REPORT

OF

THE WATERING COMMITTEE

WITH THE ACCOMPANYING

REPORTS

OF

FREDERIC GRAFF, ESQ., SUPERINTENDENT

OF

FAIRMOUNT WATER WORKS,

ON

FILTRATION,

AND

PROFESSORS BOOTH AND GARRETT,

ON

SCHUYLKILL WATER.

PRINTED BY ORDER OF COUNCILS.

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1854.

RESOLUTION

ADOPTED BY THE

SELECT AND COMMON COUNCILS OF THE CITY OF PHILADELPHIA,

MAY 11, 1854.

RESOLVED, That the Watering Committee be, and they are hereby authorized to have five thousand copies of the Report upon the Filtering and Analysis of the Schuylkill Water, printed for distribution.

(Extract from the Minutes.)

EDMUND WILCOX,

Clerk of Select Council.

WATERING COMMITTEE.

JOS. M. THOMAS, *Chairman*,
ALBERT G. WATERMAN,
FRANCIS H. DUFFEE,
WILLIAM WATT,
JOHN AGNEW,
CHARLES ABBEY,
GEORGE GRISCOM,
PAUL POHL.

REPORT.

To the Select and Common Councils of Philadelphia:

In obedience to the annexed resolution of Councils, passed October 27th, 1853, as follows:

"*Resolved*, That the Watering Committee be, and they are hereby directed to inquire into the practicability of erecting at Fairmouut, a Filter of sufficient capacity to filter all the water used in the city, before it enters the distributing pipes."

Your Committee report that they have given the subject that consideration which the importance of it demanded, and herewith submit the report of Mr. Frederic Graff, Superintendent of the Water Works, under whose immediate charge the necessary inquiries and examinations in relation to the matter were made; and also the report of Professors Booth and Garrett, the experienced and eminent chemists who conducted the analysis of the water.

TO THE WATERING COMMITTEE OF CITY COUNCILS:

GENTLEMEN: In compliance with your instructions, I have examined into the expediency of filtering the water supplied from the Fairmount Water Works, and beg leave to make the following report:

In order to ascertain if there was any well founded reason for filtering the water, I thought it necessary to have an analysis of it, made by experienced chemists, whose opinion would be considered valuable in forming a conclusion, whether the water of the Schuylkill has in fact (as has been asserted) depreciated in any important degree from its former acknowledged purity.

The remarks and analysis of Messrs. Booth and Garrett are appended to this report. In it, they compare their analysis, made this year, with those of Professors Boyé and Silliman, made in 1842 and 1845, which gives an excellent opportunity of ascertaining to what extent (if any) deterioration has taken place. For the statement of the details, we refer to the report of those gentlemen, merely inserting in this place their concluding remarks, as follows:

"The analyses exhibit another fact of some importance, that while in 1842 the quantity of organic matter was capable of being determined, and in 1845 was quite large, (although probably less than stated in that analysis,) in 1854 there was not a sufficient amount to admit of exact determination, it is possible that the water may contain more in summer than in winter, but the fact that it is nearly absent, proves that the increase of manufacturing, and of population in the valley of the Schuylkill, and its affluents has not tended to deteriorate the water, in the slightest degree, with organic matter.

"The mineral contents remain the same, and are only varied in proportion. The effects produced upon the water by clearing land, could only be an increased turbidness, from finely suspended mineral matter, or the addition of dissolved matter, in which vegetable matter would form a fair proportion. We believe there are not sufficient data to establish the fact, that turbidness is now more frequent or dense than formerly, and we have shown the absence of dissolved organic matter; we may therefore conclude, that the water is not worse than it formerly was from this cause. It has been supposed, that filtration of the water before its distribution through the city, would be desirable, and should be undertaken by the government of the City. We infer, from analysis, that filtration would scarcely, if at all, diminish the mineral matter in solution, nor is its character or amount such as to justify an attempt at removal.

"The suspended matter in a turbid condition of the water, is finely divided clay, the quantity of which is inconsiderable, and which we do not suppose to exert any injurious influence upon the water. To attempt its separation, would demand so vast an expenditure as would not, in our opinion, be justified by the result, even if it were entirely successful. But there is every reason to believe that the attempt would be attended with at least a partial failure, because the suspended matter is so finely divided, that we doubt if much of it could be removed by any practicable system of filtration.

"We may observe further, that a comparison of our waters with waters used elsewhere in the United States and in Europe, and highly esteemed, may be characterized by its greater purity, and by its being slightly alkaline, and nearly free from organic matter.

"In conclusion, we infer that the Schuylkill water has deteriorated, in no important respects, from its former excellent quality; that from the nature of its small contents of

mineral matter, and its unusual freedom from organic matter, it is superior to most waters for domestic and manufacturing purposes; that from the nature and quantity of its mineral contents, it is unnecessary to adopt a system of filtration to improve its quality; and lastly, a comparison of the past and present, leads to the inference, that no plan of improving the water will be required for many years to come."

The above remarks, made by gentlemen so capable of forming a proper judgment in the case, appear entirely conclusive that there is not really any necessity whatever for filtering the water, and the subject might, it is thought, be safely dropped here; but in order that Councils may be fully able to judge of the purity of the water, a table is inserted below, showing the comparative amount of solid matter contained in one gallon, of a number of the waters supplied, or about to be supplied to cities, in this and other countries:

	grains per gal.
Cochituate, Boston,	3.37
Mill River, proposed for New Haven,	4.00
Gunpowder, proposed for Baltimore,	4.41
Schuylkill analysed by Boye,	4.42
Patroon's Creek, supplied to Albany,	4.72
Pine River, proposed for New Haven,	5.30
Schuylkill, analyzed by Silliman,	5.50
West River, proposed for New Haven,	5.60
Supplied to Detroit,	5.72
Jones' Falls, supplied to Baltimore,	5.85
Schuylkill, analyzed per Booth & Garrett,	6.10
Troy,	6.29
Ohio River, supplied to Cincinnati,	6.73
Hudson River, Albany,	7.24
Passaic, to supply Jersey City,	7.44
Mohawk, Troy,	7.88
St. Charles River, Quebec,	8.10
Lake Ontario, Rochester,	10.00
Croton River, supplied to New York,	10.93
Genesee River, Rochester,	11.21
Average of all the above,	6.54
Average of the three analyses made of the Schuylkill,	5.34

	grains per gal.
EUROPE.	
Lake Geneva,	10.64
Seine, at Paris,	12.74
Rhone, at Lyons,	12.88
Elbe, at Dresden,	21.00
Supplied to London, from Thames, by the Kent Company,	18.7
Supplied to London, by New River,	19.2
" " from Thames, by West Middlesex Co.,	19.5
" " " Thames, by Lambeth Co.,	20.4
" " " Thames, by Grand Junction Co.,	21.00
" " " Thames, by Southwark Co.,	21.5
" " " Thames, by East London,	22.00
" " " Lea River,	23.7
" " " Thames, by Chelsea Co.,	27.2
Hempstead Co., from Wells,	40.
Bristol " "	52.
Average of all the London Companies, from the Thames,	21.46

Wells N. E. corner Fifth and Cherry streets, 115.957 grains to the gallon.

It is well known that filtration only purifies the water by arresting the solid organic matter, while it does not remove the fluid organic matter, the salts, gases and other soluble impurities. A table of several waters is given below, that it may be seen how small the solid organic matter contained in our water really is, and of how little the water would be deprived by filtration:

	Cochituate.	Schuylkill, per Boye.	Schuylkill, per Silliman.	Schuylkill, per Booth and Garrett.	Croton.	Hudson, Albany.	Thames, Chelsea.	Troy.
Solid organic matter, one gallon,	1.16	0.036	1.24	trace.	4.28	2.27	4.2	1.51
" inorganic " "	2.21	4.385	4.26	6.10	6.66	8.46	23.1	4.78
Total solid matter, one gallon,	3.37	4.421	5.50	6.10	10.94	10.73	27.3	6.29

In all the above cases, the Schuylkill water for analysis was taken direct from the river before it was raised into the reservoirs, when of course it would not have had time to deposit its impurities. The water of the Croton was taken from the distributing reservoir in New York City, after it had passed through forty-one miles of aqueduct, giving it every opportunity of depositing some of its impurities; and yet we find it to contain nearly eleven grains of solid matter in one gallon, four and twenty-eight hundredths grains of which are organic matter.

That a more correct idea of the power and actual efficiency of filters on a large scale may be formed, than appears generally to exist, some extracts are here given from a work recently published in London,* upon a microscopic examination

* "Microscopic Examination of the Water supplied to the Inhabitants of London, by Arthur H. Hassall, M. B., F. L. S."

of the waters supplied to that city after passing through the most approved filters used there. The author states "That by placing a gauze bag on the tap of the water cisterns *supplied from the filter beds of the Southwark Water Company*, it was found at the end of a few days, to contain a mass sufficient to fill an egg-shell, consisting principally of the hairs of animals." Again, "The accumulation of solid matter in the main supply pipes, is often so great as to require that they should be frequently cleansed out, this circumstance and the *variation of the earthy matter in accordance with the state of the weather*, show clearly the defective state of the process of filtration adopted, and if solid earthy and inorganic matters are largely contained in the water of the companies as supplied to the houses, it is evident that no reason can exist why the organic and living matter characteristic of impure water should not be present in them in equally large extent."

Again, "The method of filtration to be successful even to a limited extent, must be very different from that pursued by the Metropolitan Companies, for we have seen that the water which they supply after having undergone the process as conducted by them, still contains much *solid organic matter, living, dead and decomposing*, and often of considerable size."

He states further, that the only filtered water supplied to London that even approaches purity, is that of the Chelsea Company, and in this he found upon examination, eight different species of infusoria, and some dead organic matter. The following analysis made by Professor Brande, in 1849, of the water after passing through the filters of the Kent

Water Company, will show how little can be expected from such apparatus:

Carbonate of Lime,	- -	grains in one gallon,	9.9
Do Magnesia,	- -	do do	trace.
Sulphate of Lime,	- -	do do	2.5
Do Soda,	- -	do do	1.5
Chloride of Sodium,	- -	do do	3.7
Organic matter and Nitrates,	-	do do	1.1
Total,	- - - -		18.7.

It will be seen that the organic matter in the above, amounted to one and one-tenth grains after filtration, whilst Messrs. Booth & Garrett state that the Schuylkill water contains but a trace of organic matter without any filtration whatever, and but six and one-tenth grains of solid residue of every kind; so that the above water is *three times more impure after being filtered by one of the best large filters known in London, than the Schuylkill water is without any filtration whatever.*

And yet the filters used by the Chelsea, Kent and other companies, are of the most approved kind that have been employed upon a large scale; the result, indeed, of experiments made at very considerable expense; and in some form, would be the plan we should be obliged to follow.

Although I consider the above practical results as sufficient to guard us against the adoption of such defective apparatus, I will (in order that councils may have every light upon the subject) investigate the matter further, by examining if our present reservoirs would be adequate for the purpose of intro-

ducing filter beds into them. Most of the works of England where the water is filtered, have large subsiding reservoirs into which the water passes before it goes upon the filter beds, as well as large reservoirs for the pure water after filtration, and also duplicate filters, that one may be cleansed whilst the other is in use. The following table shows the rates at which the most approved of these filters pass the water:

	Gals. passed by each square foot of filter surface, per hour.	Gals. per foot of surface, per 24 hours.	Gals. supplied per day by the Companies.	Square feet, area of filter surface used.	Contents of subsiding reservoirs in gals.
Vauxhall Works, ...	2.09	50.16	6,013,716	120,000	21,000,000
Grand Junction, ...	2.67	64.08	4,500,000	70,078	9,000,000
Southwark, ...	2.74	65.76	2,160,000	174,240	
Chelsea, ...	3.12	74.88	3,136,320	90,000	
Paisley, ...	4.25	102.			
Lambeth, erected 1852, .	3.67	88.08	2,750,000	31,200	15,900,000
Average, ...	3.09	74.16			

It has been found that between the hours of ten and eleven in the morning, at least eight per cent. of the whole day's supply is delivered, and on Saturdays for short periods in the heat of the summer, it is believed the water has been delivered at the rate of twelve per cent. of the whole day's supply, which, as we have frequently supplied 11,000,000 gallons from our works, would be equal to one million three hundred and twenty thousand gallons per hour. At the average rate at which the last three filter beds named in the above list (which are now considered the best) filter the water, namely: three and sixty-

eight hundredths gallons, $3\frac{68}{100}$ per square foot of filter surface per hour, a filter bed of three hundred and fifty-eight thousand six hundred and ninety-six square feet would be required. This should properly be duplicated, that one might be cleansed whilst the other would be in use, making seven hundred and seventeen thousand three hundred and ninety-two square feet for filter beds only, without any allowance whatever, for subsiding or pure water reservoirs. The total area of the Fairmount reservoir is three hundred and twenty-two thousand one hundred and eighty-three square feet; it will therefore be seen how entirely insufficient they would be for the purpose, even for the present supply of water required for the city, which supply must increase every day, and will soon far exceed the limits set down above.

It cannot be denied that filter beds may be made to do their work moderately well; but the maximum speed at which a certain surface will filter the water properly, as obtained from the practice in Europe, is stated above, and from that data it is quite evident that the area required for our works would not be far different from the amount before mentioned, namely, for filter beds and duplicate, 717,392 square feet. The probability is, that this area would have to be exceeded rather than otherwise, unless large reservoirs, in which a supply sufficient for two or three days (say to contain 35,000,000 gallons) should be erected. In which case the filter beds would not require to be duplicated entirely, as by dividing them into sections, one or more of such sections could be cleansed whilst the others were in use, the city being supplied at the same time from the pure water reservoirs.

The process of cleaning the filter beds used in Europe, is by reversing the current of water through them, for instance, if the water has been passing downward, by causing it to flow upward, most of the dirt which has accumulated upon the surface, will be washed and carried off through sluices and culverts made for that purpose. This, however, is found not to be entirely effectual, and therefore in addition, the sand has frequently to be scraped off the surface to the depth of an inch or more; removed, washed and replaced. This, in some of the London works, is required to be done every two weeks, and in some seasons of the year as often as every ten days; it will therefore be seen that the cleaning of such apparatus is attended with considerable labor and consequent expense.

I am fully convinced that no adequate result could be obtained from the enormous expense which it would be necessary to incur in building and keeping in order such large filter beds as we should require, and that probably the certainty of constant supply and efficiency of the works might be impaired by such troublesome and expensive, and I think, needless apparatus.

Very respectfully,

Your obedient servant,

FRED. GRAFF.

May 3, 1854.

Your Committee feel fully convinced by the evidence of the analysis that they have every reason to feel perfectly satisfied with the extraordinary purity of the Schuylkill water. It is quite evident to them that there does not exist any necessity whatever for its filtration; and that the erection of filters to attempt such purpose would require a very large expenditure of money from which no adequate result could be reasonably expected.

They therefore report in conclusion, that they deem the project of filtering the water to be unnecessary and inexpedient, and beg leave to be discharged from the consideration of the subject.

All of which is most respectfully submitted.

JOSEPH M. THOMAS, *Chairman*,
ALBERT G. WATERMAN,
FRANCIS H. DUFFEE,
WM. WATT,
JOHN AGNEW,
CHARLES ABBEY,
GEORGE GRISCOM,
PAUL POHL.

May 3, 1854.

REPORT

ON

SCHUYLKILL WATER.

BY JAMES C. BOOTH AND THOMAS H. GARRETT.

A large number of the upper tributaries of the Schuylkill flowing over the anthracite formation, it has been supposed that the increased activity of mining operations in the coal region, by spreading manufactures on its banks, by increasing the population on the river and the region it drains, and by giving rise to more extensive clearings of forest, has contributed to throw so large an amount of impurity into its water as to render it unfit for domestic use or for manufactures in the City of Philadelphia.

The following analysis of Schuylkill water was undertaken with a view of determining the influence of the above-mentioned sources of impurity, and to suggest a remedy, if necessary. One means of arriving at a part of the conclusion is to compare its present with its former condition, by means of chemical analyses of the water. Two such analyses exist, and although they are avowedly incomplete, they are sufficiently

full for our purpose. We therefore present them before giving our own. They were performed, like our own, upon a quantity of water equal to the common or wine-gallon of 58,372 grains. (At 30″ Bar. and 39.6° Fahr.) The first was performed by M. H. Boyé, in 1842, and the second by B. Silliman, Jr., in 1845.

ANALYSES.

	BOYE, IN 1842.		SILLIMAN, IN 1845.	
	Salts.	Acids, &c.	Salts.	Acids, &c.
Alkaline Chlorides, - -	0.153	0.088	0.147	0.089
Alkaline Sulphates, - -	0.560	0.304		
Alkaline Carbonates, - -	0.185	0.073	1.644	0.683
Chloride of Magnesium, - -			0.009	0.007
Sulphate of Magnesia, - -			0.057	0.038
Carbonate of Lime, - -	2.190	0.964	1.872	0.824
Carbonate of Magnesia, - -	0.484	0.254	0.351	0.184
Alumina and Oxide of Iron, -	0.077			
Silica, - - - - - -	0.395	0.395	0.080	0.080
Organic Matter, - - -	0.036		1.240	
Total grains per gallon, - -	4.080		5.400	
Residue by direct trial, - -	4.421		5.500	

The above analyses are critically compared by Dr. Boyé in the Proceedings of the American Association for the Advancement of Science, for September, 1848. The alkaline chlorides and carbonates in Silliman's analysis are stated by him to be salts of soda alone. As we determined the relative quantities of potassa and soda in our analysis, we have assumed this proportion to be the same, and from these data have calculated the quantities of acid and base in B's analysis,

in order to compare both of these with our own. We determined all the ingredients directly, (except, as usual, the soda,) and some of them by repetition. We further employed different portions of the same water to determine special ingredients, in order to insure greater accuracy in the examination of so dilute a solution as Schuylkill water.

The following table comprises the three analyses:

COMPARATIVE ANALYSES.

	1 Boyé. 1842.	2 Silliman 1845.	3 B. & G. 1854.
Potassa, - - - - - -	0.114		0.087
Soda, - - - - - -	0.341	1.039	0.261
Lime, - - - - - -	1.226	1.048	1.404
Magnesia, - - - -	0.230	0.188	0.696
Alumina and oxide of iron, -	0.077		0.068
Sulphuric Acid, - - -	0.302	0.038	1.417
Chlorine, - - - - -	0.086	0.096	0.168
Silica, - - - - - -	0.395	0.080	1.080
Carbonic Acid, - - -	1.290	1.690	0.681
Organic Matter, - - -	0.036	1.240	trace.
	4.097	5.419	5.862
Residue found direct, - -	4.421	5.500	6.109

The small difference between the totals of the 1st and 2d analyses, compared with those previously given, arises partly from calculation and partly from an error in the 2d. We remark, upon the above table, that the alkalies in the 1st and 3d are concordant within 0.1 gr., but in the 2d the alkali is $2\frac{1}{2}$ to 3 times as great as it should be. The alkali in the 2d being

also estimated wholly as carbonate of soda, renders the estimate of carbonic acid double what it should be. We believe, that the carbonic in both 1 and 2 was chiefly, if not wholly calculated, while in our own it was directly determined; we must therefore prefer our own. There is every reason to believe the amount of sulphuric acid in the 2d to be too low, from the manner in which it was obtained, from the amount in the 1st, and from our having found, in former trials of the water, a very considerable quantity. We believe the organic matter in the 2d to be far beyond the truth, because it was embraced in the total loss. In our experiments, we have not been able to detect more than traces of organic matter, incapable of being accurately determined; for, upon heating the solid residue of the water, an almost imperceptible darkening was observed, and after calcination below the heat sufficient to expel carbonic acid, no material difference in weight was perceptible. The amount of silica in the 2d is too low, as pointed out by Dr. Boyé in the paper referred to, who believed even his own to be below the truth. We believe our own to be nearly correct, perhaps a shade above the truth.

For the reasons stated, we prefer taking the first analysis as a means of comparison with our own, except in the amount of carbonic acid, which we directly determined; and for the further reason, that there is a wider interval of time between them. But, in justice to the 1st, it should be observed that extreme accuracy was not called for in its execution; and to the 2d, that it seems to have been designed as a mere general

determination, without reference to minute and accurate results.

Upon comparing the two analyses together, the one executed in 1842, and the last in 1854, we observe that, during the last 12 years, an increase has taken place in the amount of solid matter dissolved in Schuylkill water, but that this increase scarcely amounts to 2½ grains per gallon. Of the 2½ grains, about 1 gr. is sulphuric acid, ⅝ gr. is lime and magnesia, and nearly ⅝ gr. is silica.

The increase of sulphuric acid is undoubtedly due to the increased activity of the coal trade. Anthracite contains iron pyrites (a compound of sulphur and iron) disseminated through it, which is sufficient, although small in amount, to impart a sulphurous odor to the fumes of the burning coal. Portions of the pyrites are gradually oxidized by the air, in the underground explorations for coal, forming sulphuric acid and oxide of iron, the former, apparently, in more than sufficient quantity to neutralize the latter. For, the waters issuing from some of the mines, are so highly charged with copperas and free sulphuric acid, as to cut out and endanger the steam-boilers employed in the coal region. We know this fact from experiments, made by one of us upon the waters of that region, with the view of ascertaining the cause of injury to boilers, and to suggest a remedy.

Beside the source of sulphuric acid from the natural oxidation of the pyrites in the subterranean workings, and in the coal on the surface, it is also formed by selecting the larger masses of pyrites by hand, and burning them in heaps, where-

by another portion of sulphate of iron is produced, to find its way, with the next rains, into the Schuylkill.

Since so large an amount of sulphuric acid and its salt, with iron, enters the river in the vicinity of the coal mines, that the water has a marked acid reaction, it is interesting to ascertain what becomes of it in the intervening space of 100 miles, between the mines and Philadelphia; for at this city the water has a decided alkaline reaction. Analysis answers the question, by showing a notable proportion of sulphate of lime in the city water. The river, beside rolling over limestone formations through many miles of its course, receives the drainage of extensive limestone districts, whereby carbonate of lime is liberally supplied to it. Carbonate of lime produces, by decomposition with sulphate of iron, the sulphate of lime which remains in solution, and oxide of iron which is deposited. Sulphate of lime, therefore, replaces sulphate of iron before the river reaches Philadelphia.

We believe that nearly all the sulphuric acid entering the river in the coal region, is retained in solution throughout its course, but the water is so largely diluted by numerous streams along the Schuylkill valley, that only a trifling increase is perceptible in the amount of this acid per gallon at Philadelphia, in the course of 12 years, notwithstanding the vast increase in the coal trade. The following statement, drawn from the last Annual Report of the Philadelphia and Reading R. R. Co., exhibits the amounts of coal sent to market, from the Schuylkill mines, in 1842 and 1853:

Tons of coal sent in	1842,	540,892
" "	1853,	2,470,000

The last is 4½ times the former. It is a singular coincidence, that the quantity of sulphuric acid in our analysis (1853) is about 4½ times that of Dr. Boyé's analysis (1842).

Analysis further shows, that there is an excess of alkaline base (including lime and magnesia) in the water at Philadelphia, above what is sufficient for the sulphuric acid, so that the quantity of this acid entering the water is not sufficient even to decompose all the carbonates, which it receives or contains. It appears that only a portion of the carbonates of lime, &c., found in 1842 have been changed to sulphates in 1853, while the total amount of lime aud magnesia has only increased by about ⅝ of a grain per gallon, in the same interval.

The analyses exhibit another fact of some importance,—that while in 1842 the quantity of organic matter was capable of being determined, and in 1845 was quite large, (although probably less than stated in the analysis), in 1853 there was not a sufficient amount to admit of exact determination. It is possible that the water may contain more in summer than in winter, but the fact that it is nearly absent, proves that the increase of manufacturing and of population in the valley of the Schuylkill, and its affluents, has not tended to deteriorate the water in the slightest degree with organic matter. The mineral contents remain the same, and are only varied in proportion.

The effects produced upon the water by clearing land, could only be an increased turbidness, from finely suspended mineral matter, or the addition of dissolved matter, in which vegetable matter would form a fair proportion. We believe

there are not sufficient data to establish the fact, that turbidness is now more frequent or dense than formerly, and we have shown the absence of dissolved organic matter. We may therefore conclude that the water is not worse than it formerly was from this cause.

It has been supposed, that filtration of the water before its distribution through the city, would be desirable and should be undertaken by the government of the city. We infer from analysis, that filtration would scarcely, if at all, diminish the mineral matter in solution, nor is its character or amount such as to justify an attempt at removal. The suspended matter, in a turbid condition of the water, is finely divided clay, the quantity of which is inconsiderable, and which we do not suppose to exert any injurious influence upon the water. To attempt its separation would demand so vast an expenditure, as would not, in our opinion, be justified by the result, even if it were entirely successful. But there is every reason to believe that the attempt would be attended with at least a partial failure, because the suspended matter is so finely divided, that we doubt if much of it could be removed by any practicable system of filtration.

We may observe, further, that a comparison of our water with waters used elsewhere, in the United States and in Europe, and highly esteemed, may be characterized by its greater purity, and by its being slightly alkaline, and nearly free from organic matter.

In conclusion, we infer that the Schuylkill water has deteriorated in no important respect from its former excellent quality; that from the nature of its small content of mineral

matter and its unusual freedom from organic matter, it is superior to most waters, for domestic and manufacturing purposes; that from the nature and quantity of its mineral content, it is unnecessary to adopt a system of filtration to improve its quality; and lastly, a comparison of the past and present, leads to the inference, that no plan of improving the water will be required for many years to come.

JAMES C. BOOTH,
THOS. H. GARRETT.

Philadelphia, 23d March, 1854.

Analysis of the water from the wells of W. H. Horstmann & Sons, N. E. corner of Fifth and Cherry streets; sunk to the rock. Analyzed by Prof. F. A. Genth. Analysis kindly furnished to Frederic Graff, by Messrs. Horstmann & Sons.

	grs. in one gal.
Sand and Silica,	1.563
Bi-carbonate of Iron,	0.290
Bi-carbonate of Magnesia,	23.490
Bi-carbonate of Lime,	21.750
Sulphate of Alumina,	0.309
Sulphate of Lime,	0.014
Sulphate of Potash,	5.755
Chloride of Magnesium,	1.541
Chloride of Sodium,	23.686
Chloride of Potasium,	0.916
Organic and Volatile Substances, as Nitrate of Ammonia,	14.592
Iodine, Phosphoric Acid, Oxide of Manganese,	Traces,
Free Carbonic Acid,*	22.051
Total,	115.957 grs. per gal.
Free Carbonic Acid, and Carbonic Acid forming Bi-carbonates,	40.357
	75.600

* The quantity of Carbonic Acid was determined in water which stood over night.