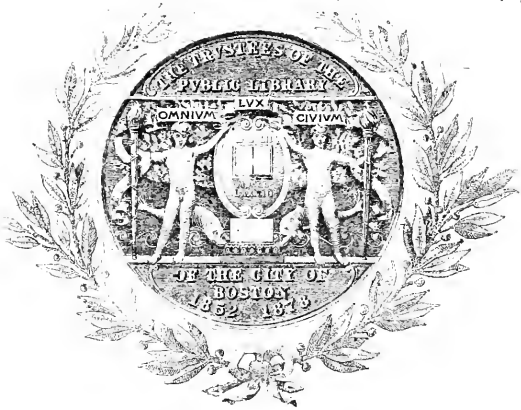
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MR. WILKINS'S

FURTHER REMARKS

ON

SUPPLYING THE CITY OF BOSTON

WITH

PURE WATER.

FURTHER REMARKS

ON

SUPPLYING THE CITY OF BOSTON

WITH

PURE WATER:

IN ANSWER MAINLY TO

INQUIRY INTO THE BEST MODE OF SUPPLYING THE CITY OF BOSTON WITH WATER FOR DOMESTIC PURPOSES, ETC.

BY JOHN H. WILKINS.

BOSTON:
CHARLES C. LITTLE AND JAMES BROWN.
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FURTHER REMARKS.

Some months ago I published a pamphlet entitled *Remarks on Supplying the City of Boston with Pure Water*, which was distributed to a great extent through the city. The views therein expressed were received with much more favor than I had reason, under the circumstances, to anticipate; and as I believe them to be still important, I now propose to review the several positions therein taken. In doing so, I shall of course have occasion to notice the objections which have been made to them; and especially those made by Mr. Hale, in his *Inquiry into the best mode of supplying the City of Boston with water*, &c. I may truly acknowledge that the appearance of this last pamphlet is the occasion which calls me again before the public; but in the following pages I shall by no means limit myself to the consideration of the objections therein made. I trust the author will excuse me for using his name for the sake of brevity; as he must be sensible that the disguise assumed on the title-page is too transparent to serve any valuable purpose.

In my former Remarks, I stated that I had endeavored to look at "facts and to form opinions for myself" on this subject of water; and that inquiring into the subject in this spirit, I had come "to some definite conclusions, not altogether in accordanee with the opinions of the commissioners." Of course it was to be supposed that Mr. Hale and myself would differ in our opinions. I certainly had no expectation of bringing him to the approval of my views; and I apprehend he did not expect me to be satisfied with his answer to them. My end I hope is, (and certainly his should be) to impart information to our fellow-citizens, so that they may form a correct judgment on this most difficult subject; so that the public mind may settle down in the approval and acceptance of that system of supply, which shall combine the best water and the greatest quantity with the greatest economy. In doing this, I shall endeavor to meet Mr. Hale's statements fairly, and qualify them, so far as they ought to be quali-

fied, by other authentic statements either from *himself* or others; and if he should deem it of importance to notice these FURTHER REMARKS, I hope he will have the same end in view.

In my Remarks I stated that I was *inclined* to favor the plan "*to distribute the water*, FOR DOMESTIC PURPOSES, *free from charge.*" From this doctrine Mr. Hale "feels bound to dissent;" and gives some reasons which appear to have much more weight with him than they do with me. As this is still a matter of no public interest at present, I beg to refer the reader, who is desirous of seeing what my views are, to note A, at the end of this pamphlet, where he will find the substance of two communications published in the *Courier*, September 24 and 25, 1844. I will notice this point no further at present than to say, that I am not tenacious of this plan; I entertain no particular desire to have it meet with public favor. And yet *I should exceedingly regret to have the city accept any act, or so commit itself in any manner, that it shall find itself restricted hereafter from the full and free control of the water when it is brought into the city.* The distribution, and the terms of distribution, should, I think, be always in the hands of the City government, to be affected through the ballot-box, like all other municipal interests.

Disposing in this manner of a question somewhat incidental, I propose to handle the matter again in the same order I did before. This is different somewhat from that adopted by Mr. Hale; but I can better examine and meet his views, by bringing them into connection with mine in the order I have adopted, than to follow him.

The three propositions which I undertook to maintain in my REMARKS were,

1*st.* *The water of Charles River is better than that of Long Pond.*

2*d.* *It is vastly more abundant.*

3*d.* *It can be introduced into the City at greatly less expense.*

And to the reconsideration of these several propositions I propose mainly to limit myself now. I shall notice some other matters at the close.

Preliminary, however, to a consideration of the first point, I propose to consider the adventitious causes of impurity in Charles River, which form the staple of Dr. Channing's pamphlet, and which Mr. Hale dilates upon with apparently great satisfaction.

In the first place, I wish to call the attention of the reader to the striking difference, noticeable in the tone and manner of treating this point, by Mr. Hale in 1837 and in 1845. In 1837 (Report, p. 15) he says, "The opinion has been often expressed that the Charles is rendered very impure by filth from the various mills upon its course. The amount of this is exceedingly minute when diffused through the

river. We are of opinion, therefore, that this ought not to be taken as seriously affecting the quality of the water of Charles River." And in page 62, in answer to objections of Mr. Baldwin to Mystic Pond on account of mills on the stream flowing into it, the Report says, "With regard to the influence of mills in rendering waters impure, we have already expressed our opinion in the report, when giving an account of Charles River." This is all very temperate and correct language — used undoubtedly under a responsible sense of the facility with which *any* water may be rendered unpopular by even a slight enumeration of possible causes of impurity. How singularly such sensible remarks as the above, contrast with the whole scope and sentiment of Mr. Hale's pamphlet from pages 47 to 54. Let me quote the following: "Into this basin (at Watertown) the water is received over another dam, on which are situated Bemis's mills, the seat of cotton and other manufactories. At Waltham, three miles only from the spot at which the water is to be taken out of the river for use, is a third dam, on which are situated the celebrated Waltham factories, with all their works for dying and bleaching, and also a great variety of other manufacturing establishments. All the waste water, and impure substances discharged from these manufactories, and from the residences of 2500 inhabitants, including the operatives at the factories, are discharged directly into the river. These, of course, go to swell the mass of those fluids, which three miles below, is to be pumped into the reservoir on Cory's hill, and conveyed thence to Boston, for the daily beverage of its inhabitants."

Now can it be that the same hand that sketched the effect of these mills and factories in 1837, wrote the above in 1845? And if so, can it be that the dams and factories are identically the same in number, and about the same in extent, now as then? All this is certainly true; and it must be left to others to judge what can have so utterly and entirely changed the author's opinions and views, where there is absolutely no visible cause. The fact I suppose to be indisputable that there has been no new dam erected on the river, within twenty miles of Watertown, during the last fifteen years; and scarcely any extension of works. I have made inquiry, and can learn of none. What was said by the commissioners in 1837 is just as true, and as worthy of confidence, now as it was then. If the views then expressed were not Mr. Hale's *real* views, he must be esteemed to have been disingenuous; and if they were his real views then, it remains to be explained how his views have become so completely revolutionized with so little, or no, change in the circumstances.

In this connection I will introduce some other extracts showing the *animum* in which Mr. Hale writes. Speaking of the impurities

(though *perhaps* not derived from mills) in that river, Mr. Hale says, (*Daily Advertiser Feb.* 10,) this impurity was "*one* of the objections to the adoption (by the commissioners of 1837) of this source of supply." But he afterwards affirms (*Advertiser*, *May* 19*th*,) referring to the action of the commissioners of 1837, "the Charles River source was the nearest and cheapest, but it was rejected on the ground of the less degree of purity of the water." Here instead of its being *one*, it is taken to be the *sole*, cause of rejecting the nearest and the cheapest source. Now let us see what the Report of 1837 says, and *all that it says*, on this subject, (p. 31.) "As the constancy of the supply, however, in this plan (that is, Charles River) depends upon the operation of machinery, which always implies some shade of uncertainty, though in this case, as our estimate provides for two complete engines, pumps, and buildings, either of which will elevate the supply by operating twenty hours per day only, the chance of failure must be very small; yet taking into consideration the possibility of such a contingency, and likewise the better quality of the waters of *Spot* and *Mystic* ponds, we are of opinion that the first plan, founded upon Charles River as a source, ought not to be adopted." Will any one pretend that the *sole*, or even the *leading*, reason for rejecting Charles River, as here set forth, was the impurity of the water? Certainly not; — it scarcely makes a reason at all in relation even to the Medford ponds; and it is all but certain that it would not have been thought of at all, had the decision lain between Charles River and Long Pond. The *enumeration* of the Medford ponds as of "better quality" than Charles River, implies that Long Pond was not so considered; for there was as much reason to name Long Pond, as Mystic and Spot Ponds.

Still farther, to show that Charles River was not rejected on the ground of its impurity, but on other ground, let us make one extract more. In answer to some of Mr. Baldwin's objections, p. 53, the commissioners say, "if it were possible to raise water by steam power, without expense, our examination would have ended with Charles River or Mystic Pond." But *how* and *why* would the examination have ended with Charles River, if that source "was rejected on the ground of the less degree of purity of the water"? Surely the "expense" would be no greater to raise a less pure, than a more pure, water. Again, if Charles River was rejected on account of impurity, why did the commissioners estimate upon it at all? Why go to the labor of finding the cost of a supply of water, which, on account of its quality, they did not intend to take?

Again: Why does Mr. Hale now print Dr. Hobbs's letter? Why did he omit it in 1837? The letter was written in 1834. If it con-

tained views deemed to be important, why was it *not* printed by the commissioners in 1837? And if deemed not to be important, why is it printed now? Its real importance was just the same then that it is now; and the reason for publishing it much greater then than now, because Mr. Hale was acting in a more responsible capacity.

It seems to me, therefore, impossible to dismiss from the mind the idea that Mr. Hale has exposed himself to the charge of having been disingenuous in 1837, or of having indulged an unjustifiable spirit of amplification and exaggeration in 1845.

And as further proof of this disposition to exaggeration in 1845, let me call attention to two prominent *overstatements*, which I chance to have the power to correct; how many similar ones may be in his book, which I have not now the power to correct, I know not. On p. 49, he says: "On the immediate banks of this basin (from which the water is to be taken) are dwelling houses on both sides the river, and also *slaughter houses*, *soap and candle works*, *and other manufacturing establishments*." Afterwards he again speaks of the offal of slaughter houses, alluding to the same establishments. Now probably some surprise will be felt at learning, that, as *possible sources* of impurity to the waters proposed to be taken, these establishments can have as little effect, as if they were established down the river in Cambridge or Brighton. Those on the north side stand beside a canal, I should judge to be seventy rods long, which takes the water from the pond above the dam down to the mills; and if any drainage come either from these establishments or the mills themselves, it can never pass up against the current to mix with the water of the pond. Every "establishment" here referred to, is more than 400 feet *below* the dam. And those on the south side are separated entirely from the water of the pond by Baptist, or Jackson's, brook, which runs into the Charles below the dam, and which must take all the drainage, if there be any, from every one of these establishments.

Again: Mr. Hale says, "At Dedham the river receives the waste water of such common sewers as are required for a manufacturing population of from 3000 to 4000." One can hardly express his amazement at such a statement, — so full of error. In the first place, the population of the whole town in 1840, was but 3,290; and this is not a *manufacturing* population to any considerable extent, but an *agricultural* one, scattered through three or four *distinct territorial parishes*. In the second place, the Charles River scarcely runs *through* the town at all, and *skirts* it only on one side; of course nearly all the population live at a distance from the river. In the third place, there is not a dam on the river where it touches Dedham, and of course there are no manufactories on the river; and there is

no tributary stream, of any consequence, in that town to which the remark could apply. In the fourth place, the people of Dedham probably do not know what a common sewer is, having no such thing on their premises; and should any one inquire for a "common sewer" there, *he would be directed to a person who took in plain needle work.* The only establishments in Dedham, worthy of being called factories, are on Mother Brook, which runs *out of*, not *into*, Charles River.

The person who supplied Mr. Hale with such facts as I have here noticed, must, I should think, have earned more than a penny a line. The ability to draw so long a bow, should have received a compensation in some degree commensurate to the rarity of the accomplishment.

But I have expatiated quite enough on this subject. There is one plain and conclusive answer to the whole difficulty, root and branch, namely; *that the real causes of impurity be removed.* It is needless to criticise the precise meaning of the act which has been rejected; but sec. 19 was, beyond all doubt, intended to give the city a complete remedy against all such practical causes of impurity; and a new act should, and would, embrace provisions to obtain the same object, only more clearly expressed. Equity would require the city to pay the actual expense; but it could be but a trifle. And no serious doubt need be entertained that the owners of the establishments on the dams would meet the wishes of the city in a liberal and accommodating spirit. Under such legal provisions, we should drink our water with as little apprehension as we eat our food. When we purchase our meat and vegetables, we seldom examine them for taint or decay, because the presumptions are that the butcher and sauceman are under the restraints of the law, and would not offer offensive articles for sale. Just so, it being unlawful to render our water impure, we should drink it freely without any apprehension or fear that the provisions of the law would be violated.

FIRST PROPOSITION.

That the Water of Charles River is better than that of Long Pond.

The waters of Charles River and Long Pond are to be compared by the qualities or ingredients; 1st, which they exhibit to the senses; 2d, which are developed by analysis; and 3d, which result from the circumstance of one being a running, and the other a stagnant mass.

1. *As to the qualities or ingredients which they exhibit to the senses.* — Water is usually considered pure when it is free from odor, taste

and color. Now as I am not aware that any body pretends that the water of either Charles River or Long Pond is objectionable on the score of taste or odor, I shall limit what I have to say under this head to color. July 1, 1834, Dr. Jackson says, of Charles River water, "clear, transparent, *colorless.*" Of Long Pond water he says, "Has a slight tint of *brown.*" He says of another specimen *taken from the outlet*, that it was free from color;" but as it is not proposed to take the water from the outlet for the use of the city, it is not very obvious how this latter examination bears upon the question. Mr. Hayes, May 24, 1837, (near three years after Dr. Jackson,) says of Charles River, "*Nearly colorless;*" and, to the praise, as I apprehend, of Long Pond water, he says, it "resembles (Charles River) in physical qualities." February 27, 1845, I obtained a bottle of water from Charles River, which was exhibited at the senate chamber before the committee, and afterwards on the *first day* of debate on the Water Bill in the house of representatives, *and which I have still in my possession*, which I regard as colorless, or nearly so. On the 3d or 4th of March, 1845, I obtained another specimen which was exhibited on the *second day* of debate in the house of representatives. I believe these specimens were regarded as *colorless* by the members of that body. The water of the *last* specimen is lost; any one may still inspect the *first.*

I am aware that, in point of color, the commissioners of 1837 ranked Long Pond water before that of Charles River; but as the number of specimens examined, and the times and circumstances under which they were taken are not stated, what they say of their examination may be entirely true, and still the conclusion may be erroneous. So in the chamber of the senate before the committee, I believe there was a sample *taken from the outlet* of Long Pond as *colorless* as the sample from Charles River, but the samples generally (for there were several taken from different parts of the pond) most certainly were not. I have also had specimens from Charles River taken at different times, say April 14 and 25, and May 14; and also of Long Pond, taken (I suppose) about March 1st, and (from the *exact point of the pond* which we propose to tap) April 25th. On carefully comparing these samples as to *color*, the last specimen of Long Pond was whiter than the first, and whiter than some of Charles River; while the first specimen from Charles River was a good deal whiter than the last from Long Pond, and the last from Charles River much whiter than the first from Long Pond, and somewhat whiter than the last from Long Pond.

Now this appears to be the true state of facts, so far as my knowledge or reading goes, and which does not appear to be contradictory

to any other authentic knowledge on the subject. There have been three times, with long intervals between, and at different seasons of the year, when the water of Charles River was found to be colorless, or nearly so; while there is not, that I am aware of, the slightest evidence or good reason to suppose, that any specimen was ever taken from Long Pond *at the point where we propose to take it*, that was free (or nearly so) from color. The inference I draw is, that if we take Charles River we shall *sometimes*, probably *often*, have the water colorless, or nearly so, and can then have our clothes washed white; while, if we take Long Pond, we shall have it with a *perpetual* discoloration, though this discoloration may occasionally be less than that of Charles River.

Dr. Gould, describing a specimen of Charles River water received from Dr. Channing, who received it from Mr. Hobbs, says, it "appears to be what we doctors would call sadly *jaundiced;* that is, it has a greenish yellow tinge, about the color of chlorine gas, probably arising from *chlorophyll*, the coloring matter of plants," &c. Having occasion to call on Dr. Gould, he showed me the identical bottle from which he took the water above described. It was a common junk bottle of black glass; I noticed that it was partly full, and feeling desirous of examining it myself, Dr. Gould was obliging enough to allow me to take it. I took it to my store, put the water into a clean, white, glass decanter, (*and have it still for the inspection of the curious,*) and I find it to be just about the most free from color of any specimen I ever saw of surface water. I think the advocates of Long Pond may be safely challenged to produce a sample more free from color, from the point of the pond at which we propose to take it. Dr. Gould says, however, that the color has changed; which he attributes to its having been kept from the light. Whether this can be so, I leave to others to judge.

In all the specimens which I have seen, the subsiding substance in the Charles River water has uniformly been of a less offensive character than that of Long Pond.

Though animalcules are exhibited to the sense of sight, I shall defer the consideration of them to the *third* ground of comparison.

2. *Qualities or ingredients developed by analysis.* — There appear to have been three distinct analyses of both these waters, at distant intervals; viz. Charles River, by Dr. Dana, Dr. Jackson, and Mr. Hayes: Long Pond, by Dr. Jackson, Mr. Hayes, and again by Dr. Jackson. The result of Dr. Dana's analysis has never been published. Mr. Hayes (p. 9, Report of 1837,) gives the earthy matter, *when dry*, in Charles River water, 100,000 grains, 3.22 grains, and in Long Pond water 3.03 grains; *when burnt*, Charles River

1.8 grains, Long Pond 2.1. Dr. Jackson in 1834, gives earthy matter in Charles River, when dry, 4. grains, and Long Pond 6. grains; or fifty per cent. more in Long Pond than Charles River. In 1845, (p. 142, Proceedings before Joint Committee, &c.) he found in the sample taken from that part of Long Pond, where it is proposed to take it for the city, 6. grains in 70,000 grains, or (to compare it with the foregoing results) near 8.7 grains; that is, near fifty per cent. more than he found in the same pond in 1834, and more than twice as much as he found in Charles River, and almost three times as much as Mr. Hayes found in Charles River. Dr. Jackson does not seem to have tested the substance by burning in either case.

But there are more subtle analyzers than the crucible — the living fibre of men and animals. Mr. Lincoln, a representative of Boston, stated, in debate on the bill, that a gentleman (a clergyman) who had resided many years on the banks of Long Pond, told him that he had known periods when the fish had become diseased and unfit for the table — supposed to arise from some deleterious ingredients in the water. An authority worthy of being quoted on such an occasion, I esteem worthy of being referred to on this. So Col. Baldwin, speaking of Concord River in 1834, says, that besides being charged with coloring matter, like Charles River, it "has the *additional* objection (that is, additional to the objections to Charles River, which has no such quality) of its possessing some *poisonous* quality. I remember when the locks, &c. of the Middlesex Canal were built 30 or 40 years ago, the workmen obliged to labor in the water, complained that it made the hands and feet sore, and if a little scratch occurred to their flesh, or the skin was torn or bruised away, *the water would cause it to fester into a serious wound, and it was often necessary to suspend working in it that the sore might heal.* This character of the water was confirmed to me a few days ago by Mr. Wilson, a master carpenter, who has been employed twenty years in the direction of the canal works there (Billerica,) whose expression was, if a man gets a little piece of skin knocked off his hand while working in it, *the water would fester it up so that I do not know but it would eat his hand up in time;* but working in the Merrimac River would wash it well again." Now Concord River water is, to a great extent, Long Pond water; and, unless both these stories are *fish stories*, it might be well to exercise some caution.

3. *Qualities or ingredients, which result from the circumstance of one being a running, and the other a stagnant, mass.* — Before entering upon this topic, I wish to introduce the following letter from Mr. Hayes. The substance of my letter to him, to which this is an answer, will appear from the questions which he has embodied in his letter.

"Roxbury Laboratory, 13th May, 1845.

"J. H. Wilkins, Esq.

"Dear Sir, — Your note, with the pamphlet, came to hand this evening. The queries, which you have proposed to me, refer to an important and not less exciting subject. In the brief replies, which follow, I must be allowed to express my opinion, without reference to considerations of comparative expense, quantity of supply, elevation of source, &c.; keeping in view only the facts of science, so far as they have a practical bearing on the points you have named. To your 1st, 'Are you aware of any general principles, on which pond water should be preferred to river water?' I reply, that I am not acquainted with any general principles, which would lead to such a choice being made.

"2d. 'Are you aware of any particular reason, why the water of Long Pond should be preferred to that of Charles River? or, on the contrary, have you in mind particular reasons why the water of Charles River is to be preferred to that of Long Pond?'

"For the general purposes of consumption, either of these sources would afford an abundant supply of excellent water. For all general purposes, I know of no reason for preferring one over the other. Of the desired supply, a very small proportion would be used for drinking in its natural state. It is in reference to the part so used, that I express a preference for the water of Charles River.

"Both these waters belong to the same class, and differ but slightly, so far as physical characters are presented. The foreign matter dissolved in them, differs but little in chemical composition. They are peaty waters, and contain all the substances of organic origin, usually found in such waters, in a changing state.

"The proportions of these matters, when referred to weight, are very small, but they are sufficiently great to affect the senses. The substances of organic origin, found in these waters, change in character and composition by exposure to atmospheric air, or by exclusion from it, as well as by elevation of temperature. The free access of air favors a change, by which a colored water becomes nearly destitute of color; the elements of the organic matter become differently arranged, and soluble colorless substances, and insoluble colored principitates, result. These changes are much aided by the presence of other substances, especially those belonging to a different class of organic matter. Chemically speaking, therefore, the addition of matter repulsive to our senses, may not increase the amount of organic impurity, but contribute essentially to diminish that already existing. It would be a forced comparison, to represent an almost pure water by 'wort,' or an infusion from which beer is made; but the action of the added impurities in water is not unlike that of the yeast, used with the intention of producing a more transparent and pure fluid. Flowing waters, most rapidly undergo the changes, resulting in a diminution of the colored organic matter, at first dissolved.

"Water, to be palatable and salubrious, must contain air, or gases, dissolved in it; and all waters, which are particularly prized for drinking, contain the larger quantities of gases, or air. In this respect,

the waters of ponds and rivers differ; and in the water of Long Pond and Charles River, the quantities are unlike. The river water contains a much larger proportion of air and gases, giving briskness, or a sparkling appearance to the water. In the sample furnished to me by the water commissioners, for chemical analysis, the dissolved gases contained more oxygen than exists in the same volume of atmospheric air; indicating that the changes requiring the aid of oxygen, or the purifying processes, had been completed.

"The existence of the larger animalcules, in greater abundance, in the pond waters, is an indication, as Dr. Gould has observed, of impurity. In the water of Charles River the number is comparatively very small, as is that of the infusorial insects; partly from the fact, that they become the prey of other animals and fishes in flowing water. In flowing waters, the elements which have presented the forms of organic life in animalcules and insects, become the materials of vegetable growth; and classes of plants result from, or depend on, the decay of animal life; all tending to the purification of the water. In future years, the surface, drained into Long Pond, will doubtless become changed, and the increase of impurities will then be concentrated in that water.

"Briefly, these are the reasons for preferring the 'living,' flowing water of Charles River to that of Long Pond. I have supposed, that from both these sources the obvious causes of impurity would be removed. Respectfully, "A. A. HAYES."

These are the views of Mr. Hayes, the same gentleman who analyzed the waters for the commissioners in 1837, and who reported of the water of Charles River that "*it is more brisk and sparkling than either of the other specimens.*" And though Mr. Hale (Daily Advertiser, February 10,) thinks these qualities are of little value except as accompanying *Champagne*, yet I can entertain no doubt that nine out of ten of those who, from principle, choice, or necessity, do not take champagne at all, but take cold water in abundance, will be glad to find these qualities in their water. It is certain that many animals appreciate the difference between running and stagnant water. A clever horse, if left to himself, will pass into the current, and not stop to drink at the stagnant margin.

I come now to the consideration of water insects or *animalcules.* In my REMARKS, I quoted the authority of Dr. Lee, of New York, to the effect that these were not to be found in river or spring water. I have reason to suppose Dr. Lee's proposition requires considerable qualification; still I suppose the remark to have grown out of an important practical truth, viz. that *animalcules are much less likely to be found in running, or river, water, than in pond water;* and when found, *are less numerous and less formidable* (if I may use the word) *in the former than in the latter.* In what I have to say of these dis-

gusting objects, I wish to be understood as speaking *only* of such as are visible to the naked eye; for it is to such only that any one can attach much importance.

Before I enter upon the subject, I will take occasion to say that I am not without apprehension that some will think me not only contending against what cannot be avoided, but also against what it is not desirable to avoid if we can. I am not without suspicion that some esteem the presence of these creatures as a positive advantage. What can be the object of publishing to the world such facts as the following, unless it be to induce a taste for such things? "Whatever its (the water of the Mississippi) effect on health may be, it is certain that it *contains a sufficient amount of animal matter* (20 kinds of animalcules in a living state, active, and in great abundance) *to be somewhat nutritious.*" Again, "That they (animalcules) are capable of affording a considerable degree of nourishment *even to man* is clear; and the facts not unfrequently stated of persons subsisting for some length of time upon water alone, will not appear paradoxical." These facts were communicated to Dr. Channing by Dr. Gould. They are sent out to the people by Dr. Channing.

Now my doctrine is that *the presence of visible animalcules is an objection to water;* that it is to be avoided entirely, if possible, and to every practicable extent, if not. However nutritious they may be to all, and however agreeable to some it may be to take their food and drink at the same time; I must be classed with those who are willing to forego all such advantages, and are desirous of taking their food from a plate and their drink from another vessel; and the following remarks on this subject are submitted for the consideration of *those only* who sympathize with these *views and tastes.*

We are told upon authority that I feel no disposition to dispute, "that animalcules exist in all water exposed to the open air"; but this is to be limited to *invisible* animalcules, and is not true with regard to *visible* ones. Dr. Gould does not appear to have found *visible* ones (to the naked eye) in either sample of Charles River water sent him by Dr. Channing; nor does it appear that any specimen has been taken from that river in which they are or were visible. And here I cannot with propriety forbear to refer to Mr. Hale's manner of quoting. Page 48 of his *Inquiry*, &c., he quotes Dr. Gould as follows, in regard to a specimen of Charles River water, "Animalcules of several kinds are detected without difficulty." This is given as Dr. Gould's statement. Now what is Dr. Gould's language? "Animalcules of several kinds are detected without difficulty *by a microscope*, upon allowing the waters to settle and pouring off the top." Now this is an important qualification; and as not one person in a

thousand has a microscope, I submit that Mr. Hale's quotation cannot be true, and is therefore a misrepresentation of Dr. Gould, whose proposition undoubtedly is true.

The following extracts will place this matter in its true position. They are from Dr. Gould's Letter to Dr. Channing, an authority I regard as highly as any one. "*In lakes or ponds of water, which may be called standing water, they* (animalcules) *will be found in greater abundance than in river or running water.*" Again: "*They are much more abundant in stagnant than in running water.*" Again: "*Though they may be in myriads at some little shallow marginal nook, they will scarcely be found at all at the flowing outlet, although it be the same water of the same pond.*" (This last was Dr. Jackson's experience of Long Pond water in 1834.) And the following is worthy of *very particular* consideration, "*their presence indicates impurity in the water;* and that which abounds most in them may be pretty safely set down as *most impure.*" Can language be plainer, can ground for inference be stronger, that the water of rivers is more pure than the water of ponds? And this not only in regard to animalcules, but to other organic matters which give life and sustenance to them.

Here then we have the *doctrine* I contend for; and now how do facts agree with it. Dr. Jackson analyzed for Mr. Baldwin 9 different waters, viz. Spot Pond, Waltham Pond, Sandy Pond, Baptist Pond, Ponkapog Pond, Massapog Pond, Long Pond, Farm Pond, and Charles River; and what was the result as to animalcules? In *six* out of the *eight* ponds he found animalcules; but *found none in Charles River.* Again, Dr. Jackson analyzed 6 specimens of pond water for Mr. Eddy in 1836, and what was the result? In every one, with a single exception, he found animalcules. Besides the discoveries of the Doctor, I have inspected a great many specimens of Charles River water, and I have never been able to discover any animalcules with the naked eye. I have also inspected many specimens of Long Pond water, and have often seen them alive and active. Citizens were invited to call at the mayor and aldermen's room, just before the vote on the water-act, to inspect several specimens of water. I called, and took particular notice that while the specimen of Charles River water was free from these creatures, all the specimens of pond water (Long Pond included) abounded with them.

It is matter of some surprise to see with what zeal and industry Dr. Channing, and after him, Mr. Hale, endeavor to break down all distinction between one water, or one kind of water, and another, in regard to animalcules, as if there were absolutely no degrees of better and worse, pertaining to them. They seem to insist, with a

pertinacity worthy of having the truth to support and justify them, that all waters in this respect are alike, and that "the *only* remedy against them is, to avoid too curious a search by microscopic eyes," &c. But they are supported by neither theory or fact, *at home;* nor are the consumers *across the ocean* so accustomed to their presence, or so indifferent to it, as we might be led to infer from extracts of evidence given by Mr. Hale. As I deem the matter of considerable importance, and as I believe the evil can be, and ought to be, in a great degree, guarded against at the outset, and we and future generations be spared the disgust of witnessing forever these creatures in our drink, I propose to quote somewhat more largely from the testimony of Dr. Clark and others, before the Parliamentary commissioners referred to by Mr. Hale, than he has done.

Dr. Clark was professor of Chemistry in the University of Aberdeen. He appears to have given much attention to water, to its ordinary impurities, and to the most effectual method of removing them. His examination before the commissioners was long and minute; and he was obviously a witness whose opinions were considered as entitled to great weight.

"*Question* 41. Is the presence of water insects of any consequence, and is that peculiar to London water, or have you found them in the water of other districts in England? *Answer.* Those insects are not peculiar to the London waters, *but the London are the first of the waters supplied for the use of the inhabitants of Towns, in which I* EVER *saw them.* They are *not* general in the waters of other towns, at least in Scotland, (Aberdeen, his residence, is in Scotland,) AND ARE NOWHERE TO BE FOUND EXCEPT IN SUCH WATERS AS ARE NOT IN A CHOICE STATE FOR DRINKING. They are an indication in general of a vegetating process going on (in) the water; I think I have observed, from examining a great variety of specimens of water kept in glass vessels, that the two things generally go together, (viz.) the vegetating process and the breeding of those insects. Either circumstance I should apprehend to be a presumption of the other, AND TO INDICATE A STATE OF WATER UNFIT FOR DRINKING."

The above question and answer I regard as exceedingly pertinent. I shall have more to say of these London waters; but I copy the next question and answer to show the effect of these impurities upon the consumption of water by those classes of inhabitants in London which ought to be the greatest consumers.

"*Question* 42. Can you state what effect on health is likely to ensue from the constant use of water containing animal or vegetable impurities? *Ans.* I am not prepared to make any statement upon that subject; nor am I aware that, in regard to a question of so much

interest, there has been much accurate information obtained. However, there is one very obvious consideration as regards the health of the inhabitants, that *if you have water not fit for drinking, in which there is matter offensive in any degree, by so much as the water is offensive you lessen the habit of drinking water. Now you cannot restrict the supply of water to such quality as is naturally repulsive — you cannot thus render the inhabitants abstinent from water, without interfering with the healthful functions of their bodies. It was with no small concern that I learned how few of the inhabitants of London,* AND ESPECIALLY OF THE LOWER ODERS, *drink water.* In making my experiments upon these (London) waters, when I inquired of the servants about me how they liked particular waters, it was with perfect surprise I discovered that they — generally mere lads — knew nothing about the taste of the water. They are the same sort of persons as would be accustomed to drink water in *other places*, but they have another beverage *here*."

And what beverage do the friends and advocates of Temperance think would be likely to be resorted to under such circumstances ?

"*Question* 82. Are the animalcules of which you speak those visible to the naked eye, or those which you discovered by a microscope ? *Ans.* I speak only of such as I have observed by the naked eye ; but it is wonderful how the naked eye improves in its power of observation by some practice in watching those animalcules.

"*Question* 83. Have you found any water supplied to the Metropolis more especially characterized by those animalcules than other ? *Ans.* I found the animalcules to abound in the waters of all the companies."

This answer requires some qualification or explanation ; Mr. Wicksteed, engineer of East London Water Company, in answer to the Question (4527) "are there insects in the water (of the East London Company) in hot weather ?" answers, "Not that I am aware of ; I have not seen any." *Quest.* 4516, to same, "Where is your water taken from ? *Ans.* From the River Lea, near Lea-bridge." From this testimony of Mr. Wicksteed, there can be no reason to doubt that the Lea-waters, distributed by the East London Company, are an exception to Dr. Clark's assertion ; and his answer *probably* should be understood as true only under the circumstance of having received a quantity of it at Aberdeen from Mr. Wicksteed, and having "kept the water for a long time in open vessels in a large laboratory." (*Quest.* 27.) Under such circumstances animalcules may have been developed.

" *Question* 84. Do you find this common ? *Ans.* I have never found them (animalcules) in the Scotch waters that I have been ac-

customed to in Towns, nor indeed had I ever observed them at all in any town's water, till I examined London water.

"*Question* 85. Do you think the poor inhabitants of London are prevented from drinking the water supplied to them from finding objectionable matter in it? *Ans.* Certainly."

"*Question* 96. You have seen the mode in which it was proposed by the late Mr. Telford to furnish an increased supply of water (to the Metropolis)? *Ans.* Yes. *Quest.* 97. He proposed to take it from Hertfordshire on one side, and Surry on the other; what opinion have you formed as to the modes suggested? *Ans.* My real impression, from a consideration of the whole subject of water in connection with London, is, that the source of supply that should not be departed from is the Thames; it is so copious. Then, with regard to the supply of water to London from a distance, there are many points that one would like to know beforehand; for instance, I found some water in the neighborhood of Watford, in one of the rivers, the Gade, about one half harder than the water here (London). One would require to know a little more about the hardness of all the waters that have been proposed to be brought to London, *and to know whether there would not be a tendency to vegetation in the course from the source to London.* I do not mean absolutely to say there would be as much vegetation as we now have in the London waters; but, I should like to see, from the experience of other places, whether such would not be the result. *My opinion is, that there would be as much vegetation and as many insects as from those waters.*"

"*Question* 98. On the whole, from your consideration of the subject, you think the Thames would probably be the source from which to derive the additional supply to the Metropolis? *Ans.* For this reason, as well as others, that where there is such a river there is an inexhaustible supply; and there are so many instances where, having started with a limited supply, the inhabitants have experienced considerable inconvenience from a deficiency, that *I do not think it would be desirable to look for a supply from any source but a* LARGE RIVER."

I now notice the evidence of Mr. Robert Thorn, quoted by Mr. Hale. He appears to have been the engineer for supplying Greenock, Paisley, and Air with water; and plans for supplying other towns were furnished by him, but the duties of his business (cotton spinning,) rendered it impossible for him to attend to their execution. In describing his plan, he says (Quest. 109) "The distinguishing features of my plan are, the obtaining some natural basin at a sufficient height, either in itself containing a large supply of water, or into which a great extent of surface can be drained. Thus a reservoir is formed, *which I take care shall be deep enough to maintain the water*

at a low temperature, and to prevent the breeding of insects and the growth of vegetables; and capacious enough to hold at least 4 months' supply of water." These are the features of his plan, to find, or make, a reservoir which shall hold in a state of stagnation 4 months supply *at least.* And though it is a part of his plan to "take care" that this reservoir shall be "deep enough to prevent the breeding of insects," can any body doubt that he tells the truth when he says he "had seen animalcules in the water in particular parts of Scotland!" and particularly "wherever the water was shallow and warm," which of course was not in his own reservoirs which were *deep* and *cool.* It is needless to call the attention of the reader to the different views of a source entertained by Mr. Thorn and Dr. Clark, who would look to no other than a "large river."

Besides the fact stated by Dr. Clark that insects in water prevent the consumption of it by classes which ought, and under other circumstances would, use it freely as a drink, we may get some appreciation of the importance attached to the matter by several witnesses examined before the commission.

Dr. Clark speaks of the importance of having reservoirs neither too large nor too small; not too large, lest the process of vegetation and of breeding insects should be promoted; and not too small, lest an opportunity for settling should not be afforded. Mr. Thorn feels obliged to make his ponds of 4 months' supply, deep and cool, to prevent animalcules being developed. Mr. *Hawkesby*, the resident engineer of the Trent water works at Nottingham, says (Quest. 5330) "if we observe the growth of certain small aquatic plants, or—*more especially* if we remark ascending to the surface of the water small bubbles produced by gases resulting from the decomposition of organic matter, we know that a *habitat* is being formed for insects, and that if this process be not arrested, insects will soon make their appearance in considerable numbers; we therefore infer from these early indications that the time has arrived at which it becomes prudent to anticipate the coming depuration of the water by cleansing out the reservoir." And at the Southwark works in London, where the Thames water has animalcules, in order to have the water as free as possible from them (Quest. 5933) "in summer weather we frequently let the water out (of the reservoirs) in the afternoon, and take in a supply of cool water for next day's distribution," is the statement of Mr. Quick, the engineer.

Hence, although the inhabitants of London are to a great extent afflicted with the presence of these noxious creatures in their water, and on that account forego to a great extent the taste of it, year in and year out, in its natural state; and although Mr. Thorn discovered

them in Scotland "whenever the water was shallow and warm," yet there is no doubt that their presence is everywhere in Great Britain regarded as a nuisance of a serious character, and to be guarded against by all the precautions and remedies which science and experience can render available. We can discover no symptoms of indifference to them among the people, nor manifestation of faith in the doctrine that "the only remedy against them is, to avoid too curious a search," &c. The remedy of the paupers of London is to go without the water, or mix spirits with it to disguise its disgusting quality; and *we* ought hardly to feel any disappointment, if a like feeling and a like habit should prevail here under like circumstances.

But Mr. Hale informs his readers "that the London companies obtain their supply exclusively from rivers or springs — chiefly from the Thames — and none of them from ponds."

The London water works derive their supplies from the Thames, the River Lea, and what is called the New River. We have seen, from the testimony of Mr. Wicksteed, for many years the engineer of the East London Company, that the water drawn by him from the River Lea is free from visible animalcules. It remains, then, to consider those circumstances of the Thames and the New River to which the breeding of these insects is probably to be attributed.

Although Dr. Clark found animalcules in the water of such London companies as take the water of the Thames "much above any part affected by the sewage of London," yet it certainly is not above the influence of other causes which are known to favor the development of these creatures. The tides of the river affect the rise, fall, and stagnation of the water, many miles above the point where water is taken by any London company. Steamboats are continually plying up and down the river, going as far as Richmond at least. The natural current of the stream is therefore rendered sluggish, and entirely checked at high water. Besides, there are numerous densely populated towns on the margin, the sewage of which probably flows into the river, and may be as prolific in this species of nuisance as the sewage of London. The town of Brentford, celebrated for mud and filth, is so situated, and probably so drained; and also other towns. So that below the lock or locks at Tedington, the Thames may be said to lose the essential character of a river, or *running* stream, and acquires that of a turbid arm of the sea. It is no more to be expected that the water of the Thames should be free from animalcules in the parts under consideration, than those of the Mississippi should be below St. Louis, where we know they abound. The flow of each is altogether too sluggish to check the development of the nuisance in question.

And how is it with New River, the supply of the oldest water company, whose works were completed in 1613, — 232 years ago? "The supply is from the springs of Chadwell and Armwell (two thirds) with additional supply (one third) out of the (river) Lea, near Chadwell in Hertfordshire, which is about twenty miles from London, in direct distance; but the course of the river is about thirty-nine miles." This supply being originally from springs and a river, and the same river which gives the East London works water without animalcules, we must look to adventitious circumstances for their development between the source and the delivery of the water. And what are the circumstances which might be expected to produce such a result? In the first place, the water traverses an artificial channel of great extent, near forty miles, open and exposed to light and air, *very sluggish in its current* from two causes, viz. its circuitous course — going round two miles to gain one — and from its very slight fall — being only three inches in the mile. These are just such circumstances as are calculated to create an *a priori* expectation of animalcules; and joined to the fact, that in a good many places the stream becomes quite wide, and therefore "shallow and warm," we should be rather surprised if animalcules did not appear. It will be remembered that Dr. Clark gave as a reason for not quitting the Thames for a supply, that he thought the tendency to vegetation and breeding insects in the water, during its course from a distant source to London, would produce as many as were in the Thames, (see above, p. 18.) It is not unlikely that he had in his mind the example of the New River in this respect.

In the second place, it is not unlikely that the very extensive reservoirs of this company contribute to the development of this nuisance. I name this as a cause which may operate, though I am not at all certain of the fact. The reservoirs are very extensive, and the water lies stagnant in them some time; and if not long enough to generate animalcules, still it may aid preëxisting causes of development.

It seems to me, therefore, that the existence of animalcules in the New River water and the Thames water, under the circumstances of the case, does not at all weaken the general doctrine in regard to river and *running* water, nor blend the distinction I have endeavored to consider and establish between river and pond water.

And here I close what I have to say on the subject of animalcules; entering my protest against all statements and arguments going to show that there is no distinction in waters in regard to them; believing that such statements and arguments are falacious and deceptive. The foregoing facts and statements I believe sufficient to establish beyond controversy, that there *is* a distinction between river and pond

water, and, of course, between Charles River water and Long Pond water, which is worthy of influence upon the judgment of the community in electing between them. On the influence which this distinction shall have, may depend the fact whether the citizens of Boston, in all coming time, shall have foreign water suitable and popular for *drinking*, or fit for *washing and cleansing* only.

There are some peculiar circumstances, worthy of a passing notice, attending Charles River. The fact that its stream, from the mouth to the source, is but a succession of ponds, affords the water peculiar facilities for becoming clear of sediment; while the constant ingress and egress of the whole contents of the river, into and out of each of these ponds every day, changes the water so often and so rapidly that no suitable time is allowed for the development of any processes of vegetation or of breeding insects. In dry times, the ponds fill up by night and are drawn off by day; and this to such an extent, that probably scarcely a hogshead of the water lies in bulk, unmixed with other portions, for eight and forty hours together, unless it be in some nook or eddy. This constant alternation of rest and motion is a most favorable promoter of purity; so that in dog-days, when one would take a drink of Charles River water, he will feel a moral assurance that it has not been ten days from the springs, and in its course has been subjected to a succession of purifying processes; while, in regard to that of Long Pond, he will feel a like assurance that it has been steeping near six months on the marshes and peat bogs of Natick, without having undergone any purifying process at all, except what results from perfect stagnation: a process, which, if it tends to purify in one way, most certainly tends to render impure in another. Within ten yards of the point in Long Pond, whence it is proposed to take the water, as laid down on the map, is an extensive swamp, the hillocks and mounds of which are submerged when the water is high, and left dry when the water is low. This swamp is full of all manner of vegetable growth, from the white birch and alder, down through all grades of aquatic shrubs and plants. All this vegetable growth deposits its foliage and stems in the pond annually, where it lies and decays in mass; and this, right at the mouth of the proposed tunnel.

Second Proposition.

The Waters of Charles River are vastly more abundant than those of Long Pond.

The commissioners of 1844 say (p. 25): "The *maximum* supply

which, in their opinion, can be held in reserve (in Long Pond) by artificial means, for regular and permanent use, is computed not far to exceed twelve feet per second." This is more than I can see good reason to regard as a *minimum*, and it is a minimum which in this connection we want. There is, in my judgment, serious ground to doubt whether any artificial means can *infallibly* supply twelve feet per second. It confessedly depends upon snow and rain ; for the springs do not sometimes yield *one sixth* of that quantity, and the *average* natural yield is less than one half. And snow and rain are, in the wisdom of Providence, sometimes in a great degree withheld. The system does not rely upon the *natural* resources of the pond, to yield half that amount ; and the *artificial* ones proposed, are subject to all the liabilities to failure which must necessarily attend experiments of this nature.

But of the amount in Charles River, *in the dryest seasons*, there can be no doubt. In this connection, I wish to put upon record the following statements, furnished me in a letter from Lemuel Crehore, Esq., of Newton Lower Falls, dated Feb. 22, 1845. He says :

" After years of controversy between the proprietors of mills on Mill Creek (or Mother Brook, as it is more usually called,) and the Neponset, and those on Charles River, some time about 1832, an agreement was matured between the parties, that one third of the water should pass to the former, and two thirds to the latter ; and in 1840, to carry into full effect the stipulation, two canals were constructed, the one on the Creek, (or Mother Brook,) twenty feet wide, that on Charles Biver, forty feet wide, and each twenty rods, or three hundred and thirty feet, in length. The sides are walled two feet high, and the bottoms level with timbers across every twenty feet, and kept perfectly smooth.

" That (canal) in the (Mother) Brook, or Creek, is situated immediately north of the old road leading to Dedham village ; that on the Charles River, about one mile above the dam at the Upper Falls (in Newton.) These were completed in the summer and autumn of 1840.

" To determine whether the object had been effected with accuracy by what had been done, sundry comparative admeasurements were made in the two canals, during the low stages of the water, in 1841, and occasionally at subsequent periods. In 1841, the following were the results in the Charles River branch : —

Inches.		min. sec.		Cub. ft. per S.
July 23 — 14 deep on sills.	Velocity	5 4,	330 feet =	50 2-3
" 24 — 14 " " "	"	5 26,	" " "	43 1-2
" 26 — 12 " " "	"	7 0,	" " "	31 3-7
" 29 — 12 " " "	"	6 0,	" " "	36 1-2
Aug. 3 — 12¼ " " "	"	5 40,	" " "	39 2-3
" 7 — 13 " " "	"	4 40,	" " "	51
" 24 — 12¼ " " "	"	4 45,	" " "	47 17-57
Sept. 4 — 14¾ " " "	"	3 4,	" " "	72

"In 1843, I have been able to find but one memorandum of an admeasurement, which was probably at its lowest.

Aug. 3 — 13½ in. deep. Velocity 5 min. 30 sec., = 44 32-33 ft. per sec."

In 1844, obstruction in the river was discovered, so that, instead of one third, something more than one half the water was found running through the Motherbrook Canal. "After its removal, (i. e., the obstruction,) no rains intervening to materially affect the stream, it was measured, and the results were as follows: —

July	26	—	14	in deep.	Velocity	5	m.	0	sec., =	51	1-2	ft. per sec.
Aug.	4	—	15	"	"	"	4	"	30	"	"	61 1-27	"	"
"	17	—	17	"	"	"	3	"	30	"	"	88 2-21	"	"

"These admeasurements were made, and minutes preserved, by Mr. A. C. Curtis, agent for the proprietors on Charles River, from whom I procured them.

"In addition to what flows through the canal, at the place of admeasurement, there falls into Charles River below, Garfield's Brook, Rice & Parker's Brook, Stoney Brook, Waltham Brook, (between upper and lower factories in Waltham,) Major Jackson's Brook, and Baptist Pond Brook at Watertown, (all) which may be safely estimated at one fifth in (additional) quantity."

It is worth remarking that the velocity, in the above instances, was measured by putting light substances afloat. Now it is very apparent that causes might operate materially to retard the speed of the floating body, so as to show that speed considerably less than that of the water; but no cause could operate to give the floating body a greater velocity than the water which bore it: so that, whatever errors may have resulted from the imperfect mode of operation, it is almost certain they are on one side, that is, they made the quantity less than it really was.

In my *Remarks*, I did not feel inclined to attach much importance to the greater quantity of water in Charles River than in Long Pond; because I did not see reason to believe that the city would ever require more than twelve feet per second, or seven millions gallons per day. But since those *Remarks* were published, I have heard so much about the importance of an "abundant," "never failing" supply to the city, "for all coming time," &c., that I can hardly be blamed if I catch a little of this expansive spirit, and inquire whether Long Pond is the source which can supply it; and if the "abundance" confessed to be in Charles River, is not worthy of more weight than I have hitherto been disposed to claim for it.

However unfortunate it may have been in other respects, it is certainly a great advantage to me, that the commissioners of 1837 were divided in their opinions. It gave occasion to Mr. Baldwin to urge some very strong objections upon his colleagues; and it gives me occasion to avail myself of some very appropriate answers, i. e.,

appropriate on the supposition that the demand for water will be as great as those commissioners, and also those of 1844, suppose.

One of Mr. Baldwin's objections was, that the works recommended by the majority, (Mr. Hale and Mr. Treadwell,) were not adequate for such an increase of population as he contemplated; and that, if adopted, the city would go on in "piecemeal way," "and never satisfy the wants of the citizens." Mr. Baldwin (who was in favor of Long Pond) probably did not dream that he was to be met by his associates on his own ground, and to be battled with his own weapon, and in a manner too perfectly indefensible; but so it was. The majority say (p. 56): "Let us look a little farther into the future. When the population shall have increased to 240,000, *which may be in thirty or forty years*, all the water which will be supplied by the conduit from Long Pond to Corey's Hill, or ALL THE WATER FROM LONG POND, WILL BE REQUIRED FOR THEIR USE, *and an additional population can only be supplied by new works.*" "*It appears, therefore, that additions will be required to the works, whichever plan may be adopted.*"

With such prognostications as this before them, it ill becomes those who advocate Long Pond, to dwell upon its capacity to furnish a *permanent and everlasting supply* for the use of the city, when, by the prediction of one who is the most prominent in their ranks, it may be entirely drained in thirty years. If any confidence at all is to be placed upon such opinions, then certainly it does become a matter of serious consequence whether the selected source will furnish forty cubic feet per second *certainly*, or only twelve, and that *problematically*. I will just add, that the commissioners of 1837 estimated the yield of Long Pond about 12½ per cent. greater than those of 1844. How the next board would estimate it is doubtful.

THIRD PROPOSITION.

The water of Charles River can be introduced into the City at vastly less expense than that of Long Pond.

In my REMARKS, in supporting this proposition, I went upon the supposition "that *enough* was as good as a *feast*" — that an adequate, and even liberal, supply of the present wants of the city, with provision for increased demand, arising from a more general habit of using the water, and from increase of population, was just as valuable as a supply four or five times greater than can at present be wanted, and which must run to waste till a demand shall be created. But Mr. Hale, I suppose, would hardly agree to this doctrine. "If it (what I

would save in providing for the supply *when* wanted and not *before*) is to be regarded as a saving, it is a saving purchased at the sacrifice of 4,500,000 gallons in the amount of supply." Well, if the supply be 4,500,000 gallons greater than can be used, and will run to waste if attained, where is the sacrifice? It is very easy to talk about an abundance of pure water, and it is easy to talk about the magnitude and magnificence of the cost that shall furnish it; but really that abundance is utterly valueless which cannot be appropriated, and that magnitude of scale and expenditure is a public loss which is uncalled for by public use and convenience.

In the REMARKS, I undertook to show that *a sufficient* supply of water from *Charles River* can be delivered into the same reservoir at the same place, *and that the quantity can be regularly increased till it equals in amount that from Long Pond*, at an expense but little more than half the estimates for bringing 7,000,000 gallons from Long Pond.

Reasoning, as I could, on the data before me, and the best opinions I could form, I arrived at this conclusion, viz. — "So far then, as the city supply is concerned, it seems that the larger work of bringing water from Long Pond, possesses absolutely no advantage whatever over the smaller one, of bringing it from Charles River; and of course that the expenditure of $436,000, which the larger is estimated to cost more than the smaller, is a sheer waste of so much public money, for which the public derive no benefit whatever."

What were the data and opinions which formed the groundwork of such conclusion? I will state them.

1st. *That the demand for water, when the works should be completed, would not exceed ten gallons a day, for every man, woman, and child in the whole city; and that this demand might regularly increase till it reached twenty-eight gallons per head daily in thirty years.*

2d. *That the number of inhabitants at the completion of the works might be* 120,000 *; and that this might increase to* 180,000 *in fifteen years.*

3d. *That the estimates of* 1837, *in regard to Charles River as a source, were to be relied upon; and might be reduced in the ratio that coal and other leading articles had since fallen in price;* and also somewhat by *the increased facility in the manufacture of engines,* &c.

If I had any success in showing that these points were to be relied upon, or if in reviewing them now, I can establish them as sound, the conclusion I before came to, that near half a million of dollars could certainly be saved by resorting to Charles River, must be re-

garded as established and confirmed. But if I should fail to establish each of these positions, it will not by any means follow that Charles River should be abandoned; for I shall maintain that *the whole* 7,000,000 gallons (which is all that Long Pond can supply) *can be delivered* NOW, *at the outset, into the reservoir on Cory's Hill, cheaper than it is estimated to bring the same quantity from Long Pond.* This proposition being established, it becomes a matter of inferior moment whether the former positions be established or not.

The first point I propose to review is, *Will the demand for water, at the completion of the works, exceed ten gallons per day for every inhabitant, as well those who do not take the water as those who do; and will the demand, arising from a more general habit of taking the water, carry up the consumption to twenty-eight gallons per head per day in less than thirty years?* Will the present demand exceed ten gallons per head of the whole population? I think not, *because I can find no instance on record where such a consumption has occurred at first;* and I know of no reason why more should be expected of Boston, under such circumstances, than of other places vastly more deficient in water than Boston is.

Before I proceed farther, I will notice what I regard as a great error in Mr. Hale's representation of the consumption in Philadelphia. He limits himself to the *city*, leaving out the *districts*, and makes the consumption come up to twenty-eight gallons or more for each inhabitant. Now every one conversant with this matter, knows that the *city* of Philadelphia is but the *central portion* of what is usually understood by Philadelphia. It is the central region cut out from the suburbs, or *districts* as they are there called. Thus we are accustomed to hear of the Navy Yard at Philadelphia; but Philadelphia *city* has no navy yard; it is in a district. The city of Philadelphia is the *central and wealthy* portion of that mass of population which lives upon the business of the place; while the working classes, the mechanics, artisans and laborers, are found in the districts. In other words, the inhabitants of the *city* are precisely the folks who will take water, while the inhabitants of the districts are those who, to considerable extent, will not, because they cannot afford it. Now if Boston were supplied with water, it would be just as absurd to select a half dozen streets, where necessity or choice should induce every occupant to take it, and hold them up as an example of the consumption of water in this city, as to abstract the *city* of Philadelphia from its suburbs, and hold that up as an example. The true way and the only way worthy of the slightest regard, is to take the *whole water district*, as well the suburbs as the city. You then get the *mass* composed of all classes; those who can and will, and those who cannot and will not,

take the water. Hence, although Mr. Hale may be correct in stating that the *city* consumes twenty-eight or even more gallons per day per head, so is Mr. Shattuck doubtless correct in stating that the consumption of the *water district* is only eighteen gallons per day per head. Now which is the true method to adopt? Most certainly *the principle* adopted by Mr. Shattuck is the true one. Mr. Hale may, with propriety, say that such a principle does not give a perfectly true result, because there are parts of the districts to which pipes do not extend, and that of course the option of taking is not extended to all. This may be true; but it only shows the difficulty of making a calculation that is entirely correct — it no way justifies the use of one obviously and clearly incorrect.

I am aware that Mr. Hale makes the distinction, and speaks clearly enough of the *city;* and yet, from keeping out of view the true character of the city and the true character of the districts, and the intimate connection between them, and limiting himself to the consumption of the *city* alone, I think he has done the subject injustice, and induced others to form notions of the consumption of water, which well-established general facts, or even *all the facts* of this particular case, will not at all justify.

Philadelphia city was supplied with foreign water about 1780, and has had it ever since. Successive works have been erected, the present one having gone into operation in 1822. In 1826, the districts were supplied; and at the end of 1831 the consumption of the whole water district was about 11 gallons per head per day. Now considering that the *city* portion of the water district had taken foreign water 50 years, and the *district* portion had taken it for over 5 years, and the *whole* had arrived at a consumption of only 11 gallons, is it unreasonable to suppose that the city commenced with much less, and that it would be a very moderate time to allow *both* 10 years to come up to a consumption of 10 gallons per head per day? If so, how very liberal is it to allow Boston to commence with a consumption which was not attained there in less than 10 years.

Besides Philadelphia, Mr. Hale takes London as an example. Mr. Hale affirms, on the authority of the evidence taken before the Parliamentary commission in 1843 and '4, that the consumption of the Metropolis was equal to $24\frac{1}{4}$ imperial, or near 29 wine gallons to each inhabitant. I suppose Mr. Hale took this from Mr. Wicksteed, (Quest. 4484.) It is only an estimate or supposition, not derived from actual data; and though an opinion, or off-hand estimate of Mr. W. is generally worthy of confidence, yet I think this is not. For as London is supplied by eight different and independent companies, nothing can be clearer than that nobody could be authorized to speak

for them all. The agent or engineer of each company might speak for that company and for no other; and from these answers of all, an aggregate might be made up. Mr. W's. statement was made merely as a basis to calculate the expense of pumping, and not to give any information as to the quantity consumed.

Now in the volume above referred to is the testimony of several of the engineers of the different companies, to which I beg to call the reader's attention. W. C. Mylne, the engineer of the New River Company, (as his father was before him,) states (Quest. 5760) that "the population within the district is nearly 900,000 individuals:" that is, nearly half the population of the metropolis; and I believe it is generally supposed that this company supplies about as much water as all the other companies. Quest. 5716, "What is the quantity of water at present (March 21, 1844) distributed by the New River Company? *Ans.* The average annual quantity of water supplied by the New River works for the last 3 years has been 614,087,768 cubic feet." A cubic foot is $7\frac{1}{2}$ wine gallons. Hence the amount furnished annually is 4,605,658,260 wine gallons; or 12,618,242 gallons per day. Apportion this quantity among 900,000 individuals, and it gives to each almost exactly 14 gallons per day. Now I do not see where there is room for error in coming to this result.

Mr. Wicksteed puts the consumption in the East London district at 18 gallons daily per head. I suspect he means those who take it, but it is not certain. Mr. Quick, the engineer of the Southwark Co., computes that district (Quest. 5874.5 and 5926) to contain 23,000 tenants; — 18000 take water, and 5,000 do not. At 6 individuals to a tenant, the population is 138,000, and the supply is 2,160,000 gallons per day, which yields $15\frac{2}{3}$ gallons per head per day. In regard to 1000 of their tenants, Mr. Quick remarks they are "consumers, having manufactories, tanners, fellmongers, hair-washers, glue-makers, curriers, dyers, hatters, brewers, distillers, steam engines, railway stations, hospitals, &c. which take large supplies."

Now taking what I suppose, but do not know, to be true, that the gallons of Mr. Wicksteed and Mr. Quick are imperial, equal to about 5 quarts, and that Mr. Wicksteed allows 18 gallons to *each inhabitant*, (which I doubt) the supply to an inhabitant in East London district is near 23 wine gallons, and in Southwark district about 19 wine gallons.

The supply of New River we have seen is .	14 gallons
East London is	23 "
Southwark is	19 "
	3) 56
Average . . .	$18\frac{2}{3}$

Here then we have the particulars of 3 out of the 8 water districts of London; and we find that the average supply to each inhabitant daily cannot exceed 18⅔ wine gallons. Now what can there be in the other 5 districts, embracing a population that cannot exceed 6 or 700,000, or say ¾ of the New River district, that can call for such an *enormous* consumption of water as shall not only go themselves, but shall carry all the other districts with them, embracing twice their own population, up to 28½ gallons per day? It is utterly preposterous to suppose any such thing.

On the contrary there are abundant reasons for supposing that the remaining districts would not increase the average, but rather diminish it; for it is well known that the west of London embraces the population which quits the Metropolis in the warm weather, and is also more free from manufactories than the more central and eastern parts. I can therefore find no reason to suppose that the actual consumption of London at this moment exceeds 18 wine gallons per day per head.

And I find the common statements of the enormous consumption of water in London have not passed without suspicion on that side of the water. Mr. Thorn, whom Mr. Hale quotes, says in relation to them, "I have seen them and heard them explained. Judging from my knowledge of the facts in other towns, I should say that the quantities set down were seldom delivered;" and afterwards he says "these facts lead me to question reports which state the *family supply* beyond 13 (16 wine) gallons, per diem. In London, doubtless, the quantity used for watering streets, for public works and the like, must be very great."

B. G. Soper, Esq., resident in London, who made a report upon the filtration of water, (p. 168, Appendix,) is incredulous in regard to the reported large quantities of water consumed in families. He says: "I will state some experiments I have recently made to ascertain the real quantity of water consumed in a private family. These experiments have convinced me that there is considerable misstatement or miscalculation on the subject of the supply of water to private houses.

"My family consists of five grown persons and six children;" have two cisterns, both together of a capacity of one hundred and fifty imperial gallons; "the water being turned on three times a week, if both cisterns were entirely empty before the water came in, the total consumption would be four hundred and fifty gallons per week." But from repeated guages, is certain that the "whole consumption of water in my family does not exceed three hundred and fifteen gallons per week, or forty-five gallons per day." This being

for eleven persons, is about four imperial, or five wine, gallons per head, per day. He adds, "that from twenty to twenty-four dozen of linen are washed in the house, weekly," and "I am not aware that any economy is particularly practised by the servants, or that there is a deficiency in the common amount of scouring and waste usually practised." After such an experiment, he might well doubt the usual estimates.

William Gravatt, (p. 259,) the engineer of contemplated works at Bristol, intended the works to be competent to afford twenty gallons, per day, to each inhabitant; but says, "the quantity persons actually require, is very much less. I have taken some pains to find out what quantity of water which families, *who are cleanly, and are abundantly supplied*, would use. I have (at Bristol) allowed twenty gallons a head, but the quantity that a family will use is only four gallons a head each day," (or five wine gallons, agreeing in this respect with Mr. Soper's experiment.) He adds further: "The actual consumption of water of an English family — a man and his wife and three children — taking the cleanest of several families of the working classes, was under twenty gallons a day, (or four gallons, five wine gallons, a piece.) This is far greater than the average of a great number; where I saw, on going into their houses, that they were clean, I ascertained this to exceed by far the quantity they could use."

Having then, as I conceive, shown that in regard to both, London and Philadelphia, the consumption of water ought not to be taken at over eighteen or twenty gallons per head per day, instead of twenty-eight and a half, as taken by Mr. Hale; I will now refer to the consumption of other places, which are esteemed to be well furnished with water. Mr. Thorn, as quoted by Mr. Hale, says, "the quantity supplied to Glasgow did not amount to thirteen (sixteen wine) gallons for each, and nearly one quarter was suffered to run to waste." "In Perth, the quantity supplied to each individual, was only eight gallons. In Grenock and Paisley, where the pipes are kept constantly full, and there is nothing to prevent the people from using what they please, the quantity taken is less than twelve (fifteen wine) gallons for each." "Plymouth has only ten gallons per head — man, woman and child." At Ashton-under-Lyne, where, according to a Report of I. R. Coulthart, Esq., the supply is most copious, (p. 75, appendix,) "fifty-five gallons per day to each house, or ten gallons per day to each individual," is given; i. e., to each who take the water, but considerably less when averaged upon the whole population. Large quantities are used for manufactories which are excluded in this estimate.

At Nottingham, Mr. Hawksley, the engineer, says (p. 136, appendix,) "it is impossible to state the quantity of water consumed by each class of tenants, as all take it *ad libitum*. The quantity delivered by the Trent Water Company, is after the rate of seventeen or eighteen gallons per diem, or eighty or ninety gallons per house, but this is inclusive of trade consumption," and is estimated on those who take the water only, and would be much less if averaged upon the whole population. The works went into operation in 1831, and in 1844, only two thirds of the houses took water. Mr. Hale refers to the case of Nottingham (p. 29); and unless the reader were particular to notice the distinction between water-takers or tenants, and the whole population, he would be likely to derive a very erroneous impression (as Mr. Hale appears to have done) of the water consumed in that place per head of the whole population. Mr. Hale goes through some statistical arguments, the force of which I hardly see, but the result, I apprehend, is clearly erroneous. There are but four and a half individuals to a tenement, and Mr. H. infers that each person has twenty-five wine gallons per day. Now Mr. Hawksley distinctly states (Q. 5248) that he supposes the consumption in a laborer's family to be forty gallons per day (or fifty wine gallons); which, divided among four and a half persons, is about eleven wine gallons per head, of those who actually take the water; and this would be reduced one third, or say to eight gallons, if averaged upon 50 per cent. more, or the whole, population. And it is to be kept in mind that the water-takers here have the water on at all times, and may draw it, for use or waste as they see fit, at any hour, day or night. And as five-eighths, at least, of their tenants appear to be of the laboring class, it shows that a very large proportion of the water supplied goes to the great consumers, such as "brewers, dye-works, steam-engines, and inns, and other places of large consumption."

But Mr. Hale (p. 28 and 29) says: "There are other towns which are supplied at a rate exceeding the estimate of Mr. Thorn, above stated. The situation of the town of Preston is described in the testimony of the Rev. I. Gray (should be Clay) before the above-mentioned commissioners, as having been very similar, before the establishment of a water company, to that of Boston at the present time, except that it is much smaller." Having then a place, acknowledged to have been as Boston is, I suppose the experience of that place in the enjoyment of water, may be taken to illustrate what that of Boston will be in the enjoyment of a like blessing. It becomes of some importance, then, to get at the facts.

In stating this case of Preston, I will quote Mr. Hale's, supplying in brackets such additional facts or remarks as seem relevant. "Water

was supplied from various sources, wells, pumps, water casks, rain water cisterns, &c., besides private works erected in 1729 [answering to our Jamaica Pond works] which afforded a limited supply. Under an act of Parliament, [obtained in 1832, and took near 2 years to get into full operation] the Preston Water Works Company had been established, which brings in an abundant supply of excellent water from a distance of 7 miles. Already [i. e. in 10 years] more than half the houses in the town, 5,026 out of 9,994 are supplied with water by the company, and there is [i. e. was "during the last three years"] an increase in the number who take it of about 400 annually." [If this increase has been regular, what was the original number of water-takers?] Omitting a few sentences not important, Mr. H. goes on thus, "The average supply is about 80 gallons to each house daily, factories and public establishments included. ["The quantity of water provided is at the pleasure of the consumer, the mains being constantly full and at high pressure."] This is equal to 16 imperial or 21 [20] wine gallons to each individual supplied [but as only half the individuals are supplied the amount averaged upon the whole is but 10 gallons] of a chiefly laboring population [like that of Boston,] and evidently [?] with a small allowance for public and manufacturing purposes." *Evidently!* "By means of the company's fire plugs, and carts adapted to the purpose, the police commissioners are enabled, in dry weather, to promote the public comfort and convenience by regularly watering the principal streets." "Fire plugs are placed in all the streets, &c." in which there are mains. "The quantity is at the pleasure of the consumer," factories and all. These quotations are from Mr. Clay. But Mr. Robert Anderson, manager of the Preston water works, gives some additional facts, *p.* 159, *Appendix*. He says, "Our actual consumption of water is 76 gallons per house (daily,) *but this includes all the large consumers*, OF WHICH WE HAVE A GREAT MANY IN MILLS AND RAILWAYS. [Here is the *evidence* of "a small allowance for public and manufacturing purposes."] The average consumption in tenements of the laboring class — [such, "chiefly," as mentioned above] is 45 gallons daily," [so that the public and manufacturing purposes consume the "small allowance" of the difference between 45 and 76 gallons to each individual water-taker, or a trifle over 40 per ct. of the whole.

Here then we come to a result in a town which *was* like Boston, and which it is expected, in the consumption of water, Boston may emulate. After having had a full and abundant supply of water 10 years, half the people take it and half do not; those who take it consume 15 gallons per head daily, (76 per tenement of little over 5,) or 19 gallons wine measure; but as only half take it, the consump-

tion averaged upon the whole population is $9\frac{1}{2}$ wine gallons per head per day. And yet I am not considered "liberal" because I think that Boston, whose situation is granted to be similar to that of Preston, will not require at the outset a supply greater than Preston has been growing up to in 10 years.

Here I close my reference to the consumption of water in other places. I have taken considerable pains to come at facts; and have endeavored to learn the lesson which experience would teach. It is idle to suppose that people here are going to do very differently from what they have done elsewhere; and so far as we have regard to the general practice elsewhere, we shall be in no danger of important errors. I have made no allusion to New York; for she has so entirely disappointed all calculation, reasonable and unreasonable, that I believe she is regarded on all hands as an anomaly.

And what does experience teach that bears upon the proposition under consideration? Does it teach that when our works are finished, the demand for water will exceed 10 gallons per head per day? Certainly not; — but on the contrary that this amount is "very liberal," and considerable time will be required to grow up to such a consumption. Does it teach that the consumption will come to 28 gallons per head per day in less than 30 years? No such thing; — but, on the contrary, that the consumption of Boston will not attain even to 20 gallons in 30, if it does in 100, years. Here then is a great gain upon my former estimate; a gain, sanctioned, as I conceive, by all experience without exception. Should, therefore, any one consider the minimum of 10 gallons to begin with too small, but that 20, as a maximum, is sufficient, he may considerably increase this minimum, without at all impairing the general result of my former calculations; while those who think 10 gallons to begin with, and 20 gallons to grow up to, are quite adequate and sufficient, will not fail to notice how *very far* within the truth those calculations really are.

The second element, assumed by me as a basis to estimate the demand for water, was, *that the population of Boston might be* 120,000 *when the works were completed, and might reach* 180,000 *in* 15 *years;* and my estimates were made on such a number and such an increase. On this point Mr. Hale says nothing; and, of course, I suppose I may assume that it meets his views. Although I conceive that the complete establishment of my points does not require me to reduce this estimate, yet there are certain facts which I did not before take into account, and which have so important a bearing upon this question, that I hardly feel justified in omitting to notice them.

In the first place, if the population be 120,000, when the works are

completed, they will not all be dependent on the contemplated works for water. To say nothing of East Boston in this connection, it is entirely reasonable to assume, that the Boston aqueduct will continue to supply to the extent of the present works, if not to the capacity of the pond. The present company will reduce their water rents to the city's scale, and they will be certain to retain their customers; and if the city should ever distribute water gratis, *for domestic purposes*, it will then be for the interest of the city to purchase those works at a fair value, and to use them to supply the southern district: so that, whatever may be the policy of the city hereafter, I do not see any reasonable ground to doubt that those works will be relied upon for such supply as they can afford.

These works, I believe, are now supposed to supply about 30,000 inhabitants, situated in different and remote portions of the city. But as the supply is, to a considerable extent, partial and insufficient, and in many instances delivered under great disadvantage, I suppose it would hardly be prudent to rely upon these works to supply a greater district than 25,000; and if that district be selected, so as to deliver the water under the most favorable practicable circumstances, I do not know of any reasonable ground to doubt that it may be fully supplied. If, then, we deduct from the supposed population of Boston at the completion of the works, (120,000,) the district supplied by the present works, (25,000,) we shall have only 95,000 inhabitants relying upon the contemplated works for a supply; and the expenses necessary to deliver 10 gallons daily to 120,000 persons, would deliver nearly $12\frac{2}{3}$ gallons to 95,000: so that the calculations in the *Remarks*, which gave only 10 gallons, are really good for $12\frac{2}{3}$ gallons, to each inhabitant in the district to be supplied.

Again, as to the increase of the city, or 180,000, to be supplied in 15 years. It is obvious that a great part of the increase to our population in the next 15 years is to be in East Boston, where the contemplated works can give no supply. I say *obvious*, because this increase must be on the outskirts somewhere, and the circumstance that the lands in East Boston are in the hands of individuals who are always alert in crowding them into the market, while those on the neck belong to the city, in whose behalf no such alertness is usually exercised, will, I conceive, operate, for many years to come, to bring into occupancy the lands of East Boston much faster than the vacant lands in the city proper. I conceive, therefore, that it is a very reasonable estimate to allow to East Boston a population of 25,000 at the end of 15 years. Here, then, will be a population of 25,000 which cannot be supplied, and another 25,000 which will be supplied from another source: making 50,000, to be deducted from 180,000,

to be supplied 15 years hence: leaving only 130,000 to be supplied at that time, or 10,000 more than were allowed in my former calculations to start with. I do not care to trouble the reader to go through a calculation to see how strongly such facts fortify my former calculations. Their bearing is obvious, and their precise value may be readily calculated. Here, again, the reader cannot fail to notice how *very* far within the truth my former calculations, based upon population, present and prospective, really are.

I now come to the third and last element or ground of calculation, adopted in the *Remarks*, viz., *that the estimates of* 1837, *in regard to Charles River as a source, were to be relied upon, and might be reduced in the ratio that coal and other leading articles had since fallen in price, and also somewhat by the increased facility in the manufacture of engines*, &c. Mr. Hale admits that the estimates for pumping are sufficient if the works were "executed under his (Mr. Treadwell's) supervision;" that is, sufficient for the work then estimated, but not for the addition I put upon them for a part of the time. But he objects to various deductions made by me, which I will notice in detail.

1st. *As to fuel.* "The reduction" made by me, he regards as "excessive by at least one half." On what grounds he objects to my reduction, I am at loss to conceive, as he gives none. The estimate of the comissioners of 1837 was based on using bituminous coal at $10 per chaldron. I reduced it to $8 per chaldron in this way, viz., by "the general reduction which has since taken place in fuel, the substitution of anthracite for bituminous coal, and the improved methods of generating steam since adopted." Now, is this reduction unreasonable? It is certain that there has been a general reduction of fuel within that time. It is certain that anthracite has been substituted for bituminous coal, to a great extent, within that time. And I supposed also, that new (and I presume improved) methods of generating steam have been since adopted, certainly to the extent required by the above change of fuel, if no further. To substitute $1\frac{1}{3}$ gross tons of anthracite for 1 chaldron of best bituminous coal, is, I suppose, very liberal — more so than need be. I submit, then, that an allowance of $6 per gross ton for anthracite (or $8 for $1\frac{1}{3}$ tons) is a *very* liberal price. Hence I conceive I have a right to insist, that the deduction I made is a fair one, even if there have been no improved methods of generating steam adopted since.

But it is truly surprising that Mr. Hale should object to this deduction; for in a written estimate which he submitted to the committee of the legislature, when he was giving testimony before it, he himself put down bituminous coal to $8; — just as I had done. Why he thinks this too low now, does not appear.

2d. *As to cost of engines.* I made a deduction on the estimated cost of engines in 1837, of 10 per cent. or $7,000. To the whole of this Mr. Hale objects. The grounds of this deduction are thus stated by me: "The two engines are heavy items in the cost (say $70,000) and are constructed almost entirely of iron. It is not obvious, therefore, why a similar reduction on the iron used for them should not be made as upon that for the pipes." (I had just gone through with a reduction of $\frac{2}{7}$ths on the cost of the pipes, to which Mr. Hale does not object.) "There can be no doubt, too, that, in the last seven years, important improvements have been made in constructing engines; so that from both considerations, it appears to be a moderate assumption that engines, of the capacity estimated, can be constructed 10 per cent. cheaper now than in 1837." But Mr. Hale will allow no deduction on either of these grounds. But if there had been a fall in iron, (as there notoriously had been at the time of writing) why should not the cost of the engines be reduced to that extent? Surely there can be no reason. Then as to improved methods of constructing engines; — if nothing is dispensed with or altered now that was in use then, surely the vastly increased demand for engines since, must have given important facilities in manufacturing them. New methods, by which labor and expense are saved, are introduced into every species of manufacture; and the competition growing out of a brisk demand is constantly operating in the same way to reduce price. In whatever way I am able to look at this matter, I do not see the slightest ground to question a reduction on the cost of the engines to the extent proposed.

But besides these deductions from indisputable facts, a letter was submitted by Mr. Derby to the legislative committee from Messrs. Hinkley & Drury, engine builders of this city, of established reputation, in which they offered to construct an engine that would raise 2,304,000 gallons, *of* 10 *lbs. each*, 100 feet high in 10 hours; — but as the weight of a gallon is usually reckoned only 8 lbs., the work would be equal to raising that quantity 120 feet, or to the top of Cory's Hill, — for 22,000 dollars. The pumps, gearing, fixtures, and other matter ready to put in operation, were supposed to be from $2,500 to 3,500 additional; — say in all, $25,000. Here instead of having a deduction of 10 per cent. on the cost of 1837 ($35,000), we have a saving of $\frac{2}{7}$ths, or near three times as much as I asked. Besides this, we are offered an engine that will do in 10 hours nearly as much work as one of those of 1837 would do in 20.

So far then as the deduction of 10 per cent. on engines is concerned, I think I have shown that it is not unreasonable; and that Mr. Hale has no just ground to object to it. But, on the contrary, a larger deduction might have been reasonably made.

Again, Mr. Hale objects that I have put upon the works more labor than was contemplated by the commissioners; and "that so far as the estimate of 1837 is relied on for an authority, it should be taken as conclusive only for the quantity for which the scale of work was specially adapted." "It is, therefore, unreasonable to assume the estimate of 1837 as sufficient for a greater permanent practical effect, than the works proposed were designed to produce." Let us look at the details of this plan of 1837. The first and largest item in the proposed works was the pipe from the source to the reservoir. The next was provision for *two* engines, each of which would do *all* the work in 20 hours per day. Now as to the pipe, why may it not convey water 24 hours as well as 20 hours? It is an arm that never tires; and if no more strain is put upon it in the additional 4 hours which it is used, it is not obvious why it may not be so used. The proposed conduit from Long Pond is to convey water 24 hours in the day; and it is not very obvious why as strong an objection may not be made to that arrangement, as to imposing a similar constant service upon an iron pipe. The only ground of objection that seems to me can be entitled to the least consideration, is afforded by the circumstance that my calculations *sometimes* required *both* engines to be at work at the same time; thus increasing the velocity of the water in the pipe. How much, if anything, this may be worth regarding, I am not prepared to say; and it is hardly worth estimating, as the time is so short in which this extra duty is required, as we shall see.

And as to the engines, no *theory* requires that *half* the motive power should be constantly idle. *Prudence* requires that there should be a spare engine to resort to in emergencies; and it comes to pass in this case that the spare engine is half the motive power provided. But if the work to be done required 3 or 4 engines, still it would not be necessary to provide more than a single spare one; — just what it is necessary to provide in this case, where the work is only that of one engine. Now the utmost labor, which any of my calculations imposed upon the *two* engines, was to raise 3,420,000 gallons per day, for a short portion of the 15 years. This is near $27\frac{1}{2}$ hours' work of *one* engine, or $13\frac{3}{4}$ hours of two. I put the question then to practical men, if this be an unreasonable effect to rely upon the engines to produce? Is not *reasonable* provision made for all ordinary contingent interruptions? I think there is; and more especially, when it is further taken into consideration that all engines are tested by a pressure many times greater than that under which they ordinarily operate; and for limited periods may be safely relied upon to perform twice their ordinary work.

I find that for 13 out of the 15 years, on which I calculated, no more than the labor of one engine is required, and no increase at all in the velocity of water in the pipe. If, then, it should be found practically expedient to increase the works or engines at the end of 13 years, instead of 15, the result will not very seriously affect my calculations. Still I regard the probability much more reasonable that the new outlay will not be required in 20 years, than that it will be needed in 13.

There is another item, introduced by Mr. Hale, to be noticed. He says, that to the estimate of 1837 for water rights, "we must add for increased value of the water right at Watertown at least $25,000." The estimate of 1837 was $15,000, of course Mr. Hale's present estimate is $40,000. It is admitted on all hands that the water of Charles River, in the dryest time, equals 40 cubic feet per second. All that Long Pond yields is 12 feet per second. But the commissioners allow 1 foot for loss between the pond and reservoir, relying only upon receiving 11 feet per second. As it is proposed to lose nothing between the river and reservoir, the present course of my argument does not require that the *whole* water right of 40 cubic feet should be purchased; it would be sufficient to acquire a right to draw 11 cubic feet per second out of the 40; and it would not be material whether this right were the *first*, *second*, or *third*, provided it came within the 40. Now it comes to pass that the water power at the Watertown dam is divided into various distinct rights, which may properly he denominated first, second, &c.; — the first drawing to the extent of its right to the exclusion of the second, and the second to the exclusion of the third, and so on. The *first* and *second* rights of water are now used to operate two distinct mills. *The first*, a *grist mill, with all its right of water and appurtenances of every kind*, together with *one third* the water right of the *second* mill, together with an undivided half of another piece of property, is in the hands of a single individual; and I have in my pocket book a bond executed by him, by which he obligates himself to sell me, or to my order, the whole of this property for $25,000. If the city shall wish to avail itself of this obligation, it shall freely have the power to do so.

As this grist-mill has the first right to water, it is obvious that nothing more need be purchased, if its right to draw be adequate to supply the city, or be equal to 11 cubic feet per second; and if so, all the other pieces of property may be at once sold. I have therefore taken some pains to ascertain what the right of water attached to this mill is; and from the best information I can obtain it amounts to 30 cubic feet per second, or near 3 times as much as we are to get from Long Pond.

This one mill, then, having the first right to 30 cubic feet per second, its value, even in dry times, can be affected but little for many years by the draft the city will make upon it. 4 feet per second will give near 2,600,000 gallons per day; and this is less than $\frac{1}{7}$ of the power. And it is to be borne in mind that during 8 or 9 months in the year, the water wastes over the dam, and the draft of the city would injure no right at all; and that it is only during 3 or 4 months in the year, that the mill privilege would be affected by such draft. Hence it appears to me quite certain that a right to draw from Charles River more water than can be had from Long Pond, can be obtained for a sum considerably less than $15,000, the estimate of 1837. On the ground that the water power of the grist mill has been accurately cast, which I have no reason to doubt; and that there are no flaws in the title, which I have no reason to suppose; I should esteem it a very satisfactory business transaction to sell the city the right to draw forever any amount of water it would bring into the city, under 24 cubic feet per second (or twice the product of Long Pond), for $15,000, or the bare estimate of 1837.

I believe I have now noticed all the points of objection made by Mr. Hale to my former estimates; and I trust I have shown satisfactorily that those objections are generally not entitled to any weight. But, on the contrary, that the positions taken by me are far within the truth.

Mr. H., however, has introduced an estimate of the cost of pumping at the new water works at Philadelphia, which I beg leave to notice. By this estimate, the expense of pumping $2\frac{1}{2}$ millions, daily, 115 (not 127, as stated by Mr. Hale) feet high, is, $531,000
My estimate for pumping the same quantity, is, 471,000

$ 60,000

Mr. Hale says of the former: "This is near $100,000 (not very near) over the estimate of Mr. Wilkins, although the distance which the water is conveyed is but one mile, instead of $3\frac{1}{4}$ miles."

Feeling much surprise on seeing this estimate, I took occasion to address the engineer (W. E. Morris, Esq.,) and made some inquiries in regard to its accuracy. His answer confirms its general correctness, but states the height to be 115 instead 127 feet. But Mr. Morris gives a key to the great expenditure. The duty of his new engines (like most others in this country) does not exceed 15 millions pound, one foot high, with a bushel of coal. The duty of the engines estimated in 1837, (and which, Mr. Hale thinks, may be relied upon if constructed under Mr. Treadwell's supervision) was 60 millions, or four times that of Mr. Morris's engines. Of course, Mr. Morris con-

sumes 4 times as much fuel as would be required on the plan adopted by the commissioners of 1837. The estimated cost of coal per year, for the Philadelphia works, is, $9,100; $\frac{3}{4}$ of which is consequently lost, = $6,825. This sum represents a capital, at 5 per cent., of 136,500; which taken from the estimate 531,000

136,500

leaves $394,500

as the cost of raising $2\frac{1}{2}$ millions in Philadelphia, on the principles adopted in 1837. This is $70,000 less than my estimate. Mr. Morris says, the "pumps are driven by condensing crank engines, intended to work expansively, but the cut-off valves not yet used. A material saving is anticipated, when the half stroke is put in operation." It apppears, therefore, that the engines, at present, work to disadvantage, and consume more fuel than they will when completed; and, as they now work, the practical effect is near 10 per cent. greater than the estimated.

I cannot but express surprise that such works should have been constructed at this day. Mr. Morris says, "I was desirous to see at our new works this kind of machinery (referring to the Cornish engine) introduced. But anxiety to secure cheapness of first cost, and apprehensions of delay and failure arising from the novelty (in this country) of the work, prevented its adoption by the water commissioners." He adds: "There are engineers in Philadelphia, who, I believe, would be willing to construct steam water-works, and guaranty double the above stated performance," (or a duty of 30 millions lbs.)

Under all the circumstances of such a case, one would about as soon expect that water commissioners would resort to actual horse-power to pump their water, and estimate the expense by the quantity and price of hay and oats, as to such machinery.

I shall have further occasion to consider the practical duty of engines.

I have now gone over all my former propositions;—have examined them anew, and the several grounds on which they were based. The result is a conviction of their truth. I have endeavored to do this in a fair and liberal spirit, in regard to points involving expense; and to err, if at all, upon the safe side. The result is a renewed conviction, that, on the principles then adopted, the saving of $436,000, as then stated, may be effected, without the slightest detriment to the supply of the wants of the city, by resorting to Charles River instead of Long Pond. All the reasoning by which such a conclusion was reached, appears to me to be valid and irrefutable. But if we qualify my former conclusions by what I *now*

believe to be facts, viz., that the population of the city, to be supplied by the contemplated works, present and prospective, was then much over-estimated, and the maximum consumption per head was also much over-estimated, I can see no good reason to question that the saving would far exceed this sum. For myself, I think this sum worth saving, " and that it is an economy worthy of the attention of the city ;" — whatever views of such economy may be entertained by Mr. Hale and the advocates of Long Pond.

But, after all, the scheme of introducing 7 millions gallons of water per day, is so magnificent, and spreads such an extent of canvass to the breeze of popular favor, when compared with one that at present promises but $2\frac{1}{2}$ millions per day, though in the end it promises even more than the other, that it becomes a matter of some moment, if it can be done as I think it can, to take the wind out of that sail, by showing " *that the whole 7 millions gallons can be delivered* NOW, *at the outset, into the reservoir on Cory's Hill, cheaper than it is estimated to bring the same quantity from Long Pond.*"

When Mr. Hale was examined before the committee of the legislature, he gave in for the use of the committee a written estimate of the expense of delivering 7 millions gallons daily at Cory's Hill from Long Pond and Charles River.

In this statement, all land and water damage was omitted entirely, in both estimates ; and a few unimportant items were also omitted in the Long Pond estimate. I subjoin a copy of this statement, so far as relates to the point in question, putting in, in brackets, the items which were omitted, and which should clearly be embraced. I do this to save printing the statement twice.

Estimate of supply of 7,000,000 gallons of water per day, by pumping from Charles River, on the basis of the calculation of 1837 — corrected for the increased amount of supply, and also for reduced cost of materials.

Cost of Construction.

Reservoir on Cory's Hill, same as Long Pond estimate,		$30,715
2 iron pipes, 30 inches diameter, 3 1-4 miles, 33,820 feet, at 9 63 (per foot) same as Long Pond estimate,		325,686
4 Stop cocks,		1,000
[4] Engines, double the estimate of 1837, which was for 2 1-2 millions gallons in 20 hours]		126,000
Buildings, &c. estimate of 1837 increased 50 per cent.		33,000

Annual Expenses.

Coal for 2 1-2 millions, 507 chaldrons, for 7 millions, 1420 ditto. at $8, delivered at [Charles River] instead of $10, as estimated in 1837,	11,360	
Superintendent, Enginemen, Firemen, Wear, Tear, Insurance, &c. [estimated, in 1837,] at	6,738	
Add to above 50 per cent.	3,369	
		10,107
[Expenses] per annum		$21,467
Equal, at 5 per cent., to a capital of		429,340
[Water rights and land damage, as per Report, 1837]		18,949
		964,690

Estimate of same supply from Long Pond,	749,191
[Water and land damages, as per Report, 1844,]	121,600
[Sundry small items omitted from page 32]	4,700
	875,491
[Making a difference in favor of Long Pond,]	89,199
	$964,690

According to this estimate, corrected, so as to cover the land and water damages and a few items omitted, Mr. Hale's statement shows the Long Pond scheme to be cheaper than Charles River by $89,179.

Now the first thing to be noticed in this paper is, that though it purports to be an estimate "on the basis of the calculation of 1837, corrected for the increased supply, and also for reduced cost of materials," this basis is soon abandoned. In this estimate is an item for *two* iron pipes of thirty inches each. But why two, instead of any other number, would not have occurred to any one, from inspecting the paper alone. In the estimate of 1837 there was only *one*, and that of twenty-one inches. And taking that of 1837 as a basis, and correcting it "for the increased supply," what is required? Of course *one* pipe, that shall bear the same relation to that of 1837 as the increased supply bears to the supply of 1837. This is obviously the true problem — and the whole of it. The increased supply is 7,000,000 gallons per day; and the supply of 1837 was 3,000,000 gallons per day. What is wanted, then, is a pipe whose capacity shall be to that of one of twenty-one inches, as seven to three. By calculation, this is found to be one of thirty-two inches diameter; only a little larger than *one* of the two here estimated for. That is, *one* pipe of thirty-two inches diameter will deliver 7,000,000 gallons in the same time, and under the same circumstances, that one of twenty-one inches will deliver three millions; and it will deliver it with a less proportional expenditure of power, because the friction in a large pipe is proportionally less than in a small one.

Here, then, instead of providing *two* pipes of thirty inches, we have only to provide *one* of thirty-two inches; and the estimate must be corrected by the difference in cost.

Now the *two* iron pipes, of 30 inches, are here estimated to cost $325,686; of course one costs	$162,843
By the ordinary rules of increase in cost as the size is increased, there should be added for a 32 inch pipe a trifle less than 12½ per cent.; but call it 12½ per cent.	20,355
The cost of *one* 32 inch pipe	183,198
Take this from the cost of *two* 30 inch pipes	325,686
Makes a saving of	142,488
Now take from this the balance against Charles River, as above stated,	89,199
Leaves in favor of Charles River,	$53,289

Here, then, we come directly and irresistibly to the result, that

7,000,000 *gallons per day can be delivered into a reservoir on Cory's Hill cheaper, by* $53,289, *than the same quantity can be delivered at the same place from Long Pond.*

It seems to me that the propriety of the corrections here made is too plain to leave any doubt. But I should hardly do justice to the argument if I omit to notice at least one other item. I refer to the engines. Allowance is here made for 4 engines, each of which will deliver 3 millions of gallons in 24 hours. Of course 7 millions requires two engines to be at work all the time, and one a third of the time. In other words, one engine is allowed to be idle all the day, and another two thirds of the day. I can entertain no doubt but that this allowance is too large, and is unreasonable; and I think one engine might with safety and propriety be dispensed with. But as my proposition will permit me to be liberal, I will allow provision for three engines, any two of which will do all the work, leaving one to be resorted to in emergencies. This plan would require the three engines to be increased in power $\frac{1}{6}$th each, or the three should have the power of $3\frac{1}{2}$, such as were embraced in the plan of 1837. But to increase the power of engines one sixth will not require an equally large increase of expense. I presume that $\frac{1}{10}$ added to the cost, will effect this increase of power. The cost of each engine in the above statement is $31,500, and three *such* will cost $94,500

add $\frac{1}{10}$ for increased power	9,400
Cost of the 3 proposed engines . . .	103,900
which deducted from the cost of 4 in the estimate	126,000
leaves a saving in engines of . . .	$22,100
Add this to the former balance	53,289
Makes balance in favor of Charles River . .	75,389

or something more than 8 per cent. of the whole cost.

But seven millions is estimated by the commissioners to be a supply for 250,000 inhabitants. Of course only a part of that supply is wanted at present, and the rest will be required nobody knows when. So that to this advantage here stated, of $75,389 in favor of Charles River, must be added all the saving that may accrue from the circumstance that only a part of this supply is wanted now, while the rest will be called for gradually, through an indefinite period of time.

Thus far the argument has been based upon the principles of the estimate of 1837. The foundation of that estimate was, of course, the *duty* of an engine, or the mechanical effect that might be produced by the consumption of a bushel of coal. This was assumed to

be 60,000,000 lbs. raised one foot high. This, although far exceeding the duty of any engines that have been set to pumping in this country, is still far below the practical result brought to pass in England. Mr. Wicksteed had an engine erected in 1838, to pump water for the East London works, which performs a duty of 90 millions, or 50 per cent. more than that estimated upon in 1837 by our commissioners. And this was not any hap-hazard result, brought about by a kindly working that nobody could account for. He says, "Messrs. Harvey & Co. were bound, under heavy penalty, to effect an average duty during 12 months' regular work of the engine, equal to 90 millions lbs. raised 1 foot, by the consumption of 94 lbs. of good Welch coals, *which was accomplished.*" (It is to be remarked, however, that it is only the best of bituminous coal that weighs 94 lbs. to the bushel. Generally it weighs less.)

Besides this result effected by Mr. Wicksteed, at page 170 Appendix to the Parliamentary Examination, so freely quoted from in the foregoing pages, may be found the following extract on

EXPENSE OF RAISING WATER BY STEAM POWER.

"To give a correct idea of the performance of the most economical steam engines yet constructed, Mr. Farey has made the following computations: —

"Taylor's engine, at United Mines, which has made the highest performance of any yet constructed, has, on an average of all the variations of its performance, during the 12 months of the year 1841, raised 92½ millions lbs. water, one foot high, by each bushel of coal which has been consumed by it; and in 1842, the average was 99½ millions.

"An average of the two years would be 95¾ millions. A bushel of the coal actually used is considered, on an average, to weigh 94 lbs., and if Taylor's engine be reckoned to raise only 94 millions one foot high, by the consumption of 94 lbs., then *one pound of coal will raise one million pounds of water one foot high.*"

No one is more sensible than I am that we are liable to disappointment in the results of mechanical operations, both favorably and unfavorably, in a manner for which we cannot easily account. But in the matter of a steam engine, where an effect has not only been produced, but been guarantied under heavy penalty that it should be produced, it is difficult to see why what has been done, may not be done again. If Harvey and Co. engaged with Mr. Wicksteed to make, under heavy bonds, and did make, an engine to effect certain results, why would they not engage with the city of Boston to do the same thing? Undoubtedly they would. And if they would do so,

I doubt not some of our own builders would do the same, even if they went across the water to obtain the necessary knowledge.

I cannot, therefore, see any good reason to doubt that the estimated duty of the engine, in 1837, is from 40 to 50 per cent. lower than need be ; and, of course, that the quantity of fuel might be estimated at the same rate less. It will be seen at once that such a saving in an annual expense would relieve the Charles River estimate of such a sum as could not fail to give it, in any possible aspect of the city's wants, a decided preference.

I had intended, in this connexion, to have obtained and presented some estimates from city builders of engines, to show what could be effected in the present state of that art or science as practised now. But I have been deterred from soliciting such proposals or estimates, because I did not feel free to put them to so much trouble with so little prospect as is at present offered of their obtaining a job.

From the foregoing facts and estimates, I cannot doubt, and I can see no good reason for other people to doubt, that a much larger quantity of water than 7,000,000 gallons daily can be delivered on Cory's Hill from Charles River, at the estimated expense of delivering that quantity from Long Pond.

I here close what I have to say upon Charles River and the expense of pumping.

A few other matters claim notice, and especially, the proposed conduit from Long Pond.

In my *Remarks*, I stated in relation to the Long Pond conduit, that " in this construction there is novelty so far as my inquiries have extended. I can find no example where a structure, so frail and unsubstantial, has been relied upon to perform so important service ; and for myself, I hope I shall never see it relied upon. If the Long Pond scheme is to be executed, let it be done on a plan less liable to failure, less liable to perpetual patching and repairing, than this project contemplates. But even at the best, a structure like this, if executed in the most substantial manner, like the Croton-works, is much less secure than one of iron pipes." Mr. H. questions all these propositions. Though there is a flavor of flippancy in the passage which I do not feel disposed to justify, I believe all the important allegations to be true. With regard to " novelty," Mr. Hale refers to sewers constructed in London, Philadelphia and New York, 8 inches thick or two courses of brick, as examples to the contrary. Now I do not regard them as pertinent to the point. In the first place, they are laid deep in earth, never disturbed. Those in Philadelphia are laid to the depth of 3 to 30 feet ; those in London never less than 10 feet deep (without the utmost necessity,) and varying to 20, 27, and even,

in one instance, to 68 feet deep. Now, I think, these are important circumstances that tend to give support to the structure. In the second place, they are not "relied upon to perform so important service," as the proposed conduit. If a drain gives way, the evil is local. It may obstruct a street for a few days, and put a neighborhood to inconvenience. But if the proposed conduit should fail, it would affect the whole city. No region would escape its injurious effects; while some could hardly endure them. I submit the point then, that, if all Mr. Hale claims for the strength and stability of the drains he names, were well established, it still would not obviate the charge of "novelty" in relying upon "a structure so frail and unsubstantial" "to perform so important service." The different importance of the services, I think, greatly qualifies the folly or wisdom of the risk incurred in their performance. As to the remaining point, that a structure of this kind, "if executed in the most substantial manner, like the Croton-works, is much less secure than one of iron pipes," I beg leave to quote from Messrs. Treadwell and Hale's Report of 1838, p. 16, as follows: "We believe, if anything may be relied upon for conveying water from one point to another, it is an iron pipe. Experience for more than half a century in Europe, and for many years in this country, attests its excellence. We may, therefore, consider this as PERFECTLY safe." I regard this as quite satisfactory authority as to the security of iron pipes. Now, the Croton conduit has been delivering water during three years only. It is notorious that it has repeatedly been examined, and repairs found necessary;—and these requiring a large expenditure. On p. 33 of Proceedings before a Joint Committee of the Massachusetts Legislature, &c., I find the following item in a statement for the year 1844, made by Mr. Shattuck, viz.

"From which (viz. amount of water rents for 1844) deduct the annual cost of maintaining the aqueduct from the Croton River to the city, about $25,000." If then iron pipes be "perfectly safe," it may be assumed that it would not cost $25,000 per annum to maintain them, as the Croton aqueduct appears to; and therefore I think the proof is furnished that works like the Croton, are less secure than iron pipes.

But even the sewers named by Mr. Hale, are not worthy the confidence and the commendation which he claims for them. The Philadelphia and New York drains have just been laid; and whether they will be successful or not, time will decide. It is not safe to deduce an argument from them; especially an argument which will be of little or no weight in regard to the present question, even if the sewers should remain firm. New York has built her palaces almost

to the clouds, with walls of 8 inches only; and, perhaps, Philadelphia has done the same. It is no wonder, then, that their underground masonry is of a like slight character. Experiments are so rife that no wonder they are tried in such cases. The disposition to run great risks for small gains, in this country, is so connate and urgent, that we perhaps ought to marvel less that these cities reduced their sewer walls to 8 inches, than that they did *not* reduce them to 4.

Let us look now to the London sewers, referred to by Mr. Hale. The English brick is $4\frac{1}{2}$ inches wide and 9 inches long; and generally I find that a brick in length and width is usually reckoned a wall of 14 inches. Hence those bricks are $12\frac{1}{2}$ per cent. greater than ours; and this difference may be of importance. As a small per centage upon the result of a voyage may often make all the difference between a good or bad voyage; so a difference in the size of brick, no greater than this, may make all the difference between a successful and unsuccessful experiment. The act of Parliament (1667) for rebuilding the city of London, (repealed in reign of George III.) directed, "that sewers 5 feet high and 3 feet wide, shall have side walls $1\frac{1}{2}$ brick thick, the top 1 brick on end; the bottom to be paved plain, and then 1 brick on edge circular." *Qu.* 3409. This act was without doubt the origin of the custom, which has prevailed, and still does prevail, in most of the districts of London, of building the side walls, let the form be what it may, $1\frac{1}{2}$ brick or 14 inches thick. Even when the form was changed, as it appears to have been in the *city*, still this thickness was preserved; while the Westminster and other districts retain both the form and thickness contemplated by the act. But within a few years, the Holborn and Finsbury districts have taken upon themselves to construct egg-shaped sewers with walls of 1 brick. As to the egg-shaped *form*, I am not aware that any one *objects* to it; though some do not allow it *any* advantages in regard to *strength*, and *many* do not to the extent claimed. As to the reduction of material in the Holborn and Finsbury districts, quite a diversity of opinion prevails among those who have these matters in charge in regard to its safety and expediency. There seems to be considerable feeling existing among the commissioners of the different districts in regard the Holborn innovations. Mr. Hale, with a little infusion of a spirit, which I have regretted as characterizing a single paragraph of my Remarks, has referred to the testimony of "four eminent civil engineers," as commendatory of the deviation. Mr. Hale stretches the testimony of these gentlemen to establish a point which, from a careful reading I am satisfied, was not in the mind of one of them. I mean the proposition, that an oval or egg-shaped form has "superior advantages in point of *strength*" over a circular

one. When these gentlemen spoke of the "greater" or "greatest" strength to be attained by this form, they were in their mind always comparing it with the Westminster form, and not with the circular. If Mr. Hale would establish this proposition, I think he must bring some other witnesses, and develop some new scientific principle. I have never before seen the proposition laid down, and, of course, never noticed any attempt to prove it. I will quote some testimony not favorable to Holborn form.

Mr. Thomas L. Donaldson, Chairman of the Westminster Commission of Sewers 8 years, and a Commissioner 27 years, examined. *Qu.* 4158. "Do you consider that a straight side is as much equal to sustain pressure as a curved side? *Answer.* Yes; built with brick." *Qu.* 4159. "You think a curved side has no greater power to sustain pressure? *Ans.* No, for the difference of form is made up of soft mortar." It is very plain, that, to obtain the full benefit of a curved side, the brick should be bevelled or radiated; in which case one witness (*Qu.* 2025) was in "doubt whether there would be the necessity for any mortar at all."

Mr. Richard Kelsey, Surveyor to the Commission of Sewers for the city of London, since 1832, examined. *Qu.* 3397. "What do you consider a good sectional form of sewers for a main sewer? *Ans.* If you have a semicircular top and a semicircular bottom, and straight sides, I think that all the conditions of a sewer are answered." This is the more candid from the fact that in his district the sewers are, mainly, of an oval form. *Qu.* 3406 (to same.) "You say that some of your sewers are elliptical, or egg-shaped, or oval? *Ans.* They are true ellipses some of them. Inclined sides have been largely used. They were introduced by my predecessor prior to 1823." *Qu.* 3408. "What are the dimensions of the brick work? *Ans.* 14 inches all round." *Qu.* 3409. "Do you not think that is heavier than necessary? *Ans.* I do not like to trust to anything else, I think the commissioners ought to build, as it were, forever." This witness then states that the Fleet street sewer, built in 1668 with 9 inch walls "and 14 inch contrefortes at intervals," fell in, at 3 separate places, in 1715, 1725 and 1737, and was rebuilt with 14 inch walls; while the ancient brick arch of the Walbrook sewer, $1\frac{1}{2}$ brick (or 14 inches) thick, stood near 400 years, till destroyed in 1834. *Qu.* 3412 (to same.) "Do you not think it would be possible, by altering the shape of those sewers, to make 9 inch brick-work answer where you now put 14 inch brick-work; that is to say, make a cheaper, and at the same time a stronger, sewer? *Ans.* I think not. I do not feel myself justified, as an officer of the commission, in recommending them to do that which, if they went into a court of

justice, they could not justify." I do not know how such testimony as this, strikes others; but the facts stated and the opinion given seem to me exceedingly pertinent and judicious, *as applied to sewers;* and vastly more so, if *applied to a conduit of the importance of the proposed one.*

But I have not quite done even with the sewers. Mr. Hale refers to the testimony of Butler Williams, Esq., Professor in Putney College. The testimony of this gentleman is of a very diffusive and expansive character, abounding in maps, diagrams, figures, formulas, and statistics, to a much greater extent than that of any other witness; —not to say more than that of all the rest put together. He appears to be a man fully up to the spirit of the age in detecting and repudiating the errors and mistakes of a by-gone generation, and even of some of his contemporaries. He would, I doubt not, soon become rich—a second Crœsus—if he could appropriate to his own benefit a moiety of what the world might save if it would adopt his suggestions. Mr. Hale says: "The witness (Mr. Williams) knew of repeated instances in which the latter structure (the Westminster sewer) had failed for want of sufficient strength in the straight sides; he stated that he had recommended the former (the Finsbury sewer) to be substituted, which he had never known to fail." This is Mr. Hale's account of Mr. W.'s testimony, and the fair inference from it would seem to be, that it was a not unfrequent occurrence for a Westminster sewer to fail, while a Finsbury one was certain to stand.

Now let us look at his testimony. *Qu.* 5823. "In respect of the strength, how have you found sewers with upright walls, and with arched walls, to stand? *Ans.* No instance of the failure of the arched sewer has come to my knowledge. I have seen one instance near Notting Hill, where the upright sewer had fallen in, been rebuilt, had again fallen, and was rebuilt, a third time, with extraordinary precaution," &c. This is the whole extent of *his own* knowledge;—had known of no failure of an arched side, which (with the economy of masonry) is a modern innovation, and has not had time to fail yet, and had "seen one instance" where a straight side had given way twice (before it was finished.) This is the whole of his own knowledge. He says Mr. Sopworth, an engineer, recites an instance of failure in Newcastle of a straight-sided sewer, which had been replaced by a "circular" one (not egg-shaped) which had not failed. But whether the old sewer had lasted 50 or 500 years, is not stated. The whole, then, of the "repeated" instances of failure which this witness "knew," was the single "one instance" of failure at Notting Hill.

This Notting Hill case appears to have been a remarkable one,

and to have drawn out the advocates of the different kinds of sewers. Mr. Williams took his pupils to see it, much as an anatomist takes his pupils to witness a hospital operation, or a post-mortem examination. The facts appear to have been these. Mr. Connop, proprietor of the estate, employed J. Stevens, a *city* architect and surveyor, to lay out the ground and erect buildings thereon. Being in the Westminster district, the sewers must be constructed on the Westminster plan, though Mr. Stevens (a very fair and candid witness) preferred the Finsbury form. The sewer was constructed, and the owner discovered that it had given way, and called Mr. Stevens's attention to it. Mr. Stevens says: "I went into the sewer, and through it, as far as practicable, and found the sides had collapsed. I found the ground had slipped (a stiff clay, very liable to sudden slips, being on a hill side) from 40 to 50 feet from the sewer, and the width between the walls was only 1 foot 7 inches, instead of $2\frac{1}{2}$ feet, the original size. Was summoned before the commissioners, and stated that I believed the failure to have originated in the form of the sewer. The commissioners thought otherwise, and ordered it to be rebuilt on same plan; that they would send a person from their office to be constantly on the spot and give directions. The sewer was carefully rebuilt. When about 100 feet of the sewer had been constructed in this (careful) way, and the ground filled in upon it, we perceived indications of a fresh failure, and in 3 or 4 days after, the pressure of the ground became so great, that the ends of the struts were forced through 3 inch planks. Hence we were obliged to take it up a second time." (This testimony is abridged, but is in the language of the witness.) Mr. Connop then applied to the commissioners to obtain leave to reconstruct the sewer in the Finsbury form, "but rather more round." The commissioners held a regular court upon the question. Their own surveyors examined the matter, and made a report. This report says, the surveyors had examined the premises, and "are apprehensive whether the parts which have lately been built, will be found to withstand the lateral pressure of the banks any better than the portion which was first built, owing to the insufficient, unworkmanlike and injudicious manner in which the work is proceeded with." "The persons who have contracted for building the sewer (have) a sum so little above the actual cost of the brick-work alone, that scarcely any price is allowed for the digging, strutting, and filling in the ground." The Report goes fully into several other causes of the failure. Mr. Joseph Bennett and George Bird, contractors, were examined, and thought the failure owing to "want of judgment in the building." The question was finally taken on granting Mr. Connop's request, and decided in the negative, *nem. con.* After-

wards Mr. Stevens says, we have "rebuilt the sewers in the form prescribed by them (the Westminster,) and they stood perfectly well." Thus ended the only instance of failure in straight sides that Mr. Williams *knew* of. Many details are given in the testimony of Mr. Stevens, and also of Mr. Donaldson, which I have not room even to condense; but are well worth the notice and consideration of those who take interest in such matters.

I here dismiss the subject of sewers. If all Mr. Hale claims for the improvements in their construction, were true, it would not justify a similar construction of the proposed conduit, because the circumstances are not the same, and the necessity of guarding against failure anything near so pressing. But unfortunately, the merit claimed for them by Mr. Hale, is not established. No other district of the metropolis, except Holborn and Finsbury, have adopted the economy of constructing 1 brick walls; nor is there any appearance that any others will. We have seen what the Westminster commissioners' opinion is, and also, a city surveyor's (Mr. Kelsey.) In the city, so far are they from adopting 1 brick sides, that they make 1½ brick tops — which is 50 per cent. more than the act of parliament required. The whole scheme (so far as economy goes) appears to be the repetition of an experiment (only under worse conditions,) which was tried a hundred and fifty years ago, and which then failed. Those who are on the stage 15 or 20 years hence, (or perhaps sooner,) will probably have occasion to notice its failure again. But as its failure is of small moment, we may never hear of it.

Let us return now to the proposed conduit. Whence did the idea of such a structure originate? If we examine the Report of 1837, we may get some light, and discover, that in this case, as in most others, *necessity was the mother of the invention.* On p. 33, the commissioners say: "We have no doubt but a conduit may be constructed from Long Pond to Cory's Hill, which shall be as much beyond the reach of interruption in its operation, as any work of human art can be beyond the reach of accident. We cannot pretend, however, that the cost given in our estimate is sufficient to produce a work of this permanent character, *and we should not think it expedient to increase the expenditure beyond the limits of our estimate, as the object of supply may be obtained upon either of the other places,* (i. e. Charles River, or Spot and Mystic Ponds,) *with more advantage to the city than by this, if its execution must be at an expense much beyond that which we have assigned to it.*" That is: We cannot pretend that a structure of a "permanent character," that may be "beyond the reach of interruption," can be made for our estimates; and the estimates ought not to be increased, because for such a sum

the object can be otherwise obtained. Hence came the *necessity*, by a short process, of either abandoning, out-and-out, Long Pond as a source, or of devising and estimating for a structure, conceded to be not of a "permanent character." No other alternative was left them; and I cannot but regard it as unfortunate that they did not accept the first, and abandon the second.

I hardly know how far I am called upon to set forth the demerits of a structure, in favor of which the commissioners themselves have said so little. They do not seem to have considered it of such a permanent character as every body must concede to be desirable; and how far it was allowable to run risks, for the sake of the proposed end, they left for others to judge, but for themselves, the majority did NOT recommend it. It is proper to add that, so far as economy of material is concerned, the conduit of 1844 was like that of 1837.

But from some cause or another, not very satisfactorily explained, Mr. Hale's views of the strength of this structure appear to have undergone a change since 1837. In testifying before the Legislative Committee, he stated that he considered a brick aqueduct, like the one proposed, to be as durable as iron pipes; and page 55 of *Inquiry*, &c., he says: "The [proposed] structure, taking into consideration its comparative size, is *demonstrately* stronger than that of the Croton aqueduct." In his testimony, he based his opinion upon experience had since 1837. Now I submit that no experience whatever (however favorable its character might be,) in 7 or 8 years, is sufficient to warrant any such opinion. What is experience, in this short period, worth in testing a work which is, or should be, (in the language of Mr. Kelsey,) built to last forever? But there has been, in that time, no pertinent experience that I am aware of, except of the Croton works; and from the published reports of the expenses of repairing that, experience seems to justify anything but such an opinion.

Now, as to the proposed conduit being "demonstrately" stronger than the Croton, considering its size, I for one should be glad to see an attempt at demonstration. Until such attempt be made, I deem it quite sufficient to invite the reader to inspect the sections of each work furnished by Mr. Hale, on page 80 of Proceedings before the Legislative Committee, &c., or page 58 of Inquiry, &c.;—bearing in mind that the *stone* masonry at the bottom is $2\frac{1}{2}$ feet thick, and laid all the way up in cement, while the foundation is always of stone where the conduit passes upon embankments. I am utterly at a loss to understand the grounds upon which such an opinion is so confidently put forth. All I can say is, that I should be unwilling to hazard such an assertion, until I was prepared to lose whatever reputation I might

chance to have acquired for good judgment and discretion, — be it much or little.

One other circumstance has been forced upon my attention, bearing upon the character of a conduit for conveying water, which I beg to notice. In the Parliamentary examination, so often referred to above, several witnesses spoke of the exudation or percolation of water from without into the sewers. Sometimes this was of an exceedingly offensive character, especially when the sewer passed through churchyards. When men went into the sewers to cleanse them, the character of this exudation became manifest. Mr. John Roe, who appears to have been the suggester of the Holborn and Finsbury innovations, and Samuel Mills, testify to this exudation. *Qu.* 1973. "You do not believe that the nuisance arises in all cases from the main sewers? *Ans.* by *Mr. Roe.* Not always from the main sewers. (*Mr. Mills,*) Connected with this point, I would mention, that, where the sewers came in contact with churchyards, the exudation is most offensive. *Qu.* 1974. Have you noticed that in more than in one case? *Ans.* Yes. *Qu.* 1975. In those cases have you had any opportunities of tracing in what manner the exudation from the churchyards passed to the sewer? *Ans.* It must have been through the sides of the sewers. *Qu.* 1976. Then, if that be the case, the sewer itself must have given away? *Ans.* No; I apprehend, even if you use concrete, *it is impossible but that the adjacent waters would find their way even through cement;* it is the natural consequence. The wells of the houses adjacent to the sewers all get dry, whenever the sewers are lowered. *Qu.* 1977. You are perfectly satisfied that in course of time exudations very often do, to a certain extent, pass through the brickwork? *Ans.* Yes; *it is impossible to prevent it.*"

From this testimony it appears to be certain that a brick conduit, like the one proposed, does not, and cannot, protect the current within it from the percolation of liquids without. The thinner the walls, of course, the liability to exudation is the greater; and by building them of a great thickness, probably little or no injurious effect of this character could result. Now there is one part of the proposed conduit which will, as it appears to me, be particularly exposed to an objectionable percolation. For 4 or 5 miles from the point of leaving the Pond, the conduit is to pass through a perfect swamp or morass, with scarcely any exception. In order to convey the water in this direction, it must, at the beginning, be almost entirely submerged in mud; and until it passes by Morse's Pond, which is but 12 feet lower than Long Pond, it cannot, to any considerable degree, be raised out of it. By looking at a map which accompanies the Report

of 1844, (a part of them at least,) the reader will be able to trace the line of conduit here referred to. A more thorough New England swamp, than this is, I never beheld. And how any reliance is to be placed upon obtaining a practicable foundation, is more than I can see. But this is not the point I have in mind. This extensive swamp, embracing that portion drained by *Snake* brook into Long Pond, at the very point where we propose to tap it, and that portion drained by a nameless, but I presume equally *snaky*, brook into Morse's Pond, appeared, when I saw it in April last, to abound in frogs and other offensive water animals, as well as to be steeping with a rank growth of vegetable matter. While these offensive things, especially the living, proved that the water was not poisonous, they certainly satisfied me that it was everything short of it. I do not intend to exaggerate in this matter; and if any one thinks I do, I wish he would visit the locality. Pass up the Worcester turnpike, survey the bogs, right and left, where the turnpike crosses the swamp as laid down on the map. Then pass up the county road, and survey the swamp drained into Long Pond. Consider that the conduit must be submerged in this semifluid mass, and that the walls of it are to be so thin that percolation is inevitable; and then make up his mind how he is going to relish the water when it gets to Boston. Several advocates of Long Pond have told us that they have drank those waters; but they do not seem to have tried the juices of this swamp by themselves.

Though the conduit is laid down to pass through this swamp, it may be said that it is not necessary it should pass there, but may be constructed in the firm land on the borders. This may be true; but if the borders are what they appear to be, the difficulty will not be overcome. If the hills are a loose, gravelly substance, as they appear to be, the water of this swamp will percolate them freely; and as the conduit *must be* placed lower than this swamp-drainage, the conduit will still be immersed in it. So that, unless extraordinary precautions be taken, through these 4 or 5 miles, either by thickening the walls or otherwise protecting them, for which no estimate appears to be made, it is not at all apparent how the difficulty is to be surmounted. This swamp water will, probably, find a readier passage through an 8 inch wall, always wet and never hardened, to Cory's Hill, than through hillocks and mounds to Long or Morse's Pond; and be its quality what it may, we shall probably have it.

I here close what I deem it expedient to say in relation to the proposed conduit. I for one confess I have no confidence whatever in its strength or durability. With my present views, I never would be accessory to, or share, in any degree, the responsibility of erecting so

frail a structure to perform a service so important. I am, therefore, constrained to repeat that, "if the Long Pond scheme is to be executed, let it be done on a plan less liable to failure, less liable to perpetual patching and repairing, than this project contemplates," or will, in all probability, require.

Mr. Hale, on page 25, says: "In the city of London, water is supplied by several rival companies. In some instances, the pipes of three or four companies, in addition to gas pipes, pass through the same streets. . . . . The consequence of the rivalry between the companies is, that they produce an average income to their proprietors of not more than two or three per cent. per annum. Another consequence of the low price is, that the quantity used is much larger in proportion to the population supplied, than in any other town of England." This I esteem a very remarkable statement,—full of error. It is true that the metropolis of London (but not the *city*, which is supplied exclusively by the New River Company) is supplied by several water companies; but they have long ago ceased to be *rivals*. I believe there is one company on the Southwark side of the Thames which has not yet lost money enough, and has recently laid, or attempted to lay, pipes into a parish belonging to another water district. But, generally speaking, there is no rivalry between the companies;—their districts are defined, and they do not interfere with each other. Mr. Mylne, Mr. Wicksteed and Mr. Quick, all speak with as much definiteness of their districts as we should of our wards. As to the statement that the pipes of three or four water companies pass in the same street, I cannot but think Mr. Hale is mistaken. Possibly the pipes of *two* companies may pass the same street, where the different sides belong to different water districts; but, except in such cases, it seems to me the statement cannot be correct. In looking over the Parliamentary Commissioners' Report, so often referred to, I noticed no such statement. Mr. Mylne, the engineer of the New River Company, speaks of the great confusion and evils of laying gas and water pipes in the same streets, and gives a diagram exhibiting a striking complexity in their interlacing; and though the *gas* pipes belong to *four* different companies, all the *water* pipes belong to *one*. I cannot but think that, if rivalry between the companies existed, it would appear in some portions of this Report.

But, besides this absence of evidence of the fact stated, there is some of a positive character. Mr. Fletcher, the counsel for the city before the Legislative Committee, based a strong point of argument upon the fact that between the London companies there was no competition, but that they had carved the metropolis into districts, and each company took its own. And he seems to have derived his in-

formation from a Parliamentary Report, which I have not seen. I beg to quote what Mr. F. is stated to have said, from p. 114 of *Proceedings before a Committee, &c.* "A parliamentary examination —to a copy of which Mr. F. referred the Committee—had shown that in London great trouble had arisen from this cause (the supplying water by private companies.) They had there thought to avoid the miseries and evils of permitting a monopoly of water by establishing a number of companies, thinking that competition would reduce the prices. But these companies combined together, each took a particular section of the city, and raised the prices by agreement. The monopoly was worse than before, and one witness said that he had been afraid to attend the commission until compelled, for fear that the company would stop his supply of water." I will add that it is well known that the companies are on the best possible terms, and if from any cause the supply of one company fails, others connect their mains with it and supply its customers.

To this rivalry, which we have seen does not exist, Mr. Hale attributes the small dividends of the companies. I apprehend that the true cause of the small dividends is the great disadvantage under which the water is delivered. The works are old works;—iron pipes have been substituted for wooden ones;—new improvements have been introduced. (*Qu.* 5269.) All these expenditures have gone into that "receptacle of things lost upon earth"—a construction account. The expenditure has been so great that the companies cannot realize a greater dividend than that received. For I have seen no evidence, nor do I know of the slightest reason to suppose, that the companies have not, and do not, regulate their water rents with the sole view of getting the greatest possible income. Mr. Hale attributes these small dividends to the "low price" of the water. There can be no greater mistake; for, on the contrary, the London water rents are the very highest of any I have noticed. Dr. Clarke (*Qu.* 31) says: "3*s.* 4*d.* seems as accurate an estimate as can now be made" "of the water-rent paid by each person in London." But at Nottingham (*Qu.* 5269) it is but 1*s.* 6*d.*, or less than half of London; and at Preston it appears to be but little, if any, higher than at Nottingham (*Qu.* 13, p. 159, Ap.;) while the several places named by Mr. Thorn (*Qu.* 140,) have water at even a much lower rate. I have noticed no place in England or Scotland, where the water rent is anything near so high as in London. The difference in the income of the London companies, and those of Nottingham and Preston, arises from the different expenditure for individuals supplied. In Nottingham this is £1, in Preston £2, (but will be less as water

becomes more generally taken ;) while it is in London £3, and no reasonable ground to expect much increased consumption.

Mr. Hale deduces, from what he considers this low price, the consequence " that the quantity used is much larger in proportion to the population supplied, than in any other town of England." Whether such be fact or not, it is clear that it cannot be attributed either to rivalry between the companies, or the low price of water. But I have already shown that there is every reason to suppose the consumption of water in London is greatly overstated ; and that it does not probably exceed $18\frac{2}{3}$ gallons, per day, per head. I have great doubts whether it in reality should be stated so high. In making the calculation, (p. 29,) I took the delivery of 3 companies to each individual per day. Now, if each company delivered to an equal number of persons, this method would show a correct result. But as the number of individuals in the several water districts is greatly different, it would seem more correct to adopt the following method to obtain an average consumption, viz.,

	inhabitants,	galls. each,		gallons per day.
New River Company,	900,000	14	=	12,600,000
East London " (about)	300,000	23	=	6,900,000
Southwark "	138,000	19	=	2,622,000
	1,338,000			22,122,000

Now, if we apportion 22,122,000 gallons among 1,338,000 persons, each will receive very nearly $16\frac{1}{2}$ gallons. So that, instead of allowing $18\frac{2}{3}$ gallons per head per day, to each inhabitant of London, it would seem to be nearer the truth to allow but $16\frac{1}{2}$ gallons. Whether this, or even the other, be a greater consumption than is elsewhere in England, is of no importance. Neither is large.

I here close what I have to say upon the pamphlet of Mr. Hale. In this review I have endeavored in no case to pervert his meaning, or to misrepresent him. If I have in any case done so, it has been unintentional. I have, also, endeavored to use no fact or argument to prove what it did not fairly tend to prove. Whether my review has a substantial substratum of facts to sustain the points intended to be established, I leave others to judge.

With a few general observations I propose to close these *Further Remarks.*

For all purposes of general reasoning in discussing questions like this, we are obliged to assume *average* results. But this is liable to lead to an erroneous view of the subject. Now, in the consumption of water, it is obvious from the nature of the case, as well as from

experience, that in the hot summer months much more water will be consumed than in the cold winter ones. Probably a difference equal to twenty-five per cent. between the extremes, is not too much to be allowed. If the Long Pond scheme be adopted, permanent provision must be made for the maximum demand during the whole year; i. e. 25 per cent. more than will be wanted in some parts of the year, and $12\frac{1}{2}$ per cent. more than the average demand. So again, with regard to the future population of the city, and the demand for water growing out of the number and habits of that population — how much uncertainty must be allowed to hang over it. The Long Pond scheme contemplates to burden a population of 125,000 with *all* the expense necessary to supply 250,000. But if this demand fluctuate between summer and winter to the extent of 25 per cent., and the works be calculated to deliver but 11 cubic feet per second, and that be only an *average* supply according to the calculation of the Commissioners of 1844, it is obvious that a scarcity of water will be felt many years before the population comes up to 250,000, and before the *average* consumption be 28 gallons per head daily.

But why limit the population to 250,000? The territory of the peninsula is limited; but still there is room for an immense increase. Besides South Boston and the neck lands, it is understood that the proprietors of the empty basin in Back Bay are ready to fill up every foot south of the Mill Dam and east of the Roxbury branch, as soon as the city shall build upon the lands of the public garden, or otherwise release them from the restrictions imposed upon them. Should this be done, (and it is difficult to see good practical reasons why it should not be done rather than compel population to go out of the city,) it will add immensely to the extent of the city, and it will be a region which must depend entirely upon water works for a supply.

But it is rather a contracted view of this subject to limit the supply to the *city*. From a reservoir on Cory's Hill it would be practicable and convenient to supply the low parts of Old Cambridge, Cambridge Port and East Cambridge, of Brookline, Brighton and Roxbury; — all which are fast filling up with a population living upon the business of the city. It is as certain as anything of the kind can be, that, within less than 50 (if not within 20) years, there will be a *water district* containing much more than 250,000 inhabitants, which might with the utmost convenience and propriety, draw its supply from the city's reservoir; and there is nothing in the way that I can see, why in process of time even this number may not be doubled, or trebled.

Now the great beauty of the Charles River plan, is its adaptation to all these varying elements. The expense of pumping is the great

leading expense; and the excellence of the scheme is, that, be the demand great or small, the city need not pump a gill more than is wanted, and when another gill is wanted, it may be had for the pumping. The present generation is not thus taxed (to any considerable extent) to provide for a doubtful and far distant demand; but as that demand grows up, whether in the city or out of it, it can be readily and conveniently supplied. How the Long Pond scheme dwindles into insignificance, in view of the demands of such a water district as is most certain to grow up within a convenient distance of the proposed reservoir; and how short-sighted is the policy that would, without necessity, and, indeed, without a single substantial reason, adopt a plan which forever puts it out of the power of the city to supply it!

Of the great importance of furnishing the masses of a densely populated district with a full and copious supply of good water, no one is more sensible than myself; and no one would more cheerfully take his share of the *necessary* burden, in order to afford such a supply to this city, than I would. It is becoming and proper that a great and growing city, like Boston, should receive this supply without stint. I would have every inhabitant take the water,—pay for it who could (if that be the plan adopted,) and without pay who could not. It is not because I would stint the use, that my estimates of consumption are below Mr. Hale's; but because from the experience of other places I do not find reason to suppose that, with a full supply, and right to use or waste *in houses*, *ad libitum*, the consumption would exceed my estimates. I say *in houses*, because I am inclined to think that the water should be taken into every house where it is used, and that no individual should be allowed to take it from the street. Public hydrants, or stand pipes, for the use of the poor, are fast going out of use in England. They are extremely liable to get out of order; and during many months they are kept from freezing with great difficulty. Hence in the erection of new water works it is getting to be the custom to have no public hydrants for the use of citizens, but to carry the water into the houses of all who are to use it. And this method is found to be economical;—much less water is wasted and much less stolen. The municipal corporations pay for the poor; but they are supplied *in* their houses. And truly, it seems to be a pitiful condition to impose upon the indigent and infirm, who from a decent pride would feel it a much greater hardship to expose themselves in the street for a supply than to pay for it if they were able, that they shall obtain their supply from a public hydrant, in order to obtain it *gratis*. Especially when that hydrant, open to whole neighborhoods, is, and will be, drawn from by many who are well able to

pay for their supply. I am inclined, therefore, to think well of the practice now growing up in England, of abolishing public hydrants, except for strictly public purposes.

To return from this digression, I repeat that, in my judgment, Boston should have a supply of water from a foreign source; and I cannot better give my views than in the language of Mr. Quincy, appended to the second edition of my *Remarks*, viz.,

"1*st*, *That water ought to be introduced into the city of Boston.*

"2*d*, *That this great and all-important interest of the city ought never to be placed under the control of one or more private corporations.*

"3*d*, *That ponds, such as now exist in our vicinity, ought never to be depended upon as the source of supply.*

"4*th*, *That a* RIVER *was the only source on which a supply of that element, so essential to life and comfort, should be allowed to depend.*" (In this Mr. Quincy agrees with Dr. Clarke and Mr. Hayes.)

Who can read and reflect upon these positions of Mr. Quincy, whose municipal experience far exceeds that of any of his successors, and to whose wisdom and ability the city owes many of its most valuable improvements, without feeling and acknowledging that they are the results of enlarged and comprehensive views of the city's interest; and that, as such, they ought to be adopted.

I think this enterprise should be undertaken by the city *itself*, not that its powers should be delegated to others for the purpose. The regular organs of municipal operation should, by their own agents, execute and manage, now and forever, this great and important public interest, *especially within the jurisdiction of the city;* and I think no act of the legislature, granting power to execute it, but taking the execution, control and management out of the hands of the regularly constituted city authorities, ought ever to be accepted, either as a "boon" or a bane. I do not wish to review the act which has been rejected; nor to characterize its provisions in such terms as I think they richly deserved. Nor would it become me to give advice in regard to the future. To impart counsel becomes those who have treasured up wisdom from an enlarged experience; and to cause it to be received, is the province of those who, from nature or education, possess largely those qualities which exercise sway over popular sentiment. But it is the lot of the humblest to entertain hopes and fears; and it is the privilege of the humblest to express them. I would, then, express the hope that the legislature will never grant, and that the citizens of Boston will never accept, an act that interferes with the regular and orderly working of all the various departments of our city government. I hope no man, or body of men, will ever

be allowed to expend public money, or run the city in debt, except those to whom the law has given authority to assess taxes, to raise the money, or pay the debt. I hope no man, or body of men, will ever be authorized to fill or exhaust, on the city's account, any treasury but the city treasury; and that every dollar ever in hand, or expended for the city, will be in the custody, or paid out under the sanction, of the city treasurer, whose oath of office, and whose bonds, and whose *annual* accountability, give some assurance of honesty and security. I hope no man, or body of men, will ever be allowed to ride over the authority of the lawfully constituted surveyors of our highways, — impeding our streets, jeoparding life and limb, and, perhaps, subjecting the city to great expense in way of damages. Finally, I hope that the citizens WILL SEE TO IT, that the execution, control, management and use of this great and important interest be always kept in the hands of the city government, to be affected through the ballot-box like every other interest; and that they will be "deaf as adders" to every attempt to persuade them to allow a different course.

I here close these *Further Remarks*. The views I here express, are respectfully submitted to the consideration of such fellow citizens as take an interest in the question. I hope they will serve to enlighten the mind of the public upon a topic which deeply affects their welfare.

I will add one word in regard to Spot Pond. The proprietors have their charter, and are endeavoring to get their stock taken up. They have acquired privileges, apparently with the acquiescence of the city; and *if they can get their stock subscribed for*, and *if they will give the city government, or one branch of it, the supervision and control, which they have publicly promised*, I do not see why they are not entitled to a fair opportunity to exercise their franchise. I should hope that such an opportunity would be allowed them — though their scheme is by no means my choice.

Note A. Page 4.

From Boston Courier, Sept. 24 and 28, 1844.

If, then, water be introduced by the city from abroad, *shall all the inhabitants use it freely? or shall those who use it pay water-rents?* In advocating the former of these methods, I should wish to be very cautious of expressing any overweening confidence in my own views. The subject, like all subjects involving taxation, has difficulties; and if I have come to the conclusion that the payment for water had better, on just and equitable grounds, be made by a general tax upon the property of the citizens than by water-rents, still I am by no means insensible to the objections that can hardly fail to occur to every one against such a method, or to the weight of reasons in favor of the usual course of collecting rents.

There are *three* distinct purposes for which water should be brought in, and for which, to a greater or less extent, it will undoubtedly be used:

1st. To furnish a domestic supply.

2d. To promote public safety, by furnishing the means of extinguishing fires.

3d. To promote cleanliness and health, by furnishing the means of washing the streets, &c.; and also of supplying many or few public fountains.

In most of the disquisitions on the subject which have fallen under my notice, it seems to me that the first of these purposes has engrossed an unreasonable share of interest, and that the second and third have received scarcely any notice. The public attention has been awakened by statements of scarcity of water at particular seasons, in particular houses or neighborhoods; and the blessings of a supply of *pure soft water* for domestic purposes, both to the rich and poor, have been dwelt upon, till we hardly can realize that there are any other purposes, and those of a general character, for which water is desirable. But if we will direct our attention to the second of the purposes mentioned above, and estimate the effect of an abundant supply of water on the public safety, so far only as indicated by its effects upon rates of insurance, especially in the city of New York, where the inhabitants have recently passed, through a transition state, from a very indifferent to a most copious supply, the conclusion is irresistible, that this second purpose is one of prominent, if not paramount, importance. Since the introduction of the Croton Water into the city of New York, the rates of insurance have fallen nearly or quite 40 per cent. It is not at all probable that the whole of this reduction is attributable to the introduction of water; but it is reasonable to conclude that a considerable portion, say as much as 25 or 30 per cent., is to be ascribed to that cause. Nor is it to be expected that the rates of insurance in Boston would be affected to the same degree by the introduction of water, as they were in New York; for Boston is better secured against fire now, than New York was before water was introduced; and the rates of insurance never were so high here as in New York, before the introduction of water. Still, if, as it would seem, the introduction of water into Boston would substantially diminish the risk of damages by fire, the conclusion is irresistible that there would also follow a substantial reduction of the premiums of insurance. By the risks referred to in this paragraph, I have in my mind, more particularly, those attaching to *personal* property — a kind of property of which every man has a greater or less portion, and by the loss of which, whether insured or not, he is more or less affected, and affected, too, not by any means in proportion to its value in dollars and cents. The risks

attaching to real estate, I shall have occasion to refer to again, in a different connection.

But the public safety, as affected by the introduction of water, is not to be measured entirely, or indeed, mainly, by the rates of insurance. A sense of security to our persons, to our families, to our homes — protection against death or injury to ourselves, our relatives and friends under our roofs, against being suddenly, if not ruinously, broken up in our business or in our abodes, — enters essentially and largely into all estimates of public safety. In all these particulars, every man, woman and child, has a deep and inestimable interest: an interest entirely irrespective of station and condition, which not only equally puts at naught the efforts of rich and poor to calculate its value, but quenches all inclination to do so.

Now we all know, and are accustomed to the fact, that all our means of defence against fires are provided at the public expense, by a general tax. In this manner we furnish and repair our engines, our hose, our ladders. In this manner we keep up an organized fire department, consisting of a chief engineer, six or eight assistant engineers, and a numerous body of foremen and privates — and we pay them for their services. In aid of the same general object, the city government have, for years, been in the habit of appropriating several thousand dollars for building cisterns. If, then, all these means of security against injury by fire, have been and are provided by a general tax; and if the introduction of water will make these means of security much more perfect, where, it is pertinent to ask, is the injustice or hardship of paying for this introduction, so far at least as this purpose is subserved, by a public tax?

So also with regard to the third purpose above stated — viz., supplying water for the purpose of cleaning the streets, &c., and for public fountains — few will be disposed, I trust, to deny that such a supply would contribute much to the general cleanliness, health and comfort of the city. Boston is full of narrow, densely populated courts, lanes and alleys, which ought to be familiar with the dash of the bucket and the friction of the scrubbing brush; but which are, alas, strangers to both. Scarcely can the rains of heaven reach them.

If, then, we raise annually a large amount by taxation for what is denominated by the city government the Internal Health Department — embracing the removal of offal and all nuisances, the sweeping of streets, and, generally, the prompt and effectual removal of every visible cause of taint to the atmosphere, and of sickness to the people; and if the introduction and free use of a copious supply of water would greatly contribute to the promotion of this invaluable object, where, it is again pertinent to inquire, is the injustice or hardship of providing this additional means at the public expense?

And as to a few public fountains — the city government are in the habit of appropriating more or less of the people's money for the recreation of the people. The Common is a special object of favor, and no inconsiderable sums are annually expended in ornamenting it, and in keeping it in order. The same, to a certain extent, is true of the public grounds on Fort Hill, and perhaps other places. Now, if we are accustomed to pay for these things, from a treasury filled only by taxation, is it unreasonable to suppose that the erection and maintenance of some four or five fountains, located in different parts of the city, imparting both pleasure and health to whole neighborhoods, to be paid from the same purse, would be begrudged by the citizens generally? I think not; and if they did, it would appear to me very unreasonable.

The purposes I have here treated of, are strictly *public* purposes. The objects to be attained are strictly *public* objects — always so considered, and always as such provided for. Still, the importance of these purposes are very likely to be under-estimated.

We have seen that *two* of the *three* purposes for which water should be introduced into the city, and for which it will undoubtedly be used, are strictly *public* purposes, and that the water for these purposes may, consistently with all our habits and notions, be paid for by a general tax. The other purpose, viz., *domestic supply*, though named first, I have, without any particular intention of so doing, reserved for consideration in the last place; and it is obvious that the whole difficulty of my case lies in reconciling the paying for the water used for this purpose by a general tax, to our sense of justice and equity.

For the better discussing of this subject, it may be expedient to consider the inhabitants of the city to be divided into three classes, viz., owners of real estate, occupants in independent circumstances, and the indigent. It is not necessary for my purpose that this division should be very accurate or distinct — generally, I wish to embrace among the indigent all those who really suffer for want of water, and also those to whom the water would be of important use, but who cannot afford to take it and pay for it, and who, in the judgment of an individual or of a board clothed with power to give licenses, would receive licenses for its free use. Nor will it affect the force or application of my remarks, that many of the independent occupants of dwelling houses are to that extent also owners of real estate; for such may be placed in both classes, and be affected alike with each class.

Now, as to the supply of those occupants who are indigent, is there any good reason why that should not be paid for by a general tax? I believe it is customary in all cases to provide for the poor *gratis*, even where the water is owned by private companies. Surely, where it is owned by the city, the claims of this class cannot be resisted. It is agreeable to all our habits of thought and action, to aid this class by a general tax. It is true that our tendency is to limit this aid to paupers; but it is not so limited in practice. If, by some aid at home, it appears probable that a person or a family may be saved from pauperism, it is usual, in practice, to give it. If persons in indigent circumstances, out of which class paupers come, and, of course, always will come, can be supplied with water, so that they can be prevented from coming into the poor house by doing washing, or any other work requiring a supply of water, it is not only the cheapest, but by far the most orderly, way in which the city can give its aid. The citizens of Boston derive much satisfaction from their charitable institutions at South Boston; and they feel a lively interest in the welfare and comfort of the less successful and prosperous portions of the inhabitants of the city. I cannot, therefore, think it necessary to argue very strongly the point that, if water be brought into the city at the public expense, it should be supplied to the poor and indigent also at the public expense. This will dispose of a considerable portion of the supply for domestic purposes.

And I will take occasion here to remark, that, with this disposition of this class of consumers, we dispose of all those considerations which we are accustomed to hear urged in favor of bringing water into the city at all. All the grounds of a public necessity arising out of actual suffering for water, exist in this class; and whoever would sympathize with this suffering, must, so far as I can see, agree, that it should be alleviated at the public expense. No one can consistently advocate the payment of a water-rent, in order to supply those who cannot pay for it, and still ought to have it.

I now come to consider the domestic supply for the remaining two classes, viz., the owners of real estate, and the independent portion of housekeepers or occupants. These two classes are the tax-payers of the city, and may be considered as the only tax-payers; so that, whether the water be paid for by a general tax or by water-rents, the payment must finally come from these classes. What we wish, therefore, is, to see (so far as the supply of these classes is concerned) how the principle of a general tax will operate.

The real estate of the city is this year valued by the assessors at seventy millions of dollars. It is undoubtedly worth more. It would be fair to consider about one half, or thirty-five millions, as destructible by fire, and properly a subject of risk. It matters not whether it be *actually* insured or not. If it be subject to destruction or injury by fire, a risk of that destruction or injury is taken by the owner, or is paid for by him; in either case, the burden, to the full extent of the risk, is upon him.

Now, whatever diminishes this risk is a real saving, and is a direct matter of benefit to the owners of real estate. No one, I apprehend, can have the hardihood to question that the introduction of a copious supply of water will greatly diminish the risk. I do not, as before stated, suppose the effect upon the risk, or upon the rates of insurance, here, will be as great as they have been in New York; still it can admit of no doubt whatever, that the owners of the real estate of the city will, and must, of necessity, derive a great, in the aggregate very great, benefit from the introduction of water, which the other class does not derive.

I can see no general reason why about the same proportion of these two classes should not take the water. If supplied *gratis*, I suppose all would take it; if water-rents be paid, about an equal proportion of each class would probably take it. And if water-rents be paid, it is to be presumed that the worth, or *cost*, of what each tenant of these classes has, he pays for. This is the least that can be expected.

Now it is obvious that neither as a class, nor as individuals, do the occupants of dwelling-houses derive an advantage merely from the introduction of water, to equal, in any considerable degree, that derived by the owners of real estate. If water-rents be paid, they pay the worth of the water, leaving the whole benefit incident to the having a supply for the extinguishment of fires, to be realized without payment by the owners of the houses. To illustrate by examples. A owns the dwelling-house occupied by B. B takes the water, and pays a water-rent of $6 per annum. A saves in insurance upon the same house, from the introduction of water, just the same sum annually, say $6. Now, it is clear that A and B derive just equal benefits from the introduction of water; but, by the supposition, B, the occupant, pays a full equivalent for his benefit, while A, the owner, pays nothing for his.

I would not imply that the saving in insurance upon *dwelling* houses would equal the water-rents to the tenants or occupants of those houses; yet I suppose that there are some cases in which that saving would equal the water rents; and when the stores and warehouses are considered, which will not usually pay water-rents, it may not be a very extravagant supposition to suppose that the saving *on all* would nearly equal the water-rents.

With the best and most popular adjustment of water-rents, (if we have them,) it must be many years before the amount of rents will pay the interest of the cost of the work. Of this all experience teaches the truth. Now, if water-rents be assessed, and an amount collected to half the amount of interest to be paid on the cost, it is obvious that the other half must be raised by general tax. How will this tax bear upon A and B, the owner and occupier of a dwelling house — supposing B to be worth as much as the value of the house? If B pay a water-rent of $6 per annum, and only half the interest is met thereby, it may not be far from the fact that, in raising the other half sum to pay the interest, another $6 must come from him and from the house — say $3 from each. So B will, in all, pay $9 for what is worth but $6, and he will, therefore, be a loser of $3; and A will save $6, and pay but $3 tax — coming out with $3 benefit, for which he pays nothing.

Now, the examples here put, are not extreme cases. I do not see any fallacy in them, as exemplifying the operation of a general rule upon the

classes now under consideration; and if they fairly illustrate such an operation, it seems to me that justice and equity require that the rule should not be allowed to operate. But, on the contrary, it seems to me that justice and equity would be immeasurably better exemplified by the payment of the interest by a general tax, than by an attempt to assess water-rents. For, although by a general tax a class might pay more in taxes than it would be required to pay as water-rent, under a system of water-rents, still there can be little or no reason to suppose that any class will be required to pay so much as it will be really benefited by the measure.

There are several other considerations which might be urged, strengthening these views; but I have neither room nor time, at present, to go into them. From the best consideration I have been able to give this subject in its several bearings, it seems to me to square more nearly with all our habits of public right and equity, that the water, when brought in and distributed for domestic use, should be paid for by a common tax, than by water-rents; and, of course, I hope such will be the plan adopted, unless there are reasons which have not occurred to me, more cogent and weighty than any that have.

If the plan shall be that every occupant may have the water *gratis*, then it will follow that all, or nearly all, will take it; and it will also follow, that provision must be made to supply all, and, of course, a source must be selected, capable of supplying all, now and prospectively, for a reasonable period to come.

POSTSCRIPT.

SINCE the preceding sheets were printed, the Croton Water Board have published their annual Report. This I have not yet seen; but the New York press has given a synopsis of it, accompanied with the usual (or a little more) laudation of the success of that enterprise.

I am not about to expatiate upon any want of wisdom in the planning, or of economy in the execution, of the Croton Water Works. I do not know that an *adequate* source for a supply could be resorted to nearer; nor do I know that the general plan of bringing in the water was more expensive than it need to have been, nor do I know that a dollar has been wasted or needlessly expended in its execution, or that the whole has cost more than ought to have been expected. But one thing we do know; — we do know, that, after many years spent in making surveys, and in discussing the subject, *a vote of the citizens was obtained to undertake the work, on the ground, and with all possible assurances, that the cost would not exceed* (including distribution) $5\frac{1}{2}$ *millions dollars, and that the water rents would be equal,* AT ONCE, *to* $310,000. *We also know that the work has cost* 14 *millions of dollars, and is not yet finished; that three years of experience has been had, and that the* GROSS *income of the second year was but* $102,000, *and of the third but* $118,000; *while the* NET *income of the second year was but* $32,000, *and of the third* $45,000, *and* 3 *miles of distribution pipe.* These are facts — these are anticipations, and these are fulfilments — within every man's

knowledge, and suitable for every man's consideration. I think them full of salutary admonition.

Though such results are before us, published to the world, yet the leading presses of New York think them highly satisfactory. One thinks that no sensible man in New York would be without the water, as expensive as it is; and the president of the aqueduct is represented (*p.* 67 *of Proceedings before a Legislative Committee, &c.*) to have written to L. Norcoss, Esq., Feb. 14, 1845, "stating that he believed that the opinion of the citizens was that they would not be without it (the water) even if the debt that it had cost were trebled."

Now all this is entitled to little more regard than mere bravado. The conclusion which every sensible man, not interested, must come to, is that, as a scheme, undertaken on specific and prudent grounds, the Croton Works is an utter failure. Every consideration which was put forth, regarding the expenditure and income, to induce the people to undertake it, has signally failed; and it remains to be seen how the city is to get out of her difficulty. I fear she will never get out of it, until she sees and acknowledges it. It is well for those to whom the debt is due, that the debtors keep good heart, and flatter themselves that they are going on *swimmingly;* but to *some* bystanders they seem to vaunt much in the spirit of Rudge's Raven, that would "never say die."

It seems, from the statement of the Croton commissioners, that but little more than half their income, small as it is, has been derived from rents for *domestic purposes;* — the rest having been received from sales for manufacturing and other similar purposes. Now, how insignificant it appears, to collect the pitiful sum of $70,000, from near 400,000 inhabitants, as a compensation for the use of the water for *domestic purposes*, and spend I know not how much in collecting it; while, probably, nearly all who contribute in this way a full value for the water they use, pay, in addition, precisely the same tax (20 cts. on $100) as those who either steal the water or go without it. I could hardly suppose a case better adapted to illustrate and enforce the propriety of allowing a free distribution for *domestic use.*