REPORT

OF THE

Joint Standing Committee on Water,

TOGETHER WITH AN APPENDIX;

MADE TO THE

City Council of Baltimore,

SEPTEMBER 3d, 1855.

BALTIMORE:

PRINTED BY JOSEPH ROBINSON.

1855.

REPORT.

The joint standing committee on water, to whom was referred "all the reports of surveys and memorials which have from time to time been presented to the Council, having for their subject the plans for affording to the citizens of Baltimore a copious supply of pure water," and who were moreover instructed to convene from time to time henceforth for the purpose of investigating the subject, respectfully report, that they have given careful consideration to the reports referred to, and for the purpose of investigating the subject of a copious supply of pure water, that they have, from time to time, since the 3d of January last, met in committee to receive and consider such information on this subject as might be submitted. To avail themselves of distinguished professional ability in the construction and in the management of water works, they addressed a series of questions to engineers, superintendents of water works, and others, relative to the proposed supply to the city of Baltimore, which questions, together with the respective answers and other information, are herewith submitted in Appendix A.

In the earnest desire to procure such information, as in their judgment may prove useful in the construction of so great a work, the committee proceeded to make careful examination of the works which supply the cities of Boston, Albany, New York, and Philadelphia, and the unfinished conduit for the supply of Washington city; in which examinations they were accompanied by officers of the respective works, who cheerfully afforded all information solicited relative to their construction and management. The committee has also repeatedly visited the several streams near Baltimore, which have been recommended as sources of supply, to judge of their character, quality and quantity.

The information acquired by all these means, it is hoped, has enabled your committee to recommend a scheme for a copious supply of pure water, which will be found the most conducive to the health, comfort and prosperity of our citizens. The committee do not think it necessary at this time to submit a history of the water question for the purpose of showing the long recognized necessity of a copious supply of pure water. They regard the action of the people in deciding, by a nearly unanimous vote, "that the next Council proceed to carry out a plan for a further supply of pure water," as imperative; and that in view of this fact, no time should be lost in first determining the best plan to effect this purpose, and then prosecuting it to completion. They did not approach the consideration of this question without being fully impressed with the magnitude of the interests involved, nor without fully realizing the deplorable results which might follow the adoption of an injudicious system of supply. The experience of many cities of our Union in the failure of their works to afford water either in quantity or quality, adequate to the requirements of the inhabitants, is too prominent to divest the committee of the feeling of deep responsibility in their action on the subject of the introduction of water into the city of Baltimore.

The committee had early occasion to notice the extraordinary facilities which are presented for procuring a supply of pure water, and upon contrasting these with the corresponding facilities of other cities, they could not but form the opinion that Baltimore, in this respect, stands unrivalled. The high grounds which bound the city on the western side, contain four distinct streams, which find their outlet within or at a short distance from the city limits. All of these streams, which are of surpassing purity in their natural state, and which either yield by ordinary flow or by storage, could be made to yield a large supply daily, attain an elevation within ten miles of the city adequate, without dams of extraordinary magnitude, or without pumping machinery, flow over nineteen-twentieths of the houses which have been and which may be built within the present limits of the city of Baltimore.

With such opportunities to obtain a copious supply, it became essential to consider with great care the various plans which have been suggested, all of which may be embraced in one of three classes—

1st. By elevating the water by pumps, with lake storage, to obtain an adequate daily supply.

2d. By natural flow, with lake storage, to obtain an adequate daily supply.

3d. By natural flow, direct without lake storage.

The first named of the above systems possesses the sole recommendation of economy of first cost, but requires large annual outlays for expenses of machinery, and involves the risk of accident, from which

it is of the first importance that works of this character should be guarded against. It also requires a resort to the system of storage.

To this particular subject the committee have given especial consideration, and they present their views as resulting from personal examination of the works where storage is resorted to, and from the testimony of the superintending officers.

The cities of Boston and Albany are supplied from large lakes or basins where the water is collected, and whence it is conducted in brick conduits to the receiving reservoir. The surface of these are of variable heights, depending upon the quantity of water consumed in the cities, and upon the amount supplied by influent streams, springs and from rains. The consequence of these fluctuations, which are unavoidable wherever the system of storage is resorted to, is shown by the report of the superintending officers.

From a report of the superintendent of the Albany water works, dated January 1st, 1855, the following is extracted:

"Upon drawing off the water to commence the stone work, it was discovered that only a part of the lake south of the said road had been cleaned, while not a yard of muck had been removed from that portion lying north of the road, which I found covered to a depth of from six to twenty-eight inches with decomposed vegetable matter, the collection of centuries. Upon reporting the facts to the commissioners, I received directions to have the bottom and sides of the lake excavated to the sand. Accordingly, on the 16th of June this work was commenced, the whole work of grubbing and cleaning the lake was finished on the 13th of October. Upon the completion of these important and necessary improvements, an explanation of the lake would have convinced the most sceptical, that no apprehensions of impure or unwholesome water for the future, need be entertained. At the highest flow line the water will rest upon clean sand, with no vegetable mould or partially decayed timber to impart to it their impurities."

It is evident from this extract that great precautions have been taken to obtain pure water, and that the character of the bed and sides of the lake (being of sand,) greatly favored the securing this result. From the same report is extracted the following, commencing on page 53:

"The lining of the dam and the large amount of muck and other vegetable impurities removed from the lake will insure hereafter, water as pure as that furnished by any 'water works' in the world. Nor need the citizens fear any deterioration in its quality, the streams and lake being principally supplied through springs flowing from the adjacent banks. In discussing the purity of the water furnished in 1853, I remark: 'In the month of October it was found necessary to close the outlet gates of Ranselear Lake to afford facilities for repairs in the conduit and at Watervliet Lakes.'

"The water immediately rose above its maximum height of summer, although still below high water mark. By thus overflowing the vegetable matter upon its banks, a peculiar and offensive taste was imparted to the water. As soon as this was discovered, the lake was immediately reduced, and the complaints of citizens, which were certainly well founded, removed. The taste resembled that of fish; and from a number of these having been taken from the service-pipes, the cause of the evil was at first attributed to this source. Subsequent and frequent complaints, however, from different and remote sections of the city, induced me to make a personal examination, when I at once discovered that the cause was a general one, the origin of which existed at Ranselear Lake. So thoroughly impregnated was the water with this unknown foreign ingredient, that upon drawing it into a basin, the odor was very offensive; the taste in every instance much resembling fish. It was observed, first upon the upper service, and about ten days elapsed before it extended generally throughout the city. In Elk street the water was distinctly marked by this peculiar fishy taste and odor for several days before it was observed in the large main in Washington street, from which the pipe in Elk street derives its supply. In October, 1854, impurities similar in taste and odor, and apparently following the same law in extending through the mains, were discovered in Boston. So general were the complaints, and so offensive the water, that a thorough examination of Cochituate Lake, and an analysis were deemed imperative. The subject was referred to Professor E. N. Hosford and Charles T. Jackson, Esq., eminent chemists of Massachusetts, who, after separate and distinct analysis, arrived at the same conclusion."

In closing an elaborate report, Prof. Hosford says: "The recent peculiar taste in the Cochituate water is, in the judgment of the undersigned, due chiefly to extracts more or less volatile from the decaying of minute aquatic organisms, for the most part vegetable, which, during the late prolonged drought, have been produced in extraordinary quantity upon the low meadow marshes, bog and peat land, which supply the surface drainage to Cochituate Lake."

The following extract from the conclusion of the report made by Charles T. Jackson, Esq., gives the result of his observations and experiments:

"I regret as much as any one that we have not been able to settle all the interesting questions that have arisen as to the origin of the impurity complained of. This much we have done—we have proved that the peculiar taste of the water does not originate within the pipes, but exists at the fountain head, and that it is not the result of animal putrefaction, but of vegetable fermentation, and that there is nothing deleterious in the water. These are some points gained. In time we may search out the other matters should the evil ever occur again.

"My examinations, although they satisfied me that the origin of the cause affecting the water in Ransselear Lake, was attributable to vegetable fermentation, and not to animal decomposition, did not lead me to the same conclusion (as to the particular material thus fermented) arrived at by Professor Hosford and Jackson. Instead of a drought, the summer and autumn of 1853 had been peculiarly marked by frequent and heavy rains, while the lake had been maintained at a uniformly high flow line for months, leaving only a small area of peat land uncovered and subject to the action of the sun.

"Beside, while Cochituate Lake receives a large surface drainage, Ransselear Lake is principally supplied by springs underlying a stratum of yellow sand, from ten to thirty feet in thickness, the adjacent lands affording no water shed, except when the ground is frozen.

"It is evident, therefore, that while the peculiar taste and odor of the water, in both instances, were similar, the circumstances under which they were developed were not the same. As my opinion of the operating cause in Ransselear Lake depends for the most part on observations, it may be deemed empirical to submit it to the public until verified by experiment."

Notwithstanding the confidence expressed in the above extracts, that all causes of impurity had been removed from Ransselear Lake, and that the citizens need not fear any deterioration in its quality, when the committee visited the Albany water works last July, the water then delivered into the city was wholly unfit for domestic use, and renewed efforts were being made to determine the precise cause. From all the facts above stated in connexion with the other important facts, that the water of Ransselear and Cochituate Lakes are remarkably pure, and that periodical deterioration exists only in those cities where the supply is from lake storage.

The committee are constrained to the belief, that be the precise cause of deterioration what it may, and it is evidently as yet undetermined, yet that cause exists only in connexion with the system of storage. They therefore consider that its adoption as a means of supply to the city of Baltimore, under all the circumstances, would be highly injudicious.

Referring to the various systems or schemes of supply for the city of Baltimore, the committee are decidedly of opinion that the plan of natural flow without lake storage is alone that which should be adopted. Whenever this has been secured, the daily quantity of water withdrawn being not greater than the daily flow of the source of supply, the purity of the water is certain to be retained.

Upon careful examination of the "question" of the quantity of water required for the city of Baltimore, the committee are of the opinion, that in devising new works a supply of not less than 60 gallons per day for each individual, should be afforded. Assuming the present population at 200,000, there is then required for present use,

12,000,000 gallons of water daily. From the guagings which have been made of the several streams near Baltimore, together with their own personal and frequent observations, the committee find that the Patapsco or Great Gunpowder Falls are the only streams of adequate capacity to afford a daily supply at all seasons of the year equal to even the present requirements of the city.

A comparison of these two streams with reference to a selection as the source of supply, does not exhibit the Patapsco as presenting any advantages over the Gunpowder, either by proximity to the city at necessary elevation for natural flow, quality of its water, or cost of required works, while the comparison of the respective volumes of water discharged during drought, shows that the latter exceeds the former by about 50 per cent.

The committee recommend the adoption of the following described plan for the introduction of water from Gunpowder Falls:

A dam to be erected at or near Opossum Hollow, so as to raise the waters 22 feet above the present surface, or to 176 feet above tide, thereby forming a lake about five miles in length. The land flooded thereby, is represented on the lithographic map as made by Capt. Chiffelle.

This dam to be built of solid cement masonry, to be similar in general proportion to the dam at the Croton river for the New York aqueduct, and to have an overfall 300 feet in length.

The shores of the lake to be grubbed and excavated where necessary, so as to have a depth of low water of not less than four feet everywhere.

From the Opossum Hollow a tunnel to be built in a direct line to Tiffany's Run, starting with its floor 20 feet below the overfall of the dam. The tunnel to be of an oval form, about 15 feet high and 12 feet wide, with an area of 142 square feet, or requiring $5\frac{1}{4}$ cubic yards of excavation to each lineal foot of tunnel.

The length of this tunnel will be 41,200 feet, and consequently require the excavation of 216,300 cubic yards of material, which, we have no doubt, will be found to be solid rock. The slope or descent of this tunnel to be 1,108 feet per mile, the capacity of which, with the water flowing through it by its own gravity, will be 140,000,000 of gallons per 24 hours. When, however, the head of water at the dam is allowed to act on that flowing through the tunnel, without back pressure from water in the reservoir, its velocity will be greatly accelerated, and, in that case, the tunnel will discharge into the reservoir upwards of 250,000,000 gallons of water for 24 hours, at an elevation of 150 feet above tide. To expedite the construction of this tunnel, it will be necessary to sink about 20 shafts, which will vary in depth from 60 to 300 feet, and will average 200 feet in depth; these shafts to be about 8 feet wide and 14 feet long, with an area of $94\frac{1}{2}$ square feet, thus containing $3\frac{1}{2}$ cubic yards per foot, and contain-

ing, in all the shafts, 14,000 cubic yards of excavation. Although a portion of this excavation nearest the surface of the ground will be in earth, and, in consequence, of comparative cheapness to remove, yet for greater security in the estimate of cost, it is assumed to be all in rock, and rated accordingly.

From the most reliable evidence the committee could procure, they are of the belief that the tunnel will not require arching in any part; but in the estimate, they assume, to cover possible cases, that it will require arching for one-half of its length.

The arch to be composed of brick masonry, twelve inches in thickness, laid in hydraulic cement. The tunnel excavation is estimated to cost $7 per cubic yard, and the shafting $10 per cubic yard. In assuming these prices, the committee rely on their being fully adequate, from the testimony which has been submitted on the subject, coming as it does from engineers and contractors distinguished for scientific attainments and practical experience. If the opinions of such men, expressed with the fullest confidence in their accuracy, are of any value, the committee do not err greatly in assuming the prices stated as the probable cost of executing this work.

At the entrance of the tunnel there should be a gate-house to control the flow into the tunnel, and at its terminus a similar gate-house to control the flow into the reservoir.

It is proposed to have three reservoirs: The first, covering about 40 acres, to be in Tiffany's Run, and when full to surface, to be 176 feet above tide; the second to be located in Cold Spring Run, to cover about 20 acres, and when full to be 146 feet above tide; the third to be located on top of the hill at Mount Belle, to cover about 2 acres, and when full to be 270 feet above tide—the water to be forced into this reservoir by a portion of the water operating a turbine in its descent from the first named reservoir to the second. From these reservoirs, iron pipes should convey the water to the city, which should be divided into three water districts. The first to be supplied with water from the lowest reservoir, and to embrace that portion of the city lying not more than 60 feet above tide. The second to embrace that portion lying in higher ground, but not more than 100 feet above tide. The third to embrace that portion more than 100 feet above tide.

The following is the aggregate estimate of the cost of all labor and materials necessary for conveying by gravity 140,000,000 gallons of water daily to the reservoir, and for the distribution of 12,000,000 gallons daily throughout the city:

Estimated Cost.

Excavation and embankment about lake,	$75,000
Dam at Opossum Hollow, gate-house and waste weirs, &c.	85,000
Excavation in tunnel, 216,300 cubic yards, $7,	1,514,100
Shafting for tunnel, 14,000 cubic yards, $10,	140,000

Arching tunnel, 20,600 lineal feet, $15, - -	309,000
Receiving reservoirs, connexions and turbine, - -	422,630
Land damages for tunnel, - - - -	10,000
	$2,555,730
Add 10 per cent. for contingencies, - - -	255,573
	$2,811,303
Water rights and land damages, which it is believed can be obtained for the sum of - - -	425,000
	$3,236,303
Add for distribution for pipes, - - -	766,000
Total, - - - - - -	$4,002,303

The quantity of pipes required for the distribution of water through all the streets at present built upon, is necessarily conjectural, but upon the basis adopted by the committee, it is believed the assumed cost will not vary far from correctness. New York, with a population of 630,000, has 242 miles of pipe work of which 160 miles are 6 inch pipe, 50 miles of 12 inch pipe, 12 miles of 36 inch pipe, and 20 miles of pipe averaging 24 inches in diameter. The population of the city of Baltimore is about one third of that of New York, and it is estimated, therefore, that there would be required one-third of those several quantities of pipe for this city. The cost of these would be $1,230,000, and adding 10 per cent. for stop-cocks, hydrants and plugs, would amount to $1,353,000, from which deduct the estimated value of pipes at present laid, there remains the sum of $766,000 as the cost for distribution yet to be incurred.

REVENUE.

In estimating the probable amount of revenue to be derived from the use of water for domestic purposes, the committee are guided by the results attained in other cities of our Union. In New York, the revenue for the year 1854 amounted to $609,000—being at the rate of 92 cents for each inhabitant. In Boston, the revenue was $223,000—being at the rate of $1.24 for each inhabitant. In Philadelphia, for the year 1855, it is estimated at $330,000—being at the rate of 97 cents for each inhabitant.

From these facts, it would appear that the revenue to be derived upon completion of the works, may be estimated at about $1 for each inhabitant, or to the sum of $250,000—being over 6 per cent. on the whole cost of the works.

There is another source of revenue, however, from which, it is the opinion of this committee, large receipts will be obtained, which is

the sale of the surplus water for power purposes. The practicability of applying water pressure as a motor, the committee consider to be thoroughly and most satisfactorily demonstrated by the working of a water-pressure engine in daily operation in the city of Boston. The committee examined this subject with great care, and obtained the information they possess by personal examination, fully impressed with the importance of this subject to the interests of the city of Baltimore. The engine referred to is of four-horse power, and is used for propelling the press of the Evening Traveller newspaper, having a daily edition of 14,000 copies. The proprietor stated to the committee, that water-pressure engines possessed many advantages over steam engines, and that at the rate of one cent per hundred gallons, which is the price paid for the water, he found the cost about twice as great as that of steam.

The Boston City Engineer stated that application had been made by other persons for the use of water as a motor, at these rates, but that the supply was not sufficient to admit its further use for this purpose.

The elevation of the water in the reservoir at Boston is 115 feet above tide. In Baltimore the height will be 176 feet, consequently the power to be afforded by any given quanity of water will be greater in the latter named city than in the former by over 50 per cent., and at corresponding valuation would be sold for $1\frac{1}{2}$ cents per hundred gallons.

If the city should sell surplus water of the Gunpowder for power purposes at one-fourth this price, at which rate it will be greatly cheaper than steam power, there would be required the sale of only 22,000,000 gallons of water daily to afford a revenue sufficient, *from this source alone*, to pay the interest on the cost of the works as herein proposed. This quanity of water, if expended during twelve hours, would yield 2,000 horse power, or less than half the steam power now used within the city limits.

Reference can be made to cities in Europe, where water is used as a motor; but without entering into further detail, the committee believe they have submitted facts sufficient to demonstrate both the applicability of water for this purpose, and the certainty of its extensive use when the opportunity may be presented. Nor do they deem it necessary in this connexion to dwell upon the great advancements of the general prosperity of all interests in this city, which would result from a material diminution of the cost of power for mechanical or manufacturing purposes.

In the construction of the works, the committee have considered a plan of operation which they regard with much favor.

Taking the cost of the works in round numbers at $4,000,000, they propose that their entire completion be effected in four years, and in the following manner:

First year terminating Jan'y 1st, 1857:		
Expenditure for tunnel,		400,000
Pipes for distributing in city,		200,000
Total expenditure first year,		$600,000
Interest,	$18,000	
Second year terminating Jan,y 1, 1858:		
Expenditure for tunnel,		$500,000
Dam, &c. at lake,		100,000
Reservoirs and connexions,		200,000
Pipes for distribution in the city,		200,000
		$1,000,000
Interest,	$67,080	
Third year, terminating January 1st, 1859:		
Expenditure on tunnel,		$600,000
Dam and lake,		50,000
Pipes for distributing in city,		250,000
Reservoirs,		100,000
		$1,000,000
Interest,	$130,020	
Fourth year, terminating Jan'y 1st, 1860:		
When the works will be completed,		$1,400,000
Interest,	$218,771	
Making the whole amount, principal and interest,		

By the completion of the pipe work at the time of the introduction of the water, it is not doubted that the receipts for the first year thereafter would equal the interest on the entire cost of the work, even if the annual interest during each year of the construction, should be added to the capital. Should it be deemed preferable, the surplus property bought from the Water Company, could be sold from time to time, so as to meet the interest coming due, and would be found adequate to the purpose.

There is evidently no necessity of imposing a water tax, during the progress of this work, nor will there be any necessity to resort to taxation to meet the interest on the debt after construction.

In submitting their report, the committee can only claim to have brought to the consideration of the subject an earnest desire to perform in a faithful and intelligent manner, the duties which were imposed upon them. They have recommended that the general plan reported to the Council last year by T. E. Sickels, civil engineer, should be adopted, with such modifications, however, as to them seemed advisable, upon personal examination of similar works, and as was suggested by men of science and experience. Indeed, the committee con-

sider that to this question of a further supply of water to the city of Baltimore, a vast amount of scientific research has been directed, and that the results point, with singular concordance, to the plan which should be adopted.

Without any intention of invidiousness, the committee refer to the testimony of Capt. Meigs, U. S. Engineer, in appendix A, for the full and entire substantiation of the views expressed in this report. This distinguished officer, possessing a reputation not less for professional ability than for great practical experience, has at this time, under his charge, two of the great works of the country, the Washington aqueduct and the enlargement of the capitol. Guided by his counsel and that counsel confirmed by others of scarcely less eminence, the committee do not doubtingly submit these results of their examinations, and recommend the adoption of the accompanying ordinance.

JNO. A. THOMPSON,
JAS. S. SUTER,
DANIEL LEPSON,

First Branch.

WM. E. BARTLETT, Jr.,
WILLIAM E. BEALE,
W. S. SHOEMAKER,

Second Branch.

APPENDIX A.

PROCEEDINGS

OF THE

Joint Standing Committee on Water

OF THE

CITY COUNCIL,

TO WHOM WAS REFERRED THE SUBJECT OF A

SUPPLY OF WATER

FOR THE

City of Baltimore.

BALTIMORE:
PRINTED BY JOSEPH ROBINSON.

1855.

COMMITTEE.

FIRST BRANCH.

JOHN A. THOMPSON,
JAMES S. SUTER,
DANIEL LEPSON.

SECOND BRANCH.

WILLIAM E. BARTLETT, JR.,
WILLIAM E. BEALE,
WILLIAM S. SHOEMAKER.

Secretary.

ALLEN E. FORRESTER.

Resolved by the City Council of Baltimore, That all the reports of surveys and memorials which have been from time to time presented to the Council, having for their subject the plans for affording to the citizens a copious supply of pure water, be referred to the Joint Standing Committee on Water; and that said committee be instructed to convene from time to time henceforth, for the purpose of investigating said subject,—having the power to send for persons and papers, and in any and every way procure such information as, in their judgment, may prove useful in the construction of so great a work.

Proceedings before Committee.

The Committee met in the chamber of the Second Branch of the City Council, at 5 o'clock, P. M., on the 3d January, 1855. Present: Messrs. THOMPSON, BARTLETT, BEALE and SHOEMAKER. ALLEN E. FORRESTER was appointed Secretary. It was agreed on, that the place of meeting of the committee should be the chamber of the Second Branch, the hour 3½ o'clock P. M., and that any three of the committee should be considered a quorum for the reception of information.

FRIDAY, *January 5th*, 1855.

SAMUEL HINKS, Esq., Mayor of the city, having been requested to attend the meeting, was asked the following questions:

1. It is noted, that in your message to the City Council, dated November 27th, 1854, you say, that "after careful investigation and due reflection, you give it as your deliberate opinion, that if all the water from Jones' Falls be properly applied, we shall have an abundant supply for all purposes, and in every quarter, for the ensuing ten or twenty years:" will you inform this committee, with such particularity as to details, as may seem to you proper and suitable, under what information and by what examination you were led to such a conclusion?

2. Are you prepared with any plan for the introduction, from Jones' Falls, of a pure and abundant supply for the present, and ten or twenty years of future, which you would suggest as proper to be adopted by the city?

Mr. Hinks requested a copy of the questions put to him, in order that he might consider and answer them in writing.

MONDAY, *January 8th*, 1855.

COLUMBUS O'DONNELL, Esq., late President of the Baltimore Water Company, having been requested to appear before the committee, was asked the following questions:

Query 1. What is the quantity of water which is now afforded daily, to the citizens of Baltimore, by the works of which you were lately the President?

2. What was the daily quanity during the last summer?

3. What was the revenue to the Water Company and city together, from water rents, during the year just ended, and what from other sources, growing out of the purchase of the Water Company's property?

4. It is noted, that in a report of the joint standing committee of the last Council, it appears that main pipe, at a cost of $86,695, had been recently laid down by the Water Company, and that the additional revenue expected therefrom was 12 per cent.: is it your opinion, that such a return for that expenditure has been or will be realized?

5. When this addition to the mains was made, and, as has been stated, at a cost of $86,695, was any addition made to the pumping power which is used for raising the water for the high service into the Chase reservoir?

6. Whatever the per centage of return for such expenditure may be, or may have been, could the same rate of return be expected for money expended on the laying of more main pipes, and if so, to what extent? that is, of main pipes so laid?

7. A point having been arrived at, when, in view of the present mode of supply, the laying of mains would no longer pay a good per centage, should the city, in your opinion, extend the present system of pumping, or adopt a new system?

8. What is the supply which is daily afforded to the citizens of Boston and New York? What is it in winter, and what in summer?

9. If the population of this city be now, as is supposed, of over 200,000 inhabitants, is it your opinion, that the quantity which you have just said was afforded to the citizens, ought to be considered a sufficient supply?

10. Have you ever stated it to be your opinion, that Jones' Falls would soon be found to be an insufficient source for a supply for this city, and that the city would have to look elsewhere for such a supply?

11. Should the city determine to project new works, whence, in your opinion, should a supply be drawn?

12. Having pointed out what should be the source of the supply, will you state to the committee what reasons you have had for arriving at such an opinion?

13. You have stated the revenue of the last year to be about $: do you suppose that this sum might be in any considerable degree raised by the adoption of a new system of charges which would be just and equitable? Give the committee any views or opinions which you may have formed of this matter? Particularly as to what increase of revenue might be expected from a water charge on those houses within the present water belt which do not now take the water, the occupants of the same having it at their option to introduce the water to their premises?

14. It is said, that you have, under the supposition that such houses may and ought to be charged, and a great increase of revenue produced, indicated a plan by which a copious supply might, at no distant day, be introduced, in such a manner as to impose no serious burthen of taxation on the community: if so, will you explain your plan to the committee?

15. It has been stated that there are numerous daily applications for permission to connect with the street mains, and you are given as the authority for the statement: will you inform the committee what you know about these applications?

16. If it be true, that these applications are as numerous and pressing as has been stated, and they should continue to be made at the same or an increasing rate, will it not happen, that to meet them properly, some new system of supply must soon be resorted to?

17. It has been proposed to raise by steam, at White's Mill, an additional supply: what, in your opinion, might be expected to be the extent and cost of such supply?

18. Would the abstraction of a greater quantity from White's dam than is now drawn thence, impair the value of the water powers below? and if so, to what extent?

To the above questions, proceeding as far as the tenth, General O'Donnell answered as follows:

Could not tell the amount of water supplied to the city; there was always an abundance; last year more water could have been furnished than was required to suply the demand.

Some years ago left home to examine the works of other cities; visited the Croton works at New York; during the drought no water passed over the dam for the space of three months; none of the mills had been in operation during that period. As an evidence of the fact, he cited that birds had built their nests on the top of the dam, bred their young and still the nests remained. From an examination of the Croton works, was led to believe that Jones' Falls would afford

sufficient water for the city. Boston was supplied with water from the Cochituate lake, which is furnished by the rains; during the drought of last year the lake was so low as scarcely to give a sufficiency. At Philadelphia there has recently been erected additional reservoirs of large dimensions.

The water of Jones' Falls, properly applied, would be sufficient to supply the city with a population three times as large as at present; there would be a sufficiency for all purposes. During the survey of the Water Commissioners, had employed at the expense of the company a person to gauge Jones' Falls, for the purpose of comparison with that report. As it had been stated, there were mistakes made by the commissioners, he presented the communication to corroborate their report. On 18th September, 1852, at 10 o'clock, gauged the falls above Lanvale dam, the water being clear and free from the influence of rain; the quantity was 34,122,240 gallons in 24 hours,—with an allowance of 30 gallons to each inhabitant, 20,000,000 gallons could be obtained, which would not require any addition for some time. If he had continued at the head of the works, he would put pumps at Bradford's mill, to secure the waste water at that point; would have formed reservoir at White's mills, and supply the city from there; Stony Run would afford as much water as would be needed in summer; ought to have water enough stored to supply the city for two weeks; had water enough, but could not use it because it was muddy; never could get the owners of property to name a price for the property at Stony Run.

His desire was, that the city should be supplied at cheap rates, which could be done by forming a lake in the ravine that would afford enough for ten or fifteen years.

The flow of Jones' Falls varied. At the greatest drought of last year, the mills ground 4,000 bushels of wheat per month. Never had intended going to any other stream; believed there was water enough for twenty years; there was enough to supply the demand; the greatest difficulty was to get water in the months of August and September; should reserve in other seasons to supply at that time.

Did not run the water into the reservoirs more than eight out of twenty-four hours. If the property continued with the company, he would lay no new mains unless the property holders would pay six per cent. interest on the money so invested in laying the pipe; they should be made to pay for main pipe as for paving streets. He believed that if the property purchased from the Water Company was properly managed it would yield a sufficient revenue to defray the whole expense of the additional supply required.

It was then proposed to submit to Gen. O'Donnell a copy of the questions, that he might answer them in writing, and his assent to

this having been given, such copy was furnished to him. The committee are without an answer.

Columbus O'Donnell, Esq., submitted a paper, written by Wm. Dawson, giving the result of a gauging of the water of Jones' Falls, September 18, 1852. The first point selected for measurement was above the foot of the Lanvale dam, about 120 yards below the first toll-gate on the Falls' road, the water being clear and free from the influence of rains. The time for observation was about 10 o'clock in the morning.

The result of six observations was an average velocity of over 30 feet in a quarter of a minute. The mean width of the stream, after deducting to compensate for friction, was 30 feet; the mean depth of the head, middle and end of the section was .88 cubic foot. The flow for a quarter of a minute was 5,924 gallons, or 34,122,240 gallons in a day.

The second measurement was made in the tail race at the Stricker mill. The result of five observations was an average velocity of over 48 feet in a quarter of a minute. The mean width of the race was 16½ feet, after deducting compensation for friction. The average depth of the head, middle and end of the section was one foot. The flow for one quarter minute was 5,924 gallons, or 34,122,240 per day.

"You see by inspection," says Mr. Dawson, "that the results of the two measurements precisely agree, which is a most remarkable case of consistency, each proving the other. For friction I made ample allowance in both trials, the rule being to deduct units from the square of the velocity at the top, and the square root of the remainder will be the velocity at the bottom. This would make the friction less than I allowed for it, hence my calculations are reliable and safe, which are 34,122,240 gallons in one day, being upwards of thirty-four millions discharging in one day."

He then recapitulates the capacity of Jones' Falls, both measurements giving the same quantity of gallons, as follows: 23,696 gallons in one minute; 1,421,760 gallons in one hour; 34,122,240 gallons in one day.

JAMES SLADE, civil engineer, of Hartford, Conn., called. Commenced the gaugings of Jones' Falls in October. He designed to have a lake at the Relay House, with a water surface of one hundred and nineteen acres, using for it one hundred and fifty acres of land. The larger the lake for the retention of water the purer the water will be, as it gives all the impurities more time to settle.

A dam could be built there, of such strength that it would not give way by the pressure of the water against it. His plan for it is very similar to the dam at the lake of the Croton water works, which has stood the greatest of freshets. The first dam built at the Croton Lake gave way. One on the Kennebec river, Maine, gave way; one at Hadley falls, Mass., gave way; one in Chelsea, Mass., gave way; and many others have given way, because of the original plans being insufficient. But after all the experience on these, there is not the slightest difficulty in building a dam to stand any rise of Jones' Falls. Made his plan for the dam with a knowledge of all the above failures, having learned by his own and others' experience that such a work must be built in the most substantial manner. Made his estimate accordingly. Estimated over $80,000 as the cost of the dam and gate house at the lake, besides $22,000 for land and work at the lake.

The soil is well adapted for its construction, there being rock on both sides, near the sluice, and much gravel on the west side. There is some sand in the bottom of the stream where it was gauged. It is a very convenient place to construct a dam. The land is mostly unfit for cultivation. It could be purchased very cheaply. Estimated it at $50 per acre.

The water in the dam would be at an elevation of 225 feet above mean tide. Estimated forty gallons per day for each inhabitant. In Philadelphia, where the drainage is like Baltimore, they do not use much over thirty-three gallons each. This estimate covers all used for shipping, steam engines, and all other uses.

A dam could be erected in the ravine at Stony Brook of great magnitude. It would require about sixty acres of land, with a water surface of thirty-one acres. Estimated the land for it to be worth $500 per acre. The estimates of the cost of land were all from 30 to 150 per cent. above their assessed values.

Gauged Jones' Falls in a much dryer time than he gauged the other streams. It was after a six weeks' drought, and it gave over 14,500,000 gallons in twenty-four hours. To be certain of making correct gauges, he put in a wooden sluice. All the water passed through it. Could not well be gauged without adopting some such method, because of the shifting bottom of the Falls.

There was a heavy storm on the 25th and 26th of November, 1852, which raised the Falls from six to eight feet in the ravine. On the 26th November 194,000,000, and on the 27th 179,000,000 gallons of water passed down the Falls. The daily average in Octo-

ber was 19,000,000 gallons; in November, 42,000,000, and in December it was 37,000,000 gallons. It would yield by storing it full 25,000,000 of gallons. The commissioners directed him to estimate for 15,000,000 gallons per day. From his surveys and observations he thought it an excellent place for a reservoir. The dam and gate house were estimated to cost $105,000, and the land and work for this reservoir and contingencies $55,000; total estimated for the reservoir and dam, and contingencies, $160,000. Water in it to be 150 feet above mid tide in the harbor. This reservoir might be dispensed with for the present.

Proposed, also, a reservoir on the high ground of Mr. Mankin; water in it to be 220 feet above mid tide; to cost about $70,000. The city can be amply supplied by a natural flow from Jones' Falls. 18,000,000 gallons daily, gives 40 gallons per day to each inhabitant of 450,000, which is more than double the present population.

Took much pains in getting the water for the chemists to analyze. Was satisfied that report of chemists was the result of a fair examination. The water from all the streams was better than the water of New York or Philadelphia. The Gunpowder and Patapsco are each one grain purer than Jones' Falls; Gwynn's Falls best of all. Jones' Falls has but one-half the impurity in the gallon that the Croton water has. The Jones' Falls water does not corrode the pipes as much as the water in Philadelphia, New York or Boston.

He was satisfied, after much reflection, that the survey was in every way correct.

WEDNESDAY, *January* 10*th*, 1855.

GEORGE Y. WORTHINGTON called. Is the author of a communication to the Council, dated November 22, 1854, on the subject of the introduction of water to the city of Baltimore; is a merchant miller by profession; founded his opinion that a right could be purchased from the owners of the property on the Patapsco to abstract 100,000,000 gallons of water from the Union dam, on each Sunday, from his knowledge of the gentlemen who owned the property; they would be willing to take a reasonable compensation, as the water was running to waste; the Patapsco flows 73,000,000 gallons per day during a protracted drought; gauged it during the period Mr. Sickels was engaged in gauging it; gauged it above the Avalon mill, the same place Mr. Slade gauged it in 1852; last summer, during the protracted drought, it was about the same as in 1845. Gauged it three Sundays in succession, and found it about the same as Mr. Sickels' report; believed Mr. Sickels' gauging was correct; its flow on the first of November last was about the same as during the drought of last summer; flowed about the same at Hockley as at Union dam; if 100,000,000 gallons were abstracted on Sunday, it would take one day to fill up the dam; during a drought the mills use all the water of the stream; there were

eight improved water powers from the Hockley to the Union; he had not consulted all the owners, but thought the right to use the *entire amount* of water of the Patapsco could be purchased for $400,000.

The advantage of the Patapsco over the Gunpowder was, that it could be introduced at about one half the expense; Union dam was 177 feet above tide, and Elysville 206 feet above tide; the water of the Patapsco could be introduced by a natural flow from Union dam, a distance of six miles from the city. If all the water was abstracted, and no water runs over the combing of the dam for one day, it would not produce ill-health by reason of still-water being left in the low places, as there would not be time for the water to become unhealthy because of stagnation.

FRIDAY, *January* 14, 1855.

THOMAS H. BUCKLER called. Is a physician by profession; is the author of a pamphlet published in 1852 on epidemic cholera; he believed the Gunpowder would be the best stream for adoption, but it would cost a large sum of money; he certainly thought the present supply insufficient; if the supply of water was large, the cost to the citizens would be small; 60 gallons per day was a fair average for each inhabitant; it would not be advisable to increase the flow from Jones' Falls, at any considerable expenditure, unless by storage, and augmenting by introducing other streams into Jones' Falls; the water in the lake should not be less than 45 feet depth every where; if the water was shallow, the action of the sun on the dregs would cause the water to become unwholesome. The supply from Jones' Falls could be augmented by introducing Bloody Run, &c., into the channel of the falls, but the cost of this would be as great as a larger supply from the Gunpowder, and it would be best to adopt the latter plan in preference; it would not be advisable to store the flush or freshet water of other seasons, to give the additional supply required during the dry season.

If all the water of Jones' Falls was taken out above the city, and the bed of the stream in the city was left dry, it would make the city unhealthy, and the yellow fever would prevail during the summer; if a dam was erected several miles above the city, and no water flowed over the combing of the dam during a drought, and at the end of the drought a heavy rain should fall, the accumulated filth would be washed into the flats in the city, and generate disease. If all the water was abstracted from the falls, the bed of the falls in the city would have to be filled up; in the event of the breaking of the dam, the city would be inundated. The water of all the streams are healthful enough for use. The water of the Gunpowder would not produce accretions in the pipes, such as prevailed at New York and Boston.

BALTIMORE, *January 20th*, 1855.

ALLEN E. FORRESTER, ESQ.,
Secretary of Water Committee:

SIR:

Accompanying this, you will find answers to the questions of the Water Committee of the City Council, received January 10, 1855. I have connected each question with its answer, so that it might be more readily understood.

Yours, very respectfully,

JAMES SLADE,
Civil Engineer.

BALTIMORE, *January 10th*, 1855.

JAMES SLADE, ESQ.,

SIR:

I have been directed by the Committee to transmit to you the enclosed questions, to which an answer is requested at your very earliest convenience.

Very respectfully,

ALLEN E. FORRESTER,
Secretary Water Committee.

First.—"On Monday, being before the Committee, (joint standing on water, of the Council,) you spoke of your plan of bringing in water from Jones' Falls, from above the Relay House, and you were understood to say that it could be brought in for about a million of dollars; in that sum, did you intend to include every expense, or was it exclusive of water rights below the Relay House, and a city net-work?"

To this I answer.—It was exclusive of the water rights and of the city net-work, but included both the Mankin and Union reservoirs and dams. But the Union reservoir might be left out for some time, which would deduct $160,000 from the estimate.

The second question.—"What would be the total cost of your plan to introduce this 18,000,000 of gallons from near the Relay House, inclusive of a city net-work and the water rights below?"

Answer.—My estimate on page 185 of the Report shows, that for the lake and dam at the Relay House, including land and every thing for it, including also the whole line of the conduit, with 4,190 feet in length of tunnelling, including also both the Mankin reservoir and the Union or Stony Run reservoir, with dams and every thing complete, including in this whole line of work over 280 acres of land, at

prices far above their assessed values, and finishing the whole line of work entire, the cost would be - - - $1,023,878

N. B. *In all this work, the estimated prices for all the tunnelling and rock excavation are more than double the estimates which others have made for other similar work for this city.*

For pipes, etc., to deliver the water at Rose Hill for the high service, - - - - - -	41,450
For cost of distribution over and above what the city now owns, - - - - - -	544,246
Add the commissioners' estimate of the value of the water rights above White's Mill, - - -	370,000
	$1,979,574
This estimate was for 19,000,000. From this we may deduct the Union reservoir, equal $160,000, and also deduct for saleable property now owned by the city, but not necessary for the water works, equal $320,000—total,	480,000
Total cost from Jones' Falls, including city net-work and water rights, equal - - - - -	$1,499,574

This quantity may be hereafter increased, at a comparatively small cost, by increasing the storage capacity of the stream above the Relay House.

The third question.—"Is the plan then (on Monday afternoon) spoken of the same substantially as that estimated for on pages 181, 182, 183, 184 and 185 of your report of June 18, 1852, (as printed)?"

Answer.—It is substantially the same plan.

The fourth question.—"It is known that you estimated for two and one-half, five, ten, and seventeen and one-half millions of gallons respectively, by pumping from White's Mill; will you state what it was that you estimated would be the cost for each of these amounts, inclusive of distribution and all other expenses?"

Answer.—I did not estimate for introducing any of the lesser amounts spoken of. I only estimated the cost of *pumping* the small amounts to the reservoir, but did not make any estimate for distributing them, as no estimate was desired by the commissioners for any amount less than 15,000,000 gallons per day.

I did estimate for introducing 17,500,000 gallons per day from White's Mill, pumping by steam into the Stony Run and Mankin reservoirs, in which case we should also get the additional million which naturally flows into the Stony Run reservoir. The estimate for this amount of water includes the engines, engine houses, and all the buildings, gates and fixtures of any and every kind, necessary to keep up such a daily supply of water. Of this amount, two and a half millions of gallons were to be pumped into the highest or Mankin

reservoir, at an elevation of 230 feet, and the remaining 15,000,000 to be pumped into Stony Run reservoir, at a height of 150 feet above mean tide, including the pipes for both the high and low services in the city, and the pipes for distribution, the same as for the estimate by natural flow.

THE ITEMS ARE AS FOLLOWS:

The cost of distribution, being the difference between the value of the old and new pipes, etc., the same as by natural flow, - - - - -	$544,246
The pipes for the low service, ending at Washington Monument—(this item should now be deducted, as the Water Co. have since put in pipes for this purpose,)	80,920
The pipes for upper service, to deliver the water on Rose Hill, same as estimated for natural flow, - -	41,450
The cost of the engines, with boilers, pumps, etc., also engine houses, with foundations, bulk-heads, wells and gates, also the rising mains, through which to pump the water, and all other necessary fixtures, -	627,500
The dam at Union Run and reservoir for upper service,	159,550
Actual original cost of getting seventeen and one-half millions of gallons of water by pumping at White's Mill, and distributing it, independent of the pipes then owned by the Water Company, - - - - -	$1,453,666

And then, to make a fair comparison between getting the water in this manner, or by natural flow from the Relay House, I made an estimate of what would be the *annual expense* of fuel, engineers and assistant engineers, firemen, oil, tallow, etc., repairs of engines, etc., depreciation of engines and machinery, etc., to keep up this daily supply of seventeen and one-half millions of gallons of water. This *annual expense* represents the "*capital required*," the interest of which is totally lost, just as much as if the same amount of capital was put into a line of aqueduct, to bring the water by natural flow, and therefore to make a fair comparison between any project of getting water by pumping, or by natural flow, this "*capital required*" should be charged to the pumping project.

My estimate for this capital was,* - - -	915,200
My estimate for seventeen and one-half millions was,	$2,368,866

*At the rate of cost to the Baltimore Water Company for pumping by steam the past season, the "*capital required*" would be much more than the above, but with such engines as would be used for pumping on a large scale the above amount would be sufficient.

If from this we deduct the Union dam, the saleable property now owned by the city, and also the pipes since put in by the Water Company, equal - - - 496,720

Then the total cost of obtaining seventeen and one-half millions, *by pumping at White's Mill*, plus 1,000,000 in Stony Run, and including city net-work, equal, $1,872,146

The fifth question.—"You state it as an objection (page 181) to these last plans, (for pumping by steam at White's Mill,) 'that we must take it at its flow in dry seasons, because we cannot store it; therefore we cannot get as much at this point of the stream as we can at the Relay House, without having larger reservoirs than are now proposed* into which to pump it when it is plenty.' Do you still entertain such opinions?"

Answer.—I still entertain the same opinion, for the following reasons:

If we were to take the water from White's Mill, it is supposed that we should not own any thing above it. Then all the storage from which to pump must be on the stream below the mill. This, as can easily be seen, affords comparatively but little room for storage, even if the Falls turnpike is built up so as to raise the water below White's dam to the full height of it. I have not made an actual survey of this spot, but it certainly could not be made to contain but a very few millions of gallons of water, and therefore if we desire much more than what the proposed Mankin and Union reservoirs will contain, we must find more room for reservoirs. When I said, at this point "we must take it at its flow in dry seasons, because we cannot store it," I intended to be understood as using this expression somewhat in comparison with the cost of other methods of obtaining similar amounts of water. Plenty of land could no doubt be obtained on the hills near White's Mill, on which to build reservoirs to hold as much as is designed for the lake at the Relay House. It would take at least one hundred acres for reservoirs and banks, (making this deeper than the lake,) which, at $500 per acre, the estimated value of the land for the other reservoirs at this place, amounts to $50,000. It would cost at least $300,000 to build it and furnish materials. Say $350,000 as the cost of the land and reservoir. The Brookline reservoir, Boston, has a water surface of about 23 acres. It cost much less proportionally to build it than it will to build one on the high ground near White's Mill. Its cost, including land and gate-house, was $197,477.

To be able to have all the water in times of flood, we should require much more machinery than I have estimated for, so as to have enough of it with which to pump up the water at such times.

It will be seen, that as the storage reservoir and the pumping cost so much near the city, and also that so much more machinery will be

* At White's Mill is meant.

required, when larger quantities of water are to be obtained by pumping at White's Mill, that it will be much cheaper to store the water above the Relay House, as land is much cheaper there, and we save the entire pumping. *Or, in other words,* when more water is wanted in the city than the natural flow of the stream in dry times, it is much cheaper to stop it in the high valleys, in times of freshets, and let it flow through a conduit, when it is wanted, than it is to let it all run down hill, (falling 140 feet in the four or five miles of distance,) and then to pump it all up again to the heights wanted.

The sixth question.—"If the city should decide to adopt either of those points, the Relay House or White's Mill, as the source of her future supply, which of them, under your plans, would you recommend to its adoption?"

Answer.—I would, and do recommend, that it should be taken from the Relay House.

The seventh question.—"Do you, or do you not think that it would be advisable for the city to draw its supply, looking to a long future, from White's Mill?"

Answer.—I do not think it would be advisable to take the water from White's Mill, for reasons given in the answers to the fourth and fifth questions, and also for the reason that the water will be growing more and more impure at the mill, owing to the increase which there will be hereafter of factories and habitations on the line of the stream.

The eighth question.—"If you should have been satisfied that during the last year the average daily flow of Jones' Falls was, for the month of August, about eight millions of gallons, and that in September it fell down to a daily flow of five and a half millions of gallons, would you still think it would be advisable to adopt Jones' Falls as the source of supply for Baltimore?"

Answer.—The rain-fall in the months of June, July and August, in the year 1854, was only about one half as much as the average of the rain-fall in the same months, in every year that a record of it has been kept near Baltimore since 1817. By a reference to the table of rain-fall, page 12, of Mr. Sickels' report, it will be seen that in the month of May, 1854, that 5.63-100 inches of rain fell in that month, and that nearly one half the average annual amount of rain fell in the first five months of the same year. If such rains are stored above the Relay House, as they can be, and sent down as wanted for city use, there will be no lack of water in the summer.

The gaugings which show a flow of only eight and a quarter millions were commenced at the end of a ten weeks' drought, and were continued through the dryest season ever known.

I have no hesitation in advising the adoption of Jones' Falls as the source of supply for the city of Baltimore, and I have no doubt, that with proper storage, it will afford all the water needed in the city for twenty years to come. In that time, the money, and the interest of it

which will be saved, by taking this stream, instead of either of the larger ones, will more than pay for the introduction of either of the larger streams, at the end of that time, and you will then also have Jones' Falls, giving the same amount of water as heretofore.

THURSDAY, *January* 30, 1855.

ALFRED DUVALL called. Is by profession a mechanical and civil engineer; has had much experience in the construction of various hydraulic works. (Mr. Duvall presented letters from J. H. Alexander and James Murray, of Baltimore, and A. Ruden & Co., of Payta, Peru, testifying to his competency as an engineer.) Is the author of a memorial to the Council, during the last session, entitled "Communication in relation to a supply of water, &c., from the Gunpowder river." It is still his opinion, that it is only to the Gunpowder that Baltimore can look for an abundant and constant supply of water, at a reasonable cost, and that he had for years looked upon the Gunpowder as the only proper source. He believes that at or near Opossum Hollow is the best site to locate a dam across the Gunpowder from which to draw a supply of water for our city.

There are, in his opinion, serious objections to the site proposed by Mr. Sickels for a dam to suit the purpose designed.

In making a tunnel from the Gunpowder, by the lines indicated by himself or by Mr. Sickels, believes that no lining or arching would be necessary, except at the beginning and termination. From his examination of the region referred to, believes it will be easy to construct a tunnel through; there are few objections to the geology of the same; he believes the line of tunnels proposed would be found to be principally through Gneiss rock, that will be of the most desirable character through which to construct a tunnel.

He also presented a memorial to the Council in November, 1854. If the city was going to adopt means to obtain a temporary supply of water, he would recommend it be taken from Herring Run. If the city was prepared to do it, he thought it most desirable to go direct to the Gunpowder; he recommended Herring Run, because it was on the route to the Gunpowder, and as the work for a supply from same would be preparatory to an abundant supply from the Gunpowder. He was satisfied 5,000,000 of gallons per day of reasonably pure water could be had from Herring Run, (through long droughts, as per plans he had recommended;) he believed that such plan could be executed for less than $485,350, as material and labor is lower now than when he made the estimates for such plan; it would require an addition of about $67,000 for thirty-six-inch main, to connect with the present network. All his plans and calculations look to a future abundant supply. He would contract to give five millions of gallons from Herring Run, at his estimates, and give satisfactory security for the performance of the work; he believes it could be done in a good manner for $50,000 less.

Estimates for excavating, masonry, embankments, puddling and iron pipes, can be made with correctness where correct surveys, etc., have been made, from which to procure data for calculations; such estimates are less difficult to have correct than estimates for an ordinary building.

His first objection to taking an additional supply of water from Jones' Falls is, that storage is the only dependence; believes that through the drought of last summer nearly all the flow was extracted for present supply; noticed the falls at Monument street bridge and neighborhood some ten or fifteen times during the late drought, and his opinion was, that it did not flow 1,000,000 of gallons in twenty-four hours, beyond the supply for city purposes. Mr. Slade has, in his opinion, suggested the best general plan for a supply of water from Jones' Falls, and which will cost, for nineteen million of gallons delivered at Rose Hill and Washington Monument, as shown by Mr. Slade's report, page 99, $1,146,248, and to which must be added the value of water rights on Jones' Falls, as per commissioner's report, pages 26 and 39, $700,031, and to which should be added the value of the water rights required on Stony Run, which, it is presumed, cannot be had for less than $30,000, making the cost $1,886,279 for a supply of 19,000,000 of gallons, and much of it from storage in dry seasons; such supply would be greatly reduced below Mr. Slade's estimate, as the flow of the Falls, falls below the minimum his gaugings show, and which it did very much last summer, as shown from gaugings made by Mr. Sickels; see Slade's report, page 79, and Sickels's, page 26, showing a diminution in the flow, in 1854, of Jones' Falls of 8,209,116 gallons below Mr. Slade's lowest gaugings.

Two hundred and twenty-five feet above tide is not sufficient elevation, in his opinion, from which to water every part of the city properly.

Visited New York in June last; found no water in any of the public fountains, showing the supply from the Croton was exhausted; believes the Croton works are represented to furnish 35,000,000 of imperial gallons a day, equal to rather more than 42,000,000 wine gallons, as 100 imperial gallons are equal to 120.0320 of wine.

In years past, Jones' Falls, he believes, was not claimed to flow more than 8,000,000 gallons in very dry seasons.

The expenditure to construct a proper dam and lake on Jones' Falls, for the purpose indicated by Mr. Slade, he believes would cost a much larger amount than estimated for; believes Mr. Slade's other estimates to be such as the work he proposes could be done for, *less the dam and labor* proposed on Stony Run, which he believes to be considerably too low for a good and secure work, situated as the same would be.

If a dam on Jones' Falls or its tributaries, forming a large lake, was to give way, such would be most destructive to life and property in the lower parts of the city.

Almost all waters hold in solution matter that has an affinity for metals, producing in pipes oxidation, accretions, &c.

Has never tested the effect of the waters of the Gunpowder on iron or lead.

Has devoted himself to the study of hydraulics for more than twenty years, and has made various experiments in hydraulics and hydrodynamics.

From mature deliberation, his opinion is, that no other stream presents any thing near equal advantages to the Gunpowder for a supply of water to our city.

By introducing the entire flow of the Gunpowder from the point referred to, is satisfied the surplus water, over a supply for domestic use, &c., can be disposed of for power, and at a price that would yield a revenue that would pay the interest on the entire cost of the work, leaving the supply for domestic purposes free, or but at a nominal charge.

It appears to him that Mr. Slade has made no estimate for excavating much of the large lake he proposes on Jones' Falls, or for the one in Union Run; lakes, in his opinion, when used for storage, ought to be at least twelve to fifteen feet deep, in shallowest parts, and the embankments or banks of a slope of not more than $2\frac{1}{2}$ horizontal to one vertical; and for a permanent work, if the supply should be required to be drawn down much, the banks, when not of rock, ought to be walled or lined with stone; he is of opinion, the necessary excavations, so as to give a depth of twelve feet in shallowest parts, and the necessary walling or lining the embankments of the lake, which Mr. Slade proposes should flood an area of 119 acres, will cost very largely over his estimates for same. He believes the location proposed by Mr. Slade for a dam on Jones' Falls a good one, but considers such work, if done, should be constructed without regard to cost, considering the large amount of water intended to be stored behind it, and believes it would cost more than estimated for if made secure, or as far so as it ought to be to provide against extraordinary causes.

The dam of the Croton works gave way not long after its first erection, (and which had been built at a very heavy cost;) it is presumed it was constructed under the supervision of a skillful engineer.

He believes Mr. Sickels's estimates per cubic yard, perch, &c., are in general such as contractors would take them at; believes that a dam built on the Gunpowder, at the site and of the height Mr. Sickels proposes, to serve the purpose intended, should be of greater overfall, &c., and would cost much more than estimated for; considers Mr. Sickels's estimates for dam would be sufficient for the erection of a good dam at or near Opossum Hollow; at such point the dam would not require to be a high one.

For twelve or fifteen thousand dollars a good boulder dam could be built across the Gunpowder at or near Opossum Hollow, by filling in

across the stream a large barrier of boulder rocks, thrown in promiscuously, and filled behind with broken stone—such dam would be strong and not very tight at first, but would most likely serve all necessary purposes for some years, and serve as a coffer and back-filling for a future tight dam to be built in front of it.

Has seen a boulder dam on Deer Creek, some years past, that was some six or eight feet high, and believes it is standing yet; the owner and constructor told him he had three dams that had given way (on the same site) previous to his erection of the boulder dam, which had then been standing a number of years, and that it had cost but a trifle to keep it in good repair.

Has a knowledge of all the water rights on the Gunpowder, from its debouch to the Warren factory, and believes the entire control of all the waters of the stream dammed at Opossum Hollow ought not to be valued at more than $330,000 to $360,000.

The flow of the Gunpowder at Opossum Hollow, by gaugings, is about as fifteen to one of Jones' Falls. If the same should be conducted to Homestead valley, at an elevation of 175 feet above tide, and be used along the course of same, for manufacturing purposes, to Jones' Falls, and fall into the dam of the Salisbury Mill, and be used from thence through the city for power, as Jones' Falls now is, the value of such supply, if valued in proportion to quantity and elevation, according to what the city has paid for water rights on Jones' Falls from the crest of Denmead's dam to that of White's mill, (being $340,000 for not over 65 feet, equal to $5,230 76 per foot, say $5,000,) it would be worth $75,000 per foot, or $13,125,000 for 175 feet; or valuing the waters of the Gunpowder (if turned to our city) in proportion to quantities, &c., at what the water rights are valued at on Jones' Falls, from White's Mill up, viz: $370,000 for 140½ feet, as per commissioners' report, page 26, equal to $2,633 per foot, showing a value for the waters of the Gunpowder of $39,495 per foot, or $6,911,625 for water rights in the valley of Homestead and city, valued at the same as water rights are on Jones' Falls, at an average distance of 3½ to 4 miles from Baltimore. $6,911,625 is a larger sum by some two or three millions than it will cost to introduce the entire flow of the Gunpowder to our city.

He had expended considerable time and money in making surveys, &c., relative to a supply of water for our city. He had not been influenced by any person or parties relative to the same, or received any compensation directly or indirectly from any source for what he had done.

In January, 1854, after an absence of two years, he returned to his native city, and expected to have found our city engaged in constructing works for a supply of water, by natural flow, from the Gunpowder river, but finding the plan recommended for a supply from said river was by pumping, he was not surprised that such work had not been undertaken, as he considered such plan had but little to recom-

mend it. After reading the reports of various engineers relative to a supply of water for the city of Baltimore, he felt satisfied the most practicable, permanent, and by far the most economical plan of furnishing our city with an abundant supply of water, had been overlooked.

Having a measureably correct knowledge of the topography of the country for some distance around Baltimore, and of the flow of the various streams near the city, and their elevations above tide at given points, he was well satisfied that a supply of water for Baltimore could be more economically had from the Gunpowder river, from an elevation of some 180 feet above tide, by natural flow through tunnel, than by any other possible plan; an opinion he had entertained for twenty years.

Considering all the plans proposed for a supply of water to our city up to the time he refers to, (viz: January, '54,) objectionable, expensive and inefficient, he was induced to make surveys, etc., at his individual expense, to show to the citizens of Baltimore the most practicable and economical plan of procuring an unfailing and abundant supply of water. The result of his labors are known to your honorable committee.

The motives that have induced him to make the expenditures he has made, relative to the subject matter, have been honorable. If the plan he has originated for a supply of water for our city has merit, (which he believes is generally admitted,) and is or will be of benefit to the city of Baltimore, it will be to him a gratification (if he has no other reward) to know that he has contributed to the interests of a city that he is proud to be a citizen of. He has originated and defined a general plan for supplying our city with water, which, if carried out, surpasses in the magnitude of its benefits, and is more economical in its construction, considering the supply, than any water works in the world, and believes such general plan will eventually be carried out, and that posterity at least will give him credit for what he has done.

ROCKDALE, *February* 9, 1855.

To the Joint Standing Committee on Water:

GENTLEMEN:

Having, in the accompanying paper, replied to the questions you were pleased to ask us, we now desire to invite your notice to the following:

We are authorized to suggest to your honorable body, that competent parties would be willing to contract with the city for the erection of a good and sufficient dam above "Woodberry," on Jones' Falls, the surface of water in which would be at an elevation of nearly 170 feet above tide, to hold not less than millions of gallons

of water; the water to be taken from thence by iron pipes or mains of sufficient capacity to pass forty millions of gallons every twenty-four hours, into two reservoirs, one in the valley of the Union Run, to be at its water surface at an elevation of 130 feet above tide, of such dimensions and capacity as might be desired, and which would furnish about "six-sevenths" of the present population of the city with water, mostly on top of their houses; in other words, that this reservoir would furnish water at the same altitude, by natural flow out of the proposed dam, that the present Chase Hill reservoir does, into which the water is now pumped from the Salisbury pump house; and the other reservoir to be on the higher grounds adjacent to the valley of the Union Run, and at an elevation at its water surface of 165 feet above mean tide, and likewise of such dimensions and capacity as might be desired. This reservoir would also be filled by natural flow from the proposed dam above Woodberry. Furthermore, the parties would agree to contract for delivery from these two reservoirs, by iron mains of sufficient capacity, or as large as may be required, one to connect the lower reservoir with the present distributing pipes of the city, at a point to be designated, say in the vicinity of Washington Monument, (which at its base is 99 feet above tide,) and to supply all that part of the city inside of the line of 100 feet above tide, as laid down on the map of James Slade, Esq.; the other to connect the higher reservoir with the distributing pipes for the highest parts of the city, or say all higher than 100 feet above mean tide, and which should terminate at a point to be designated, say in the vicinity of Madison and Biddle streets, which is 126 feet above mean tide. The water from this upper reservoir would be furnished to the citizens about thirty feet higher than it is at present, with a certain, constant and powerful force of head. The parties would agree to complete these works in the most substantial manner—would, before or at their completion, convey to the city the full and perfect title of the water rights from the proposed dam above Woodberry to the city property, the Rock Mill, together with the pipes and necessary rights of land to the same, and the reservoirs and appurtenances connected therewith, for the full and effectual ownership by the city of the same, and would take in part pay thereof the Chase Hill and Mount Royal reservoirs, to be delivered when the supply was had from the new works, the Salisbury mill and grounds, the Lanvale Factory and grounds, the Mount Royal mill and grounds, and the Rock mill and grounds, the city reserving, in the conveyance of the same, the free and absolute right to the use of all the water of the stream to be drawn out of dam or dams above Woodberry—and

dollars, in the stock or bonds of the city, bearing six per cent. per annum interest. This blank could only be filled when was ascertained the quantity of water that the dam above Woodberry, as well as each of the two reservoirs proposed, should contain, and also the size and capacity of the iron mains, and where they should terminate. With

these requirements furnished us, we would convey the same to our principals, who would as soon thereafter as the examination was completed, be prepared to make proposals for the entire works, which, by extending the capacity of the reservoirs, could be made to furnish a supply of thirty to fifty millions gallons of water every twenty-four hours. As either of these quantities is so much larger than the city would require for many years, and as it is an ascertained fact that the *minimum* flow of Jones' Falls can be relied on for a daily supply of about fifteen millions of gallons every twenty-four hours, and with very small reservoirs a daily supply of over twenty millions gallons, it would seem an unnecessary expense to make large provision for storage at the present time, but the land necessary for future storage might now be obtained, if deemed most desirable.

We believe it can be shown by the working power of the stream, as applied to the water wheels at Rock mill and Mount Royal mill, for many years, in the manufacture of flour, with a reasonable allowance for waste of water during times the mills were not running, that an *average* daily flow can be relied on of over thirty millons of gallons of water every twenty-four hours.

The city, by purchase from the Water Company, being now owner of the distributing pipes in the city, reservoirs, water rights, &c., up to Rock mill, inclusive, must henceforth look to the laying of further distributing pipes in the city, and water at a greater elevation than she now has. The report made by Mr. James Slade of his surveys, examinations, altitudes and estimates, is so full and definite as to give every information necessary for a perfect understanding of the subject, yet the work recommended most favorably by him is so elaborate, and involving so much expenditure of money, that it may well be questioned whether the city is in a position to embark in it at the present time; besides, to a large extent, it is apparently unnecessary. For instance, where is the necessity for bringing water for some miles by an expensive aqueduct, through tunnels, and embankments at an elevation of 225 feet above tide, to let down into a reservoir "150 feet above tide" before reaching the city limits? when, by Mr. Slade's own showing, "six-sevenths" of the present population of the city are living below the line of 100 feet above tide.

Hence it appears what is now wanted is the procurement of water for city use, by natural flow of the stream, at a sufficient elevation for practical use in the city, *from above the localities of its present pollution*. A hasty glance will show the existence of these sources of pollution to be from Woodberry factory down; and here, by constructing a dam, and backing the water to the Rural mill dam inclusive, it would be at an elevation of one hundred and sixty-seven feet eight inches above tide at its surface, and would cover about fifty acres of ground. This elevation would furnish water, by natural flow, to the highest present inhabited parts of the city, with but few exceptions. Whenever it might be wanted higher, the removal of the present

pumping works to the proposed dam would throw it into a reservoir that should be constructed on the west side of the falls, on or between the lands of Mr. Rogers and the city limits, at any desired elevation; and as the quantity would be small, the pumps could probably be always operated by the waste or surplus water, without any steam power whatever.

For the works named, at a price contracted for, the city would know the extent of her liabilities for the same. The only additional outlay would be for extending the distributing pipes of the city as requisite, but which would of course increase the annual revenue from water rents; and it is altogether likely, that the water revenue, besides paying the interest on the water debt, would yield annually a sufficient sum to pay for finishing the entire distributing pipes in a few years, and that the surplus water revenue will, by the time the whole water debt should become due, (say twenty to thirty years hence,) have amounted to a sum sufficient, or nearly so, to extinguish the same. If so, the "good time" will then have come, when that necessary element can be distributed "*free gratis*," abundantly, to the good people of the city.

Very respectfully,

S. D. Tonge & Co.

Second Branch Chamber, City Hall,
Baltimore, February 17, 1855.

Captain Meigs,

Sir:

The Joint Standing Committee on Water, of the City Council of Baltimore, respectfully requests your answers to the questions herewith sent, at your earliest convenience.

By order of the Committee,

Allen E. Forrester,
Secretary.

United States Capitol Extension and
Washington Aqueduct Office,
Washington, February 17, 1855.

To the Joint Standing Committee on Water,
of the City Council of Baltimore:

Gentlemen:

I have the honor to transmit herewith replies to the questions submitted to me, with your letter of February 17th, in regard to the Baltimore and Washington water works.

From the tenor of these replies, you will see that I am decidedly of opinion, that among the various plans presented, that which proposes to introduce the water of the Gunpowder, by the larger air-line tunnel, is the proper one to adopt.

Mr. Sickels' estimates are evidently carefully and faithfully made, and I do not doubt that the work can be executed for the amount stated.

I am, very respectfully, your ob't serv't,

M. C. Meigs,

Capt. Engineers in charge extension U. S. C. and Washington Aqueduct.

Query 1. What is your profession or calling?

Answer. Engineer and architect; a captain in the U. S. corps of Engineers, educated at the United States Military Academy at West Point, from which I graduated in 1836.

2. Where do you now reside?

A. At Washington, District of Columbia, in charge of the construction of the United States Capitol Extension, of the Washington Aqueduct, and Fort Madison, at Annapolis.

3. You projected and commenced the Washington and Georgetown Water Works, did you not?

A. I did.

4. Will you give some account of the estimates of cost of these works, and their capacity?

A. There were only four modes of supply to be thought of. *First:* The introduction by natural flow of the water of Rock Creek, which would supply in winter and spring 26,732,300 gallons, but with the best arrangements for storage of surplus water in reservoirs would be liable to be diminished in the heats of summer to 9,860,000 gallons. Estimated cost, $1,258,863.

Second. A supply from the Potomac, by pumping into reservoirs, using for that purpose the water power of the Little Falls, about six miles above Georgetown, a daily supply of 12,000,000 gallons, and at an estimated cost of $1,662,215.

Third. A supply by a brick aqueduct seven feet in diameter, bringing the water by its natural flow from the Potomac, above the Great Falls, about fifteen miles from Washington. The quantity to be thus supplied being 36,015,400 gallons daily, at an estimated cost of $1,921,244.

And *Fourth.* The construction of a larger aqueduct, nine feet in diameter, which, at an increase of one-fifth of the total cost, would nearly double the supply of water, giving 67,596,400 gallons daily, at an estimated cost of $2,300,000,

5. What were the reasons which led you to recommend the introduction by these works of so large a quantity as 67,000,000 of gallons?

A. From the increase of the population of Washington and Georgetown in the two years preceding the date of my surveys and estimates, the lowest estimate for their population at the end of forty years would be 250,000, who, at a consumption of 90 gallons a day for each individual, a rate now well established by experience as sure to occur at certain seasons of the year, would require for absolute use 22,500,000 gallons, without any allowance for public fountains, most needed when the consumption for domestic use is greatest. A single jet of the fountain in Boston, under a head of 126 feet, consumes four millions of gallons of water if allowed to flow for ten hours. And in a city of large extent like Washington, with many public squares and parks, with a climate whose heat in summer is very great, with wide and dusty streets, I considered that it was a necessity to provide for many fountains, and for a very large expenditure of water in watering the streets, laying the dust, cleaning out the gutters and alleys, generally badly drained, and thus adding greatly to the purity and health of the city, and tempering in some degree the intense heats of summer.

Provision ought also to be made when practicable, for a supply of water power, at least to the smaller workshops, where a steam engine of two or three horse power or less is often employed at an expense for fuel and for an engineer which far exceeds the cost of water power if once introduced.

These considerations fixed the diameter of the conduit at not less than seven feet.

Then, upon examining the additional cost of one of nine feet in diameter, I found that it did not much increase the excavations and embankments, did not effect the reservoirs and dams, &c., and that with an addition of only one-fifth of the total cost, we could obtain a double supply of water. I did not hesitate to recommend this increased size. It was adopted by the President, and its construction has been commenced.

6. In projecting new works, if it could be had at the same or nearly the same cost, would you recommend that this city should adopt a plan for bringing in so large a quantity, (as your plan proposes to introduce to the above cities,) or more, or less?

A. Baltimore is a commercial city, and will probably always exceed Washington and Georgetown in population and manufactures. It should therefore, in my opinion, have a larger supply than Washington, if it could be obtained at a reasonable expense. It will be much more used for manufactories, such as breweries, dying establishments, sugar refineries, &c.—much more used as a motive power. Its working population need the relaxation of public parks and places of resort, to which liberal supplies of water in fountains lend the

greatest attraction. Every reason which would induce me to recommend a liberal supply of water for Washington, applies with equal force to Baltimore, which, moreover, needs a large quantity of water to purify the stagnant harbor, whose odors during the last summer must be within the recollection of all its inhabitants, as they are within that of all who passed through the city by railroad. I think that the most ample available source should always be resorted to. By the regulating gates at the entrance of an aqueduct, the quantity to be supplied at any particular season may be diminished to any proper degree. While, if the source from which the water is drawn is unlimited, and the aqueduct constructed of ample dimensions, the increasing demands of a population growing in numbers, in luxury, in cleanliness, and in manufactures, can be met by simply opening the gates.

On the contrary, if from a short-sighted economy the works are at first constructed on a contracted scale, their increase is very costly.

Baltimore has recently, I understand, paid for the imperfect works which she now uses, money enough to construct a great part of the largest work proposed by her engineers.

7. Of Jones' Falls, the lowest flow that was observed in 1852 was 14,696,225 gallons per day; in 1854, it was 5,482,080 gallons per day. In 1854, it is believed that the average daily flow of six months was but little, if any, over 8,000,000 of gallons. On November 24th, 1852, it was 31,239,172 gallons, (4.47 inches rain having fallen on the previous days of the month.) On November 26th and 27th it was 194,245,128 and 179,491,276 gallons respectively, from which it fell to 36,403,963 gallons on the 29th of same month. In view of these facts, it having been determined by her citizens that a "pure and abundant supply of water" should be introduced to Baltimore, is it your opinion that it would be advisable to expend a large sum for the introduction of whatever supply Jones' Falls is likely to afford?

A. No.

8. In a report of certain commissioners appointed by the City Councils, dated August, 1852, it is shown, that having in view the lowest (observed) flow of 1852, by the plan and estimates of Mr. Slade, 19,000,000 of gallons of water may be had from Jones' Falls by natural flow for the sum of $2,990,494, including distribution. In a report to the City Council by Mr. Sickels, dated September 9th, 1854, it appears that, by pumping, 16,000,000 of gallons may be had and distributed from the Patapsco for $2,393,850, and $1,127,215 for net-work—and that from the Gunpowder, by natural flow, 70,000,000 gallons may be had and distributed (as the city is now improved) for $1,958,850, and $1,127,215 for net work—and that from this last mentioned stream also 140,000,000 gallons may be had (and in like manner in part distributed) for about $3,627,215.

If these estimates should be supposed to be correct, or nearly so, would the adoption of Jones' Falls for a future abundant supply be, in your opinion, advisable?

A. No.

9. Have you read the report of Mr. Sickels to the City Council?

A. I have.

10. If you should be convinced that Mr. Sickels' estimates are generally correct, or nearly so, what *stream* should, in your opinion, be selected as the source of a supply for this city?

A. The Gunpowder.

11. You may have noted that in Mr. Sickels' estimates of the cost of introducing water from the Gunpowder Falls, the largest item is a tunnel 6¾ miles long, and of an area of 74 feet: taking it for granted that this tunnel would be cut through a formation of rock such as is described by Mr. Tyson, pages 62 and 63 of the appendix to that report, and that the shafts are of the average depth stated by Mr. Sickels, do you think that Mr. Sickels' estimate for that tunnel per cubic yard is about correct; and if not, whether, according to your information and experience, it is too high or too low?

Pray explain, at such length as your leisure from your arduous duties will admit of, giving, particularly, some account of what you have been charged, have paid, and expect to pay for similar tunnel work.

A. Upon the Washington Aqueduct there was no tunnel so long as to require shafts. Work was done at the ends of the tunnels in four different places. The rock is an exceedingly hard gneiss or mica slate. The average work of the best cast steel drills in it before requiring sharpening, being in some cases where I had a careful account kept, 3⅞ inches. In another place, where the account was kept for several days, the average work was 2¼ inches. I mention this, because to contractors and engineers it will be the best indication of the character of the material.

The rock in our tunnels is not regularly stratified. The strata are thrown up, twisted and contorted in different ways.

I observed that wherever the rock for a short distance showed a regular disposition of its strata, the work was much more rapid, the blasts much more effectual, and the cost less.

I paid for this work at the rate of $7 50 per cubic yard in one opening; $7 in the three others. Measuring only the net excavation in the tunnel, supposing it to be perfectly smooth, circular, and 11 feet in diameter, giving an excavation of 3.52-100 cubic yards to each foot in length. A much larger quantity of rock was removed by the workmen, as the irregular stratification caused great irregularity in the

effect of the blasts, and all parts projecting within the cylinder of eleven feet diameter were removed.

The work done up to the present time at the first opening is 201 lineal feet, which cost, at $7 50 per cubic yard, and 3.52 yards to the lineal foot, $26 40 per lineal foot, or $5,306 40.

At one of the other openings 150 feet are finished, costing, at 3.52-100 yards to the foot and $7 per cubic yard, $24 64 per lineal foot, or $3,696. At one other opening 60 feet have been completed, and at the fourth 41 feet. They were paid for at the same price of $24 64 per lineal foot, or $7 per cubic yard. One other tunnel, nearer the city, and more convenient to supplies, in which the rock appeared to be somewhat softer, I have made arrangements to have excavated at $6 50 per cubic yard, by the same persons who have been at work upon the others.

In these excavations we were not subjected to any expense for pumping or for hoisting the material from shafts. I have not the data for determining the exact cost to the person who undertook the work, but the impression among the agents and engineers of the United States who superintended it was, that he made a fair, if not a liberal profit.

We did not find any lining of the rock necessary. The little trickling springs which, near the surface of the hill, found their way through the roof, collected upon the floor of the tunnel and flowed out at its mouth. The rubbish of the excavation falling to the floor sufficed to close the small seams in the rock, and I think that no masonry or lining will be needed in this rock, except to stop here and there an open seam, should such occur, by a little brick work.

The concrete lining and side walls for which Mr. Sickels estimates, I am of opinion can be dispensed with, and thus a saving made in the estimate.

By sinking the shafts alongside of the tunnel line, instead of over it, much of the cost of refilling may be saved. A strong brick arch at the rock surface, sufficing instead of filling the whole shaft, if indeed they are not walled up from the rock, and preserved as means of entrance to the tunnel, and for removal of such stones as might in time fall from its roof.

Considering the great quantity of work in this tunnel, where a small charge on each cubic yard of excavation will cover the extra expense of machinery for hoisting and pumping from the shafts, I am of opinion that the prices named by Mr. Sickels, amounting with the 10 per cent. to $7 70 per cubic yard, with judicious management will suffice to execute it.

The saving in dispensing with the concrete floor and the lining will alone nearly cover the cost of the machinery for hoisting out the material of the excavation.

12. Will you look over Appendix D of Mr. Sickels' Report, and having examined its details, inform us how his prices compare with those which you have paid and expect to pay for similar work in the construction of the Washington and Georgetown water works; say for masonry, whether cut or rubble, (dry, mortared or cemented,) in wet or dry places, excavations in earth and rock, embankments, refillings, puddling, and for iron pipes?

A. Mr. Sickels' estimates were made after mine, and after the extraordinary rise in the price of iron. His prices are as follows, compared with those I adopted, not taking into account the allowance for contingencies, which in his estimate is generally taken at 10 per cent., in mine 20 per cent. upon the prices adopted.

	Estimate of Baltimore Aqueduct.	Estimate of Washington Aqueduct.
Thirty-six-inch iron pipe,	$15 00 per foot,	$15 00 per foot.
Thirty-inch do.	none	9 00
Twenty-inch do.	7 00	5 00
Twelve-inch do.	none	2 20
Excavation about reservoirs,	20 per cub. yd.	20
Dry wall, - - -	3 00 per yard,	3 78 per yard.
Embankment on dams,	20	25
Puddling, - - -	50	40
Rock excavation in tunnel,	7 00 paid 6 50 to	7 50
Concrete, - - -	6 00 estima'd	3 64
Open cut rock excavation, -	1 00 av. est.	1 80
Earth excavation, - -	20	21
Stone, - - - -	6 00 average	6 00
Brick work in conduit per cub. yd.	7 00	6 66

From the above comparison it will appear that I assumed prices rather higher than Mr. Sickels, and took a larger estimate for contingencies.

The banks of the Potomac on the line of the Washington Aqueduct are unhealthy for some months of the year. The work is further from the city, and so much complaint has been made of public work overrunning the estimate, that I determined to assume prices which should be in the opinion of engineers beyond all cavil or suspicion.

They are so; yet they have been attacked severely by those who are not engineers, and the assertion made that the work must cost four or five millions more than the estimate, which was $2,300,000.

I think Mr. Sickels' prices in the neighborhood of Baltimore are fair and just, and that the work with proper superintendence will be executed within them.

13. You are doubtless aware that since the last summer there have been great changes in the prices of labor and iron: would not such

changes materially and favorably effect the cost of a great work, such as that proposed under Mr. Sickels' plan?

A. The fall in prices which has lately taken place, and the present want of employment for laborers, would of course facilitate the construction of any public work, and would tend to reduce its cost materially.

14. Are such matters as tunnelling, (the characteristics of the material being correctly ascertained,) masonry of all descriptions, excavations of rock and earth, embankments, puddling and iron pipes, amongst those things which experienced engineers consider difficult to estimate with correctness?

A. While it is difficult for an unpracticed person, and even an engineer, to say what will be the exact cost of a small piece of work of any kind, as a single cubic yard of masonry, for example, the average cost per cubic yard for large quantities, whether of excavation, embankment, tunnelling, masonry or puddling, is well ascertained by experience. Indeed, upon this knowledge all the contracting upon our extensive railroads, canals, public buildings, &c., is founded. The close agreement often found between the bids of different and competing contractors for public works, shows that those who are skilful are able to estimate with closeness the prices at which they can do the work and make a profit.

15. From your knowledge of the consumption of water in the Northern cities, what do you think should be provided for the daily average consumption of the citizens of Baltimore, per head of its population?

A. Exclusive of all use of water for decorations by means of fountains and jets d'eau, the quantity should not be less than 90 gallons per day for every member of the population, at this date, if the work is only for the present time or one hundred years hence, if the city wisely resolves to build a work to supply the city for that period.

An aqueduct well constructed is the most durable of the works of man. Aqueducts built before the Christian era still continue to supply the city of Rome with water.

If the work be buried beneath the surface, and properly constructed, it can be made secure against nearly all the accidents to which other public works are liable.

I have lately examined a portion of the Croton aqueduct. Wherever it is buried beneath the natural surface it requires no repair; wherever it passes over an embankment annual repairs are needed. A tunnel through gneiss rock in this country, where we are not liable to violent earthquakes, may be considered as enduring as the rocks themselves.

16. Where the course of a stream is for miles through a large city, would it, in your opinion, be advisable to retain in large storing lakes on that stream very great quantities of water?

A. No. The bursting of one of the upper dams would probably destroy those below it, and the accumulated waters of the reservoirs sweeping through a populous city might destroy property to an amount far exceeding the cost of any aqueduct prepared for Baltimore; and, moreover, in such accidents, life is always likely to be sacrificed.

WEDNESDAY, *February 21st*, 1855.

DR. CHARLES A. LEAS, Commissioner of Health, having been requested to appear before the Committee, was asked sundry questions, to which he responded as follows:

Query 1. Have you, in your capacity of Health Commissioner, given much consideration to the matter of the quantity and quality of the water which is afforded to the citizens of Baltimore?

Answer. I have.

2. Whatever is the quantity and quality of the supply which we now have, is it your opinion that we need more and better water?

A. I think there can be but little doubt that the people of Baltimore require a much greater supply than they now have; and certainly a better quality of water would be desirable, if it can be obtained. My reasons for thinking so are as follows:

There are in the city of Baltimore some two hundred thousand inhabitants and about thirty-four thousand houses. For the purposes of an abundant supply, we require at this time not less than *ten* millions of gallons, (10,000,000;) that is to say, six millions four hundred and twenty-six thousand (6,426,000) gallons daily for household or domestic purposes, and three million five hundred and seventy-four thousand (3,574,000) gallons daily for general purposes, making a total of ten millions gallons daily. Under the head of domestic or household purposes is comprehended all the water that is wanted for washing, scrubbing, washing yards, pavement washing, bathing, closet uses, horse and carriage washing, drinking, &c. Under the head of general purposes is comprehended the water used for extinguishing fires, washing the public gutters, (and streets to some extent.) The 6,426,000 gallons here appropriated for domestic purposes will give an average of about one hundred and eighty nine gallons daily for each house in the city, or six barrels, or thirty-two (32) gallons for each inhabitant. And if to the 6,426,000 be added the 3,574,000 gallons appropriated for general purposes, it will give an average of fifty gallons per day for each person. Hence you will see, by the above calculation, we want at *this time*, to constitute a necessary supply, a total of 10,000,000 of gallons daily.

In regard to a better quality of water, I would say, that in my judgment a far superior article can be obtained than that which ema-

nates from Jones' Falls; the water from this stream is the most unfavorable of all the waters spoken of, both for washing and drinking purposes. The Patapsco is the most friendly for washing, but the Gunpowder the best for drinking. In classifying the different streams for those purposes, you may place them as follows:

For Washing purposes.	*For Drinking Purposes.*
No. 1. Patapsco.	No. 1. Gunpowder.
2. Gwynn's Falls.	2. Gwynn's Falls.
3. Gunpowder.	3. Jones' Falls.
4. Jones' Falls.	4. Patapsco.

The above streams are, however, all very good for drinking purposes. Should the Patapsco be selected over Jones' Falls, the people of Baltimore will save about fifty thousand dollars per year in the purchase of soap. Should the Gunpowder be selected, the saving will be about twenty-five or thirty thousand dollars per year in that article, as before remarked, the waters of the Jones' Falls being the most unkindly disposed towards servants in their washing operations.

3. It being admitted by all, that if we continue to rely on Jones' Falls alone for our future supply, large provision must be made for stored water, would the use of such stored water be advisable? Give your reasons for arriving at any conclusion on this head?

A. Stored water would not be objectionable, all things else being favorable. The lakes or reservoirs should be so constructed as to protect the water from contamination by vegetable decomposition. If water is confined for a considerable length of time, it is liable to suffer change by the death and decomposition of its animal and vegetable components. I should say, however, that with the proposed lakes or reservoirs this would not amount to an objection, for the water would not be permitted to remain sufficiently long to produce a decided change. But what are the advantages to be derived by the proposed storage plan? Answer, nothing—from the fact, that when we have the full capacity of Jones' Falls, and that by storage it can only give (by Slade's calculation) 18,000,000 gallons daily, when, as will be seen, we shall want in 1870, 23,000,000, and when stored we have an inferior water.

4. For how many years of future do you think provision should be made, in projecting a future supply?

A. In morals, we are bound not only to look to ourselves, but future generations; but in matters purely physical or financial, if we take care of ourselves and our own generation it is all that can, in my judgment, be demanded of us. But in projecting a measure of this kind, whilst economy and efficiency should be the prime considerations in the principle of self-protection, yet if in taking care of ourselves and generation we can, without additional cost, throw advantages into the future, a principle of common humanity demands it should be done.

By the calculation which I have before made, giving to each inhabitant an average of fifty gallons per day, we shall want, in 1860, for general and household purposes, 13,950,000 gallons daily, or for domestic purposes alone 8,928,000. In 1870, 23,000,000, or for domestic purposes alone 14,720,000. In 1880, 38,000,000, or for domestic purposes alone 24,320,000. Now, it will be perceived, that if we want to furnish a sufficient supply for our own generation we must look beyond Jones' Falls, that stream being only capable of giving, under favorable advantages, but 18,000,000 daily.

Well, it is true, that the Patapsco, by expending $3,300,000, will give 20,000,000 gallons—quite an abundant supply, but then you have an inferior water for drinking purposes. Again, if Gwynn's Falls and Jones' Falls are both taken, at a cost of $3,740,000, they combined, can only give 32,800,000 gallons, not enough to last until 1880, and you have water inferior to both the Patapsco and Gunpowder. But if the Gunpowder is selected, you have a good drinking water, sufficient for the next hundred years, at a cost (by Sickels' air-line) of $1,958,850,* or by commissioners', by pumping, of $3,361,545.† Now for the purposes of accommodation, should it be proved that Sickels is mistaken in his estimated cost, and the commissioners be correct, the advantages to the present generation are in favor of Gunpowder.

5. If Jones' Falls should be adopted as the source of supply, and at any period of time, during a protracted drought, the whole flow of that stream should be diverted from its channel, below the storage reservoir, what would probably be the effect of the diversion on the health of our city?

A. The effect upon the health of the city might be very disastrous, from the fact that the entire bed of the falls within the limits of the city would be exposed; and as there is a vast amount of animal and vegetable offal continually cast therein, the large decomposing surface would favor the elimination of so much miasm as might produce serious mischief. Such a result in very warm weather might be considered a calamity.

6. Should the lake at the Relay House, if that plan were adopted, be drawn down below the combing of the dam, for some weeks, what would become of the filth of all kinds, from men, animals and factories, which, finding its way to the bed of Jones' Falls, is now carried down to the basin by the current? Would it not remain in the depressed places in the bed of the falls?

A. It would.

7. In such a state of things as pointed to in the last query, should the lake be suddenly filled by a heavy rain, which, having filled the

* Exclusive of distribution. † Including distribution.

lake, would pour over the combing of the dam a few thousand or millions of gallons, what would become of the accumulated filth spoken of in the last query? Looking to the condition of the bed of the falls within the city, might not this filth be expected in great part to lodge therein?

A. The accumulated filth would be carried into the basin.

8. You are supposed to have a knowledge of all parts of this city, and the wants of its inhabitants: therefore, in view of the facts that in Boston the revenue from the service of water is yearly, from 160,000 inhabitants, - - - - - - $217,007
New York, - - - - - - 608,966
Philadelphia, - - - - - - 335,000
do you believe that the revenue from the service of a pure and abundant supply of water to the citizens of Baltimore would be sufficient to pay the interest on the cost of its introduction?

A. If we look at this matter outside of its sanatory benefits, and consider it as a financial speculation, and which this last question seems to do, I would say that every thing depends upon the stream that may be selected. There are in the city of Baltimore thirty four thousand (34,000) houses, and if the pipes be so extended throughout the city as to furnish a supply to each house, (and this will be necessary, for the people have decided at the ballot box in favor of an abundant supply, and if this is obtained at a heavy cost to the tax-paying community, no portion of our citizens can with impunity be neglected; besides, if water is worth any thing for sanatory purposes, and that it is most valuable cannot be doubted, then it should have the most extensive circulation possible; and this is a matter of commercial economy, fo it will not be doubted that upon the health of a city mainly depends its commercial prosperity,) and if the water rents were so arranged as to average but eight dollars per year from each house, say five dollars for small houses, and ten or twelve for the larger class, this would give a revenue of two hundred and seventy-two thousand (272,000) dollars; and this is a great reduction on the present water rates, for if a family desires the fullest benefits from the present water board they will charge over twenty dollars per year. It is said, and I believe correctly, that if we secure an abundant supply for domestic purposes, and to spare, that a large revenue can be derived from the superabundance, through the sale of water rights, &c., which is to be added to the two hundred and seventy-two thousand (272,000) dollars; then I argue, that in carrying out this project, if we can secure an abundance for ordinary purposes, with a large surplus to be disposed of for manufacturing uses, without any or much more cost than would be required to furnish simply an abundant supply for household and other sanatory purposes, why, unquestionably, that which will in the end yield the largest revenue should be adopted. For the purpose of demonstrating this view in relation to the various

streams named, and in order to complete the answer to the question, let us take the estimates made by professed engineers, and going upon the presumption that *something* must be done to give us a greater supply than the water works now in use are capable.

Mr. Slade estimates the cost of bringing the Patapsco, by water power and steam, into the city, with her seventeen and a quarter millions (17,250,000) of gallons, at four millions eight hundred and seventy-three thousand, one hundred and ninety four (4,873,194) dollars, the interest of which would be two hundred and ninety-two thousand three hundred and ninety one (198,000) dollars. Mr. Sickels estimates the cost of the same stream, by pumping by water power, at two million three hundred and three thousand seven hundred (2,303,700) dollars, the interest of which would be one hundred and thirty-eight thousand two hundred and twenty two (138,222) dollars.*

Mr. Chiffelle estimates the cost of bringing the Gunpowder to the city, with her forty-one millions of gallons, at three millions three hundred and sixty-one thousand five hundred and forty-five (3,361,545) dollars, the interest of which will be two hundred and one thousand six hundred and ninety-two (201,692) dollars.† Mr. Sickels estimates the cost of the same stream at one million nine hundred and fifty-eight thousand eight hundred and fifty (1,958,850) dollars, the interest of which would be one hundred and fourteen thousand eight hundred and forty-seven (114,847) dollars. It has been estimated that to bring Gwynn's Falls to the city, in connexion with the full capacity of Jones' Falls, say thirty-two millions of gallons, (32,000,000,) will cost three million seven hundred and forty thousand (3,740,000) dollars; the interest of which will be two hundred and twenty-four thousand four hundred (224,400) dollars. And to get the fullest capacity of Jones' Falls, by storage at the Relay House, and taking in Stony Run, with their nineteen millions (19,000,000) gallons, has been estimated by Mr. Slade to cost two millions nine hundred and ninety thousand four hundred and ninety-four (2,990,494) dollars, the interest of which will be one hundred and seventy-nine thousand four hundred and twenty-nine (179,429) dollars. Now suppose it be admitted that Sickels is mistaken in his calculations, and that Slade and Chiffelle be correct, it will be seen that the Patapsco, with her 17,250,000 of gallons, or the Gunpowder, with her 41,000,000 of gallons, can be brought to the city for but a fraction more than it would cost to patch up an inferior stream (Jones' Falls) to secure but nineteen millions of gallons, and which would not be sufficient in 1870 for our domestic or household use alone. My impression, therefore, is, that any stream which would give only a sufficient supply for household or domestic purposes and other sanatory uses, might be made to pay the interest on the outlay; but if the Gunpowder or Patapsco should be brought to the city, a large surplus will remain after paying the interest on the original cost.

*By pumping. †By natural flow.

BALTIMORE, *February 28th*, 1855.

MYNDERT VAN SCHAICK, ESQ.,

SIR:

It is understood that you have been for a long time connected with the Croton water works and the water department: that you was one of the earliest advocates of this great work, the framer of the present code by which its benefits are dispensed, and that you are now for the second time President of the water board.

The following queries refer to the subject of a pure and abundant supply of water to the city of Baltimore:

Query 1. In projecting water works for a large and growing city, with sources whence a supply may be drawn, many, abundant, near, and of great elevation, what, in your opinion, is the least quantity which should be provided daily per head of the population?

2. In contemplating a large expenditure for the introduction of an abundant supply of water, what extent of future should be provided for?

3. From the documents herewith sent, you may see that it is supposed by certain engineers, who have carefully examined and estimated the sources of supply, that there may be introduced and distributed* from:

Jones' Falls, for	-	$2,990,494	19,000,000 gallons.
Patapsco, "	-	3,520,915	16,000,000
Gunpowder, "	-	3,086,065	70,000,000

(the first and third by natural flow—the second by pumping by the power of the stream.) If these estimates of quantity and cost be correct, or nearly so, which, according to your opinion, should be introduced?

4. If, on an examination of the various estimates for the above named streams, it should seem to you that these estimates are not correct—being in any case either too high or too low—what, following your own idea of their cost, would be your opinion about the adoption of a source?

5. From the experience which your connexion with the New York water works has afforded you, taken with your knowledge of results in other great cities of the Union, is it your opinion that the income from the service of an abundant supply of water to this city would be such as to pay the interest on the cost of either of these projects, the rates of charge being reasonable? Give us your views on this subject at length.

6. Having noted, that in the year 1852 (when the above mentioned examination of Jones' Falls was made and the supply of

*I. e., the distribution of the whole flow of Jones' and Patapsco, and of a like quantity of the seventy millions from the Gunpowder.

19,000,000 deduced therefrom,) the lowest observed flow was 14,696,225 gallons, (see Slade's Report, p. 94,) and that in 1854 the lowest observed flow was 5,482,080 gallons, and the average flow of August something over 8,000,000 gallons, (see p. 26 of Sickels' Report,) how do these facts affect your views of the adoption of a source of supply?

7. Is the plan of Mr. Sickels for bringing in the Gunpowder more or less costly than those for the introduction of the Croton to New York and the Cochituate to Boston proved to be, of course in proportion to the length of the conduit?

8. Will you do us the favor to examine the plans and details of Mr. Sickels, and inform us what is your opinion of the sufficiency or insufficiency of his estimates for the Gunpowder plan?

9. In a letter to the chairman of the water committee of the Council, you spoke of Mr. Sickels as having been engaged on the Croton and Boston aqueducts: are you well acquainted with Mr. Sickels, and if you have formed an opinion of his character for ability and integrity, will you give it to this committee?

10. If you have a general idea of the configuration of the ground on which the city of Baltimore is built, you will have perceived that a sewerage system is not needed there, as in Boston and New York: is it your opinion that serious inconvenience will be felt on account of our system of surface drainage, should a full supply of water, say of 60 to 70 wine gallons per head, be afforded to our citizens?

Will you do us the favor to give this committee any additional information in your possession?

By order of the Joint Standing Committee on Water.

ALLEN E. FORRESTER,
Secretary.

CROTON AQUEDUCT BUREAU, *March* 12, 1855.

SIR: I last night took up your papers, and having examined them thoroughly, I came to the conclusion that it would be in my power to furnish you with a general answer, such as it would be safe for unscientific men to give. Accordingly, I came down to the office early this morning, and having explained my views to Mr. Deforest, assistant commissioner, in some detail, his better and more recent acquaintance with minute particulars has enabled him to furnish the accompanying answer to your questions. Having been for nearly six years in this department, and for two years before the chairman of the Joint Croton Aqueduct Committee of the Common Council, his accuracy may, I think, be relied on, and corresponds with my opinions. You can judge whether we have covered sufficient ground for your satisfaction. * * * * * * *

Yours,

M. VAN SCHAICK.

Question 1.—Answer. New York now consumes in use and *waste* not less than 50* gallons for each inhabitant, (estimating those supplied at 600,000.) The actual amount usefully consumed is estimated at 20 gallons for each person, the waste at 30 gallons. We have no doubt that did the supply admit, and a want of care and energy in the administration allow, that the waste would be nearly if not qnite double. A head of from 100 to 268 feet should be sufficient for the extinguishment of fires, but a large deduction, say in our experience about 30 per cent., must be made for friction.

2.—A. The largest supply practicable. Your city will grow rapidly under the advantage of a large and efficient supply of water?

3.—A. The Gunpowder. Water received under the pressure of natural head and flow is superior to that requiring the intervention of machinery, which, however perfect in its action, cannot be maintained except at great expense. I think the *air-line plan* by tunnel is preferable, as are all straight lines in aqueducts, unless attained at too great cost, and that the estimate based on so large a quantity of rock cannot be far wide of the truth.

4.—A. Either of the plans proposed will furnish your city with water at a less cost per thousand gallons than the supply of Croton to New York, and the Gunpowder is by far the best plan, on the basis of cost and quantity. If the estimates of cost and quantity are about correct, it will be unnecessary to search for other sources.

5.—A. Under a general law of like features and application to that now governing the Croton aqueduct department, with like charges for the use of the water, an interest of 6 per cent. on the cost of the work would be almost immediately attained, although this city has not yet reached that point. Croton water has to a great degree made New York what she is, and no tax is paid by her citizens with more satisfaction.

6.—A. Not at all. Having already in previous answers committed myself in favor of the Gunpowder, as not only the cheapest but the best plan of those submitted, I have no opinion to offer on the report of Mr. Slade, except that the quantity will be found insufficient, without greater safeguards on the consumption and waste can be effected in your city than those of New York, Boston or Philadelphia.

7.—A. Mr. Sickels' plan, consisting almost entirely of rock tunnel, is not more costly than the portions of the Croton aqueduct of like construction—a very large proportion of the latter work being in earth cutting, and therefore comparatively cheap.

8.—A. I have no practical knowledge on this point, and can only refer to the general conclusions in answers 7 and 9.

9.—A. Personally, I have no knowledge of Mr. Sickels, but have read the printed certificates furnished by the committee appointing him to the Second Branch of the City Council of Baltimore, and consider them satisfactory in every respect.

*Imperial gallons, equal to 60 wine gallons.

10.—A. A system of sewerage in every city largely supplied with water will be found absolutely necessary to carry off the contents of baths, water closets, urinals, &c., which will then come into the daily and common use of every house supplied with water. The water carried over the surface will be found not only offensive, but will render the streets unhealthy in summer, and dangerous from ice in winter. The only objection which can be made is, that the sewers serve to carry off secretly the enormous quantities of water wasted daily without the cognizance of the officers of the water works.

A copy of the foregoing questions* was also addressed to E. S. CHESBROUGH, Esq., of Boston, (who constructed the Boston Water Works, and now superintends them,) to which the following reply has been received:

BOSTON, *March 26th*, 1855.

WM. S. SHOEMAKER, ESQ.,

Of the Committee of the

City Council of Baltimore on Water.

SIR:

I take it for granted you have preserved a copy of your inquiries of the 14th inst., and shall therefore proceed to answer them in their numerical order, without repeating them here.

Answer to the First.—About 75 wine gallons.

Answer to the Second.—Not less than twenty or twenty-five years, and a longer time would be desirable; but the compound interest on the excess of cost for a supply larger than would be needed for a given term of years, should not exceed the first cost of supplying just the amount required, otherwise there would be unnecessary expenditure.

Answer to the Third.—The Gunpowder.

Answer to the Fourth.—I am unable to form an independent, and to my own mind satisfactory opinion, with regard to the sufficiency of these estimates. I can only say, that I have confidence in the competency of both Mr. Sickels and Mr. Slade to make estimates of the probable cost of such works, because I know them, and know the opportunities they have had of qualifying themselves.

In view of the past and the prospective growth of your city, I should not change my preference for the Gunpowder, if the estimated cost of introducing water from it was $1,000,000 higher, and should hesitate to abandon it if it was $2,000,000 greater.

Answer to the Fifth.—The maximum gross revenue from such a source, for domestic and manufacturing purposes, should not be estimated at over $1 per annum for each and every inhabitant of the city

* See pages 38 and 39.

supplied. Boston is the only city on our Atlantic coast whose water revenue exceeds this standard. New York and Philadelphia fall short of it, and so does Cincinnati. London in 1848 came very near it. But no one city is in this respect a certain criterion for another. The gross income of Baltimore might not be more than 75 cents for each inhabitant, and the net income probably not more than 65 cents. At this rate, and with a population of 280,000, which you expect to have in 1860, your net income would be $182,000, or about 6 per cent. on the estimated cost of the works. The probability is, that the cost of the necessary amount of pipes to supply so large a population would be greater than has been allowed for in the estimates, which I suppose is for the city as at present improved. As an offset, you would no doubt have some revenue from the sale of water for motive power.

Nothing is more difficult than to estimate with certainty the income to be derived from the establishment of water works in a large city. The number, habits and business pursuits of the people, and the existing facilities for procuring wholesome well and rain water, are all essential elements in the calculation. These differ in different cities, in different districts of the same city, and at different periods in the same district.

Answer to the Sixth.—They would make my opinion more decidedly in favor of the Gunpowder.

Answer to the Seventh.—Taking Mr. Sickels' estimate of the "air-line route," page 24 of his report, as the basis, and leaving out the item of $173,000 for mains to the city, and calling the whole length from the dam to the commencement of the pipe about 8 miles, and the estimated cost $1,785,850, the cost per mile would be $223,000.

By reference to Schramke's description of the Croton aqueduct, I make the corresponding portion of that work cost less than $212,000 per mile. The corresponding portion of the Boston water works cost about $120,000 per mile. It should be remembered that this comparison includes the cost of dams, reservoirs and water rights at each end.

Answer to the Eighth.—My answer to this must be substantially the same that it is to the fourth inquiry. As an illustration of my difficulty, take the item of rock excavation on Mr. Sickels' conduit sections. He allows $1 a yard as an average for the whole. If the excavations are dry and shallow, and the rock loose or rotten, 50 cents a yard would be a liberal price; but if the excavations are deep, wet, and in compact rock, $2 a yard might not be sufficient. The same difficulty applies to earth excavations, and similar ones to other items in the estimates. With regard to the price allowed for tunnel excavation, I feel in still greater doubt. With all the light that scientific geologists and experienced contractors can throw upon such a subject, much uncertainty must remain. Seven dollars a cubic yard may be a very liberal allowance; my own experience and observation would lead me to say that such a tunnel, with a proposed sectional

area of 74 square feet, might cost more. How much, I am not prepared to say. The geologist can ascertain by examining the surface of a region, together with such natural or artificial indentations as he may find, the chemical and mineralogical constituents of the different strata, and their dip and clearage, if they have any, together with their general character for hardness or softness, and can thus throw great and important light on such a question as that now before you. He cannot, however, reveal the character and frequency of the seams, the quantity of water, and the number and thickness of quartz veins and trap dykes, which latter, my own experience teaches me, frequently occur less than 100 feet below, where no indication of them is seen on the surface. These are circumstances that have great influence upon the cost of such work, and can only be certainly known by actual development.

Answer to the Ninth.—Mr. Sickels was first employed on the Boston water works as an assistant to the resident engineer of the first division. His readiness in professional matters, and his industrious application to business, soon attracted my attention, and on the resignation of the resident engineer he was, with the consent of the water commissioners, put in charge of the division. He continued in charge of it till it was completed, and gave evidence of unusual ability in overcoming some of the great difficulties encountered on that portion of the work. He retained my confidence in his character to the last. The occasional interviews I have had with him since have impressed me favorably.

Answer to the Tenth.—I have "a general idea of the configuration of the ground on which the city of Baltimore is built," and it is my opinion that if a system of sewerage is not to be adopted there, the increased flow of water in the gutters that would take place if the Gunpowder was introduced into the city would add to its health and cleanliness. It might, and probably would be an inconvenience in some streets, by forming ice in cold weather. This, however, would furnish palpable evidence of unnecessary waste, and lead to its prevention.

Answer to the Eleventh.—Having sent you copies of our most important documents, I do not think of much other information that it would be necessary to send you now.

My answer to the fifth inquiry was confined strictly to the question as put. In addition to the actual revenue received by a city into the treasury from an abundant water supply, there are other very important advantages which should not be overlooked—such as the supply of its own public buildings and fountains, the diminished expense of extinguishing fires, and the reduced rates of insurance which generally follow; but no doubt you have already considered these and others that might be mentioned.

Respectfully submitted,

E. S. CHESBROUGH,
Engineer Boston Water Works.

NATHAN HALE, Esq., of Boston, being interrogated in the same manner as Mr. Chesbrough, replied as follows:

BOSTON, *March* 27, 1855.

WM. S. SHOEMAKER, ESQ.,

DEAR SIR:

I regret that the pressure of my avocations has prevented my giving so immediate a reply to the questions on which you have requested my judgment as I could have desired, and that I have not been able to give them that uninterrupted attention and deliberate consideration which, from the rather complicated nature of some of the questions, would justify me in giving a very confident reply. I must beg you to accept a rather tardy reply, and the best which, under the circumstances, I find myself able to give.

1. In regard to the quantity of water per head for each inhabitant which would be an adequate supply for a city, it is a question to which it is difficult to give a satisfactory answer, because it must depend upon the particular circumstances of each case, such as the usages of the inhabitants in regard to water closets, baths and other uses for water, the extent of demand for manufacturing purposes, the fact whether each house is provided with an underground drain for carrying off waste water, the nature of the regulations for guarding against waste, &c. If every family could be made to pay for the water in proportion to the quantity drawn by them, by means of a water meter, or could be prohibited from waste by some stringent system of regulations, I should think a supply not far exceeding an average of 30 wine gallons per head of the population would be sufficient for all domestic uses, together with the demand for ordinary manufacturing purposes, on a small scale, but not including a supply for water power, or a continued flow in winter to prevent the freezing up of the pipe. The consumption of the city of Boston has increased from the ratio of 30 gallons per day in 1849 to over 60 gallons in 1854, there being no effectual security against waste. Such a security, however, I conceive, may be provided, which will have the effect of greatly limiting the consumption per head, whenever a limitation shall become necessary.

2. What extent of provision should be made for a prospective demand for future use, beyond the amount required at the present time?

This must depend mainly on the increased cost involved in the additional supply, compared with the estimated cost of an equal supply if provided by additional works at a future day, taking into the estimate the interest on the increased expenditure up to the date when the increased amount may be presumed necessary. An allowance may also be reasonably made for the benefit of the assurance thus obtained of an ample competency for all present wants. It would be

proper to consider, also, on the other hand, the liability of an over present supply to lead to waste and to an habitual extravagant use of water, which it might be difficult to restrict at a future day. A specific decision of the question, I think, must necessarily depend upon the comparative cost at which it is found that a supply on a larger or smaller scale can be obtained, taking care to select that which may be the most sure and economical for the uses to which it may be made available.

3. As to the comparative merits of the three sources referred to in question third, I should not hesitate to discard the Jones' Falls source as insufficient to allow an unfailing supply. This fact might be with some confidence inferred from the shortness of the stream; and the inference is sufficiently confirmed by the gauging of it by Mr. Slade in 1852, which was not a dry year; and this impression is more fully confirmed by the gauging by Mr. Sickels in the dry year 1854, when the estimated flow fell off for an entire month to about half the proposed average daily supply, it being one of the months when the ordinary consumption is greatest.

As to the comparison between the Patapsco and the Gunpowder rivers, there appears to me strong reasons for preferring the latter. The evidence of the sufficiency of the Patapsco, for the double purpose of supply and of affording power for so large a pumping service as is proposed, does not appear to be satisfactory. It rests, so far as I observe, upon estimates of the daily flow, based on measurements taken in November and early in December, 1852, it being a very wet month, and on five days only in August, 1854. It appears to be a river suddenly affected by rains, and one in which the water rapidly subsides during a continued absence of rain. From these few measurements of the flow, limited to short periods, it seems questionable whether a continued supply can be relied on sufficient for the uses of the city to the amount of 16,000,000 gallons per day, and for the estimated service of pumping. To insure this average through the year, the supply should be considerably larger in the months in which the chances of failures would be the greatest.

The estimated capital to cover the expenses of so large an amount of property, together with the cost of such machinery as will be demanded, in the supposed cases of the minimum flow of the river, appears to me small, both in the estimate for the Patapsco and the Gunpowder. On this point, however, I speak with some hesitation, as I am not sure that I am possessed of all the data for a satisfactory estimate. But, considering the pressure on the wheel, and the weight of the lift of water to so great a height, with the friction of so rapid a flow as will be required, through so long a pipe, requiring machinery of great strength, together with the necessity of duplicate works to guard against occasional failure, I should be disposed to take a larger allowance. Yet I have no doubt Mr. Sickels is much better acquaint-

ed with the safe principles of computation than I am, and it is very likely that his estimate may be entitled to full reliance;—I therefore mention this only as presenting a possible contingency of a heavier cost.

The sufficiency of the supply afforded by the Gunpowder river, appears to have been somewhat more satisfactorily tested than that of the Patapsco, by the measurements of 1852 and 1854, yet it would have been more reliable had there been evidence of a similar character, founded on a longer period of observation, and on the state of the river in dry seasons in years back. This consideration, with others of a more decisive character, leads me to the opinion that the other proposed mode of supply, from the Gunpowder river, by means of a tunnel, on such a level as will obviate the necessity of pumping altogether, is decidedly preferable. These reasons are:—the permanent character of the works required, and their exemption almost, from the possibility of failure, as well as from a great part of the cost of annual maintenance and superintendence; and finally, the more abundant supply of water thereby obtained, the surplus of which, beyond the immediate demand for domestic purposes, cannot fail to be of great value. I may add also, that although the cost of tunnelling must be a very uncertain item, and in any event a very heavy one, this mode of obtaining the water, may prove the cheapest. This however, I conceive must be somewhat uncertain until the actual experiment is made.

The estimate of Mr. Sickels is founded on the supposition that the rock to be tunnelled will not prove to be of excessive hardness—that it will be of a character for the most part, to render a lining of masonry unnecessary—and that no great quantity of water will be encountered in the shafts or tunnel. This is perhaps, the most probable supposition; but it cannot be safely assumed with confidence. My observation of many works of this description, has led me to the belief that one cannot be fully assured against the encountering of either or all these obstacles, by a judgment founded upon the mere external appearance of the rock to be perforated, and especially of the outcropping portions of it, where it is covered with earth. The most striking instance of this, was in the two tunnels of the Boston water works, which an experienced contractor, after a careful examination, undertook to execute at 5 and $6 per cubic yard, and in the belief that the rock would be uniformly of similar character to that which appeared on the surface, and which could be excavated in open cutting at $1; and that there would be little water. The rock proved to be in great part, of excessive hardness, and springs were opened so copious, that seven steam engines were required in that number of shafts with a length of tunnel of 3,500 feet, and the actual cost of execution amounted to over $15 per cubic yard, which was the exact amount which another experienced contractor had offered to take the

contract at. The tunnel, however, besides encountering the obstacles above mentioned, was of smaller dimensions than that proposed on your works, and the excavation was consequently more dilatory and expensive for that reason. The most serious impediment to be apprehended on the Gunpowder tunnel is, perhaps, large quantities of water, and next to this, falls of rock with portions which will disintegrate on exposure to the atmosphere, so as to require arching—and lastly, occasional layers of trap on other extremely hard rock, possibly of considerable extent. Yet with all these hazards, the air line tunnel described in Mr. Sickels' report, appears to me, from the evidence contained in the reports which you have sent me, entitled to the preference as probably capable of being executed in a durable manner, at the least cost, and at any rate possessing the advantage of being of much greater capacity. In considering the question of cost, I give great weight to the uncertainty in regard to the amount of pumping; the uncertain cost of lifting so great quantities of water to so great height; the extent and depth of reservoirs required, and the heavy pressure which must come upon parts of the dams and banks, and consequently the costly character of this portion of the works, together with the heavy claims likely to be made for land damages. These afford a partial counterbalance at least to those which must be encountered in the tunnel plan.

Question 4th is answered in the foregoing.

5th. The question of the probability that the supply of water proposed for the use of the city, will afford an income sufficient to cover the interest on the cost of the works, is perhaps sufficiently answered above. I understand it to be a part of the proposed plan, to purchase the works of the existing water company. This appears to me an equitable and expedient measure, provided the purchase can be made at a reasonable rate. It is quite desirable that the city should have no competition in the supply, and that the rates should be so assessed that every citizen may feel that he is placed on an equal footing with his neighbors, with no other discrimination than one in favor of the poorer class of housekeepers, which I conceive it would be just and expedient to make. If a large surplus is introduced, applicable to manufacturing purposes, great care should be taken that this abundance shall not be made a pretext for putting the rates for ordinary uses so low that they will not afford a sufficient revenue to cover the interest of the cost, reserving the surplus as a sinking fund to extinguish the debt. This surplus may doubtless be disposed of for manufacturing purposes, at a rate which will afford an important accession to the revenue. This should be done by a regular tariff, common to all classes who may require it for such uses—this appropriation of it not to be suffered to interfere with the primary design of an ample supply for domestic purposes, subject only to restriction against waste.

The 6th question is answered above.

7th. The cost per mile of introducing the water of the Gunpowder river by Mr. Sickels' air line tunnel, will be considerably above the average cost of the aqueduct and tunnel of the Boston water works. Our heaviest item of cost was the distribution. This, including the three city reservoirs and the two mains of 36 and 30 inches diameter, for bringing the water five miles from the Brookline reservoir, amounted to $2,550,000. The cost of the aqueduct, tunnel and Brookline reservoir, measuring together fifteen miles in length, was $1,229,375, making an average of about $82,000 a mile. This includes $74, 500 for bridges, culverts, waste weirs, &c., and $197,777 for the Brookline reservoir, with the land and the gate house. If we add the further expenditure of $236,000 for land and land damages along the line, it swells the average cost of the aqueduct and its appurtenances to $97,000 per mile. The only remaining item of heavy cost, consists of the water rights, which, including the dam, and other works at the lake, amounted to about $300,000. The items which most exceeded the anticipated cost, were the tunnels, the land damages, and the reservoirs.

In regard to your question relative to the effect of so liberal a use of water, as 60 or 70 gallons a head per day, with only surface drains, I am not competent to judge. My impression is, that it may in many instances produce inconvenience. But on the other hand, it would afford more ready means of detecting waste, and of enforcing the regulations restricting water takers within the prescribed limits. This would be a great advantage; for it is obvious that the increased average consumption, in this city, arises not so much from a general increased use, as from occasional and very frequent gross waste, by the leaving of taps running wantonly or unnecessarily, especially in cold weather, to save the trouble of shutting off, to prevent the freezing up of the pipe.

I take pleasure in bearing testimony to the eminent ability and efficiency of your engineer, Mr. Sickels, as proved by his services while resident engineer on one of the divisions of the Boston water works, in 1847 and 1848, and to the great confidence which I should have in his skill and fidelity, and in the accuracy of his estimates upon the works which you have under consideration.

Preliminary estimates of the cost of works of this nature, necessarily involve to some extent, elements of computation, which are in part conjectural,—depending on physical and other facts, which cannot be fully ascertained by examination, or determined by measurement and mathematical computation, or by the rules of calculation, based on long experience. For this reason, the estimates of different persons necessarily differ, and all must be subject to some degree of uncertainty. Facts on which depend the amount of work to be done, the price of labor, and other elements in the cost of work, may be hidden either under the earth, or under the veil of futurity; and

until these are disclosed, it is impossible to determine with precision what the cost of a great work of this nature will be. Under this uncertainty, it behooves us to be on our guard against the natural disposition to be too sanguine in anticipating favorable contingencies.

Very respectfully,
Your obedient servant,
NATHAN HALE.

T. E. SICKELS, Esq., the author of a communication to the Council, dated September 9th, 1854, was requested to appear before the Committee with a view of eliciting from him further information relative to a supply of water for the city. The questions propounded to him, and the responses thereto, are as follows:

Question 1st. What is your profession or calling?
Answer. A civil engineer.
2nd. Has hydraulic engineering engaged much of your attention?
A. It has.
3d. Will you mention the works of that character on which you have been engaged, with your period of engagement on each?
A. I was engaged upon the Croton water works three years; upon the Boston water works, two years and nine months; upon the U. S. dry dock at Brooklyn Navy Yard, two years; and upon the Erie canal enlargement, for the six months previous to the suspension of that work.
4th. We have before us a report presented by you to the Council on Sept. 11th, 1854. Would you modify, alter, or strike out any material part of that report, now that you have had more time for reflection upon its various parts?
A. I would not make any *material* alteration in it. The idea of an air line tunnel did not occur until a few weeks before that report was written, and until all other surveys had been nearly completed. An engineer corps was re-organized, and surveys prosecuted upon the air line route with all practicable dispatch, to enable the report to be presented to the Council by the time appointed to receive it. It is quite probable, therefore, that more extended surveys would have resulted in some modification of the line of the tunnel in the detailed plans, and more especially in the location of the dam. A very favorable location of this work may be had near Opossum Hollow, by the adoption of which, although the length of tunnel would be increased, yet a saving would result in land damages, in the cost of the dam, and from the diminished height of the latter, there would be less liability of its being carried away by floods.

5th. Have you reason to believe that the drought of last summer extended into the autumn and winter to a period later than the date of your report?

A. I know by observation, that the drought extended through the fall and into the winter.

6th. What effect did this fact have on any modification of your views?

A. It rendered still more obvious the superiority of the Gunpowder to all other streams, or combination of streams, in the vicinity of Baltimore, for the supply of water to that city.

7th. During the period of your engagement by the city last summer, did you not visit the northern cities for the purpose of conferring with the superintendents of their water works?

A. I did.

8th. What did you learn about the consumption of water? Its use and its abuse, so called, and the means employed to prevent its abuse, and the result.

A. I learned that the average consumption of water for each individual was increasing,—arising in part from its application to new uses, and in part from its wasteful use or abuse, so called; that vigorous measures, by the imposition of fines and other penalties, had been adopted to restrict such wasteful use, but that even these had been ineffectual to any considerable extent.

9th. What, therefore, is now the opinion that you entertain on this head?

A. I am satisfied that in providing a supply of water to a city, the only judicious plan, is to adopt the system that affords the largest quantity, having reference, of course, to reasonable expense.

10th. Have you well considered the subject of the storage of water; and if so, what conclusions have you come to on that head?

A. I have considered the subject carefully, and am of opinion that the system is objectionable, and should only be resorted to in the absence of opportunities to obtain water in sufficient quantity by other means.

11th. On page 27 of your report of Sept. 11th, you declare that "Regarding this stream (referring to Jones' falls) as insufficient, &c. &c., you deemed it unnecessary "to present estimates of the cost of its introduction." Will you favor us with some further details of your reasons for this?

A. An examination of the water courses in the vicinity of Baltimore, was conclusive to my mind that the proper method of supplying that city was by natural flow,—to avail of which from Jones' falls, would require the location of the dam near the Relay House. A line of conduit thence to the city limits, it was apparent, would prove of an expensive character,—not less expensive probably than for the same distance on the route from other streams of vastly greater

capacity. Considering this circumstance, in connexion with the fact of the extremely small flow of the stream, compelling thereby a resort to the system of storage to obtain even a very moderate supply, I regarded it a waste of time to enter fully into details relative to any particular manner of introducing water from this stream.

12th. Since, according to the views of the former board of commissioners, at 60 gallons per day per head, in 1858, there will be needed

In 1860—279,000	inhabitants	requiring	16,740,000 gallons.
1865—370,000	"		22,200,000 "
1870—460,000	"		27,660,000 "
1880—760,000	"		40,660,000 "

Why have you in estimating for Gunpowder by natural flow, estimated for so large a flow as 70,000,000 gallons?

A. The examination I have made with reference generally to a supply of water to large cities, and consideration of the various uses to which it might advantageously be applied, have convinced me that the rate of consumption of water per head will continue to increase for many years in all the cities where facilities for its use are presented. I believe that if the entire flow of the Gunpowder should be introduced, in less than ten years thereafter all the water would be used for sanatory, domestic and other important purposes.

13th. What are the other important purposes to which you refer, and would they, in your opinion, prove a source of revenue to the city?

A. Any surplus amount of water delivered in Baltimore under a large head, would be availed of as a power in place of steam, provided the cost did not exceed that of steam power. Water pressure engines, yielding the same power as steam engines, cost much less,—are more reliable in their operations—require less superintendence—involve less risk of accident—occupy less space, and afford the greatest security against fire.

They have been used to the extent that facilities have been offered, and wherever operated, are held in the highest favor.

The superiority of localities for manufacturing purposes, depends chiefly upon facility of export and economy of power. To them may be attributed the position which Philadelphia maintains as a great manufacturing city.

The introduction of the entire flow of the Gunpowder into the city of Baltimore, would reduce the cost of power to much less than that of Philadelphia, while yielding a revenue ample to meet the interest on the cost of all required works.

Assuming a flow of 140,000,000 gallons daily, which there can be no doubt but that the Gunpowder will yield, and deducting 50,000,000 gallons for other than power purposes there would then be 90,000,000 of gallons delivered daily, at an elevation of 168 feet above tide.

This power would be availed of principally at points approaching tide level; but deducting 20 per cent. of a full effect for all causes, as friction in pipes, &c. there would then result 90,000,000 gallons falling 134 feet in height every 24 hours, as the nett applicable power.

Computing this power as the horse power is generally considered, being 33,000 pounds raised one foot in height per minute, there would be 90,000,000 gallons multiplied by $8\frac{1}{3}$ pounds, (the weight of a gallon of water,) multiplied by 134 feet, the result divided by 1440, (being the number of minutes in 24 hours,) and again divided by 33,000 as follows:

$$\frac{90{,}000{,}000 \bowtie 8\frac{1}{3} \bowtie 134}{1440 \bowtie 33{,}000} = 2115 \text{ horse power.}$$

Experience has shewn that the production of one horse power requires the consumption of ten pounds of best Cumberland coal per hour, or of 240 pounds for 24 hours.

For power purposes, therefore, the 90 millions of gallons of water are equivalent to 2115 multiplied by 240, or 507,600 pounds of coal, equal to 226 tons daily, and at $5 per ton, amounting to $1,130, or to $339,000 per annum of 300 days.

Should the water be furnished at rates to reduce the cost of power therefrom, to that of *merely the cost of fuel* for steam power, there would result to the city an annual revenue equal to the interest of $5,650,000, a sum exceeding any possible cost of all work for the introduction of the Gunpowder, including distributing mains and extensive sewerage.

In Boston, the Cochituate water is sold for power purposes at the rate of one cent per hundred gallons, but owing to the insufficiency of the supply to that city, the amount of water so used, is restricted to a very small quantity.

In London, large quantities of water is used for pressure engines, the rates charged being two cents per thousand gallons. If the surplus water of the Gunpowder should be sold at this rate, there would result to the city a nett revenue therefrom of $657,000 annually, being the interest of upwards of ten millions of dollars; if sold at the price charged in Boston, the annual revenue would be $3,385,000, being the interest on upwards of fifty millions of dollars.

The aggregate power of the stationary engines now in operation in this city, is well known to be 5,000 horse power, an amount twice as great as the power to be afforded by the surplus of the Gunpowder. If the advantages of water pressure engines over steam engines, were combined with greater economy in their operation, they would be, to a considerable extent, substituted for steam engines, and the construction of new manufacturing establishments, would also be largely promoted.

Having arrived at the carefully matured opinion, I state with great confidence, my belief that the introduction of 140,000,000 gallons of water would result in an annual revenue, from the sale of surplus water for power purposes alone, greater than the interest of the entire cost of all required works, so that for domestic use the water might be supplied to the citizens free of cost or taxation; and, moreover, that the adoption of this scheme, while providing for present necessities, would also contribute an element of prosperity and advancement to this city, greater than could be afforded from the expenditure of a like amount of money in any other manner.

Q. You are aware doubtless, that your estimates have been questioned on the score of sufficiency; have you, since the report from you was handed in, made inquiries relative to the cost of work similar to what you have recommended, and if so, to what result?

A. I have availed myself of frequent opportunities since then, on meeting with experienced engineers and contractors, to learn the cost of works of nearly corresponding character, and in every instance have had confirmation that my estimates are adequate.

Q. In your appendix is an offer from Carr & Smith to do the tunneling at $7 per cubic yard; how did it happen that this proposal was made?

A. Although well satisfied of the probable cost of the works upon the plan recommended, I deemed it judicious to invite an examination of the line of tunnel and a proposal for executing the work, by some contractor of large experience and well established character. From the number and extent of the tunnels on the Baltimore and Ohio rail road, I concluded that an experienced contractor from that road, would be a desirable person for the purpose, and accordingly asked the officers of that company to give me the name of some proper person to whom I might apply. The President, Chief Engineer, and two of the Directors of that company, united in designating Mr. Roseby Carr, as a gentleman eminently adapted to make the proposed examination and estimate, Mr. Carr having been engaged for a long period of years upon that road, and having established a reputation for strict integrity and excellent judgment in the prosecution, more particularly, of the great Kingwood tunnel. Inquiries made elsewhere, and in various quarters, having resulted in a recommendation of the same gentleman, I felt assured that the opinion of Mr. Carr was entitled to be regarded as that of one of the best qualified tunnel contractors in this country. Being personally unacquainted with Mr. Carr, I made known my wishes to a friend of his, who soon afterwards introduced me to that gentleman. Although then engaged in the excavation of a tunnel upon the North-Western rail road, which required his entire attention, Mr. Carr kindly consented to make the examination and

estimate for the air-line tunnel, together with Mr. Smith, with whom he had associated himself.

The letter from these gentlemen, published in Appendix D, of my Report, is an offer to contract for the excavation of the tunnel, at $7 per cubic yard, which price, although somewhat in excess of the price I had considered adequate, was adopted in the estimate.

Soon after the presentation of my report to the Council, I was informed that parties interested in another stream as the source of supply, had stated that Mr. Carr misapprehended the exact nature of the work for which he had proposed, and had expressed himself to this effect. To remove all doubt on this subject, I despatched a messenger to Mr. Carr's work, 250 miles distant, with whom Messrs. Carr & Smith promptly returned to Baltimore. These gentlemen not only disclaimed any misapprehension on the subject of their proposal, as contained in my report, but submitted a proposition for the construction *of all work for the air-line tunnel project*, including the dam, reservoirs, &c., which is as follows:—

Baltimore, October 5th, 1854.

Mr. T. E. Sickels, *Engineer*,

Sir:

After careful examination of the route of your proposed line of works from the Great Falls of the Gunpowder, and of your report relative thereto, we hereby propose to do all the work, and furnish all the materials necessary for the entire completion of the plan for the introduction of seventy millions of gallons of water daily from the Gunpowder, at the prices you have estimated, and to execute the same in a faithful manner and according to your specifications.

We are prepared to enter into contract which shall specifically set forth the terms and conditions, at any time before the first day of January next, and will give any amount of security that may be desired for its faithful performance on our part.

Roseby Carr,
William Smith.

The circumstances connected with Mr. Carr's proposals, are stated with some particularity, in consequence of efforts which have been made to destroy confidence in their reliability.

T. E. Sickels, *Civil Engineer*.

The following answers were received from E. S. Chesbrough, Esq,, in reply to questions propounded to him relative to the supply of water furnished the city of Boston:

Question 1. What was the greatest consumption of water in Boston in any one day, week and month of 1854, respectively?

Answer. The consumption cannot be stated for any day or week, because the quantity consumed is measured as it flows through the brick conduit into the Brookline reservoir, ; and as the flow has been irregular, (the water having been drawn off from parts of the conduit, sometimes for two or three days in a week, for repairs,) the quantity has only been measured for each *month* by itself. The greatest monthly consumption was in June, and amounted to 11,745,200 wine gallons a day, or 352,356,000 for the month.

2. What was the average greatest consumption in any three months?

A. The consumption in June, July and August, 1854, was 992,258,000 wine gallons, or 10,785,400 a day, on an average.

3. What was the average of the year?

A. 9,901,800 wine gallons a day.

4. What was the total amount of receipts from the service of water for 1854, and to how many inhabitants was it supplied?

A. The receipts for water service were $217,007 51. The number of *water takers* was 19,193. The whole population of Boston, (about 160,000,) with inconsiderable exceptions, is supplied from the Cochituate water works; and water is also supplied to the shipping.

5. What was the gross income of the year?

A. It varied little from the amount just above given. A few thousand dollars are received for services (shutting off and letting on water, &c.,) which cost as much as is paid in for them.

6. What is the least quantity per head which it would be wise to provide for, supposing the sources of supply to be many, abundant, and near?

A. It is difficult to answer, without going at length into various things which aid in forming a judgment on this point; but it is thought that 75 wine gallons per head per day may be safely taken as the minimum quantity.

The same queries propounded to Mr. CHESBROUGH, were also addressed to A. W. CRAVEN, Esq., chief engineer of the Croton water works, and the following reply was received relative to the supply of water furnished the city of New York:

CROTON AQUEDUCT DEPARTMENT,
ENGINEER'S OFFICE, *New York, Jan.* 27, 1855.

SIR:—I reply hurriedly to your questions received by note this morning.

1st. My estimate of the quantity of water which passes through our city per day, would give an average of 50 imperial gallons (at

the present time) for each inhabitant,—be it adult or infant. This is the average for the year. During the hottest days in summer, and the coldest days in winter, there is more used, (or *wasted,*) as we find by the diminished depth of water in the reservoirs; but how much more, we have never measured with sufficient accuracy to justify any *positive* assertion in regard to it.

In answer to your second question, I would say that in constructing new works for any city, "with *abundant supply* of water *within available reach,*" I would endeavor to provide at least 50 gallons per day for each present inhabitant, and would make my aqueduct large enough to meet the prospective growth of the city at an equal rate. This quantity is more than would be used for domestic purposes, but it would afford water enough for manufacturing purposes and shipping, and for that waste which, without police regulations of extraordinary efficiency, cannot be controlled.

I am very respectfully,

Your obedient servant,

A. W. CRAVEN, *Civil Engineer.*

FREDERICK GRAFF, Esq., chief engineer of the Philadelphia water department, was interrogated in reference to the supply of water furnished that city. He replied that "the consumption of water increased every year; that the amount per head for each person was from 30 to 40 gallons per day."

"I should think," writes MR. GRAFF, "60 to 80 gallons a sufficient allowance for each person per day. The receipts from all our works last year were about $310,000,—will be this year, I think, $335,000."