriol, and 17 lbs. soda ash; also 7 lbs. catechu per day for three months in the year. About 100 operatives are employed, all of whom use privies over a well receiving roof water, and having an overflow to a small brook. The dye-house waste runs in the street gutter most of the way to the river. (Last inspection in August, 1884.)

T. Kinworthy & Bro., just above the preceding, scour 1,540 lbs. of wool per day, using 46 lbs. of soap and 13 lbs. of soda ash. The waste water from this process runs in the street gutter most of the way to the river. Privies for 80 operatives are over the same stream as the preceding.

Flanigan's ("Freeland") Mills, (spinning), above the preceding, give employment to about 40 operatives, who use privies over the same brook referred to above. Just above the mill

considerable quantities of waste material—short fibres and dust—partly rotten, have been deposited on the banks of the brook, into which more or less of the foul matter is washed by every rain. (Last inspection in August, 1884.)

The "Albion Dye Works" (G. J. Littlewood & Co.), on Main street below Shur's lane, is a large custom dye-house, coloring about 5,000 lbs. of cotton and some wool, and using 600 lbs. of liquid extract of logwood, 200 lbs. of catechu, and 2 lbs. of aniline dyes per day, liquid waste from which goes directly to the river. The dye-tub sediment—said to be about only one cubic yard per year—is dumped on the bank; also an unknown quantity of dye stuff casings, mats, and sacks. About 7 cubic yards of the latter, which had been dumped over the river wall, opposite the works, remained above high water on June 19. Probably much had been washed away by high water.

The Superintendent of the City Gas Works, just below the preceding, claimed, on June 20, 1884, that no waste entered the river from the works when in operation. (At that time the gas was pumped from the city.) Nevertheless, after the works were started again in the fall, a considerable quantity of tarry matter was found to be running into the river under the corner of Hey's mill, opposite, which undoubtedly came from the gas works. In the summer a large pile of waste lime remained on the river bank, opposite the works, more or less of which was washed in by heavy rains, which also wash out old deposits of coarse waste products of a tarry nature which have been buried in the bank.

Below the Gas Works, on the same (N. E.) side of Main street, is A. Platt & Bro's cotton and woolen yarn mill. Liquid waste from dye house (using 130 lbs. logwood, 60 lbs. catechu, and 3 lbs. aniline dyes per day) runs in the street gutter a short distance to the sewer inlet.

Opposite the above (on the river side of Main street) is Richard Hey's "Progress Mills"—woolen yarns. The waste from scouring 257 lbs. of wool per day, with 4 lbs. of soda

ash and 21 lbs. of soap, goes directly to the river. The dye house waste water (from 17 lbs. chipped logwood, 2 lbs. aniline dyes and a little catechu) is partially filtered by flowing through the cellar wall. The privies for 90 employés are on the river banks, and are reached by high water.

Just below Platt's mill is J. P. Holt's cotton yarn mill, having a sewer direct to the river, taking water-closet drainage (50 operatives) and liquid waste from a dye house, which was using, on January 12, 1884, an average of 17 lbs. chipped logwood, 17 lbs. soda ash, 17 lbs. blue vitriol, 3½ lbs. aniline dyes and 7 lbs. catechu per day.

The following, in reference to heaps of refuse on the river bank near this point, is from my report of June 21, 1884:

"A short distance below Richard Hey's Yarn Factory is a large and rapidly increasing pile of ashes and other refuse, extending more than sixty feet into the river bed. This is open to the street, and is a common dumping ground for those manufacturers who have not a convenient place adjacent to their own premises, and for oyster dealers and the street cleaning contractor for that district. The largest pile contains, approximately, 7,000 cubic yards, principally coal ashes, but with large quantities of oyster shells, wool and cotton dust and waste, and many other kinds of refuse. Below this is a long and narrow pile, beside the street, containing about 350 cubic yards of oyster shells, wool and cotton waste, etc. All this refuse has been deposited within five years. Near the upper end of the large pile are two or three small wooden buildings where Coates, Mills & Co. manufacture cotton and woolen waste (for cleaning machinery and for packing boxes) from refuse cotton and wool from the mills. From this process results about one-half cubic yard per day of short cotton and wool fibres and dust, which is dumped down the ash bank toward the river. This establishment has been in operation only fifteen months. J. P. Holt (cotton mill, just above) dumps ashes here—about one-half cubic yard per day—about four cubic yards of sediment from dye-tubs during a year, and an

indefinite (small) quantity of mill waste of various sorts. One of the employés of John Anderson, Street Cleaning Contractor for the Twenty-first District, stated that about fifteen cartloads, per day, of street sweepings were dumped here regularly. A part of the ashes from the Albion Dye Works (G. J. Littlewood & Co.), amounting in all to about two cubic yards per day, are dumped here, and about one cubic yard per year of dye-tub sediment; also, during the winter, one cubic yard of ashes per day from A. Platt & Bro's Mill, and small quantities of shoddy waste."

Shortly after the publication of the above, notices were posted at this point forbidding the deposit of refuse along the highway, and the street cleaning contractor stopped dumping here. But deposits of mill waste and other refuse continued to be made on the great dump below Coates, Mills & Co.'s works, and are apparently still made at this date.

"A heap of refuse dumped over the river wall opposite the Albion Dye Works, contains about 17 cubic yards of dyestuff, sacks, and matting, together with small refuse,—sweepings, etc. Probably the greater portion of this will be washed away by the next high water.

"Just below Richard H. Patton's Machine Shop, at the foot of Shur's lane, is another common dumping ground for ashes and refuse from the neighboring mills, oyster shells, etc. The pile here contains about 650 cubic yards, mostly ashes, with a few yards of cotton and woolen mill waste, oyster shells, etc." (Report of June 21, 1884.)

On Main street (the river road), a short distance above Wissahickon, are the "Enterprise Mills" of Hutchinson & Ogden, manufacturers of woolen yarns. One thousand pounds of raw wool are scoured here per day, with about 45 lbs. of soap. All the waste from this process goes direct to the river by drain under the street. This is claimed to be the only pollution. The privies are over dry wells not connected with the river. On the river bank was (in June) a small pile of refuse—teasels, yarn, sheet iron, etc.

A small brook entering the river a little way above this mill drains a small slaughter-house (two or three cattle a week) situated near it, about eight hundred feet back from the river. The liquid waste runs through small piles of manure, one close to the stream.

At West Manayunk (Montgomery County), the principal pollution is from the four following mills:

Dobson's "Rock Hill Mill" is the highest, on Gully Run. The principal waste here is from cloth scouring or fulling, and this is treated with chemicals, precipitated and partly filtered, before being turned into the stream, in order not to render the water unfit for the use of the paper mill below. The manager claimed on January 7, 1884, that all the privies were over wells, the contents of which were removed to farms, but I saw one over the stream, in use on August 11.

A short distance below, or a quarter of a mile from the river, on the same stream, are the "West Manayunk Worsted and Woolen Mills," of Schofield, Mason & Co., having one hundred and ten operatives, all of whom were using privies over the stream on August 11. The waste from scouring 857 lbs. of wool per day, with 8½ lbs. of soap and a little soda ash is carried by pipe to below the dam of the paper mill. Above the mill is a large heap of rotting wool or cotton waste on the bank of the stream, and below it ten houses drain in wash water, and six have privies over the stream.

The "Ashland Paper Mill" is near the mouth of the same stream, into which it drains all liquid waste from the usual treatment of 4 cords of poplar wood and 430 lbs. of old newspapers with 1,666 lbs. of soda ash, 733 lbs. of chloride of lime, and 3,000 lbs. of lime. There are eighty operatives, one-half of whom use privies over the stream. The waste lime is dumped on the bank at the mouth of the brook and much is washed away. The pile remaining in June contained about 1,600 yds. which was being increased at the rate of more than 2 yds. per day.

A short distance below is an old mill, now used by the

Messrs. Dobson as a dye house. The quantity of materials used is probably at least twice as great as the list given above as having been used in January, 1884, at the mill in Manayunk, since the latter mill has been started in the meantime. The appearance of the stream from this place as it flows down the river bank is very filthy—much resembling that at the Falls, though not so extensive. Opposite the above is a small cotton waste factory belonging to H. Dougherty, from which small quantities of shoddy dust and some coarser material are dumped on the bank close to the water.

A short distance above the paper mill was a hog-yard, containing in June about 25 swine, on the river bank; but this had been abandoned before the August inspection.

Two houses near the railroad just above West Manayunk Station have privies over a small brook to the river. A few other houses above here drain wash-water and cast considerable refuse down the river bank.

Along the bank below here there are only small piles of ashes from the houses on the river road, and a little other house refuse. The presence of the canal tow-path on this side prevents any considerable deposit directly on the river bank.

A considerable portion of West Laurel Hill Cemetery is favorably situated for drainage into the river, by reason of the stream that flows along its lower side. At the foot of this stream are the Pencoyd Iron Works, from which the pollution is very slight, but about twenty tenement houses back of the works, beside the stream, discharge all waste water and small garbage directly into it; the privies are also near it, and probably give considerable pollution by filtration.

On a stream entering above the cemetery, and draining the upper side, is a small mill having a dye house, but the pollution from it seems very slight.

Above the iron works, about one hundred houses on or near the river bank—most of them on the opposite side of the road running along the river—discharge more or less waste water and garbage into the river or on the bank. About half a dozen

have privies on the bank, but all are so high as to be reached, if at all, only by the highest freshets. There are about the same number of small stables, with manure heaps draining down the bank.

The following in regard to "Riverside Mansion"—a day resort and stopping-place for teams passing from the East Park to Wissahickon drive, having grounds bordering the river just above the mouth of Wissahickon creek, and containing the upper landing of the Fairmount and Wissahickon steamers—is from my report of September 4:

"This resort is extensively patronized on hot summer days, sometimes by more than six hundred people in one day. Not only does all wash and waste water from this place go directly to the river by pipe, but also the waste from the men's urinals and water-closets. This place is only about two and one-half miles above the Belmont Pumping Station, supplying West Philadelphia, and three and one-half miles above the Spring Garden Station, supplying the largest portion of the city proper. In view of these facts, and of the probable manner of life and habits of the people frequenting this resort, the home surroundings of many of whom are probably very insanitary, thus impelling them to such a place, especially in the first stages of illness, and the facility with which the germs of zymotic diseases are transmitted by drinking water, it seems to me one of the most dangerous sources of pollution within the limits of this investigation."

The proprietors of this place, Messrs. G. & C. Soulas, were afterward convicted of maintaining a nuisance, since which the Medical Inspector of the Board of Health reports that a well or cesspool for water-closet drainage has been made.

The investigation of the sources of pollution of Wissahickon creek was made chiefly between June 24 and July 3. The information was obtained by a personal inspection of the creek from very near its source to its mouth,—following the main stream, on the banks or by the nearest road, noting the appearance and taste of the water in most of the tributaries, how-

ever small, and going up such as showed evidences of pollution or on which it could be learned that there were any special sources of contamination.

Above Ambler Station (North Penn. R. R.), in the west end of Upper Dublin township—about ten miles from the source, and twelve from the Schuylkill—no special sources of pollution were discovered except two creameries, one at North Wales and one at Spring House. The former is quite small and at a distance from the creek, and probably most, if not all the organic matters in the small amount of waste liquid are oxidized by flowing through the meadows. That at Spring House (Gwynedd township) is beside a small stream flowing into the Wissahickon, one-and-a-half miles below. This does a large business (8,000 to 9,000 lbs. of milk per day), but the proportion of waste is unusually small since the cheese whey is run into a tight well and thence pumped out and removed by farmers. About the only waste entering the stream is the rinse and wash water, and this contains so small an amount of milk and cream as to give little or no offense in the brook a few rods below the point where it enters.

Farm lands border the creek and its tributaries throughout most of its length above the city, but near the sources the soil is not so highly cultivated, so that there appears to be little pollution from fertilizers in that portion.

Considerable grazing land appears in the upper portion of the water shed, and trees and bushes are allowed to grow along the stream more than in the lower portions. The earth consists largely of "red shale," causing a very muddy condition of the water after heavy rains. Even after long absence of rain the water is not clear, having a clouded, milky appearance when seen in a glass. The course is quite winding, and the bed broad, making a shallow and somewhat sluggish stream in summer. Brown *algæ* cover the rocks which appeared to a greater or less extent in the bed at most of the points examined. Still, the taste of the water continued quite pleasant

as far down as the eastern corner of Whitpain township, where a small branch draining the vicinity of Ambler Station enters.

This stream receives the drainage of a tannery, a hotel stable, and the hotel and railway station water closets. The tannery, owned by A. D. Faust & Sons, is located about three-quarters of a mile above Ambler Station, and a little over a mile from the creek. About one hundred hides per week for the most of the year are tanned here; also about two hundred dozen calf skins during the year. The hides are mostly from Philadelphia—from Western cattle slaughtered here. Animal matter from the hides are deposited on the bank all the way to the village (three-quarters of a mile), causing an unpleasant odor (noticeable only a few feet from the stream) in hot, dry weather. The bed of the stream is also blackened by the action of the bark liquor in combination with the lime used in the process of tanning.

Between the tannery and the railway station one private residence drains into a loose rock-lined cesspool on the bank of the stream, and two or three other houses drain wash water into it more or less directly—generally over the ground for several rods.

The hotel stable (Godfrey's) and privies are built over this brook, and drain into it directly. The proprietor claims that there is not usually more than one horse in the stable, and that the summer population of the house does not exceed fifteen. The North Penn. Station Ambler also has its privies over the stream.

The chemical works of Keasby & Mattison, situated near Ambler Station, are the sources of the most extensive pollution of the Wissahickon above the city. Their principal products are sulphate of quinia and carbonate of magnesia; also, a few iron salts, bromide of quinia, etc., and the waste principally sulphate of soda (average 350 lbs. a day), and a smaller quantity (10 to 25 lbs.) of carbonate of soda, carried away by water, of which about 150,000 gals. per day are used, on the average. Carbonate of lime (3,000 lbs. a day), another waste

product, is dumped in out-of-the-way places, frequently beside the streams; but as this is nearly or quite insoluble, it does not affect the water. The waste water containing the sulphate and carbonate of soda runs in an open ditch about eight hundred feet to a small meadow brook, from which it overflows considerable pasture land on the way to the Wissahickon, about two thousand feet farther, the vegetation in its course being largely destroyed by the carbonate of lime.

At the mouth of the brook, a rough gauging showed an approximate flow at the time of the inspection of 100 gals. per minute. At this point the Wissahickon is divided into several channels, into the smallest of which the brook from the chemical works empties and flows for half a mile, very sluggishly, in a muddy bed obstructed by weeds, before entering the main stream. Yet the peculiar taste is quite perceptible in the main stream some distance below, even at times of quite high water.

Below Ambler the farms are more highly cultivated; large herds of cows and horses are occasionally seen in pastures beside the streams, a few farm houses are situated quite near the creek, causing some pollution from the washing of yards by heavy rains, and one or two privies were seen on the bank; but no serious pollution was discovered above the city limits. Limestone is quite common through Whitemarsh township, and kilns are frequent near the creek.

The most offensive and apparently most serious pollution comes from within the city limits, and considerable even from the Park. Near the right bank of the stream just within the city limits is a Catholic seminary for young ladies, called "Mt. St. Joseph's Academy," which had the following drainage arrangement as late as October 31: All water-closets and baths for a population of about 130 drain into a tight cesspool having no ventilation except through an overflow to the creek—about 1,000 ft. distant. This cesspool was built two years before and had never been cleaned. The drain from the kitchen sinks entered the cesspool overflow pipe. The bedroom basins

discharge into a separate pipe running to within 50 ft. of the creek, beyond which point the water runs in an open ditch. Thus all liquid waste entered the Wissahickon.

Four hotels on the Park drive along the creek, viz.: Indian Rock Hotel, Valley Green Hotel, Maple Spring Hotel, and Nippin's Wissahickon Hall drain all wash and waste water directly into the creek, and two—the Valley Green and Maple Spring—have privy drainage. The particulars of the pollution from these houses are as follows:

"Indian Rock Hotel." Pipe drain to creek takes all liquid waste, including that from urinals; much refuse dumped on bank—old shoes, oyster shells, matting, broken bottles, brooms, paper, tin, etc.; chicken coops, dog kennels, and hog yards (five swine) on bank; also, large manure pile, unprotected; feathers from picking fowls scattered over bank.

"Valley Green Hotel." Privies over a little brook, nearly dry most of the time, but excrements thoroughly washed into the creek by heavy rains; hog pen and chicken house near the above brook; all sink and waste water directly to the creek, washed in by overflow from watering trough; oyster shells and other garbage on bank of creek; unprotected manure pile and chicken coops near top of bank.

"Maple Spring Hotel." All wash and waste water direct to creek by small brook running under privies and washing in all excrementitious matter.

"Wissahickon Hall." All wash water direct to creek; much kitchen and restaurant garbage—lemon skins, oyster shells, etc.—on bank of brook, entering the creek above the house.

"High Bridge Mansion," on Ridge avenue near the mouth of the Wissahickon, was said to drain all liquid waste, including that from urinals, into the creek through a 15-inch pipe sewer; this discharges some distance above ordinary low water level and causes noisome odors in hot weather.

"The Wissahickon," a very large new hotel near the Chestnut Hill branch of the Pennsylvania Railroad and Springfield

avenue, has a complete drainage system connected with the creek. The sewage is first received by settling-basins, from which the liquid portion runs through about 2,000 feet of tile pipe to a small tributary of the Wissahickon creek. Although this house has been open only a short time, the discharge at the mouth of the sewer was quite offensive; the sewage probably contains much organic matter. [Since the above was written, work has been commenced on a sub-surface distribution system which will probably mitigate the evil.]

After the above, the worst pollution within the city limits is on Cresheim creek (tributary of the Wissahickon). Near its source it receives considerable pollution from several houses on Germantown avenue, just above the crossing of that street, chiefly the washing of filthy back yards. One privy with loose stone vault is directly on the bank of the stream, and two others have open ditches (about 60 feet long) running to the brook to drain off the excess of liquid matter. Clark's Mermaid Hotel, Germantown and Mermaid avenues, discharges wash and waste water into this brook.

On Cresheim Creek, below Germantown avenue, is a shoddy mill, owned by David Hey. The process is a dry one, tearing up carpet rags and spinning carpet yarn; but large quantities, 200 to 300 lbs. a day, of light dust and short wool and cotton fibres, very dirty, are dumped back of the mill beside the creek, on a pile now amounting to about 40 cubic yards. The grounds about this mill are very filthy, and several houses contribute much pollution to the stream, three having privies with shallow loose stone vaults close to a small tributary of the creek, and throwing kitchen waste near the banks. A privy for the mill operatives is also situated on the bank of the creek, the vault being of loose stone and probably reached by high water; many geese and ducks swim in the pools near the mill. The same man is about building another mill (to tear up carpet rags) below the preceding, under the Chestnut Hill branch of the Pennsylvania Railroad. Two houses near old mill ruins below Thirty-fifth street, on Cresheim Creek, have

privies directly over the water in the pool, and three or four others on the banks, very near the water.

On a small creek entering the Wissahickon, at Gorgas lane, are 2 small dye-houses, that of Carmany & Boone, situated just outside the park boundary, being the largest. About 1,800 lbs. of cotton per day is dyed here (mostly brown and black) by logwood and catechu; about 85 lbs. of the former and 100 lbs. of the latter are used per day. They also dye some blue and violet.

A. M. Haley & Bro., a short distance above on the same stream, dye about 1,000 lbs. of cotton per week. But little information was obtained from the latter, but they appeared to use a larger proportion of bright color than the firm below. Both places discharge their waste water directly into the stream; this colors the stones and bottom of the bed, producing the appearance of colored water even when it is quite clear.

Some pollution comes from dwellings near Rittenhouse Creek and its smaller tributaries, the most serious being from 5 hog pens near the bank below Wissahickon avenue. A large quantity of green water that had apparently been stagnant a long time was being pumped from a quarry near the same place at the time of the inspection.

Along the bridle path on the lower Wissahickon much kitchen refuse is scattered by picnic parties, and most of it probably goes into the creek; also the washings from the drive and much other foul refuse not apparent in an inspection covering so short a time. Probably dead animals are sometimes thrown into the stream, but none were discovered. A considerable portion of Ridge avenue, on either side of the Wissahickon has gutter drainage into the creek, but the amount of house waste water discharged into the gutters is not sufficient to keep up a constant stream; however, much solid matter is deposited and washed in by the first heavy rain.

Below the mouth of the Wissahickon the park borders the river on both sides, all the way to Fairmount dam, and the

polluting matters entering this lower portion are for the most part brought in by small tributary streams.

Powers & Weightman's chemical works, near Ridge avenue, above the Falls bridge, have an independent sewer to the river which carries, along with considerable condensed steam, small quantities of chemicals. The principal products of the works are alum, oil of vitriol, green vitriol (copperas), and tartaric and citric acids. The Superintendent claimed that the only waste was from the rinsing of carboys, and an occasional breakage of a carboy. This information being unsatisfactory, I collected a series of six samples, on July 21 and 22, from the mouth of the sewer, and forwarded them to Dr. A. R. Leeds, of the Stevens Institute of Technology, for analysis. Three or four dwelling houses, on the lane leading to the upper works, drain waste water into the stream flowing to the river. The new quinine works above the preceding, near School lane and the Norristown Railroad, were found to have practically no drainage to the river.

At the foot of Mifflin street, Falls of Schuylkill, a small natural water course enters, bringing the wash water drainage from about 155 houses below the Norristown Railroad quite directly—generally over the sidewalk to stone gutters, or through wooden drains—and many others less directly, where water runs over the ground for some distance in no regular channel, as, for example, from ten houses on the east side of James street, just below the Norristown Railroad, from the rear of which the ground has a steep slope to one branch of the brook about 100 feet distant, the privies of these houses being situated on the extreme edge of the bank, down which is thrown much garbage and waste water. Such conditions permit river pollution only during and shortly after heavy rains. An ice pond just above the railroad on the same branch, serves as a swimming bath for many small boys in summer, and just above it are two stables and a hog-yard, near the stream and draining into it more or less completely.

One brewery (J. Stein's), having a yearly product of 2,500

barrels, drains into this brook, and another when in operation, but not now running. From just above the railroad, a short distance above these breweries, to Ridge avenue, this brook runs underground through a culvert or sewer. Stein's brewery had a privy over this culvert, also one dwelling; and ten dwellings near the railroad on Wiehle street drained water-closet waste into it as late as February 6, 1885. Above the railroad, about sixty houses drain wash-water into the same brook—mostly through wooden culverts and sandy street gutters. One house on the Park drive drains all wash-water into the same stream; and a stable, for three horses, is situated nearly over it.

Odd Fellows Hall, containing on the first floor the City Police Station of that district (occupied by six men all the time), and one or two shops, is located beside the same stream on the southwest side of Main street, and has a privy well in the back yard, separated from the culvert only by a loose stone wall. Into this well the police station water-closets drain, and from it into the river through the culvert. The other tenants of the building have the same arrangement, and on the occasion of fairs in the hall many people use the privies in the yard over the same cesspool.

The Park here consists of little more than a roadway beside the river bank, and consequently is no protection against the drainage of liquid wastes into the river. Several small "hotels," (beer saloons) viz.: "Wm. Stehle's," "Leon, Jr.," "L. Tissot's Fountain Park," and "Seitz's Falls Hotel," also, a boat club house and seven dwelling houses, between the Park drive and Ridge avenue, above Dobson's run, drain all waste-water into the river, either directly by pipe sewer, or through the gutters to the storm-water culverts under the roadway.

The principal sources of contamination at the Falls are the extensive carpet, blanket, and cloth mills of John & James Dobson, situated a short distance back from the river, on a natural water course commonly called "Dobson's run," which furnishes water for the mills, and carries the waste matter to the river. The principal pollution is evidently from dyeing

and wool scouring; whether there is any other I cannot with certainty say, having been denied permission to inspect the mills. The proprietors claim to remove all water-closet waste to farms for manure, and to use a process for recovering the oil employed in scouring cloth. How carefully and fully this is done I am unable to state, but the appearance of the stream at its mouth beside the Park drive is certainly very repulsive, often attracting the attention of parties driving past, and indicates a striking if not serious case of pollution.

In order to measure the amount of this filth, and to determine its composition, I built a weir near the mouth of the run, on the Park property (by consent of the Superintendent), and collected samples of the water to be analyzed by Dr. A. R. Leeds, of Stevens' Institute.

While it is impossible to determine the actual pollution by this means except an infinite number of samples be taken, on account of the great variety and constant changes in the character of the waste, I believe that those samples fairly represent the average flow during the daytime, especially Nos. 1 and 2. No. 3 was taken just after the midday recess, and seemed to consist principally of dye-house water with little or no wool scouring waste.

When sample No. 1 was taken about 70,000 gallons per hour of this filth were flowing into the river, or 700,000 gallons in the ten hours per day during which the mills are in operation. This I have found to be about the average dry weather flow during working hours. During the first part of the night, while the storage reservoir above the mills is filling up, the flow falls to less than half that quantity. The stream below the mills does not then assume the same purity as above, as some might suppose, but continues very foul even till the mills start up again in the morning, on account of the long bed of semi-liquid filth through which it flows. Observations in the early morning, after the reservoir is full, and before the mills start, show that the corresponding natural flow of the stream is about 38,000 gallons per hour,

or 912,000 gallons per day. The natural character of the stream above the mill is shown by the analysis of the sample taken (at about the same time as No. 1, at the weir) from above the reservoir. Over 60,000 gallons per hour of the liquid represented by No. 2 was flowing into the river when that was taken, and about 27,000 gallons of No. 3.

Some idea of the great extent of the pollution from these mills may also be obtained from the following list of the quantities of material used per day, as obtained from the office of the proprietors in January, 1884. The quantity of dye-stuffs and chemicals given are, approximately, one three hundred and sixty-fifth of the amount actually used during one year.

45,000	pounds of	wool scoured.
500	"	tallow (used in soap for scouring.)
11	"	acetic acid.
19	"	muriatic acid.
31	"	oxalic acid.
3	"	tartaric acid.
88	"	alum.
64	"	aniline dyes.
27	"	butter of antimony.
235	"	aqua ammonia.
42	"	aqua fortis.
674	"	archil liquor.
24	"	barwood.
90	"	bi-chromate of potash.
33	"	black dye.
12	"	blue stone (blue vitriol).
3	"	borax.
245	"	brimstone.
9	"	camwood.
124	"	caustic soda.
17	"	cochineal.
7	"	copperas.
16	"	cream of tartar.
27	"	crystals of tin.
8	"	cud-bear.
24	"	cutch (catechu).
247	"	extract of bark (quercitron).
80	"	extract of fustic.
19	"	extract of indigo (acid).
165	"	extract of indigo (neutral).

22	pounds of	extract of logwood.
11	"	extract of logwood (liquid).
192	"	extract of sumac.
4	"	flavine.
7	"	fuller's earth.
47	"	chipped fustic.
2	"	gambier.
715	"	Glauber's salts.
60	"	gum substitute.
69	"	hypernic.
32	"	indigo.
3	gallons of	iron liquor.
1	pound of	litharge.
2,351	pounds of	chipped logwood.
26	"	madder.
3	"	muriate of copper.
3	"	muriate of iron.
3	"	muriate of tin (double).
16	"	muriate of tin (single).
3	"	nutgalls.
505	"	oil of vitriol.
82	"	Paris white.
36	"	pipe clay.
3	gallons of	red liquor.
2	pounds of	red sanders wood.
344	"	sal soda.
349	"	soda ash.
66	"	sumac.
4	"	turmeric.
10	"	yellow prussiate of potash.

The same stream also receives wash water and other liquid refuse from about twenty houses on the north side of Ridge avenue, under the back yards of which the run flows in a culvert, and water closet drainage from three of them (having 15 occupants); wash water, kitchen and other garbage from three houses beside the uncovered portion between the mills and the river, and privy drainage from one of them (having six occupants); the liquid waste from a slaughter house, between Ridge avenue and the Park drive (slaughtering four cattle and one calf per week), as well as the drainage of a manure pile at the same place, on which is thrown some of the offal; the

drainage of a hog pen, adjacent to the slaughter house, containing, at time of inspection, four swine; some wash water from about twenty houses east of Ridge avenue, near the railroad, draining into the run, opposite the mills, through shallow channels on the surface of the ground from which the liquid is largely absorbed or evaporated leaving the solid organic matters to be washed in by the first heavy rain; and more or less house waste water from an indefinite number of dwellings on Ridge avenue, flowing in at the intersection of the stream with that street, together with the street washings from about half a mile of Ridge avenue at the time of rains.

Above the mills, Dobson's run appears to be quite a pure stream, receiving no pollution of note, except the drainage of a large pile of rotting wool waste from the mills. It drains a considerable territory, mostly grass and wood lands, with few houses near its course.

Between the Falls and Girard avenue, there is no special source of pollution on the left hand side, except from the Park buildings—Woodford House, and Strawberry Mansion—which have cesspools with overflows to the river—about to be cut off however—and the extensive cemeteries occupying the steep slopes below the Falls. No special investigation was made to determine the extent of the pollution from the latter source.

Just below Girard avenue bridge and the Spring Garden Pumping Station is the mouth of a public sewer, built many years ago on or near the line of a natural water-course from above Thirty-first and Master streets. It formerly drained entirely the extensive breweries of that vicinity, but after the extension of the Pennsylvania avenue sewer to a point near Thirty-third street, all foul waste connections with the old sewer were ordered to be cut off; but repeated efforts to enforce this order had not been wholly successful, as was evident from the vile appearance of the outflow. By your instructions, I explored this sewer from the mouth to its source, on August 23, 1884, under the guidance of Mr. J. K. Little, of the Survey Department, Engineer in charge of the construction of sewers. At that time the lower portion consisted of a 6 ft.

and 5 ft. circular brick tunnel (except opposite the forebay of the pumping station, where a plank culvert had been temporarily placed), and owing to imperfect grade there was a deposit of gravel and silt, saturated with filth from the breweries, two feet in depth in some places, and averaging more than a foot in depth. A small stream, entering opposite the upper end of the old pumping station, was clear at that time, and the Engineer of Sewers stated that it was from springs, and received no brewery waste. Three foul discharges were found. The first was under or opposite the brewery of J. & P. Baltz. The flow at the time was small (six or eight gallons per minute), and not very foul, apparently the rinsing of kegs or vats. Much more filthy in appearance was a larger stream (perhaps fifteen gallons per minute) under or near the grounds of G. F. Rothacker & Sons, brewers. The third discharge was just above this, and probably from Rothacker's brewery also, consisting apparently of condensed steam mixed with a small quantity of brewery waste. The source of the small stream flowing through a stone and plank culvert into the upper end of the sewer was not determined, since, from lack of ventilation, the amount of oxygen was too small to support combustion in lamps, or to sustain life long enough for a thorough examination; but it is my belief that the most, if not all, comes from springs or by filtration from a natural water-course, which has been diverted just above this point into a branch of Pennsylvania avenue sewer.

A second examination of this sewer was made on February 26, when more brewery drainage was found coming in than before. There seemed to have been an attempt made to close three inlets in the crown of the sewer, by inserting thin wooden disks (like valves), fitted in with coarse cloth; but none were tight, as was shown by small quantities of water flowing in at each, and one disk (or valve) had been opened, evidently by a heavy fall of water on one side. The same inlet was discharging a large volume on my return (down the sewer), so great as to be heard several hundred feet away. Hastening to it as rapidly as possible, I measured the flow (by means of a

bucket brought in for the purpose), and found it to be about 60 gallons a minute. It soon decreased in volume, and this flow may not have been the maximum. The character of this discharge was very foul, sour to the taste and smelling strongly of spoiled beer. The smaller flow, observed on going up, was less offensive. All of these three large inlets in the crown of the sewer were under or opposite the J. & P. Baltz brewery.

The other discharges discovered in this second inspection (February 26) were as follows: About five gallons per minute of milky water, slightly sour, opposite Bergner & Engle's brewery; a small flow of nearly clear water from a very foul looking inlet opposite Arnholt & Schaffer's brewery, and two inlets evidently from George F. Rothacker & Sons' brewery—one flowing about one gallon per minute of very foul water and the other warm water (condensed steam), slightly sour.

Since the first inspection the lower portion of the sewer from the old pumping station to a point past the new intercepting (Manayunk) sewer had been rebuilt with three feet section having sufficient and regular grade, so that there was no longer the collection of filthy mud above referred to, though some remained in the old part a short distance above the new.

A gauging of the flow at the outlet of the sewer on February 28, 1885, gave a volume of about 200 gallons per minute or 288,000 gallons per day, of which considerable is underdrainage through the sides of the sewer, which are not water tight. This condition favors additional pollution, other than the direct admission of foul waste liquid. The walls of the sewer opposite the breweries were thickly covered with slime, showing the passage along the outside of the tunnel through the earth of much foulliquid. This is also the case under Bergner & Engel's stables which are thus indirectly drained into the sewer.

[Supplementary.—March 13, 1885. In accordance with your instructions I have made to-day a third inspection of the Girard avenue sewer to ascertain the result of the work of the Board of Health in cutting off the foul drainage into the river from this sewer. Just above the manhole at Thirty-second street and Pennsylvania avenue a bulkhead of brick and cement had

been built in the tunnel, stopping entirely the flow through the sewer at that point. But water was flowing in through the walls just below in quantity apparently nearly as great as before. The water, having been filtered in passing through the earth around the bulkhead, was much clearer than before, but still had a decided odor of brewery waste. All inlets to the sewer above this point having been closed according to the specifications of the Board of Health, I could make no inspection of the work above—other bulkheads and closed inlets.

March 16. In a fourth inspection of the Girard avenue sewer to-day I discovered that the branch sewer entering opposite the old pumping station, and said by the Engineer of Sewers to have no connection with any breweries, was discharging water having a decided odor and taste of brewery waste. I am informed by Inspector William May, of the Survey Department, that this has direct connection with breweries on Thirty-third street. In his inspections of last fall he had often found it discharging brewery waste. The discharge from these breweries is not constant, and the sewer is so smooth and well graded that little or no sediment is retained long after the foul flow stops, which accounts for the clear water without suspicion of foul drainage in my first inspection. A public sewer, connecting with Pennsylvania avenue sewer, is about to be built up Thirty-third street, with which, I understand, these breweries will have to connect.]

No further pollution from the left hand side was discovered, except some drainage from the boat-houses just above the Fairmount Pumping Station. The Fairmount Rowing Association (having 10 active members) had urinals draining into the river last summer, but all the others claimed to drain all water-closet waste into tight cess-pools.

From the right hand side, within the city limits (West Philadelphia), the following foul drainage is received:

In the ravine back of Horticultural Hall (Fairmoount Park) was (on August 8, 1884) a public urinal draining into the

brook beside which it stands, and on the top of the bank, some 200 feet distant from and 30 feet above the stream, a large heap of manure, decaying leaves, plants, etc.

At the Belmont steamer landing more or less waste water (from washing milk glasses and ice cream dishes) runs in over the ground from a small restaurant.

The repair shops of the Pullman Palace Car Company at Forty-first and Poplar streets had privies (as late as February 21, 1885) for 250 men over a brook entering the park east of Fortieth street, above Girard avenue. The same stream receives considerable foul waste as it flows past the block of houses on the south side of Girard avenue, between Fortieth and Forty-first streets.

The Zoological Garden, on the right bank, below Girard avenue bridge, has partial drainage into a small brook flowing from the garden to a swamp beside the river, viz.: from the yards containing the alligators, beavers, llamas, and deer; also the pelicans and other water fowl. The flow of this stream is quite small in dry weather, and appears to have no regular course through the swamp, which is separated from the river by the tow-path of the Navigation Company; hence but little pollution from this is indicated in dry weather.

The total population having water-closet drainage in the summer into the Schuylkill River, between Flat Rock and Fairmount dams, when all the mills are in full operation and the drainage arrangements the same as last summer, aggregates about 4,150, divided as follows: Manayunk mills, 2,300; dwellings, stations, offices, etc., at Manayunk, 500; Wissahickon and the Park hotels (including Riverside Mansion), 1,000; Falls of Schuylkill, 100; West Philadelphia, 250.

The number of persons using water-closets on boats (excursion steamers, and canal boats) is not included in the above and I have made no estimate of their number.

Very respectfully,

DANA C. BARBER,

Assistant Engineer.

Summary of Pollution of the River Schuylkill by Domestic Sewage.

FROM INVESTIGATIONS MADE IN THE YEAR 1884.

(*Population estimated for January 1, 1885.*)

ITEMS.	DISTRICTS.						
	FIRST. (Whole Valley above Reading.)	SECOND. (From Upper Boundary of Reading to mouth of Manatawny Creek.	THIRD. (From above Manatawny Creek to intake of Phœnixville Water Works.)	FOURTH. (From Phœnixville Water Works to Norristown Water Works.)	FIFTH. (From Norristown Water Works to Conshohocken Water Works.)	SIXTH. (From Conshohocken Water Works to Roxboro' Pumping Station.)	SEVENTH. (From Roxboro' Pumping Station to Fairmount Pumping Station.)
Drainage area	656.9 sq. mls.	398.0 sq. mls. 1,054.9 "	149.4 sq. mls. 1,204.3 "	517.6 sq. mls. 1,721.9 "	29.5 sq. mls. 1,751.4 "	38.5 sq. mls. 1,789.9 "	74.0 sq. mls. 1,863.9 "
Population	91,000	95,000 186,000	28,000 214,000	66,000 280,000	22,000 302,000	18,000 320,000	52,000 372,000
DOMESTIC SEWAGE.				†			
Daily water supply,* representing domestic waste water	2,600,000 gals.	4,500,000 gals. 7,100,000 "	200,000 gals. 7,300,000 "	500,000 gals. 7,800,000 "	1,000,000 gals. 8,800,000 "	80,000 gals. 8,880,000 "	
Population having water-closet drainage into the river	5,000	12,000 17,000	750 17,750	1,100 18,850	2,800 21,650	1,100 22,750	4,150 26,900
Population having wash-water drainage into the river	22,000	40,000 62,000	5,000 67,000	3,000 70,000	4,500 74,500	1,500 76,000	9,000 85,000

☞ Figures in Red Ink indicate totals down to the lower end of the district represented by the column in which they occur.

* From public supply only.

† Perkiomen water-shed above Schwenksville not included in the remainder of this column.

SURVEYS

FOR THE

FUTURE WATER SUPPLY

OF THE

CITY OF PHILADELPHIA.

ANNUAL REPORT OF PROGRESS

DURING 1884.

By RUDOLPH HERING, C. E.,
Engineer in Charge.

PHILADELPHIA WATER DEPARTMENT,
February 14, 1885.

COL. WILLIAM LUDLOW,
Chief Engineer:

SIR:—I have the honor to present to you herewith the following Annual Report of Progress of the Surveys for the Future Water Supply of the City of Philadelphia:

The work has been continued in accordance with the plan of investigation described in the Annual Report for 1883, and the progress made has been such that about nine-tenths of all the field-work required has been completed, leaving the present year to be devoted mainly to the office-work of plotting and compiling the results.

The field notes were obtained for the topographical, physical, and sanitary features of the Perkiomen, Tohickon, and Ne-

shaminy watersheds, except for an area of about thirty square miles, mostly in the latter.

The available lines for conduits to the Delaware and Perkiomen have also been surveyed and plotted. A reconnoissance has been made with sufficient accuracy to enable the approximate cost of the conduit extension to the upper Lehigh to be determined.

Geological profiles have been made of the most important lines for the proposed conduits.

Sanitary surveys were made of the Perkiomen, Tohickon, and Neshaminy water-sheds with reference to a future supply.

The hydrographic work has been continued in the Perkiomen, Tohickon, and Neshaminy valleys, comprising rainfall observations and stream-gauging. Low water gaugings were also made of the Delaware river at the Water Gap and at Point Pleasant, also of the Lehigh River at White Haven. The first five months of the year were occupied in plotting and compiling the information collected during the previous season, but it was not possible to finish this work without losing the best part of the year for continuing the surveys. Office labor was therefore discontinued on May 31, and field work resumed. The latter was continued until the week before Christmas, when office work was again begun, at quarters temporarily furnished the Department by the United States Government in the new post office building.

The following is a detailed account of the work done during the year, grouped under similar headings as in the report for 1883:

A. TOPOGRAPHICAL WORK.

Conduits.

The surveys made during the year for conduit lines were limited to alternates from above Schwenksville, on the Perkiomen, skirting the latter to near Evansburg, thence crossing over the Skippack at a favorable point and joining the line

previously surveyed near Fairview. This line had been suggested in the report made to Councils by a commission of engineers in 1875, but shows itself inferior to the one surveyed in 1883, both in length and in character of ground, being badly cut by valleys and ravines which cross the line. The survey has been plotted, but neither a location nor an estimate has been made.

Nearly all of the office work during the past year consisted in plotting the surveys made the year before for the conduit lines (scale 200 feet to one inch), and also in making paper locations, a profile and an estimate of cost. The conclusions arrived at are as follows:

Perkiomen Conduit.—On the Perkiomen line, the Wissahickon alternate *via* Gwynedd, and the one from Hickorytown to Saw Mill Run was abandoned as being more expensive for the grade line adopted. The alternate from one mile north of Lederachville to Salford station was adopted as more economical, providing a dam is built either near Schwenksville or Salford station, and the profile and estimates were made on this line. The size of the conduit has been assumed at twelve feet diameter, which, at the grade of one foot in six thousand, will deliver over 210,000,000 gallons in twenty-four hours when running full.

The quantity of work required was carefully measured, and the prices assumed were those at present current for labor and material.

The total length of the Perkiomen conduit from the crossing at Wissahickon creek about three-quarters of a mile above its mouth, to the storage basin at Salford station is 26.55 miles, and the total estimated cost $6,354,250. The line contains 5.3 miles of tunneling, five inverted siphons measuring 5,931 feet horizontally, and thirteen arch bridges, 10 to 80 feet spans, with 26,000 cubic yards of masonry.

In order to obtain a fair idea of the feasibility of continuing the Perkiomen conduit line to the Lehigh watershed, and also of its cost, it was determined to make a reconnoissance of the

territory. From the Perkiomen watershed to White Hall on the Lehigh, the contour maps of the State Geological Survey furnished all that was necessary. From White Hall to White Haven the surveys of the Lehigh Valley Railroad were of great use as a base line, but gave insufficient data at the desired elevation of the conduit. Mr. Linton was therefore detailed to make such additional surveys as would enable a conduit line to be located on the maps. The work was to be only a fair reconnoissance, as the time available did not justify the taking of much detail. The instruments used were the transit, the prismatic compass, Pratt's range finder to obtain distances, and the hand level, clinometer and barometer. For both distances and levels the railroad served as the basis. About two miles below Mauch Chunk, the ground at the elevation of the conduit is quite a distance from the railroad and a stadia line had to be run over this area. From White Haven to Kuntz's dam near Laury's station, the conduit is best located on the east side of the valley. At the latter place it crosses over, follows the river to White Hall, and then leaving it runs to Millertown, at the northern foot of the South Mountain, whence a four-mile tunnel carries it to the Hossensack creek in the Perkiomen valley.

But little office work has so far been done in connection with this project, beyond making a preliminary location on the map of the geological survey, from the Hossensack creek to near White Hall.

Delaware Conduit.—The alternate line from the city to Huntingdon valley *via* Jenkintown was selected as being less expensive although longer than the line by way of Harper's run. Among the alternates between the Pennypack and Little Neshaminy waters, the one by way of Hartsville station was found to be the better line. Both the size and grade as well as the height of delivery are the same as for the Perkiomen conduit. In estimating the cost, the prices were also assumed as being the same.

The total length of the Delaware conduit from the city line

near Second street to Lumberville, where it first reaches the Delaware river, is 31.01 miles, and the total estimated cost is $6,630,600. The length of tunnel is 4.7 miles. The line contains two inverted siphons, together measuring 1,990 feet horizontally, and 13 arch bridges, 8 feet to 40 feet spans, with 19,000 cubic yards of masonry.

To extend the conduit from Lumberville to Point Pleasant, at which point it can receive the waters from the Tohickon creek by gravity, would require an additional length of 1.6 miles at a cost of $424,700. No tunneling and no arch bridges are necessary on this line, but there is a siphon 600 feet long.

The extension of the conduit from Point Pleasant to Portland below the Water Gap, where it would reach the same elevation as the Delaware river and therefore take its water directly without pumping, is 48.36 miles long, and the estimated cost is $9,876,600. The line would have ten inverted siphons, together measuring 10,735 feet long horizontally, 12 arch bridges with spans from 10 to 25 feet, and 5.9 miles of tunneling.

The total length of the Delaware conduit from Philadelphia to Portland, is 80.97 miles, and the total cost is estimated at $16,931,900.

A comparison between the conduit lines to the Perkiomen and to the Delaware, at Lumberville or Point Pleasant, therefore shows that their length and cost are nearly the same.

Storage Basins.

The available sites for dams have been cross-sectioned and the contours of the storage basins ascertained. For the Perkiomen such sites are to be found near Schwenksville, Frederick, Green Lane, Sumneytown, mouth of Hossensack creek and at Dale Forge. On the Tohickon there are suitable sites above Point Pleasant, and at the mouth of Haycock creek; on the Big Neshaminy a feasible site exists above Bridge Valley; on the Little Neshaminy there is one near Hartsville, and on Mill creek at the point where the proposed conduit crosses it.

As yet the surveys of these localities have not been plotted.

General Watershed.

After it had been determined to extend the survey into the Delaware Watershed it was impracticable to proceed further without a triangulation. Unfortunately the United States Coast and Geodetic Survey and the State Geological Survey had not covered the territory, although they had gone almost completely around it. A series of secondary and tertiary triangles were therefore determined upon and connected with the Coast Survey primary stations at Haycock Mountain, in Bucks county, and Goat Hill, near Lambertville, N. J., which line served as our base. Its length, azimuth and the geographical positions of Haycock and Goat Hill were obtained from the government records through the courtesy of Prof. J. E. Hilgard, Superintendent of the United States Coast and Geodetic Survey.

The triangulation was placed in charge of Mr. F. L. Paddock, who, assisted by Mr. C. E. Taylor and Mr. John P. Watson, erected the necessary towers and signal stations and made the angular measurements at intervals during the summer, selecting only the most favorable days. The instrument used was a Heller & Brightly High Power Transit and the angles were repeated according to circumstances from twelve to twenty times, which was considered sufficiently frequent for the purpose in hand.

The following is a list of the stations which were occupied:

Goat Hill, N. J., near Lambertville, granite monument.
Haycock, Bucks County, granite monument.
Hilltown, Bucks County, stake near house of D. Morgan.
Gearyville, Bucks County, stake on rocky point, property of I. Mumbauer.
Trumbauersville, Bucks County, spire of church.
Krupp's Hill, Bucks County, stake on southeast end.
Steinsburg, Bucks County, stake on hill about one quarter mile north of village.
Quakertown, Bucks County, spire of L. and R. Church.
Richlandtown, spire of L. and R. Church.
Bursonville, Bucks County, stake on hill one-half mile north of village.
Applebach Mills, Bucks County, spire of church.

Keelersville, Bucks County, stake on Rock Hill ridge, one and one-half miles west of post-office.

Bedminsterville, Bucks County, stake on hill west of village.

Dublin, Bucks County, cupola of hall near hotel.

Plumsteadville, Bucks County, cupola of Kratz's wagon factory.

Newville, No. 1, Bucks County, cupola of hall near hotel.

Newville, No. 2, Bucks County, stake on highest ground east of hall.

Doylestown, Bucks County, tower of court-house.

Gardenville, Bucks County, stake near hotel.

Hartsville, Bucks County, marked point on roof of J. Carroll's house on old York Road.

Jamison's Corner, Bucks County, stake on high ground half a mile northeast of village.

Frederick, Montgomery County, stake on highest point of hill opposite Zieglersville station, Perkiomen Railroad.

Pleasant Run, Montgomery County, stake on ridge half a mile northeast of Pleasant Run Post Office.

Fagleysville, Montgomery County, stake on Chestnut Hill.

Roberts Farm, Montgomery County, stake on ridge near county line.

The following stations on the chained line from the Delaware to the Perkiomen were also occupied for triangulation:

Stake near confluence of Tohickon and Haycock creeks, Bucks County.

Stake near Tohickon Post Office, Bucks County.

Stake north of Keeler's Church, Bucks County.

Several other points which could not be occupied without considerable expense were fixed by a number of angles carefully turned and repeated from the foregoing stations. They are as follows:

Schlichtersville, Bucks County, spire of church.

Bucksville, Bucks County, cupola of stable opposite store.

Rock Hill, Bucks County, marked poplar tree on highest point of Rock Hill ridge, three-quarters of a mile east of Rock Hill station, North Pennsylvania Railroad.

Sellersville, Bucks County, spire of stone church near school-house.

Buckingham Mountain, Bucks County, marked chestnut-oak tree, west end of mountain.

Wormansville, Bucks County, spire of church.

Pennsburg, Montgomery County, spire of church.

Goshenhoppen Church, Montgomery County, near Mechanicsville.

Tylersport, Montgomery County, mark on roof of tobacco warehouse.

Lansdale, Montgomery County, standpipe of water works.

Horsham, Montgomery County, marked hickory tree on Free Soil Farm.

For five of the stations it was necessary to build observation towers. Those erected by the Coast Survey at Goat Hill and Haycock were found decayed and partly fallen. They were rebuilt at a cost of $76.30 and $90.12 respectively. Others were built at Hilltown, Gearyville and Frederick, at a cost of $56.77, $49.17 and $40.14 respectively. The remaining points were designated by flag poles.

The geographical positions have been calculated according to the method given in Appendix 19 to the report of the United States Coast and Geodetic Survey for the year 1875. Those of the more important stations are as follows:

	Latitude.	Longitude.
Goat Hill, Lambertville, N. J.	40° 20′ 44″93	74° 56′ 16″98
Haycock, Bucks County	40° 29′ 18″96	75° 13′ 10″34
Hilltown, Bucks County	40° 20′ 02″00	75° 14′ 40″93
Gearyville, Bucks County	40° 25′ 13″24	75° 27′ 04″26
Frederick, Montgomery County	40° 16′ 06″93	75° 27′ 23″99
Lansdale, Montgomery County	40° 14′ 28″45	75° 16′ 53″66
Krupp's Hill, Bucks County	40° 30′ 33″44	75° 20′ 45″69
Quakertown, Bucks County	40° 26′ 29″65	75° 20′ 52″07
Plumsteadville, Bucks County	40° 23′ 13″02	75° 08′ 52″55
Sellersville, Bucks County	40° 21′ 43″26	75° 18′ 41″26
Doylestown, Bucks County	40° 18′ 43″10	75° 07′ 48″93
Hartsville Station, Bucks County.	40° 12′ 47″30	75° 05′ 59″05

The entire water-shed area is to be mapped on a scale of 400 feet to the inch, this being most convenient, and will be divided into six sections running due east and west, each representing exactly four miles in width. The polyconic projection was adopted for plotting the work. The true meridians were drawn upon the maps for every two minutes of arc, and the latitude for each minute of arc, and the trigonometrical stations placed upon them in their true geographical positions.

Two methods were used in taking the topography. According to one, used principally by Messrs. Paddock, Forsythe, Taylor, and Cheyney, all the notes and sketches were entered in a transit book; by the other method, used by Messrs. Linton, Mifflin, Allen, and Parker, the entire topography was plotted to scale in the field on light tables, carried in addition

to the transit. The advantage of the latter method has been: First, the immediate detection and correction of errors in angles or measures while plotting, thereby saving delays and inaccuracies in the office work; secondly, the drawing and sketching of the contours in greater conformity with the shape of the ground while viewing it, and saving the measuring of many points which would be necessary in the case of office plotting; thirdly, the possibility of putting in minor points by sight intersections, as on a plane table; and, fourthly, of having the map so far completed in the field that it requires little more than an adjustment and transfer by means of blackened paper to be in its proper form and place upon the section maps. The results have so far been very satisfactory, the plotting shows a great degree of accuracy, and the gain in time has been considerable. In the field the plotting parties could, on similar territory, of course not cover as much ground per week as the others, their gain being in office work. The total number of square miles plotted in the field was $137\frac{1}{3}$, and of those not plotted, $203\frac{2}{3}$. In fair country it was found possible readily to survey and plot in the field, to a scale of 400 feet to one inch, three square miles per week, the party consisting of the engineer and one rodman.

The manner in which the topography was taken when not using the tables is as follows,—the instruments being a transit, stadia rod, slope level, prismatic compass, and barometer: Main or base lines, with magnetic courses and stadia distances, were run over the territory, so as to form approximate quadrilaterals of about one-half to three-quarter square miles each. They were bounded by definite lines, as roads or streams, tied at the four corners. They were again directly tied with the trigonometrical stations wherever two or more of them could be seen. The position and elevation of high and low points was taken by magnetic and vertical angles, and stadia distances directly from the main line, if possible, otherwise a spur line was run to where they could be seen. In thickly wooded regions the topography was taken with the prismatic compass,

slope level, and barometer. Buildings were located either by at least two magnetic angles from the base line or one angle and stadia measurement. Roads, streams, etc., were fixed in the latter way. Levels on the main line were carried along by the transit, partly by spirit level and partly by vertical angles, from the benches established by the leveling parties, and they were generally found to check within a foot in a circuit of two to three miles. The vertical angles were reduced by the table of natural sines and co-sines, on the main lines, but also by paper co-ordinate protractors on laterals. All notes and sketches were entered in a transit book.

The method of field plotting was as follows—the instruments being a field table,* fifteen inches square, with universal joint and tangent screw, the whole resting on a very light tripod, in addition to the instruments already mentioned: The sheets for plotting were ruled to one-quarter-inch squares, each representing 100 feet square. Main lines were run with the transit by magnetic courses and stadia distances in circuits of one to three miles, and tied to the trigonometrical stations wherever possible, as before. They were, however, immediately plotted to scale upon the sheets clamped to the table, standing beside the transit. The elevations were carried along as before, and plotted at once, and the contours were drawn in on the ground. Buildings, roads, streams, etc., were located either by transit angles and then plotted, or sighted from the table when leveled and oriented. For the sake of clearness colored pencils were used to mark certain features—the water-courses being marked blue, the outlines of the woods green, and the roads shaded yellow. This coloring was found to be of great assistance.

Early in the season the area to be surveyed was covered with a series of bench marks taken from those established during the previous year on the two principal conduit lines. They were selected so that one could be found about every two miles. Mr. Allen was in charge of the work, and was assisted by Mr.

* Made for the Department by Messrs. Heller & Brightley, mathematical instrument makers.

Cheyney and Mr. Bull. Mr. Cheyney leveled over the western part, establishing 105 benches, and Mr. Bull over the eastern part of the territory, establishing 197 benches.

The levels for the Delaware conduit, taken in 1883, had been started from a bench mark at the corner of the Oxford road and Somerville street, furnished by the District City Surveyor. Those for the Perkiomen conduit had been started from a bench mark near the proposed Cambria reservoir, furnished by Mr. Chas. G. Darrach, Assistant Engineer of the Water Department, and based on the district levels. In order to tie these points and thus complete the circuit with our own instruments, and according to the method pursued in the rest of the work, the two benches were carefully connected last spring by Mr. Allen, and a discrepancy was found to exist between them equal to 0.354 feet, which reduces the error given in last year's Report, of the circuit of 97.23 miles leveled in 1883, from 0.997 foot to 0.643 foot, and of the circuit of 73.4 miles, from 0.473 foot to 0.119 foot, giving a rate of error equal to 0.0066 foot per mile for the longer circuit, and 0.0016 foot per mile for the shorter one.

About sixty-three square miles of the Perkiomen watershed —the portion situated in Berks County—were surveyed by the State Geological Survey. Little more than the main roads and contour lines, however, were taken. To have this work conform with our own, Mr. Linton was instructed to reconnoitre the area and place upon the map the buildings, to mark the forests and lands not cultivated or arable, and such features as would affect the condition of the streams from a physical and sanitary point of view. This work occupied his time from June 16 to June 28.

Comparatively little of the topographical survey, outside of that for the conduit lines, has yet been plotted. About twenty square miles, covering the Perkiomen valley from Zieglersville to above Green Lane, and the West Swamp creek valley from Zieglersville to the Berks county line, were partially mapped last spring, before the party returned to the field, leaving over

seventy square miles of the ground surveyed in 1883 to be plotted during the present year. This work is now being done.

Parties Engaged in Topographical Work.

The corps engaged in topographical work was as follows:

F. L. Paddock, Assistant Engineer, January 1 to December 31; engaged in field work from June 9 to December 15.

Harvey Linton, Assistant Engineer, January 1 to December 31; engaged in field work from June 6 to December 19.

Kenneth Allen, Assistant Engineer, January 1 to December 31; engaged in field work from June 10 to December 18.

George B. Mifflin, Assistant Engineer, January 1 to December 31; engaged in field work from June 1 to December 20.

Wm. T. Forsythe, Assistant Engineer, January 1 to December 31; engaged in field work from September 10 to December 20.*

C. E. Taylor, Sub-Assistant, September 1 to December 31; engaged in field work from September 1 to December 20.

George S. Cheyney, Sub-Assistant, June 1 to December 31; engaged in field work from June 9 to December 24.

William E. Parker, Sub-Assistant, September 1 to December 31; engaged in field work June 10 to December 19.

E. C. Bull, Leveler, June 10 to July 23, and September 1 to September 15; assisted the hydrographic party from July 23 to August 30; engaged in field work from June 10 to September 15.

H. A. Schofield, Rodman to Mr. Linton, January 1 to May 20.

C. E. Taylor, Rodman to Mr. Paddock, January 1 to September 1.

George S. Cheyney, Rodman to Mr. Paddock, January 1 to June 1.

William E. Parker, Rodman to Mr. Allen, January 1 to August 31.

E. C. Bull, Rodman to Mr. Paddock, September 15 to De-

*Absent on account of sickness from May 20 to September 10.

cember 15; Rodman to Mr. Forsythe, from December 15 to December 31.

A. E. Miller, Rodman to Mr. Cheyney, from June 1 to December 31.

William S. Gleim, Rodman to Mr. Mifflin, July 14 to August 26; Rodman to Mr. Allen, August 26 to September 9; Rodman to Mr. Parker, September 9 to December 31.

J. P. Watson, Rodman to Mr. Paddock, June 1 to July 5; Rodman to Mr. Linton, July 7 to August 26; Rodman to Mr. Mifflin, August 27 to December 31.

George W. Wood, Rodman to Mr. Linton, June 7 to June 28, and August 22 to December 20.

Thomas T. Jamison, Rodman to Mr. Bull, June 10 to July 23, and September 1 to September 15; Rodman to Mr. Sanborn, July 23 to August 30; Rodman to Mr. Forsythe, September 15 to December 31.

F. D. Jones, Rodman to Mr. K. Allen, November 1 to December 24.

A. P. Allen, Rodman to Mr. K. Allen, from September 1 to October 31.

H. Taylor, Rodman to Mr. C. E. Taylor, from September 24 to December 24.

Max Atlee, Rodman to Mr. Mifflin, from June 1 to July 12.

It is due to those in charge of the different parties to state that they displayed praiseworthy energy and ability in the endeavor to complete the allotted field work during the last season, starting often before daybreak and driven home only by the setting sun. Their surveys were carefully and conscientiously executed. The sections surveyed by the eight separate parties often penetrate each other and in this way form good checks which have so far been very satisfactory.

We are indebted to the Pennsylvania Railroad Co. and to the Philadelphia and Reading Railroad Co., for the use of the locations of the railroads, both built and projected, which traverse the territory, rendering us assistance in securing carefully measured base lines.

SANITARY SURVEY.

A most essential part of the inquiry regarding the fitness of the watersheds to furnish potable water consists in the collection of data showing whether any, and if so how, the streams are at present polluted by sewage, also whether the causes of such pollution are removable, and if not whether they would be likely to increase.

The examinations having this end in view were made by Mr. Dana C. Barber, and his report embodying the detailed results is appended.

Some of the elements having a bearing on this question will be more fully determined when the topographical surveys have been mapped, such as the areas under cultivation, the number and character of buildings, etc.

Perkiomen Scheme:—The valley of the Perkiomen and its branches, from which water could be stored and brought to the city, contain no sources of pollution which at present are not capable of correction. There is considerable difference, however, between the several valleys.

The water shed of the main stream above Green Lane and the East Swamp Creek, including Rich Valley, have a small population, comparatively less farming country than the rest, only a few creameries and one small paper mill, using paper rags only, near the Berks County line. Between Green Lane and the mouth of West Swamp Creek the Perkiomen receives the surface drainage of a number of buildings, which, however, would have to be removed, as they are situated on the site of the proposed storage reservoir.

The Macoby Creek shows much inferior conditions. The area is almost entirely under cultivation, and as it almost runs dry in the latter part of the summer, the water is at such times highly charged with sewage and other polluting matter.

The West Swamp Creek, while it is less advantageous than the former streams, is better than the latter. Near the stream there are a few tanneries, a few creameries, and one small

woolen mill, and nearly all of the area is under cultivation. Its summer flow as well as its area are much larger than those of the Macoby, and the relative pollution is less.

The Northeast Branch has a long and narrow water-shed, almost entirely under cultivation. It has several villages near the creek, notably Sellersville and Perkasie, besides a few creameries. The summer flow is very small comparatively, and the distance from the creek to the water-shed line is short. A low flow will therefore be relatively highly charged with polluting elements.

The above unfavorable sanitary conditions increase still more in the valley of the Skippack, which is the lowest affluent of the Perkiomen, and it was therefore decided early in the season to omit the consideration of its hydrographic and topographic conditions.

To conserve the streams of the Perkiomen valley so that they will be suitable as a source of water supply, will require the effluent waters from creameries and manufactories to be purified before they enter the stream and the discharge of domestic sewage to be absolutely prohibited. It will be necessary further to allow the late summer flow and the first water after a storm, in the case of the Northeast Branch, to pass by without being stored. The same should be done with the water from the Macoby, were it not for the fact that its flow is extremely small compared with that of the rest.

It is feasible therefore to remove all the serious causes of pollution in the Perkiomen valley so that the water could be made potable. A second railroad has been projected to run through the valley, and it is likely that the cultivation of the area will increase rather than diminish. But in this event there seems to be no reason why the same precautions which would thoroughly guard the stream now would not do the same then, because a great increase of population cannot take place from the lack of natural advantages for manufacture or trade.

Delaware Scheme.—The Tohickon water-shed has a totally different character from that of the Perkiomen. While the

latter is rugged and sparsely inhabited at its head waters, but flat and cultivated below, the former presents the reverse condition. This has the effect that whatever organic matter is washed into the upper part of the Tohickon has a better chance of getting oxidized below than in the Perkiomen. Nearly all the elements of pollution in the Tohickon Valley from habitations, industries, and cultivated fields, are found near the upper part. Quakertown, the largest village on the watershed, is over twenty miles above the point where the water would enter the proposed conduit. Comparatively little objectionable drainage enters the creek, mostly from creameries and tanneries, and none that could not be readily kept out.

The Neshaminy watershed again has a similar character to that of the Perkiomen, but its upper parts are less elevated and rugged and much more extensively cultivated. It has, like the North East Branch of the Perkiomen, a quick watershed. The summer flow is small for the area, and this as well as the first wash from a rain after a drouth would contain a large percentage of polluting and suspended matter. At other times the water is clear and receives objectionable drainage only from a few creameries and one small tannery. Doylestown, the only centre of population of any size, from its situation on a hill, with no runs or water-courses of any kind leading from it to the creek, cannot contribute to the permanent pollution of the same.

The Little Neshaminy and Mill Creek valleys, from which water could also be turned into the Delaware conduit, do not contain any objectionable features beyond being a fairly well settled agricultural country.

It is not likely that the conditions at present existing in the above valleys will be materially changed. A railroad was projected a number of years past to cross a part of the territory, but has not yet been located. No inducements prevail for development beyond agricultural pursuits, which have already caused all available territory to be placed under cultivation. To protect the streams against pollution, it is therefore only

necessary to compel the purification of the effluents from a few creameries and tanneries before discharging into the streams, and to prohibit any future contamination by domestic sewage. It would further be necessary in using the Neshaminy water for the city supply, to prevent the summer flow and first wash from a storm from entering the conduit.

B. HYDROGRAPHIC WORK.

The hydrographic branch of the investigation was in charge of Mr. C. S. Gowen until February 28, when he resigned to accept a position with the Croton Aqueduct Commission, and since then it has been very efficiently conducted by his former assistant, Mr. H. W. Sanborn. The work has consisted in ascertaining—

First. The rainfall on the areas to be investigated.

Secondly. The complete flow of the various creeks in the Perkiomen, Tohickon, and Neshaminy watersheds, also the minimum flow of the Delaware river at Point Pleasant and the Water Gap, and the minimum flow of the Lehigh river above White Haven.

Thirdly. It was sought to obtain such collateral information as might assist in the proper interpretation of the foregoing results, principally the amount of water flowing off small areas having regular and definite surface characteristics during rains of different intensity and at different seasons.

Rain-Fall.

Additional gauges were placed during the past year at Lansdale, Sellersville, and the Forks of the Neshaminy, in Bucks County. The gauge at Pennsburg was removed to Seisholzville, Montgomery County. The automatic gauge formerly at Green Lane was removed to Frederick station, Perkiomen Railroad.

The three automatic gauges at Philadelphia, Doylestown, and Frederick have furnished graphic representations of the

fall during every storm. Altogether the rain is being measured by eleven Department gauges, and by fifteen others belonging to volunteer observers located within and near the area investigated.

The rain-falls were compared and tabulated. The results for the year 1884, giving monthly totals, are appended. For better comparison, diagrams will be made showing the date and quantity of each fall separately. I have appended a table showing the results obtained by the automatic gauges during a few of the most violent storms. An examination will readily show the importance of such registration, as compared with simply giving the time and quantity of the *entire* storm. Besides what is shown in the first table, no conclusions regarding the distribution of the rain over the area in question have yet been drawn.

Weir Measurements.

It was found desirable during last winter, in view of the favorable conditions of the Delaware scheme, to have careful measurements also of the Little Neshaminy and Mill creek, and locations for weirs on these streams were sought early in the spring. On the former the best location that could be found required rather an expensive weir, and inasmuch as it was possible to get fairly good results with a current meter, no weir was built. On Mill Creek, however, a suitable site was found about a mile and a half above the Forks of the Neshaminy, and near where the proposed Delaware conduit crosses the creek. The weir was built between June 10 to June 19, and was similar to the one on West Swamp creek, but was only 14.97 feet long. The weirs built and in use up to date are as follows:

Perkiomen Division:—Perkiomen creek at Green Lane, Macoby creek, East Swamp creek, West Swamp creek, and North East Branch creek.

Delaware Division:—Tohickon creek, Big Neshaminy creek above the Forks, and Mill creek.

Except during the winter, when all the weirs were dismantled, measurements upon them were taken twice a day, as a rule. The winter of 1883–1884 did not seriously injure any of them. The paving around them was in several cases washed out; some repairs to the woodwork were also needed at the Macoby weir and at the stone wall of the Neshaminy weir.

Nearly all of the weir measurements have already been computed, but are not yet compiled.

Meter Measurements.

To obtain the flow during high stages of the water, when the weirs would not act as such, the various streams have been gauged at different times by meter measurements. To do this it was necessary either to build a special foot-bridge across the stream or to suspend a staging from an existing bridge. At Frederick, a foot bridge had to be built. It is 18 feet above the bed of the stream, has a clear span of 122 feet, and consists of two-and-a-half-inch wire cables, holding six by eight inch stringers, upon which the flooring is spiked. Another foot-bridge was built below the forks of the Neshaminy, with a height of 13 feet and a clear span of 132 feet, and otherwise was similar to the one at Frederick. A staging for metering had been built in 1883, at Leidy's bridge, above Zieglersville, for the West Swamp creek. During 1884 one was built at Point Pleasant, from which to meter the high flows of the Tohickon.

The results of the measurements are now being determined.

The minimum flows of the Delaware and Lehigh rivers during the year were ascertained at the same points where the gaugings were made in 1883, and in addition the Delaware was metered at Point Pleasant, with the following results:

Minimum flow during 1883 and 1884, in gallons per 24 hours.

Delaware at Water Gap.	Delaware at Point Pleasant.	Lehigh at White Haven.
Sept. 20, 1883..... 697,000,000	.....	Sept. 19, 1884..... 76,000,000
Sept. 23, 1884.....1,050,000,000	Sept. 24, 1884.....1,662,000,000	Oct. 2, 1884.....127,000,000

Ordinary Stream Gauges.

During the winter 1883–84, when the weirs could not be used, the observations of flow were confined to the reading of ordinary gauges attached to posts fixed at the banks of the streams. Such readings were taken regularly twice a week, on the Perkiomen at Green Lane, the Macoby, the East Swamp, the West Swamp, the Northeast Branch, and as often as possible during high flows. Daily observations were taken on the Tohickon at Point Pleasant, and on the two branches of the Neshaminy at the Forks, and also at Longaker's dam at Schwenksville.

During the winter all stream gauges in the Perkiomen division were carried away by ice, except those on the Macoby and at Schwenksville, but were immediately replaced by temporary ones until it was possible to re-establish permanent posts in the spring.

The observations in the Perkiomen division were taken by Mr. J. G. Hillsman, and at Longaker's dam by Mr. John Wisler; those at Point Pleasant were taken by Mr. R. C. Stover, and at the Forks of the Neshaminy by Mr. J. Kirk.

Maximum Stream Gauges.

The rapidity with which water rises and falls during a freshet makes it impracticable to get to the different points at the right time to ascertain the maximum height. Self-acting maximum gauges were therefore placed on all the streams. To further facilitate the obtaining of results, and as a check, by means of established formulæ, two such gauges were placed

at points from 250 to 500 feet apart, and between which the bed was regular, straight, comparatively smooth and of nearly the same width, and of which cross-sections were made every 100 feet. These gauges consist of a three-quarter inch brass rod as long as the height of the greatest freshet, graduated and placed in the centre of a box six inches square inside. A cork float two and a half inches square, two inches thick, with a hole slightly larger than the rod, slides upon it and by means of a brass spring pressing gently against the same, is held in position. The rising water carries the float up and the spring prevents its falling. The observer, after every high flow, takes the reading and thereupon pushes the cork down again to the water's surface.

Pairs of these maximum gauges have been placed in the Perkiomen valley on the West Swamp Creek, three-quarters of a mile above the weir, on the East Swamp Creek 500 feet above its mouth, on the North East Branch three-quarters of a mile below the weir, and on the main Perkiomen 800 feet below the weir. In the Neshaminy valley there is a pair on the main stream about three-quarters of a mile above the weir, and on the Little Neshaminy about 1,000 feet above the forks. Single maximum gauges were placed on the Macoby, 300 feet above the weir; on Mill Creek, 300 feet above the weir, and on Tohickon Creek the regular automatic gauge alone recorded the maximum height.

Automatic Stream Gauges.

The great irregularity in the flow of the various streams, owing to their water being used for mill purposes, which causes it to be stored at certain times and to flow at others with a much larger volume than the natural one, made it very desirable to have automatic registration, at least at the most important points. Such gauges offer the further advantage that a continuous record is kept, especially in the winter, at a smaller expense than would otherwise be necessary. Through the kindness of Mr. A. Fteley, Executive Engineer of the

new Croton Aqueduct, and Mr. D. Brackett, Assistant City Engineer, Boston, we were enabled to procure three of similar design to those used on the survey for the additional water supply for Boston. One has been placed at Frederick, recording the flow of the Perkiomen streams (excluding the West Swamp Creek and North East Branch), another at the forks of the Neshaminy, recording the flow of both streams, and a third at Point Pleasant, measuring the flow of the Tohickon Creek. The West Swamp Creek and North East Branch were excluded because of the expense it would have entailed in proportion to the importance of these streams. Their flow has been ascertained during the winter by the ordinary-stream and maximum gauges with sufficient accuracy.

The automatic gauges were made by Mr. George M. Stevens, in Boston. Continuous paper is rolled from one cylinder upon another by clockwork, passing over a smooth surface between the two and upon which a stationary pencil makes a continuous straight line, and another, so connected with a float resting on the surface of the stream that the rising and falling of the water causes it to move back and forth on the paper, makes a curved line corresponding to the oscillations in the stream. The distance between the straight and curved line indicates the desired measure, which is one-twelfth of the natural scale. The whole instrument is carefully boxed, and in winter a floating oil-lamp inside has readily kept the water from freezing in the gauge.

Some trouble was at first experienced in getting the paper to roll evenly and the pencil to mark without tearing the same, but it ceased after we had paper specially made to suit the conditions. The sheets are now being analyzed and the flows computed.

These observations, together with those of the ordinary and maximum stream gauges and of the weir and meter measurements, will enable us to obtain a continuous record of the flow in the main streams and most of the branches with a fair degree of accuracy for the purpose in hand.

Rain Water Flowing off Surfaces.

At a small additional expense it will be possible to collect some data concerning the amount of rain water flowing off surfaces of different characters and inclination, as the observer stationed at the forks of the Neshaminy has some time left for the purpose. Permission was obtained from parties owning suitable land, and areas were thereupon prepared in such a manner that all rain falling upon them, which was not absorbed and held back by the ground or evaporated, would flow to a point where its amount could be measured. Seven plots of ground were thus prepared, having areas of one-fourth to one acre each, slopes of eight, twenty and fifty feet per hundred and surfaces covered by grass, ploughed fields and forests. Rain-gauges were so placed that the amount of water falling upon these areas could be measured. If these observations can receive sufficient attention and time during the present year the interpretation of the relation of rain-fall and stream-flow on the different water-sheds will be greatly facilitated.

Parties Engaged in the Hydrographical Work.

H. W. Sanborn, Assistant Engineer, January 1 to December 31.

Amasa Ely, Rodman, January 1 to December 31.

H. A. Schofield, Rodman, May 20 to December 31.

J. G. Hillsman, Rodman, January 1 to December 31.

E. C. Bull, Leveler, July 23 to August 30.

Thomas T. Jamison, Rodman, July 23 to August 30.

List of Observers Engaged by the Water Department.

R. C. Stover, Point Pleasant, January 1 to July 1.

J. Wisler, Schwenksville, January 1 to May 1.

J. Kirk, Forks of Neshaminy, January 1 to May 14.

O. H. Hart, Pennsburg, January 1 to June 1.

N. S. Reminger, Green Lane, January 1 to April 1.

George W. Roth, Ottsville, January 1 to August 1.

Thomas Walton, Doylestown, January 1 to December 1.

H. S. Shull, Lansdale, May 1 to December 1.
C. D. Fretz, Sellersville, May 24 to December 31.
John A. Roth, Seisholtzville, June 1 to December 31.
Edwin Heavner, Ottsville, August 1 to December 31.
Albert Stover, Point Pleasant, October 23 to December 31.
John A. Steltz, Green Lane, December 1 to December 31.
M. H. Bean, Zieglersville, December 1 to December 31.

We are indebted also to the following observers, who have furnished us with records taken by them in various localities, which greatly assist in arriving at proper conclusions:

Gen. W. B. Hazen, Chief Signal Officer, Washington.
Serg. C. N. Kitchel, U. S. Signal Service, Philadelphia.
Mr. E. F. Smith, Chief Engineer Canals of Reading Railroad Company, Reading, Pa., for observations at Palo Alto.
Mr. Thomas Mechan, Germantown, Pa.
Mr. Thomas J. Beans, Burlington, N. J.
Dr. Charles Moore, Pottstown, Pa.
Mr. S. B. Lehman, Lebanon, Pa.
Mr. Millnor Gillingham, Fallsington, Pa.
Mr. M. McNeill, Princeton, N. J.
Mr. J. L. Heacock, Quakertown, Pa.
Miss Emily Kent, Phillipsburg, N. J.
Prof. S. J. Coffin, Easton, Pa.
Dr. J. C. Green, West Chester, Pa.
Pennsylvania Hospital, Philadelphia.

C.—GEOLOGICAL WORK.

Mr. R. H. Sanders, Geologist, continued his work of last year, but only as far as necessary to make a geological profile of the Perkiomen and Delaware conduit lines. The remaining geological work, which is to determine the surface formations, is best suspended until the topographical maps have been completed.

The rocks which will be encountered on either of the two conduit lines are mostly shales and sandstone, and their quantity is about the same in both. No features of the soil or rocks were found which might entail an unexpected and large expenditure not provided for in the estimate.

D.—WORK REMAINING TO BE DONE.

To complete the investigation as suggested in my last report there still remains at the date of this report the following work to be done.

Perkiomen Project.

A part of the territory surveyed in 1883 is to be re-inspected and to have placed upon the maps the buildings, roads, etc., which are situated within the areas of the proposed storage basins and at other important points.

Estimation of land and other damages for storage basins.

Geological examination of watersheds.

Continuation of Hydrographic work.

For the Lehigh extension, the field work done last year remains to be plotted and a location profile and estimate of cost made for the conduit.

Mapping of the topography.

Computations and compilation of results.

Final drawings, charts and tables.

Delaware Project.

Topographical survey of about 30 square miles.

Estimation of land and other damages for storage basins.

Geological examination of watersheds.

Sanitary survey of upper Delaware.

Continuation of Hydrographic work.

Mapping of the topography.

Computations and compilation of results.

Final drawings, charts and tables.

It is expected that the above work will be completed during the present year, excepting, perhaps, the preparation of the

final report. It will be necessary, however, to continue the rainfall and stream flow observations for a number of years after the present one. It is utterly impossible to reach conclusions sufficiently exact for the economical construction of storage basins and dams upon data extending over a period of only two years. We know that the season of 1882 (the year before our gaugings were begun) was drier than the subsequent ones have been, and the stream flow was probably less. The observations should be continued at least until another extremely dry season is encountered.

In Boston, gaugings of the rainfall and stream flow in the Cochituate Watersheds have been made since 1863. The same has been done in the Croton Watershed (for the New York supply) since 1864. In Baltimore and Washington also these observations have been taken continuously for a number of years.

Very respectfully,

RUDOLPH HERING,
Engineer in Charge.

PRECIPITATION DURING 1884, *in inches and decimals.*

STATION.	Elevation above sea level, in feet.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for year.	OBSERVER.
Philada. Water Dep't (automatic)...	110	.....	.....	4.254	1.780	4.276	3.048	4.550	4.393	0.192	1,465	2.984	3.785	.....	Philada. Water Dep't.
U. S. Signal Service, Philada.....	140	5.46	5.70	4.70	1.63	3.39	3.00	3.83	4.30	0.20	1.54	2.31	3.28	39.34	C. N. Kitchel.
Pennsylvania Hospital, Philada...	50	5.019	5.815	5.410	2.023	3.902	4.548	4.672	3.224	0.266	1.994	4.014	4.350	45.237	Penna. Hospital.
Germantown, Penna.....	309	.....	.....	4.170	2.020	3.250	4.520	4.440	4.020	0.140	2.220	3.500	5.050	.....	Thomas Meehan.
Moorestown, N. J.....	67	4.36	5.33	4.64	1.65	3.29	3.52	3.775	5.075	0.16	2.29	3.40	5.37	42.86	Thomas J. Beans.
Fallsington, Penna.....	44	4.90	5.04	4.79	2.25	4.48	5.30	4.24	4.58	0.22	2.30	3.12	6.00	47.22	Millnor Gillingham.
Princeton, N. J.....	223	4.72	4.56	4.10	2.08	2.75	3.58	3.35	4.49	0.24	2.33	3.14	6.16	41.50	M. McNeill.
Lansdale, Penna.....	373	.....	.....	.....	.....	3.107	4.395	4.890	2.531	0.475	3.091	3.701	5.275	.....	Philada. Water Dep't.
Doylestown, Penna.....	387	5.580	6.270	5.200	2.420	3.370	5.420	5.918	5.130	0.210	3.475	3.673	6.070	52.736	" " "
Doylestown, Penna. (automatic)...	387	5.616	6.202	5.104	2.152	3.386	5.304	6.005	5.338	0.333	3.434	3.736	6.070	52.680	" " "
Ottsville, Penna.....	340	5.920	5.510	5.400	2.340	3.540	6.320	6.070	4.240	0.400	3.790	3.488	6.067	53.085	" " "
Sellersville, Penna.....	311	.....	.....	.....	.....	.....	5.920	3.850	3.070	0.390	3.370	3.740	6.510	.....	" " "
Quakertown, Penna.....	536	4.710	5.380	4.980	2.700	3.530	6.540	7.920	3.760	0.530	4.380	3.530	6.460	54.420	J. L. Heacock.
Phillipsburg, N. J.....	163	3.88	4.38	3.47	1.60	2.77	3.73	4.93	3.40	0.41	1.58	2.72	4.01	36.88	Emily Kent.
Easton, Penna.....	340	4.73	4.77	4.97	2.38	2.28	2.87	5.19	5.91	1.01	3.96	3.25	6.07	47.39	Prof. S. J. Coffin.

PRECIPITATION DURING 1884, *in inches and decimals.*—Continued.

STATION.	Elevation above sea level, in feet.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for year.	OBSERVER.
Mouth of the Perkiomen, Penna..	87	6.24	5.95	5.20	2.62	3.54	5.52	4.23	3.20	0.39	2.84	3.79	6.25	49.77	E. F. Smith.
Pottstown, Penna.....	150	4.67	4.42	4.55	2.76	4.00	6.53	7.08	1.83	0.60	3.64	3.77	5.19	49.04	Dr. Charles Moore.
Frederick, Penna.....	165	6.020	5.356	4.696	2.255	3.485	5.588	6.215	2.430	0.441	3.413	3.400	5.920	49.219	Philada. Water Dep't.
Frederick, Penna. (automatic).....	170	.....	.....	.....	.....	.....	5.172	6.972	3.549	0.390	3.127	2.993	5.443	.....	" " "
Green Lane, Penna.....	363	5.278	5.844	4.352	2.305	3.064	5.239	7.324	3.717	0.405	3.969	3.119	6.035	50.651	" " "
Pennsburg, Penna.....	354	5.140	5.040	5.040	2.630	2.720	.....	.....	.....	.....	.....	.....	.....	.....	" " "
Siesholtzville, Penna.....	875	.....	.....	.....	.....	.....	4.646	7.436	3.157	0.770	3.992	3.190	6.780	.....	" " "
West Chester, Penna.....	455	7.32	7.29	6.09	2.94	3.64	7.52	5.27	2.12	0.42	2.56	4.36	7.05	56.58	Dr. J. C. Green.
Reading, Penna.....	200	5.25	5.52	5.44	3.30	3.96	3.78	6.22	2.77	0.68	2.77	2.79	6.22	48.70	E. F. Smith.
Lebanon, Penna.....	498	3.95	4.59	4.88	2.92	3.96	4.02	6.15	4.56	0.94	3.85	3.13	5.82	48.77	S. B. Lehman.
Schuylkill Haven, Penna.....	513	4.15	5.19	4.07	2.32	2.91	2.90	5.73	4.32	1.25	2.58	2.45	5.98	43.85	E. F. Smith.

Rain Storms of Greatest Intensity as Recorded by Automatic Gauges.

Water Department, Philadelphia.

Date. 1884.	Total Fall.		Heavy Fall		Maximum Fall.		
	Amount. Inches.	Duration. Hrs. Min.	Amount. Inches.	Duration. Hrs. Min.	Amount. Inches.	Duration. Min.	Rate per Min. Inches.
May 14.....	1.514	15 00	1.462	2 04	0.462	7	0.066
July 5.....	1.465	17 00	1.160	3 00	0.160	7	0.023
July 6.....	1.576	4 30	1.500	1 00	0.500	12	0.042
Nov. 23.....	1.454	7 00	1.100	1 44	0.400	10	0.040
Dec. 21.....	1.168	13 00	1.120	10 00	0.180	60	0.003

Doylestown, Bucks Co., Pa.

Date. 1884.	Total Fall.		Heavy Fall.		Maximum Fall.		
	Amount. Inches.	Duration. Hrs. Min.	Amount. Inches.	Duration. Hrs. Min.	Amount. Inches.	Duration. Min.	Rate per Min. Inches.
June 26.....	4.861	16 45	4.000	8 50	0.500	14	0.036
July 5.....	1.303	12 15	1.127	5 42	0.169	10	0.017
July 31.....	1.440	10 35	1.325	1 46	0.500	10	0.050
August 5.....	2.080	10 15	2.032	1 14	1.300	20	0.065
Nov. 23.....	1.622	8 30	1.465	3 26	0.465	13	0.036

Frederick, Montgomery Co., Pa.

Date. 1884.	Total Fall.		Heavy Fall.		Maximum Fall.		
	Amount. Inches.	Duration. Hrs. Min.	Amount. Inches.	Duration. Hrs. Min.	Amount. Inches.	Duration. Min.	Rate per Min. Inches.
Nov. 23.....	1.263	9 15	1.095	2 40	0.500	28	0.018
Dec. 6.....	1.475	12 00	1.467	10 24	0.400	12	0.033

APPENDIX.

REPORT ON SANITARY SURVEYS OF PROPOSED FUTURE SUPPLY WATERSHEDS.

PHILADELPHIA WATER DEPARTMENT,
February 4, 1885.

MR. RUDOLPH HERING,
Engineer in Charge of Surveys for Future Supply:

SIR:—I have the honor to submit the following report of sanitary surveys of proposed future supply watersheds, made by me under your direction during the past season. These surveys comprise the whole of the Tohickon Valley, the valleys of the Neshaminy and the Little Neshaminy above their confluence, together with that of Mill creek above Forrestville, and the Perkiomen above Schwenksville, with the North East Branch and the Skippack above Evansburg.

The object of this investigation was to ascertain to what extent the natural advantages of the valleys in supplying water of satisfactory purity have been altered by habitation and industries.

The Valley of the Tohickon was investigated in June by following the stream on horseback by the nearest roads from near its sources to its mouth and by interviewing various parties well acquainted with the whole valley.

The head-waters of the stream are in a very flat farming country about the borough of Quakertown (about 23 miles from its mouth) which village it drains, so far as it is drained at all; being very nearly level a great part of the rain-fall is absorbed and comparatively little surface drainage reaches the creek without being filtered through the soil. The town has a popu-

lation of about 1,900, but contains no manufactories having foul drainage to the creek, except a small creamery which discharges its liquid waste—cheese whey, buttermilk and wash water—into a ditch about 100 feet long, emptying into the creek. In summer the grass grows luxuriantly along the ditch, consuming much of the organic matter which is discharged only periodically, so that the stream receives but little pollution from this source which, however, causes a local nuisance, much complained of by the residents in its vicinity.

The town has no public water supply, but obtains water from wells and by collecting rain water. The latter is mostly used on account of the hardness of the well water, which also contains some iron from bog ore.

The borough government contains no Health Board, so that complete vital statistics cannot be given, but the following information was obtained from Dr. Moyer, one of the leading physicians. The mortality is very small and largely from old age. Pulmonary consumption is the most prevalent disease, and pneumonia, which was formerly very rare, is increasing. There has been no epidemic of diphtheria for fifteen years, and scarlet fever is very rare, while cholera infantum is almost unknown. There was formerly much typhoid, but it has been largely reduced, Dr. Moyer thinks, by artificial drainage of the meadows about the town. He also stated that Richland township, which contains the borough of Quakertown, and is drained entirely by the headwater tributaries of the Tohickon, is exceptionally healthy. It consists almost entirely of farming land, highly cultivated. One Quakertown dealer in fertilizers sells 75 tons of artificial manure per year—most of it going to the Tohickon watershed. On account of the flatness of the land probably but little of the fertilizing material reaches the streams directly.

Below Richland township the greater portion of the Tohickon watershed is contained in Rockhill, Bedminster and Haycock townships. This is also largely farming country, though but little artificial fertilizer is used. A mile or two below Quaker-

town the creek loses the character of a meadow stream, has steeper slopes and considerable hard wood growing on its banks. It continues broad and sluggish with a great quantity of *algæ* in its bed for two or three miles further when its banks become more densely wooded and rugged.

At Keelersville, a small hamlet about seventeen miles from the mouth, is a creamery about an eighth of a mile from the creek. Most of the waste seemed to be absorbed in flowing through the fields. A small tannery at the same place drains over the meadows a quarter of a mile.

The only sources of pollution discovered below this point were two creameries and one tannery. The latter (Atherholt's) is on a small brook about half a mile from the creek, above Tohickon Post Office, some twelve miles from the Delaware. It is larger than the preceding and has direct drainage. Moreover, dead animals from the surrounding country are taken to this point and, buried in a manure pile below the tannery, allowed to rot, draining into the stream. This is the same place referred to by Dr. Leeds in his report of last year as being probably a main cause of the large amount of albuminoid ammonia found in the Tohickon samples.

One of the creameries referred to, on Haycock creek, about two miles from its confluence with the Tohickon a mile below the tannery, gives but little pollution, but the other, in Bedminster township, on Wolf run, half a mile from the Tohickon, six or seven miles from its mouth, is uncommonly bad in summer, when the waste whey and buttermilk is not taken by the farmers.

Haycock creek, referred to above, drains the northeastern slope of Haycock mountain (640 feet above the Tohickon), which is rough and wooded, and surrounded by several square miles of uncultivated land. The eastern side of the valley of the same stream is also about half covered with wood. Otherwise the watershed is almost entirely occupied by farms, except along the Tohickon itself whose banks continue to become steeper and more rough. In the last two miles the

stream falls 150 feet, forming rapids and cascades over a very rocky bed. Above these cataracts, for fifteen miles the fall averages about ten feet to the mile. The larger tributaries, from Bedminster township, have a fall of 25 feet to 30 feet per mile.

In general, the sources of the Tohickon are in a rich farming country of nearly level land on which are used large quantities of artificial manure; while the lower twenty miles and the principal tributaries in this portion are rapid streams, generally over a rocky bed, draining a gently sloping country, for the most part cultivated (except Haycock mountain and vicinity) though with but little artificial manure. In collecting samples of this water near its mouth at Point Pleasant every fourth week from July 2 to December 17, I have found the water to be almost without exception very clear and pleasant to the taste. The total population of the Tohickon watershed is about 10,000.

The Valley of the Neshaminy, including the Little Neshaminy and Mill Creek, was, for the most part, investigated in June by following the streams on horseback by the nearest roads from their sources to the Forks (confluence of the Little Neshaminy with the main stream).

The Neshaminy has its most distant sources (about twenty miles from the Forks) in the North Branch and Pine Run, uniting with the main stream at Chalfont, about ten miles above the Forks. Both are meadow streams, draining long, straight valleys, for the most part highly cultivated. The slopes to the north branch are quite uniform and direct, so that the rainfall runs off quickly, leaving this stream nearly dry after summer droughts, while Pine Run is fed by never-failing springs. No manufactories or other special sources of pollution were discovered in either of these valleys except the following creameries: One near Deep Run, about six miles above Chalfont; one two miles below, near the crossing of the Doylestown and Dublin turnpike, and one at Woodlawn, on a

small brook entering the North Branch about a mile and a half above Chalfont.

At New Galena, about three miles above Chalfont, is an abandoned lead mine, where very rich ore has been found, but no mining done for many years.

The main stream above Chalfont is mostly through gently sloping farm lands, less fertile than the tributary valleys above named, and the highest portion of the watershed, in the southern part of Hilltown, is very irregular and rocky. The stream from this region drains a small tannery on the county road one mile above Line Lexington, and a creamery near Colmar station, which are the only special sources of pollution discovered above Chalfont.

Below this village the Neshaminy is a broad, shallow stream, with sandy or rocky bed, and a gentle fall—about twelve feet to the mile. The farm lands which slope moderately to the creek are not naturally rich or highly cultivated. On one side of the stream the bank is frequently steep and wooded. A small creamery near New Britain and another near Chalfont, and a very large one at Jamison's Corners, Warwick township, on a small brook one and a half miles from the creek and five miles from the Forks, are the only sources of pollution discovered.

The borough of Doylestown, though in this watershed, causes no pollution of the stream, being on a hill and using so little water that all is evaporated before reaching a watercourse. Nor does it seem likely ever to become a source of pollution of the Neshaminy or any other stream.

The Little Neshaminy drains a farming country, not very rich but nearly all cultivated, with small areas of woodland. The surface is gently undulating, and the fall of the stream considerably greater than in the Neshaminy. No sources of pollution were discovered in its watershed, which in general is better adapted for water supply than the main stream.

Mill Creek, entering the Neshaminy just below the forks, has a more irregular and rugged valley than any of the

streams heretofore mentioned, containing more pasture and woodland, with many springs, and no special sources of pollution.

The population of the Neshaminy water shed (including Mill Creek) is about 16,400.

The *Valley of the Perkiomen* above Schwenksville, together with the tributaries Northeast Branch and Skippack entering below that point, was investigated mostly in November by driving over the roads nearest the streams throughout the water shed, but the upper portion of the Northeast Branch was followed in June on horseback.

The sources of the main stream, about twenty miles above Schwenksville, in the eastern corner of Berks County and the southern corner of Lehigh County, are mountain springs of a very uniform flow, yielding their full supply when the tributaries below are nearly dry. They flow through irregular valleys, largely wooded on the hillsides and but little cultivated. After reaching the broader valleys below, in Montgomery County, they assume the character of meadow streams through intervales of richer farming land, with considerable wood on the hills on either side, some of which are quite steep and rough. This, in general, is the nature of the main valley all the way to Schwenksville, though the woodland decreases and the cultivated land increases in proportion towards its mouth. The valley is sparsely populated and there are few towns of any size. The villages are generally scattered collections of separate houses, at some distance from the creek, containing few, if any, manufactories. The only establishments having foul drainage directly into the main creek above Schwenksville (so far as discovered) are a creamery at Hossensack, Lehigh County, and one at Perkiomenville. A small paper mill (using paper rags only for unbleached wrapping paper) is located on the West Branch, near the Berks and Montgomery county line, about twelve miles above Schwenksville.

The Macoby, entering at Green Lane, drains a moderately

rich farming country, but little wooded, with gentle slopes to intervales along the streams. At Greenville is a creamery, and another at McLean's Station, both near the creek.

The East Swamp Creek, entering the Perkiomen below Green Lane, has the wildest and most rocky valley of any of the streams investigated. From Sumneytown to the Bucks County line (four miles) the land along the stream is almost entirely uncultivated and with scarcely any inhabitants, being covered with boulders and stunted trees. The sources in Bucks County are more level and drain some farming land, as also the lower part below Sumneytown. In the former are three creameries, at Trumbauersville, Milford Square, and Spinnerstown.

Rich Valley creek, joining the East Swamp creek at Sumneytown, has not so rugged a valley as the preceding, having more intervales along the stream and considerable wood land. The soil is rocky but quite fertile. A small tannery is located near its confluence with the Swamp creek.

West Swamp creek, entering at Zieglersville station, about a mile above Schwenksville, drains a large area of farming country, mostly of quite flat or gently rolling land. The lower three or four miles of the main valley is more irregular with considerable pasture and wood land, but the fall in this lower portion (about 50 feet in three miles) is not sufficient to effect so complete an oxidation of organic (vegetable) impurities received from the swampy land in the upper part as occurs in the Tohickon which it somewhat resembles. There is a small tannery and a creamery at New Hanover, a creamery near Fagleysville and another near Obelisk Post Office (Frederick township), all on small branches of the main stream; also, near the sources, in Berks County, a small woolen mill and two small tanneries, and a small tannery near the main stream within a mile of its mouth.

The valley of the Northeast Branch does not greatly differ in general from the West Swamp creek, the upper portion of the creek being a meadow stream, generally with a pebbly or rocky bed which becomes more clayey and muddy, broad and

sluggish in the middle portion between Tylersport and Branchville. The watershed much resembles the Neshaminy, above described, but the water appeared to be not so good at the time of my investigation in June. The stones in the bed of the upper middle portion were covered with brown *algæ*, and the horse refused to drink at the fords though thirsty. The lower portion contains considerable meadow intervale lands with gently sloping farms well cultivated. A manufacturer of phosphates near Sellersville sells seventy-five tons per year, a large part of which goes on this watershed. A creamery near Dublin, one near Sellersville, one near Tylersport, and one near Salfordville are the only sources of special pollution discovered. The first three have more or less drainage into the streams.

The Skippack, entering two or three miles from the Schuylkill, drains a large area of very flat and gently sloping farming land. That portion above Evansburg only was investigated. This stream is less suited for a water supply than any investigated, containing much swampy land along the stream and very gentle slopes, even to near the sources. Most of the first rainfalls after dry weather are absorbed before reaching the streams, so that this creek was very low when others above, having steeper slopes, were high. The only manufactory found draining foul waste products into this stream was a small creamery on a branch nearly east of Lederachville.

In general you will observe that the Perkiomen watershed above West Swamp creek is fairly well suited for a water supply of superior quality; the West Swamp creek and Northeast Branch are inferior—the former much so; while the Skippack is quite unsuitable.

The population of the Perkiomen watershed above Schwenksville, excluding the Northeast Branch and the Skippack, is about 21,600, and of the Northeast Branch 8,500.

Very Respectfully,

DANA C. BARBER,

Assistant Engineer.

REPORT OF PROGRESS

OF A

CHEMICAL INVESTIGATION

INTO THE

PRESENT AND PROPOSED FUTURE

WATER SUPPLY OF PHILADELPHIA.

MADE UNDER THE DIRECTION OF THE CHIEF ENGINEER OF THE WATER DEPARTMENT BY

ALBERT R. LEEDS, PH. D.

PHILADELPHIA WATER DEPARTMENT.

March 18, 1885.

COL. WILLIAM LUDLOW,

Chief Engineer:

SIR:—I have the honor to present to you herewith the following report of the progress of the chemical investigation into the present and proposed future water supply of Philadelphia during the year 1884.

This investigation was begun in May, 1883, in accordance with your instructions, with a view of determining the relative characteristics of all the waters in Eastern Pennsylvania, which, in your judgment, might be regarded as available sources of water supply for the City of Philadelphia. It included the personal inspection and analysis of the waters collected along the line of the Delaware river, from the Water Gap to the pumping station at Frankford; the tributaries of the Delaware, including more especially the Pennypack, Neshaminy, Tohickon, and their branches; the waters of the Lehigh, and

its tributaries: the Schuylkill river, both in its upper portions at various points and at the several pumping stations, and finally, the Perkiomen drainage area, the waters inspected and analyzed being collected from the Perkiomen and its branches, including the Skippack, Macoby, and East and West Swamp creeks. The results of the examinations made during the year 1883 were included in the preliminary report for that year. (See Annual Report of the Water Department for 1883, pages 231–262.) They afforded not only a general knowledge of the whole field of future inquiry, but indicated the particular lines of examination along which that inquiry should be directed in order to obtain precise and definite information as to which stream or streams in particular might afford the best drinking water. They excluded from future study certain streams like the upper Lehigh and the Tobyhanna, which yielded on analysis the most positive evidence of purity, and, on inspection of their banks and drainage areas, no probability of contamination from extraneous sources.

With regard to such streams, the work of the chemist was regarded as finished, and the question of their incorporation into the future water suply became entirely one of engineering. On the other hand, certain streams afforded water so inferior to that readily obtainable from other sources that their future study was abandoned.

Having in this two-fold manner usefully circumscribed the scope of inquiry, it became possible to make the study of what remained correspondingly more minute and exhaustive.

The contemporaneous collection of a large number of samples from different parts of the same stream, as had been done with special object in the preliminary work, was abandoned. In lieu thereof were substituted analyses of samples taken on the same day in each week of the year, beginning April 23 and ending December 17, of the streams requiring systematic study. It is obvious that analyses of samples taken at different dates from the water supplies compared may afford misleading results, inasmuch as some of the samples may be taken

under favorable conditions, others under conditions of flow, recent rainfall, aquatic vegetation, etc., quite the reverse. On the other hand, samples taken simultaneously do not always admit of correct comparison, since the rain-falls in neighboring drainage areas are frequently the same neither in duration nor amount. Moreover, apart from this difficulty, the personal analysis of very many samples taken contemporaneously is impracticable from the excessive amount of labor necessary at any one time, and the impossibility of performing it prior to serious alteration in the composition of the samples.

To overcome these difficulties the following plan was drawn up, and, after receiving your approval, was rigidly followed during the whole course of the inquiry. The points from which the samples were collected were divided into four series, —a sample taken from the Delaware River at Byram being included in each series as a basis of comparison.

First. Perkiomen drainage area.
- *a*. Perkiomen at Zieglersville.
- *b*. Perkiomen at Green Lane.
- [Delaware River at Byram.]

Second. Delaware River.
- *a*. At Water Gap.
- *b*. At Byram.
- *c*. At Frankford.

Third. Tributaries of the Delaware.
- *a*. Mill Creek.
- *b*. Big and Little Neshaminy.
- *c*. Tohickon at Point Pleasant.
- [Delaware River at Byram.]

Fourth. Schuylkill River.
- *a*. At Phœnixville Pumping Station.
- *b*. Roxborough " "
- *c*. Spring Garden " "
- [Delaware River at Byram.]

The Delaware River at Byram was fixed upon for the reason that it occupied a middle point in the whole area studied, and

also because the preliminary analysis of the preceding year had given good grounds for supposing that the Delaware River water at this point would be found to represent practically pure drinking-water. The correctness of this anticipation was abundantly confirmed during the progress of the work.

Zieglersville and Green Lane, upon the Perkiomen, were selected as being those points which the analyses for 1883 had shown to give the most satisfactory results for this particular drainage area, and as affording also a fair criterion of the character of that portion of the whole drainage of the Perkiomen Valley which the engineers proposed to utilize in case of the adoption of the Perkiomen for a future water-supply.

In making regular examinations of three, only, of the tributaries of the Delaware,—the Neshaminy, Tohickon, and Mill Creeks,—the design was to supply the chemical data requisite for the determination of the comparative merit of the project which involved a high-level conduit from Point Pleasant on the Delaware, and the delivery of the waters of these streams, collected by storage dams, to the city by gravity. The report of progress of the engineer in charge of surveys for the year 1883 had indicated very strongly the advisability of making these examinations.

Before locating the points for future systematic analyses of the Schuylkill River a preliminary visit of inspection was made in company with Mr. Dana C. Barber, and samples were collected from the following localities, April 16. By reference to the table (p. 312 of the Annual Report for 1883) it will be seen that the analyses of the samples from these localities may be taken as representing the character of the water in the districts into which, for purposes of proper presentation of the statistics of pollution, the valley of the Schuylkill River had been divided.

No. 435. Kissinger's Bridge, representing First District, viz.: the whole valley above Reading. The water was slightly turbid from suspended earthy matters.

No. 436. Pottstown, just above Manatawny Creek, repre-

TABLE I.

ANALYSES OF SCHUYLKILL RIVER WATERS, COLLECTED APRIL 17, 1884.

Number of sample.	435.	436.	437.	438.	439.	440.
Locality.	Kissinger's Bridge, above Reading.	Pottstown, above Manatawny Creek.	Above Phœnixville pumping station.	Intake Norristown Water Works.	Intake Conshohocken Water Works.	Roxborough pumping station.
Free ammonia.						
Parts per 100,000	0.0035	0.004	0.0025	0.0035	0.001	0.0015
Grains per gallon	0.00204	0.0023	0.00146	0.00204	0.00058	0.00087
Albuminoid ammonia.						
Parts per 100,000	0.014	0.0085	0.01	0.0075	0.014	0.01
Grains per gallon	0.0082	0.0049	0.0058	0.00437	0.0082	0.0058
Ratio of free to albuminoid ammonia	4 to 4	1 to 2.1	1 to 4	1 to 2.1	1 to 14	1 to 6.6
Oxygen required to oxidize (permanganate).						
Parts per 100,000	0.058	0.14	0.19	0.13	0.23	0.15
Grains per gallon	0.034	0.082	0.111	0.076	0.134	0.087
Oxygen required corresponding to silver reduced.						
Parts per 100,000	0.037	0.17	0.15	0.23	0.43	0.25
Grains per gallon	0.022	0.099	0.087	0.134	0.25	0.146
Nitrites.						
Parts per 100,000	.....	0.00005	0.00005	0.00008	0.0005	
Grains per gallon	.....	0.000029	0.000029	0.000047	0.00029	
Nitrates.						
Parts per 100,000	0.96	0.92	0.92	0.86	0.86	0.80
Grains per gallon	0.56	0.54	0.54	0.50	0.50	0.467
Chlorine.						
Parts per 100,000	0.20	0.25	0.25	0.25	0.6	0.20
Grains per gallon	0.117	0.146	0.146	0.146	0.35	0.116
Hardness.						
Parts per 100,000	2.5 c. c.	3.5 c. c.	3.7 c. c.	.....	.....	3.0 c. c.
Grains per gallon	1.46	2.04	2.16	.....	.....	1.75
Total solids.						
Parts per 100,000	9.0	11.5	10.5	10.5	10.0	11.5
Grains per gallon	5.25	6.7	6.12	6.12	5.83	6.7
Color	Faint yellow.	Yellow.	Faint yellow.	Faint yellow.	Faint yellow.	Faint yellow.
Taste	Pleasant.	Earthy.	Sweet and pleasant.	Slightly unpleasant.	Earthy.	Slightly earthy.
Smell	None.	None.	None.	None.	None.	None.
Temperature	51°	55.°5	55.°3	54.°4	54.°4	54.°4

senting Second District, viz.: from upper boundary of Reading to mouth of Manatawny Creek. Owing to a heavy local rain in the morning this sample was very muddy.

No. 438. Above intake of Norristown Water Works, representing the Fourth District, viz.: from Phœnixville to Norristown. Slightly muddy.

No. 439. In front of intake of Conshohocken Water Works, representing Fifth District, viz.: from Norristown to Conshohocken. Slightly muddy.

No. 440. Opposite Roxborough Pumping Station, in middle of the current, representing Sixth District, viz.: from Conshohocken to Flat Rock Dam.

On the same day, Mr. Amasa Ely collected a sample from the Delaware River, at Byram. Owing to a heavy fall of rain immediately preceding, the river was muddy and at high level. This isolated sample, collected especially for purposes of comparison with the Schuylkill River series, is properly given in this place.

DELAWARE AT BYRAM, April 17, 1884.

	Parts per 100,000.	Grains per gal.
Free ammonia	0.0025	0.0015
Albuminoid ammonia	0.01	0 0058
Required oxygen [permanganate]	0.30	0.175
Required oxygen [silver]	0.28	0.16
Nitrous acid	None.	None.
Nitric acid	0.86	0.50
Chlorine	0.20	0.12
Total solids	8.0	4.67
Temperature, 52°.3 Fahr.		

From these results, and others previously obtained and bearing on the same question, the three following conclusions were drawn:

First. The analysis of samples collected at Phœnixville might be taken as a basis for comparison of the Schuylkill River waters, just as the samples of the Delaware River, at Byram, might be taken as a base for general comparison.

Second. That the analyses of the Schuylkill river, at Phœ-

nixville, would yield results as favorable to the character of the water as the analyses of samples collected above Phœnixville, and might fairly be regarded as favorably representing the quality of the water in the upper Schuylkill.

Third. That for similar reasons, the analyses of the samples collected at Roxborough Pumping Station, might be taken as representative of the quality of the water in the Fourth, Fifth, and Sixth Districts, lying between Phœnixville and Roxborough, and that there would be no benefit in multiplying the analyses of samples collected between these two points.

Phœnixville and Roxborough therefore, with the Spring Garden Pumping Station (the latter being studied with a view of determining the amount of deterioration below Roxborough) were selected for the three points of systematic examination of the Schuylkill river throughout the remainder of the year.

The execution of the very comprehensive scheme above indicated necessitated the collection and analysis of 123 samples. No portion of the work was lost except the determination of the dissolved gases, in samples Nos. 594, 595, and 596, a loss due to an accidental destruction of my laboratory memoranda of these three determinations. The labor of collecting the samples was performed by Mr. Dana C. Barber, and his task was accomplished with such care and promptitude, that each sample unquestionably represents the water of the locality from which it was derived, at the date assigned to it.

In addition to the main inquiry, as set forth in the foregoing preliminary remarks, I have analyzed, in accordance with your instructions, numerous samples of water representing the waste and sewage waters of factories located along the banks of the Schuylkill, for use in legal proceedings instituted in connection therewith.

These results, together with those of certain of the same waters after partial purification, will be placed by themselves as an appendix to the main body of the present report.

Methods of Analysis.

In the two reports previously made, I have given in so great detail the methods of analysis pursued, that there is no need of again entering upon this topic except in so far as new, and I trust, better methods have been adopted. These relate to the following four determinations:

I. *Nitric Acid.* Instead of estimating the nitric acid by measuring the ammonia found after reduction by a copper zinc couple, I have determined it by reducing to nitrous oxide out of contact with air by means of ferrous chloride. The nitric oxide was collected and measured in a eudiometer over caustic soda. The former method was abandoned because of the tediousness and uncertainty connected with obtaining an end-reaction, and also for the reason that when the distillations were pushed too far, ammonia was given off, which was derived not from the reduction of the nitric acid, but from the organic nitrogen present.

II. *Oxygen required to oxydize the organic matters as determined by reduction of silver nitrate.*

Since the publication of the report for 1883 it has been objected to this method, that the silver nitrate may also undergo reduction by ferrous salts, or may be converted into sulphide by sulphur compounds possibly present in the waters analyzed. This objection is valid; but it applies with equal force (as was well recognized when the method was first proposed) to the permanganate also. The permanganate is readily reduced in the presence of the same bodies which affect the silver nitrate. I have, therefore, continued to give the results as obtained by both methods, since whilst these results maintain a general correspondence, the indications afforded by the silver are in many instances different from those given by the permanganate, and bear a closer relationship to the quantities of readily decomposable nitrogenous bodies present.

III. *Alkalinity and acidity.* Instead of estimating quantitatively the degree of alkalinity or acidity by adding a very

sensitive indicator, like alizarine or phenolphthalein, as I originally proposed, and then running into the water sufficient of a centinormal solution of acid or alkali to establish a neutral reaction, I have found it better to begin by the immediate addition of one or two tenths of a cubic centimeter of a decinormal solution of alkali, and then adding the requisite quantity of a corresponding decinormal acid solution to make the reaction neutral.

IV. *Gases held in solution.* The very large number of samples to be analyzed rendered it necessary to devise a method which should be both accurate and rapid for the determination of the dissolved gases. In the report for 1883 the percentages of dissolved oxygen only are given, these percentages being determined in accordance with Mohr's method. But this and similar indirect methods of estimating the gases dissolved in water, containing, as it does, so many unknown organic substances capable of affecting the re-agents employed, are objectionable and were abandoned. Moreover, of the direct methods, those which depend upon expelling the dissolved gases by long-continued boiling at atmospheric pressures were rejected for the reason that such protracted boiling, in contact with decomposable organic matter, alters to a greater or less degree the percentages of the evolved gases. The apparatus eventually devised and used in the performance of all the analyses tabulated in the present report, has not hitherto been described in print, and a brief description will therefore be essential.

It consists of a globular glass vessel of three liters capacity, which is suitably connected with a mercury air-pump. A tube descends through the top of the flask nearly to the bottom, this tube being re-curved outside the flask and extending downwards to a lower point than the opening of the tube inside the flask. The syphon so formed is controlled at its upper curvature by a glass stop-cock. In using the apparatus a partial vacuum is first made in the flask and a small amount of water drawn in through the syphon. The water is then gently

TABLE II.

ANALYSES OF PRESENT AND PROPOSED WATER SUPPLIES OF PHILADELPHIA,

FROM APRIL 23 TO DECEMBER 17, 1884, ARRANGED ACCORDING TO DATE,

MADE UNDER DIRECTION OF COL. WILLIAM LUDLOW,

BY ALBERT R. LEEDS, PH. D.

Month.	Day.	Location.	Laboratory number.	Free ammonia.		Albuminoid ammonia.		Ratio of free to albuminoid ammonia.	Nitrous acid.		Nitric acid.		Ratio of nitric acid to albuminoid ammonia.	Oxygen required to oxidize organic matter. [Permanganate.]		Oxygen required corresponding to silver reduced.		Gases in solution in 1,000 cubic centimeters.				Relative volume—per centage of oxygen to nitrogen.	Relative volume—per centage of oxygen to total gases.	Organic carbon.		Organic nitrogen.		Ratio of organic carbon to organic nitrogen.	Chlorine.		Hardness.		Total solids.		Acidity.		Color.	Taste.	Smell.	Temperature. Fahr.
				Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.		Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.		Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Oxygen.	Carbon dioxide.	Nitrogen.	Total.			Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.		Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.				
April	23	Perkiomen, at Zieglersville	443	0.006	0.0035	0.018	0.0105	1 : 3.00	None.		0.43	0.25	23.9 : 1	0.21	0.122	0.25	0.151	5.40 c.c.	0.53 c.c.	11.12 c.c.	17.05 c.c.	32.5 : 67.5	24.1 : 75.9	0.324	0.1889	0.181	0.105	1.8 : 1	0.35	0.204	3.0	1.75	10.5	6.12	0.25	0.145	0.75	None	0	60.29
	23	Perkiomen, at Green Lane	444	0.008	0.0046	0.016	0.0093	1 : 2.00	0.00005	0.000029	0.43	0.25	26.9 : 1	0.26	0.151	0.25	0.146	5.80 c.c.	0.47	10.40	16.67	35.8 : 64.2	25.8 : 74.2	0.345	0.201	0.172	0.071	2.8 : 1	0.25	0.146	3.0	1.75	9.0	5.25	0.25	0.145	2.00	None	0	59.54
	23	Delaware River, at Byram	445	0.003	0.00175	0.011	0.0064	1 : 3.67	None.	None.	0.42	0.24	38.2 : 1	0.24	0.14	0.20	0.116	5.40	0.63	12.70	18.73	29.8 : 70.2	22.4 : 77.6	0.287	0.167	0.110	0.064	2.6 : 1	0.20	0.116	2.6	1.52	8.5	4.96	0.25	0.145	0.75	None	0	53.92
April	30	Delaware River, at Water Gap	446	0.0025	0.00146	0.012	0.007	1 : 4.80	None.	None.	0.38	0.22	31.6 : 1	0.35	0.204	0.30	0.175	5.40	0.43	10.2	16.03	34.6 : 65.4	25. : 75	0.321	0.187	0.081	0.047	4.0 : 1	0.20	0.116	2.6	1.52	6.0	3.50	0.15	0.087	0.75	Sweet	0	58.90
	30	Delaware River, at Byram	447	0.003	0.00175	0.015	0.0087	1 : 5.00	None.	None.	0.41	0.24	27.3 : 1	0.30	0.175	0.28	0.163	5.62	0.72	11.76	18.10	32.3 : 67.7	23.7 : 76.3	0.342	0.199	0.092	0.053	3.7 : 1	0.20	0.116	2.6	1.52	8.0	4.67	0.25	0.145	0.75	Pleasant	0	
	30	Delaware River, at Frankford pumping station	448	0.004	0.00233	0.015	0.0087	1 : 3.75	None.	None.	0.43	0.25	28.6 : 1	0.33	0.192	0.30	0.175	5.90	0.83	11.86	18.59	33.2 : 66.8	24.1 : 75.9	0.299	0.174	0.121	0.0705	2.4 : 1	0.25	0.146	3.4	1.98	9.0	5.25	0.00	0.00	0.75	Flat	0	
May	7	Big (⅓) and Little (⅓) Neshaminy	454	0.001	0.00058	0.016	0.0093	1 : 16.00	0.0005	.00029	0.40	0.233	25.0 : 1	0.35	0.204	0.30	0.175	5.52	0.72	10.80	17.04	33.8 : 66.2	24.5 : 75.5	0.346	0.2017	0.114	0.066	3.0 : 1	0.40	0.233	3.0	1.75	9.0	5.25	0.50	0.291	0.75	Woody	0	56.30
	7	Tohickon Creek, at Point Pleasant	455	0.003	0.00175	0.019	0.01108	1 : 6.33	0.0008	0.00046	0.425	0.248	22.3 : 1	0.38	0.222	0.35	0.204	6.00	0.47	11.00	17.47	33.3 : 64.7	25.6 : 74.4	0.325	0.189	0.201	0.116	1.6 : 1	0.40	0.233	3.2	1.87	9.0	5.25	0.50	0.291	2.00	Peaty	0	56.92
	7	Delaware River, at Byram	453	0.0005	0.00029	0.011	0.00641	1 : 22.00	None.	None.	0.375	0.218	34.1 : 1	0.28	0.163	0.20	0.116	5.10	0.64	11.72	17.76	31.5 : 68.5	23.3 : 76.7	0.302	0.176	0.168	0.098	1.7 : 1	0.20	0.116	2.5	1.46	8.0	4.67	0.25	0.0145	2.00	Earthy	0	56.97
May	14	Schuylkill, above Phœnixville pumping station	457	0.0045	0.00262	0.0125	0.00728	1 : 2.77	0.00008	0.000046	0.375	0.218	30.0 : 1	0.15	0.087	0.14	0.082	5.95	0.47	10.96	17.38	35.2 : 64.8	25.5 : 74.5	0.342	0.199	0.146	0.085	2.3 : 1	0.30	0.175	3.5	2.04	10.5	6.12	0.25	0.145	0.5	Earthy	0	62.90
	14	Schuylkill, opposite Roxborough pumping station	456	0.001	0.00058	0.0155	0.00903	1 : 15.50	None.	None.	0.375	0.218	24.2 : 1	0.17	0.099	0.18	0.105	6.00	0.83	11.11	17.91	35.1 : 64.9	25.1 : 74.9	0.299	0.174	0.198	0.115	1.5 : 1	0.30	0.175	3.6	2.10	11.0	6.41	0.25	0.145	2.5	Earthy	0	61.26
	14	Delaware, at Byram	458	0.0035	0.00204	0.018	0.0105	1 : 5.33	None.	None.	0.35	0.204	19.4 : 1	0.45	0.262	0.31	0.181	5.40	0.66	11.03	17.09	35.2 : 64.8	24 : 76	0.367	0.214	0.217	0.126	1.7 : 1	0.20	0.116	2.6	1.52	7.5	4.37	0.25	0.145	0.5	Flat	0	58.80
May	21	Perkiomen, at Zieglersville	460	0.001	0.00058	0.024	0.014	1 : 24.00	None.	None.	0.42	0.245	17.5 : 1	0.32	0.187	0.34	0.198	5.80	0.81	10.14	16.75	36.3 : 63.7	25.7 : 74.3	0.382	0.222	0.201	0.116	1.9 : 1	0.40	0.233	3.1	1.81	11.0	6.41	0.25	0.145	0.75	Agreeable	0	75.20
	21	Perkiomen, at Green Lane	461	0.008	0.00466	0.0215	0.0125	1 : 2.94	0.00008	0.000046	0.42	0.245	19.5 : 1	0.30	0.175	0.26	0.152	5.75	0.72	12.13	18.60	32.2 : 67.8	23.6 : 76.4	0.302	0.176	0.112	0.065	2.7 : 1	0.40	0.233	3.2	1.87	10.0	5.83	0.25	0.145	0.5	Good	0	74.02
	21	Delaware, at Byram	462	0.0035	0.00204	0.015	0.0087	1 : 4.28	0.00005	0.000029	0.375	0.218	25.0 : 1	0.28	0.163	0.26	0.152	5.53	0.83	11.20	17.36	32.3 : 67.7	23.5 : 76.5	0.324	0.188	0.101	0.059	3.2 : 1	0.20	0.116	2.7	1.57	8.5	4.96	0.15	0.087	0.75	Pleasant	0	66.96
May	28	Delaware, above Water Gap	465	0.002	0.00116	0.0135	0.0078	1 : 6.75	None.	None.	0.35	0.204	25.9 : 1	0.14	0.082	0.18	0.105	5.72	0.60	10.27	16.59	35.8 : 64.2	25.6 : 74.4	0.286	0.166	0.084	0.049	3.4 : 1	0.20	0.116	2.5	1.46	6.5	3.79	0.15	0.087	0.75	Pleasant	0	67.82
	28	Delaware, at Byram	464	0.003	0.00175	0.011	0.0064	1 : 3.67	None.	None.	0.35	0.204	31.8 : 1	0.25	0.146	0.22	0.128	5.60	0.83	12.00	18.43	31.8 : 68.2	23.3 : 76.7	0.246	0.143	0.082	0.047	3.0 : 1	0.20	0.116	2.6	1.52	8.0	4.67	0.25	0.145	0.75	Flat	0	69.97
	28	Delaware, at Frankford pumping station	463	0.011	0.00641	0.017	0.0099	1 : 1.55	0.00005	0.000029	0.40	0.233	23.5 : 1	0.35	0.204	0.33	0.192	5.47	0.47	10.41	16.35	34.5 : 65.5	25.1 : 74.9	0.298	0.173	0.100	0.058	2.9 : 1	0.25	0.146	3.4	1.98	9.5	5.54	0.25	0.145	0.5	None	0	74.90
June	4	Big and Little Neshaminy Creek	475	0.003	0.00174	0.023	0.0134	1 : 7.67	0.0005	0.00029	0.40	0.233	17.4 : 1	0.33	0.192	0.32	0.187	4.12	1.25	12.00	17.37	25.5 : 74.5	19.2 : 80.8	0.362	0.211	0.221	0.128	1.6 : 1	0.40	0.233	3.0	1.75	9.0	5.25	0.00	0.00	1.0	None	0	68.97
	4	Mill Creek, above Forrestville	476	0.001	0.00058	0.011	0.00641	1 : 11.00	0.00005	0.000029	0.375	0.218	34.1 : 1	0.40	0.233	0.35	0.204	6.07	0.92	11.02	18.61	37.7 : 62.3	26.4 : 73.6	0.321	0.187	0.201	0.116	1.6 : 1	0.40	0.233	3.2	1.87	9.5	5.54	0.15	0.087	1.0	Woody	0	79.90
	4	Tohickon, at Point Pleasant	474	0.0015	0.00087	0.018	0.0105	1 : 12.00	0.00005	0.000029	0.40	0.233	22.2 : 1	0.35	0.204	0.36	0.223	4.80	0.62	11.23	16.65	29.9 : 70.1	22.4 : 77.6	0.348	0.203	0.169	0.0985	2.1 : 1	0.35	0.218	3.0	1.75	9.5	5.54	0.25	0.145	0.75	Pleasant	0	
	4	Delaware, at Byram	473	0.002	0.00116	0.011	0.00641	1 : 5.50	None.	None.	0.325	0.189	29.5 : 1	0.24	0.14	0.20	0.116	6.28	0.48	11.22	17.98	35.9 : 64.1	25.9 : 74.1	0.264	0.154	0.072	0.042	3.6 : 1	0.20	0.116	2.8	1.63	8.0	4.67	0.15	0.087	0.75	Good	0	73.02
June	11	Schuylkill, above Phœnixville pumping station	479	0.006	0.0035	0.013	0.0076	1 : 2.17	0.0005	0.00029	0.40	0.233	30.7 : 1	0.25	0.146	0.20	0.116	5.20	0.82	11.27	17.29	31.5 : 68.5	23.6 : 76.4	0.345	0.201	0.094	0.054	3.6 : 1	0.35	0.218	3.6	2.10	11.0	6.41	0.25	0.145	2.0	Earthy	Earthy.	
	11	Schuylkill, at Roxborough pumping station	477	0.0015	0.00087	0.013	0.0076	1 : 8.33	0.00005	0.000029	0.40	0.233	30.7 : 1	0.20	0.116	0.22	0.128	4.40	0.86	10.42	15.68	30.4 : 69.6	21.9 : 78.1	0.261	0.152	0.08	0.0046	3.3 : 1	0.30	0.175	3.4	1.98	11.0	6.41	0.00	0.00	2.5	Peaty	Peaty.	
	11	Delaware at Byram	478	0.004	0.00233	0.015	0.0087	1 : 3.75	None.	None.	0.35	0.204	23.3 : 1	0.21	0.122	0.18	0.105	5.72	0.75	11.46	17.93	33.3 : 66.7	24.2 : 75.8	0.278	0.162	0.072	0.042	3.8 : 1	0.25	0.146	2.8	1.63	8.5	4.96	0.15	0.087	0.75	Earthy	0	62.98

Acidity.	Grains per gallon.	Color.	Taste.	Smell.	Temperature. Fahr.
	0.145	3.0	Peaty	Peaty	71.°0
	0.087	2.5	Peaty	Peaty	73.°0
	0.087	1.25	Earthy	Earthy	78.°0
	0.087	0.5	Good	0	
	0.145	1.0	Peaty	0	78.°0
	0.145	1.5	Good	0	77.°0
	0.145	1.0	Unpleasant	0	87.°0
	0.087	1.0	Pleasant	0	82.°0
	0.087	0.75	Slight	0	78.°0
	0.087	1.25	Pleasant	0	
	0.00	1.5	Pleasant	0	69.°0
	0.00	0.75	Flat.		
	0.087	1.60	Unpleasant	0	68.°0
	0.145	0.75	Unpleasant	0	69.°3
	0.087	0.5	Flat	0	69.°1
	0.087	0.75	Pleasant	0	70.°5
	0.087	0.5	Pleasant	0	73.°3
	0.087	0.75	Pleasant	0	69.°0
	0.145	0.50	Pleasant	0	78.°0
	0.145	0.75	Pleasant	0	77.°6
	0.145	0.50	Pleasant	0	72.°5
	0.087	0.75	Sweet	0	80.°0
	0.00	0.5	Slight	0	78.°5
	0.087	0.5	Pleasant	0	84.°0
	0.145	0.75	Pleasant	0	72.°6
	0.087	0.5	Flat	0	73.°7
	0.145	0.5	Woody		73.°0
	0.087	1.25	Very pleasant	0	74.°5
	0.14	1.5	Very pleasant	0	78.°3
	0.145	1.0	Very pleasant	0	83.°2
	0.151	1.25	Unpleasant	Faint	79.°5

* Alkalinity equivalent to o...

Acidity.		Color.	Taste.	Smell.	Temperature. Fahr.
Parts per 10,000.	Grains per gallon.				
				0	73.°7
0.25	0.145	1.5	Unpleasant	Earthy	65.°4
0.49	0.285	2.5	Earthy	0	86.°1
0.00	0.00	1.5	Pleasant	0	75.°8
0.24	0.14	1.0	Pleasant		
				0	80.°1
0.49	0.285	0.05	Pleasant	0	79.°9
0.49	0.285	0.00	Earthy	Earthy	69.°1
0.50	0.291	3.5	Earthy		
				0	80.°1
0.49	0.285	1.5	Pleasant	Earthy	80.°0
0.50	0.291	1.0	Foul	Slight	83.°0
0.025	0.014	1.0	Pleasant		
				0	72.°0
0.40	0.233	0.5	Pleasant	0	72.°4
0.25	0.145	0.5	Very pleasant	Slight	72.°9
0.50	0.291	1.5	Unpleasant		
				0	77.°0
0.45	0.262	0.5	Slight	Vegetable	71.°6
0.0	0.00	2.0	Pleasant	Vegetable	76.°7
1.40	0.81	1.0	Pleasant	Vegetable	70.°0
0.25	0.145	0.0	Pleasant		
				0	77.°4
0.25	0.145	0.0	Pleasant	Foul	73.°9
0.74	0.431	0.0	Unpleasant	Foul	78.°0
0.73	0.425	0.0	Woody	Earthy	68.°0
0.49	0.285	0.0	Earthy		
				0	70.°0
1.12	0.65	1.0	Unpleasant		
				0	65.°7
0.25	0.145	0.75	Pleasant	0	65.°2
0.73	0.425	0.0	Unpleasant	0	67.°1
0.40	*Soda.	0.5	Pleasant		
				0	59.°0
0.24	0.14	1.5	Pleasant	Peaty	61.°5
0.25	0.145	1.0	Earthy	Foul.	
0.25	0.145	0.75	Faint		
				Unpleasant	65.°6
0.50	0.291	0.05	Pleasant	Earthy	59.°0
3.80	2.21	0.05	Earthy	0	66.°8
0.00	0.00	0.0	Pleasant	0	60.°1
0.50	0.291	0.05	Pleasant		

* Alkalinity equivalent to 0.40 parts of soda.

Oxygen required corresponding to silver reduced.		Gases in solution in 1,000 cubic centimeters.				Relative volume—per centage of oxygen to nitrogen.	Relative volume—per centage of oxygen to total gases.	Organic carbon.	
Parts per 100,000.	Grains per gallon.	Oxygen.	Carbon dioxide.	Nitrogen.	Total.			Parts per 100,000.	Grains per gallon.
0.39	0.227	6.35	0.70	14.95	22.00	29.8 : 70.2	22.1 : 77.6		
0.25	0.145	6.70	1.23	15.07	23.00	30.7 : 69.3	22.5 : 77.5		
0.30	0.175	5.70	1.10	14.00	20.8	28.9 : 71.1	21.5 : 78.5		
0.33	0.192	6.80	0.60	14.60	22.0	31.8 : 68.2	23.6 : 76.4		
0.56	0.326	5.80	0.80	13.80	20.1	29.5 : 70.5	22.2 : 77.8		
0.45	0.262	5.86	0.80	13.34	20.0	30.5 : 69.5	22.7 : 77.3		
0.40	0.233	6.53	1.00	14.47	22.0	31.1 : 68.9	22.9 : 77.1		
0.41	0.239	6.80	1.06	16.00	23.86	29.9 : 70.1	22.2 : 77.8		
0.40	0.233	6.80	1.20	16.13	24.13	29.7 : 70.3	22.0 : 78.0		
0.31	0.180	6.26	0.80	14.00	21.06	30.9 : 69.1	22.9 : 77.1		
0.38	0.221	7.6	1.46	15.20	24.26	33.3 : 66.7	23.9 : 76.1		
0.31	0.181	8.53	3.4	17.07	29.00	33.6 : 66.4	22.5 : 77.5		
0.41	0.239	7.86	1.933	14.94	23.733	34.1 : 65.9	24.9 : 75.1		
0.31	0.181	6.53	2.0	15.73	24.26	29.4 : 70.6	21.2 : 78.8		
0.24	0.14	7.33	1.73	15.17	24.53	32.2 : 67.8	23.1 : 76.9		
0.40	0.233	6.6	1.06	15.54	23.2	29.8 : 70.2	22.2 : 77.8		
0.35	0.204	5.46	1.20	15.20	21.86	26.5 : 73.5	20. : 80		
0.36	0.21	6.26	1.06	15.61	22.93	28.7 : 71.3	21.4 : 78.6		
0.18	0.105	8.26	1.46	16.81	26.53	32.9 : 67.1	23.7 : 76.3		
0.27	0.157	7.86	1.53	16.51	25.93	32.3 : 67.7	23.2 : 76.8		
0.24	0.14	7.33	1.06	14.14	22.53	34.2 : 65.8	24.5 : 75.5		
0.26	0.15	7.00	0.60	15.33	22.93	31.3 : 68.7	23.4 : 76.6		
0.33	0.19	7.46	0.733	15.81	24.00	32.1 : 67.9	23.8 : 76.2		
0.20	0.12	7.00	0.60	15.46	23.06	31.1 : 68.9	23.3 : 76.7		
0.22	0.13	7.17	1.07	15.59	24.13	32.1 : 67.6	23.7 : 76.3		
0.30	0.17	7.80	1.20	14.30	23.3	35.3 : 64.7	25.1 : 74.9		
0.26	0.15	7.00	1.50	18.70	27.2	27.3 : 72.7	20.5 : 79.5		
0.29	0.17	7.70	0.93	16.87	25.5	31.4 : 68.6	23.2 : 76.8		
					Average.	29.5 : 70.5	21.7 : 78.3		

heated, and a perfect vacuum established with the aid of the steam, the water boiling violently at a low temperature in vacuo. To obtain a perfect vacuum by means of a mercury pump when so large a flask is used, and no steam is present, is very difficult and tedious.

With the steam a vacuum can be produced by twenty minutes' pumping. The whole of the syphon tube being now filled with the water to be analyzed, and its open end being submerged in a graduate filled with the same water, the stopcock is opened and exactly three-quarters of a liter forced over into the exhausted flask by atmospheric pressure. After boiling for fifteen minutes in vacuo the evolved gases are pumped over into a eudiometer and analyzed by customary methods. Duplicate analyses afford identical results. These results are somewhat higher than those given by methods involving expulsion of the gases by boiling at atmospheric pressures. But when we recall to mind the extreme difficulty of expelling from water the last portions of dissolved air, unless, as in the present instance, the water is boiled in vacuo, it will be seen that this difference is one which is in favor of the accuracy of the results obtained by the method stated.

Table of Analyses and Graphic Chart.

The accompanying table of analyses gives the results of the examination of each weekly series of samples, arranged according to dates of collection. From the table, Mr. T. M. Rogers has constructed, in accordance with your instructions, a very elaborate and handsomely executed geographical chart, in which the analyses are grouped, primarily according to locality, and, secondarily, within the limits of locality, according to date. The determinations of ammonia, free and albuminoid, are brought together, the unit of the scale being 0.001 part of ammonia in 100,000 parts of water. In a second horizontal division the oxygen required to oxidize the organic matters, the nitric acid and the chlorine are graphically represented, the unit of the scale attached thereto corresponding to

0.05 parts of these bodies dissolved in 100,000 parts of water. The quantitative measurements of the tint of color are also represented in this division of the map, but with a special scale. The unit of this scale corresponds to that particular tint of yellow color which is struck by 0.00025 part of ammonia in 100,000 parts of water when treated with 1 c.c. of Nessler re-agent.

The third horizontal division is devoted to the dissolved gases, the divisions in the scale not representing parts per weight in 100,000 parts of water, as in the two preceding, but the number of cubic centimeters of oxygen, nitrogen, carbonic acid, and total gases contained in one liter of water.

The chart is supplemented by a fourth division, in which the rain-fall is given for days and months at three localities of observation, viz.: the mouth of the Perkiomen, at Easton, and at Doylestown.

Upon the study of these tables and chart the statements and inferences are based which constitute the substance of this report. No separate presentation will be made of the principles involved in the interpretation of the analytical data, inasmuch as these principles are very fully discussed in the preliminary report for 1883.

I. Free and Albuminoid Ammonia.

An inspection of the chart shows, in the first place, that in only one instance does the free exceed the albuminoid ammonia. This is in the case of the sample taken from the Perkiomen at Green Lane on August 13. Both substances are present in this sample in very unusual amounts, a fact which of itself indicates something exceptional and peculiar. In the preliminary report I have called attention to the fact that the operation of natural forces always tends to render the free much smaller than the albuminoid ammonia, the ratio between them in pure river waters being usually less than one part of the former to three of the latter. When the free ammonia exceeds, the operation of some extraneous interfering agency,

such as trade or sewage contamination is indicated. Such was the case in the present instance. At the time of collecting this sample the water in the Perkiomen was higher than the usual summer flow, and at the point where the sample was taken the water had acquired a strong woody taste from the saw-dust used for filling in a dam located on the river only 800 feet above. This analysis, therefore, must be excluded from any discussion as to relative purity.

The same remark applies to the sample taken from the Perkiomen at Green Lane in the month of June. The river at that time was very low, and repairs on the dam no doubt affected the purity of the sample, making the percentage of the albuminoid ammonia very high. But it does not apply to the sample taken from the Perkiomen in June at Zieglersville, in which the percentage of albuminoid ammonia is still higher.

About the beginning of October, a general diminution in the amount of albuminoid ammonia is noticeable. This improvement, which is likewise observable in the free ammonia, continues until the close of the year. This change of character is not peculiar to the various streams considered in the present report, but is generally true of river waters. It shows that the influence of decaying vegetation, attendant upon the end of summer, has passed away.

Examination of the chart renders it apparent that in regard to free and albuminoid ammonia, the Schuylkill waters above Phoenixville and at Roxborough, are closely similar. A maximum for the albuminoid ammonia is noticeable at Phoenixville and Roxborough in July, and a second maximum on October 1. The Schuylkill river at Spring Garden Station exhibits a larger amount of albuminoid ammonia in August and October than it does at Roxborough on the same dates.

A general survey of the Perkiomen samples in regard to these two data of comparison, shows them to be inferior to the Delaware river at Byram, and still more inferior to the Delaware at the Water Gap.

The Delaware river samples present a progressive falling

off, those at Frankford being inferior to those taken at Byram, and still more inferior to those collected at the Gap.

Of the tributaries of the Delaware, Mill Creek, at Forrestville, affords, in regard to ammonia, the best exhibit, the Big and Little Neshaminy Creek and the Tohickon not being equal in this respect to the Delaware, at the Gap.

II. Required Oxygen.

The oxygen required to oxidize organic matters is represented by a solid red line when it was determined by the use of potassium permanganate, and by a broken red line when it was determined by the reduction of nitrate of silver. These two lines, it will be noticed, show a general correspondence. If we follow the silver line alone, it will be seen how favorably the samples taken from the Delaware river, at Byram, compare with those collected from any other localities, even with its own tributaries—the Tohickon, Neshaminy, and Mill Creek. The Perkiomen waters also manifest the same inferiority.

III. Chlorine and Nitric Acid.

The percentage of both of these substances, and their variations in amount, are considerably greater in any of the tributaries of the Delaware than in the Delaware itself. A similar remark applies to the Schuylkill and Perkiomen, when compared with the Delaware river at Byram. The Schuylkill, at Spring Garden, shows a notable increase in the amount of chlorine as compared with the same river at Roxborough, a difference connected with the influence of manufacturing and sewage contamination.

IV. Color.

The purest and best drinking waters are those which are perfectly colorless. With an increase of yellow tint they become more and more open to suspicion, although not necessarily unwholesome. The ground for this suspicion is that analysis reveals in many cases an increase in the amount of dissolved organic matter along with the increase of color. Sometimes

this organic matter is of purely vegetable origin, as the amber-colored or brownish tint imparted by peaty substances; at other times its origin is to be sought for in the presence of more deleterious substances. For these reasons the quantitative measurement of the depth of color is of practical importance, and the results are accordingly formulated in the accompanying tables and chart. It should be borne in mind that in these remarks I do not refer to the yellow discoloration and turbidity produced by suspended mud and earthy matters. These matters, being insoluble, are deposited on standing, or after the influence of the rain-fall which has occasioned them has passed away, and leave the water in a sweeter and better condition than before. But I refer to the permanent tinge which is imparted by organic matter in a state of solution, and which is quantitatively determined by examination of the waters after filtration.

This explanation throws light upon what would otherwise be an apparent anomaly, namely, that the variations in the amount of color do not correspond with the variations in the amount of rain-fall. For example, in the Perkiomen Valley there was but little rain between the middle of May and the middle of June, whilst the greatest amount of color observed in any of the Perkiomen samples was in that collected on June 18. Between the middle of June and the middle of July, on the contrary, the Perkiomen rainfall was the largest for any similar interval during the entire year, and yet the color of the July samples was slight. The same observation applies to the high color observable in the Schuylkill samples for May and June with the small contemporaneous rain-fall. In September, the rain-fall in the Delaware valley, as registerd at Easton, was small, while the color of the Delaware water, at Byram, was greater than at any other date during the year. In November and December the rain-fall at Easton was large, whilst at Byram the water was nearly colorless. At Doylestown there was a very heavy rain-fall on June 25 and 26, nearly five inches of rain falling on those two days. Again,

from July 4 to 6, more than two inches of rain fell, while the sample collected from the Neshaminy on July 30 shows very little color. On November 19 and 20, half an inch of rain fell at Doylestown, whilst the Neshaminy sample of corresponding date shows little color. If, instead of comparing the rain-fall with the color, we compare it with the organic matter (as inferred from the amount of oxygen required to effect its oxidation), we see that in many cases, though not in all, an increase of organic matter corresponds to an increase of color. For instance, there was increased coloration of the Schuylkill at Roxborough and Spring Garden on the 26th of November, and a corresponding increase in dissolved organic matter. The Byram samples exhibited most color September 3. On the same date a notable increase of oxidizable organic matter was apparent.

IV. Dissolved Gases and Artificial Aëration.

In atmospheric air the ratio of oxygen to nitrogen is 21 to 79. In contact with water, oxygen is absorbed more rapidly than nitrogen, owing to its higher co-efficient of solubility. Theoretically, in pure water the ratio between the dissolved oxygen and nitrogen should be as 35 to 65. In other words, the air dissolved in water should be 14 per cent. richer in oxygen than ordinary atmospheric air. In the tabulated series of 113 analyses of the gaseous constituents of as many different samples of water, this theoretical percentage is not attained. In the 53 samples collected between April 23 and August 13 the ratio of the oxygen to the nitrogen is 32.7 to 67.5; in the 63 samples collected between August 20 and December 17 it is as 29.5 to 70.5. This would make the average for the entire series approximately 31 per cent. by volume of oxygen to 69 of nitrogen. The relative proportion of oxygen to the total dissolved gases in these 116 samples is approximately 23 per cent.

In the Sixth Report of the Rivers Pollution Commission of England, the analysis of the dissolved gases is objected to on

the ground that "in the present state of our knowledge the gaseous constituents of water throw but little light upon its character. The existence of dissolved atmospheric gases in water doubtless adds to its palatability. Recently-boiled water, for instance, has a notoriously flat and vapid taste, but the solution of these gases by water is so rapid as almost to preclude the possibility of lack of aëration in natural waters."

"It was at one time supposed that the proportion of oxygen in these gases was an important item in the history of the water, and it was believed to indicate, if small, the presence of putrescent organic matters; but the discovery that deep-well waters (in which putrescent organic matter is certainly not present) contain little or no dissolved oxygen deprived this analytical fact of much of its importance."

A table of analyses of the dissolved gases contained in five samples of water is given, from which it is concluded,—"that the total volume of dissolved atmospheric gases differs but little, even in waters from the most widely different sources."

The analyses of the dissolved gases in more than 200 samples of water has yielded the author far different results from those quoted in the above report, and warrants, he believes, a very different estimate of the value and utility of such analyses. In the first place the percentages of oxygen and total gases, instead of being nearly uniform, vary between very wide limits. Thus, a sample taken at Mill Creek, September 24, contained only 2.2 cubic centimeters of oxygen in a liter, and 14.7 c. c. of total gases, whilst a sample taken from the same stream November 19 contained 8.53 c. c. of oxygen and 29 c. c. of total gases.

So, likewise, the estimations of the dissolved oxygen in the Schuylkill River water, at the time this water acquired a nauseous taste and smell, in the month of January, 1883, were of more value in determining the origin of its unpalatability than any of the remaining analytical data. Some of these samples contained only 4.4 c. c. of oxygen. By artificial aëration the percentage of oxygen in these samples was raised 50 per cent.,

and the percentage of readily oxidizable organic matter was diminished in one case 80,—in another sample, 50 per cent.

In the latter part of July, 1884, the oxygen in a number of samples from the Hackensack river fell to 3.87 c. c. per liter, and the total dissolved gases to 14.93 c. c. Contemporaneously, the same waters, when impounded in the reservoir became covered with a scum several inches in thickness, consisting largely of *Oscillariæ*. These quickly died, and yielded up a dark blue coloring matter (*the Phococyan of Cohn*). Finally this great accumulation of vegetable growth passed into a state of active decomposition, attended with the formation of white foam, and the liberation of large volumes of carbonic acid and other gases. The water for ten days previous had been too nauseous to drink, but the whole succession of phenomena above described took place within twenty-four hours, the vast development of algæ, their breaking up with evolution of green and blue coloring matter, and their final decomposition occuring with astonishing rapidity. The entire reservoir had the appearnce of an enormous dyeing vat, covered with dark green and blue dyestuffs.

A repetition of the same disastrous sequence of events was threatened on September 14, when the percentage of dissolved oxygen fell to 4 cubic centimeters, and at the same time a growth of algæ began in the reservoir. But, meanwhile, arrangements had been perfected in anticipation of this catastrophe, and by pumping air under pressure into the mains the percentage of total dissolved gases was raised from 15.9 cubic centimeters to 21.2 cubic centimeters. The green scum on the reservoir disappeared, and the taste and smell of the drinking water became satisfactory. The subject is too new to assert that the lack of oxygen in the water, and the rapid development of *oscillariæ* stood in the relation of cause and effect, but the fact that the proper habitat of these algæ is in stagnant pools and ditches renders it reasonable to infer that these two phenomena are correlated.

The samples which you directed to be transmitted to me

from the reservoir near the Chestnut Hill Pumping Station, collected October 4, presented similar characteristics. It was nauseous in taste, disagreeable in smell, and green in color. It contained only 4.9 per cent. of dissolved oxygen, and 16 per cent. of total gases.

On the 11th of November, a preliminary experiment was instituted at the Fairmount Pumping Station, an air-pump being attached to the main at that point. The aërated water was pumped into the Corinthian Basin through the 48-inch main, a distance of 3,000 feet. At the point of discharge a second sample was collected. The dissolved gases in the two were as follows:

	Before aëration.	After aëration.
Oxygen in 1 liter	6.1 c. c.	7.3 c. c.
Carbonic acid in 1 liter	1.6 "	3.0 "
Nitrogen in 1 liter	14.2 "	14.9 "
Total gas in 1 liter	21.9 c. c.	25.2 c. c.

The foregoing remarks refer to river waters. In reference to well waters, the analysis which I made of a sample drawn December 8, from a well in the Twenty-third Ward of Philadelphia, may be aptly quoted. It required the very unusual amount of 2.1 parts of oxygen to effect the oxidation of the dissolved organic matter. Out of a total in 100,000 of 10.15 parts of total solids, 6.95 parts, or nearly 70 per cent., was of vegetable and animal origin. It contained in solution:—

WELL WATER IN TWENTY-THIRD WARD.

Oxygen in 1 liter	0.60 c. c.
Carbonic acid in 1 liter	11.20 "
Nitrogen in 1 liter	14.36 "
Total gas in 1 liter	26.16 c. c.

After reading the above details of its analysis, it will afford no surprise to learn that this water swarmed with living organisms, and on standing a few days in the laboratory became nauseous to smell and taste.

But the chief ground of objection to the utility of analyses of the gaseous constituents of drinking water was, as above

stated, that there are deep wells which contain no putrescent matter, and at the same time little oxygen. It is true that the waters of such wells may be safe, either because the putrescent matter originally present has been oxidized at the expense of the oxygen, or because, having a deep-seated origin, and having been derived from filtration of subterranean water, no putrescent matter has happened to find its way into them. But the consequence of an irruption of sewage into the non-aërated waters of such wells is only too familiar. The virulence of the septic poisons therein developed produces outbreaks of typhoid and other zymotic diseases far exceeding in violence anything of which we have certain knowledge as having arisen from the waters of flowing streams.

The results arrived at in the present report, therefore, point to conclusions the reverse of those indicated by the Rivers Pollution Commission. The determination of oxygen and dissolved gases is regarded as of great importance inasmuch as in the large number of samples analyzed a low percentage of oxygen has been coincident with a precarious and in some instances a dangerous condition of the water.

V.—Ratio of Organic Carbon to Organic Nitrogen.

The determinations of organic carbon and nitrogen were made in 53 samples, beginning April 23, and ending August 13. Then they were discontinued, because the amount of information which they afforded did not appear commensurate with the great labor which they involved. The sum total of the evidence afforded by all the other factors in these sanitary analyses seemed adequate to base conclusions upon. These conclusions are, in the main, identical with those afforded by the determinations of the organic carbon and nitrogen. For instance, in the three samples obtained from the river Delaware in April, that at the Gap exhibits the highest ratio of carbon to nitrogen, that from Byram the next, and that from Frankford the lowest. The same remark applies to the three samples collected in May. As compared with the Perkiomen

samples, the ratio in most cases is in favor of the contemporaneous samples at Byram. In fact, the samples collected from this latter point have a higher average ratio of carbon to nitrogen than almost any of the other samples, except those taken at the Water Gap.

VI. Hardness.

The waters from the Delaware river are the softest of any examined, and from this point of view are the best adapted to laundry and manufacturing uses. The Schuylkill waters are the hardest, although the amounts of dissolved carbonates and sulphates rarely rise to such a figure as to bring them within the category of hard waters. The Perkiomen is about the same in hardness as the Big and Little Neshaminy, Tohickon, and Mill creek, and all of these tributary streams are intermediate in regard to hardness, between the Schuylkill and the Delaware. As compared with the Neshaminy, the Tohickon and Mill creek are less soft. Of the Delaware samples, that taken at the Gap is extremely soft, standing first in this respect of all the waters examined. Then follow at a little distance the Byram samples, while those collected at Frankford were usually inferior to the preceding two.

VII. Acidity and Alkalinity.

So far as the experience of the author indicates, the usual condition of river waters is that of acidity. Of course this acid reaction is very feeble, so feeble, indeed, that it cannot be appreciated by the sense of taste, and is only revealed through the application of delicate chemical tests. Though slight, it is of importance in the hygiene of drinking waters, inasmuch as it tends to arrest processes of putrefactive decomposition. Such processes are quickly set up when water containing organic matter in solution acquires an alkaline reaction, whilst the presence of very minute amounts of free acid tends powerfully to arrest the development and growth of those micro-organisms, on the multiplication of which the phenomena of putrefactive changes depend.

The only instance in which such an alkaline condition of the water was noted, was that of the sample taken at Byram October 8, which manifested an alkalinity equivalent to that shown by a solution of 0.4 parts of caustic soda dissolved in 100,000 parts of water. I am unable to give any explanation of this phenomenon, nor of the equally surprising large amount of free acid present in the sample taken from Mill Creek August 22, which showed an acidity equivalent to that of a solution of 3.8 parts of sulphuric acid dissolved in 100,000 parts of water. The sample taken from Tohickon creek on the same day was absolutely neutral. Of course no soda, and probably no sulphuric acid was present, these bodies being merely taken as measures of the relative amounts of alkalinity and acidity when determined by quantitative tests in the laboratory. The acid reaction in river waters, especially those fed by the pumping discharge of coal and iron mines, is sometimes, it is true, due to free sulphuric acid, but ordinarily it results from weak organic acids formed during processes of vegetable decomposition. The alkaline reaction is more especially due to dissolved carbonate of lime.

VIII. Total Solids in Solution.

Elaborate tables are frequently drawn up in which the amounts of solid matters in solution at the date of particular analyses, are taken as a basis of comparison of different water-supplies. Such a basis is fallacious unless the comparison includes samples extending over a long period in each case, and represents each water-supply in all seasons and conditions. The table of analyses illustrates this statement forcibly. The maximum amount of total solids found in the Delaware river at Frankford was 10 parts in 100,000, and the lowest 5.1 parts. At the Water Gap, the maximum was 7 parts and the minimum, 3 parts. At Byram, the maximum was 9.5 parts and the minimum, 3.95 parts. These figures indicate that there is a progressive increase of the dissolved solid matters as we go down the river from the Gap to Philadelphia.

The largest amount in the Schuylkill waters was 16.9, the smallest was 10. The samples collected from the other streams compared, usually contained more solids than the corresponding Delaware samples, and less solids than those from the Schuylkill. The upper Delaware compares very favorably, in respect to the data under consideration, with the water-supply of any city in this country or in Europe.

IX. Relation between Rain-fall and Chemical Constitution.

The difficulties and uncertainties connected with the attempt to connect the amount of rain-fall with the amount of impurities present in river waters, has already been alluded to in relation to the various tints of color exhibited by the samples analyzed. Rain-water is by no means absolutely pure water. It is laden, especially the portions falling in the beginning of a shower, with a considerable amount of organic matters, at all times present in the atmosphere in the form of floating germs and particles detached from plants and animals, and also with notable amounts of inorganic substances, as chlorides, meteoric and telluric dust, etc. The first scour of a heavy storm washes into streams many impurities. The subsequent portions, in their course of slow filtration through the ground, acquire a very different composition from the first storm-waters.

In illustration of these difficulties the variations in the curve of albuminoid ammonia may be considered in relation to the data of rain-fall. In the Schuylkill River there are two maxima for the former,—the first occurring July 9, and following a fall of 2.1 inches on July 4 to July 6; the second, of inferior magnitude, occurring October 1, after a prolonged period of drought. In the Perkiomen Valley the maxima occur at periods of drought and low-water in the river. At Byram the three maxima—upon May 4, June 25, and August 13—follow considerable falls of rain. In the Neshaminy the maximum occurs on June 4, after a period of drought.

It would be profitless to discuss the other analytical data in relation to the rain-fall, inasmuch as similar contrarieties pre-

sent themselves throughout. The popular notion which connects as an inevitable consequence a less pure condition of a river water with a recent rain-fall is erroneous, and is based upon the apparent impurity due to the "riled" condition of the stream, and the color and turbidity arising from suspended earthy matters. As previously remarked, chemical analysis, which is made upon the filtered waters, tells a very different story, and shows that such "riled" and turbid streams very often, though not invariably, contain in *solution* little unwholesome or deleterious matter.

Pollution of the River Schuylkill.

During the course of the year numerous samples of waters, polluted by the factories and sewers emptying into the Schuylkill River, were collected by Mr. Dana C. Barber, in order that I might make suitable analyses and report thereupon.

The most important of these investigations was that upon a series of six samples collected by Mr. Barber, August 6, 8, and 12, with the view of determining the amounts of pollution of the waste waters from Stelwagen's Paper Mill and in Dobson's Run. The analytical results are presented in the accompanying table, in which I have also given the analysis of a sample taken from the Roxborough Pool on the same date. They include only those data which bear directly upon the impurity, or otherwise, of the samples analyzed, from a sanitary point of view. The assistant engineer, who collected the samples, enumerates in his report a great variety of acids, alkalies, salts, dye-stuffs, mordants, fixing agents, many of them containing poisonous metallic substances. These, he states, were used in the factory which empties its refuse into Dobson's Run, and it might be supposed that I should have endeavored to find some or all of these substances in the samples analyzed. He states, likewise, that the refuse from kitchens, water-closets, a slaughter-house, a pig-pen, manure drainage, etc., enters the stream.

I am quite unable to make such an analysis as will satis-

TABLE III.

COMPARISON OF POLLUTED WASTE WATERS, WITH WATER COLLECTED AT ROXBOROUGH PUMPING STATION, AUGUST 6, 1884.

Number of Sample.	533.	528.	529.	530.	536.	537.
Locality.	Roxborough Pumping Station, August 6.	Head of Dobson's Water Supply Pool, August 6.	Weir near mouth of Dobson's Run, August 6.	Weir near mouth of Dobson's Run, August 8.	Weir near mouth of Dobson's Run, August 12.	Stelwagon's Paper Mill, August 12.
Free ammonia.						
Parts per 100,000	0.0035	0.002	7.40	6.10	6.92	5.25
Grains per gallon	0.002	0.0017	4.31	3.56	4.03	3.06
Albuminoid ammonia.						
Parts per 100,000	0.010	0.014	5.20	4.00	3.86	2.30
Grains per gallon	0.0058	0.008	3.03	2.33	2.24	1.34
Ratio of free to albuminoid ammonia	1 : 2.8	1 : 7.0	1.4 : .1	1.5 : 1	1.7 : 1	2.2 : 1
Oxygen required to oxidize (Permanganate.)						
Parts per 100,000	0.32	0.35	1.52	1.22	1.92	1.20
Grains per gallon	0.187	0.20	0.88	0.71	1.11	0.70
Oxygen required, corresponding to silver reduced.						
Parts per 100,000	0.50	0.20	18.00	25.00	1.92	1.20
Grains per gallon	0.29	0.117	10.50	14.60	1.11	0.70
Nitrates.						
Parts per 100,000	0.56	0.90	0.90	0.96	0.98	0.90
Grains per gallon	0.33	0.52	0.52	0.56	0.57	0.52
Chlorine.						
Parts per 100,000	0.30	0.40	0.70	0.70	0.60	1.40
Grains per gallon	0.175	0.233	0.41	0.41	0.35	0.82
Hardness.						
Parts per 100,000	3.50	3.40	3.00	.....	3.20	3.40
Grains per gallon	2.00	1.98	1.75	.....	1.86	1.98
Total solids.						
Parts per 100,000	9.50	10.00	15.00	14.50	14.00	31.00
Grains per gallon	5.54	5.83	8.75	8.45	8.16	18.08
Dissolved gases.						
In cubic centimeters per liter.						
Oxygen	5.07 c. c.	4.67 c. c.	3.20 c. c.	3.60 c. c.	4.00 c. c.	4.12 c. c.
Carbonic acid	0.62	0.52	8.72	6.20	3.40	3.04
Nitrogen	11.26	11.20	10.50	11.41	12.13	11.14
Total Gas	16.95	16.39	22.42	21.21	19.53	18.30
Color	2	2	Opaque grey	Nearly black	Grey, full of floating particles.	Grey, from suspended matter and woody fibre.
Taste	Pleasant	Pleasant	Untasted	Untasted	Untasted	Untasted.
Smell	None	None	Of wool, gave off sulphuretted hydrogen on standing.	Of wool and soap, gave off sulphuretted hydrogen on standing.	On standing, gave off sulphuretted hydrogen.	On standing, gave off sulphuretted hydrogen.
Temperature	.....	.....	.....	106° F.		

factorily establish what portion of the organic substances came from the pig pens, what from slaughter houses, what from cess-pools, and what from the inextricable mixture of dozens of dye stuffs, etc. Nor is it important from a sanitary standpoint that I should make such an analysis. But it is of the greatest importance that we should be able to discover how large a fraction of these organic substances is capable of undergoing decay and putrefaction. This fraction is given under the head of "Albuminoid Ammonia," in the accompanying tables. Now it will be found that at the mouth of Dobson's Run the amount of readily decomposable organic matters is nearly *400 times greater* than it is at the water-supply pool above the mill. It is more than *500 times greater* than is contained in the Schuylkill at the Roxborough Pumping Station. The estimate is based upon analyses of samples collected at the three points compared upon the same day.

While the water at Roxborough Pumping Station was of good quality for drinking purposes, and that of the water-supply pool of Dobson's Run, above the mill, not greatly inferior, the samples obtained at the mouth of Dobson's Run became highly offensive on standing, and gave off in the course of the putrefactive decompositions, sulphuretted hydrogen gas.

In every gallon of the water at the mouth of Dobson's Run there were 2.92 grains more of dissolved solid matter than at the water-supply pool.

This increase is mostly due to decomposing organic substances. If such decomposition and putrefaction were taking place among the organic matters present, as I have stated would necessarily occur in view of their chemical nature, the evidence of such putrefaction would be found in a diminution of the oxygen and an increase of carbonic acid. This anticipation is verified by the results of the analyses. The oxygen is diminished 30 per cent., whilst the carbonic acid is enormously increased. Such a great excess of carbonic acid cannot possibly be held in a state of solution at ordinary tempera

tures and pressures, and must make its escape in the form of bubbles. This liberation of gas, the natural result of putrefactive decomposition, is constantly observed at the mouth of Dobson's run, according to the observations of the Assistant Engineer.

The amount of nitric acid is not greater at the mouth than above the mill, despite the fact that some nitric acid is used in the factory, according to the report of the Assistant Engineer. This is noteworthy, inasmuch as the amount of nitrogenous organic matters present which would be capable of conversion into nitric acid by processes of oxidation is very large. But the opportunity for such beneficial oxidation does not exist. The supply of oxygen in the water tends continually to diminish, whilst that of carbonic acid, sulphuretted hydrogen, and other products of decomposition tend continually to increase, and to be carried into the Schuylkill river without the intervention of any remedial action. Taking into consideration the various analytical results, some part of which I have herein briefly explained, I am led to the opinion that the liquid discharge from Dobson's Run is grossly polluted, and that its influence upon the waters of the Schuylkill river is to destroy their wholesomeness and fitness for drinking purposes.

The sample of waste water from Stelwagon's Paper Mill was collected by the Assistant Engineer on the 12th of August. It was gray from suspended matter, and on standing in the laboratory began to decompose and give off sulphuretted hydrogen gas, which rendered it very offensive. It contained *230 times more* albuminoid ammonia and *1,500 times more* free ammonia than was present in the water of Roxborough pool, on August 6. This excess could occur only in the case of a highly contaminated water.

Each gallon of waste water from Stelwagon's mill adds 12½ grains of impurity to the Schuylkill river, and, of this total, a very large fraction consists of organic filth.

Remedial Measures.

I have previously communicated to you in a special report, a brief abstract of such methods, as by their inexpensiveness and simplicity have found their way into use along the banks of the polluted Passaic river in this country, and in many places in England, for the treatment of sewage and the waste-waters of factories.

To ascertain what improvement had been effected by the changes made at Stelwagon's Mill in order to abate the nuisance which the proprietors plead guilty of maintaining, you instructed Mr. Barber to forward me a sample of the waste-water from their mill, which was taken by him on January 24, of the present year. The sample was dirty brown in color, with a great quantity of short fibres, and other visible impurities in suspension, and whilst, for manifest reasons, it was not tasted, its unpleasant smell as of wool-washings was very noticeable.

Purified (?) Waste-water from Stelwagon's Mill, January 24, 1885.

	Parts per 100,000.	Grains per gallon.
Free ammonia	0.0036	0.0021
Albuminoid ammonia	0.0101	0.0059
Required oxygen (permanganate)	2.92	1.71
Required oxygen (silver)	1.18	0.69
Nitric acid	0.10	0.06
Chlorine	1.68	0.98
Hardness	4.30	2.51
Total solids	31.00	18.08
Mineral matter	18.00	10.49
Volatile and organic matter	13.00	7.59
Dissolved oxygen in 1 liter	= 3.33 cub. cent.	
" carbonic acid in 1 liter	= 9.73 " "	
" nitrogen in 1 liter	= 14.00 " "	
" total gas in 1 liter	= 27.06 " "	

A comparison of the above figures with those given in the analysis of the same waters before any measures of relief were adopted, shows that a decided improvement has been effected, although the large amounts of total solids, mineral matter,

required oxygen, etc., demonstrate that much more yet remains to be accomplished.

Concluding Remarks.

If the waters in flowing streams were invariable in composition, the task of deciding between their relative fitness for domestic water supply would be an easy one. But many natural agencies interfere to bring about variations in composition, such as season, temperature, rain-fall, topographical and geological features, etc., and the influence of such natural agencies must be carefully discriminated from the more serious ones of artificial contamination by sewage, manufacturing refuse, etc.

In weighing the great bulk of evidence contained in the accompanying tables and chart, I have endeavored to allow due weight to all of the above considerations, and to summarize impartially the merits of the various sources of present and proposed future water supply.

First.—The Waters of the Upper Delaware.

They are pleasant to the taste, and ordinarily clear, transparent, and with little or no color. Sometimes these characteristics are impaired by heavy rain-falls, and they are rendered turbid. While this turbidity is temporary in character, its occurrence and influence must be considered and allowed for.

They contain the smallest amount of dissolved solid matters, both mineral and organic, of the waters herein considered.

In this respect the waters of the Gap are especially noteworthy, the total amount of all substances in solution being usually between two and three grains per gallon. They are very soft, and are admirably adapted for technical uses, for laundry purposes, and in boilers.

The above remarks apply to the condition of the waters in the Upper Delaware at the present time. And if it is certain that the stream will not be contaminated in the future, a supply drawn from either of the two points referred to in the accompanying tables—viz.: Point Pleasant (Byram) or the Water Gap—will afford, for all time to come, wholesome and palata-

ble drinking water. Before reaching a final conclusion, therefore, it is necessary to determine whether the waters of the Upper Delaware can be so protected that they will permanently retain their present excellence.

Second.—The Tributaries of the Delaware.

The taste, color, and physical characters of the waters in the Tohickon, the Neshaminy above the forks of the Big and Little Neshaminy, and in Mill Creek, conform to the accepted standard of palatable waters. The analyses have yielded no evidence of the presence of substances deleterious to health. I regard these waters as of suitable quality for future water supply.

Third.—The Perkiomen.

The Perkiomen waters, taken as a whole, have afforded the least satisfactory results of those analyzed and reported upon in the present report. They are inferior in quality to the Delaware at Point Pleasant, and the Schuylkill at Phœnixville. In a considerable number of cases, from causes partly natural and partly artificial, the analyses have shown very decided impurity.

On the score of both purity and quality, the evidence contained in this report, and that for 1883, is least favorable to the adoption of the Perkiomen alone for a permanent source of future water supply, although the addition of the Lehigh, which is of a high order of purity, would greatly improve it.

Fourth.—The Waters of the Schuylkill.

The waters of the Schuylkill ordinarily contain much more solid matters in solution than those of the Delaware and the other streams examined. This higher percentage of solid matters is largely composed of salts of lime, which communicate to them a slightly increased degree of hardness.

When not disturbed by heavy rain-falls, the waters of the Schuylkill, at Phœnixville and above, are clear and limpid, frequently manifesting that beautiful greenish tint which is

seen in streams after they have become clarified in their less rapid portions by the precipitation of earthy and saline matters previously held in suspension.

The large amount of lime salts in solution is a disadvantage, so far as it entails an increased consumption of soap in laundry use, and a greater deposit of scale in boilers. The annual increase of expenditure for the entire community, due to these two factors of expense, amounts to a considerable sum. But, so far as their influence upon the palatability of the waters is concerned, it is not a disadvantage, and could immunity from artificial contamination be secured, the Schuylkill waters would leave little to be desired in regard to excellence or taste.

The insuperable objection to the waters of the Schuylkill under the actual conditions now prevailing, is that they are grossly polluted by sewage, etc. The influence of these pollutions upon the taste and quality of the water varies very greatly. At some seasons it is so largely diminished by volume of flow, and the natural agencies at work in effecting the purification of a flowing stream, that the water, as delivered to the consumers, is pleasant and palatable. At other times, these remedial agencies are entirely inadequate, and the water acquires so foul a taste and smell that great popular indignation and disgust are excited.

As a consequence of these variations an analysis of the waters taken at Spring Garden or Fairmount assigns to it a high rank at one time, and a very low rank at another. For example, on June 24, 1881, I found that it ranked second when compared with the water supplies of ten other cities examined. But there have been many seasons since then, when it has been so contaminated and so unpalatable that there has been universal complaint among its consumers, and when it has ranked very low when compared with other water supplies. And as it has been in the past, so must it be in the future, unless proper remedial measures are adopted. These methods are entirely feasible, so far as they depend upon chemical and engineering methods for their success. They involve the ex-

clusion of sewage from the stream, the disposal as far as practicable of manufacturing refuse by the adoption of suitable mechanical and chemical means, and before delivery to the consumer, the final purification and clarification of the water.

In what is said above, I have expressed an opinion as to the possibilities of purifying the Schuylkill river, without reference to the practical difficulties involved in the enforcement of existing laws and in the maintenance of a system of sanitary inspection and control. In stating this opinion, I have been guided by the desire to present impartially what can be stated in favor of a supply from the Schuylkill river, as well as what can be said against it, so that in the formation of a final judgment the various sides of the questions involved may be duly considered.

In conclusion, whatever may be done in the future, it is certain that one thing should be done at present and at once, and that is the rigorous exclusion of sewage from the Schuylkill. For on this point, the most eminent authorities agree, that the presence of sewage in drinking water is a predisposing influence towards cholera in times of epidemic, and an important factor at all times in the dissemination of intestinal disorders in general.

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