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V I E W

OF THE

PRACTICABILITY and MEANS

OF

S U P P L Y I N G

T H E

City of Philadelphia

W I T H

WHOLESOME WATER.

I N A

Letter to JOHN MILLER, Esquire,

F R O M

B. HENRY LATROBE, Engineer.

December 29th. 1798.

J. L. COOPER

Printed by order of the Corporation of Philadelphia.

—Philadelphia:—

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Philadelphia, December 29th. 1798.

S I R,

AGREEABLY to your request, I now submit to you my ideas upon the subjects which you have communicated to me for consideration, *viz.*

I. To supply the city of Philadelphia with a sufficiency of wholesome water for culinary purposes:

II. To introduce an additional supply of water for the purpose of washing the streets, and, if possible, of cooling the air of the city.

The season and the weather are at present both unfavorable to an investigation of all the circumstances, which may affect a measure of so much importance; and indeed the time allotted to me has been so short, that it cannot be expected that my opinion should extend far into the minutiae of estimate and execution: I have, however, endeavored to establish general principles, which cannot be affected by any variations of detail, and to which every attempt to accomplish your object must be made to bend.

The indispensable requisites, of every work which may be executed, appear to me to be the following. Indeed so indispensable do I consider them, that every proposal in which they do not meet, ought, I think, to be at once rejected. Their importance is in the order in which I have arranged them.

I. The works must be in full operation before the end of July, 1799.

II. They

II. They must be *certain* in their effects, and *permanent* in their construction.

III. They must not be liable to interruption from ice or freshes, but be equally useful in the severest winter, and in the wettest summer.

Having maturely considered all the schemes, which I have seen published, or have heard mentioned in conversation, I shall proceed to state to you, what appear to me to be the *only* means of concentrating all these requisites in *one* work; and, having laid before you what I propose to accomplish, with the means, and the probable expence of effecting it, I will then give you my reasons for rejecting every other proposal.

The nearest waters to the center of the city of Philadelphia are those of the Delaware and Schuylkill. I conceive them both to be wholesome, for reasons which I will mention in a postscript, in order that I may not interrupt this consideration of the principal object.

It is evident that the exertions of only seven months, cannot in this country bring water from a greater distance.

In choosing between the waters of the Delaware and Schuylkill, the following considerations occur:

I. In favor of the Delaware: It is true that works erected upon the margin of the river would supply water to the city immediately, from the river upwards, and save all the expence, which must, in the other case, be incurred between the Schuylkill and the center square.

II. Against the Delaware will operate, the impurity of its water, which is subject to a strong running flood tide, and which must be supposed to be contaminated by the decayed vegetables of the marshes over which it passes; independently of the filth,

filth, thrown from the numerous vessels lying along the wharves, or running into it from the public sewers.

III. In favor of the Schuylkill: The principal circumstance is the uncommon purity of its water; its bed is every where narrow and rocky, its sources lie entirely in the lime-stone country, and the tide opposite to the center of the town does little more than raise the water by accumulation.

IV. On the other side; the extraordinary expence of works from the banks of center square may be alleged.

I believe however that you will agree with me in thinking, that, as the difference of expence on the largest estimate cannot exceed thirty thousand dollars, there ought not to be a moment's hesitation in preferring the Schuylkill. I shall therefore confine my remarks to that river.

Neither the waters of the Delaware, nor of the Schuylkill can become useful, unless they be raised to an elevated level, commanding every part of the city. To do this, in sufficient quantity, very powerful machinery will be required; and, I am very certain, that human ingenuity has not hitherto invented any thing capable of producing the proposed effect with constancy, certainty and adequate force, excepting the *Steam-engine*.

Taking therefore all the preceding principles for granted, I submit to you the two following proposals, which are in effect the same; and the choice between which must depend upon the practicability of the *first*.

N. B. The distribution of the water over the city being the same under every scheme that may be adopted, I shall postpone its consideration to the last.

The objects which I propose to accomplish are:

I. To raise a reservoir in center square. It is not sufficient that this reservoir should be elevated so high, that it will discharge its water into the distributing pipes: I think it should be forty feet above the level of the pavement, in order that the pressure of the water, in so elevated a head, may not only propel it to every part of the city, but throw it up in fountains in every street, wherever it may be required.

II. To bring to the reservoir the waters of the Schuylkill.

III. To raise them into the reservoir.

A culvert, or tunnel, six feet in diameter, carried under ground, the bottom of which should be level with the bed of the Schuylkill, would bring the water into a reservoir in center square, at the depth of about forty feet. I am not perfectly informed of the levels, but ten feet more or less, would affect the expence very inconsiderably. Over or near this reservoir, which ought to be a cylindrical well of at least twenty-five feet diameter, the Engine-house should be erected. It may, at the same expence that would render it useful, be made an ornamental building. Upon the top of the Engine-house should be the reservoir. With the reservoir all the distributing pipes are to be connected. The engine will keep it perpetually full, being of a power sufficient to supply every possible demand of the city.

There is however a circumstance, which may render the scheme impracticable, or at all events unadvisable. It is this. The gravel stratum, to which all the wells of this city are sunk, seems to be nearly on a level with the waters of the adjoining rivers, and to be supplied by them with that inexhaustible quantity of water, for which it is remarkable.

markable.* Should it so happen, as I believe it will, that the tunnel lay near, or in, this stratum, it might be difficult, if not impossible to keep the work sufficiently dry; and I doubt, whether, at any rate workmen could be induced to labor in this subterraneous situation, which will always be wet, and the safety of which may depend upon the certainty of working the pumps above. I shall therefore make another proposal, which is liable to no inconvenience in the execution, but which, though not more expensive at first, will, as it requires two engines, be liable to more *annual* expence.

II. A reservoir being made on the banks of the Schuylkill, an engine will throw up a sufficient quantity of water into a tunnel, carried from thence to a reservoir in center square. This tunnel should be sunk so low, that three feet of earth may cover it, in its whole length. The reservoir in center square, might be sufficiently elevated to supply all the streets from Water-street to Fourth or Fifth-street with water for culinary uses. To supply the rest, and to raise fountains for the purpose of washing the streets, a smaller engine and an elevated reservoir would still be necessary.

It is very evident, that in either of these proposals, the three requisites meet: the supply of water would be inexhaustible; the work might be accomplished in a few months; the ice would never obstruct the operations of the works, as the tunnel would be inaccessible to frost; and the power employed is that, of which the amount, and the effect depends not on the variable seasons, nor on the natural advantages of situation,—but solely on the *option* of man.—In every

* The perfect permeability of this stratum is evident from the connection of the wells with each other, and with the sinks and privies, from whence arises the extreme unpleasantness of the water in the crowded parts of the city. It is worth considering, whether the pumps do not act as chimnies to bring up volumes of noxious Gas from the putrifying water, which may predispose the inhabitants to receive the Yellow-fever.

every species of machinery in which mechanical powers alone operate, the bulk, the friction, and the unwieldiness of the works, encrease nearly in proportion to the effect required;—in the chemical operation of a Steam-engine, power is encreased in a ratio far outstripping the bulk and the price of the engine, and when the first expence is incurred,—the *two* men that are necessary to attend the smallest, can manage the most gigantic mechanism.—The expence would be 75,000 dollars.

Having accomplished thus much of the proposed object,—enough to substitute pure, for putrifying water, and effectually to provide for the cleansing and cooling the streets,—a very important part of it still remains unfinished,—but which may be a work of more leisure. This is to bring to Philadelphia the spring, which turns the mill, called Spring-mill, for the sole purpose of supplying the city with water for culinary use.

It has been generally supposed, and perhaps with great truth, that limestone water has a medicinal effect in bilious cases. The mill-springs form a rivulet gushing from a limestone basin, and, as nearly as I could ascertain it, under all the disadvantages of the season, and the want of instruments, it would run through, and fill a trunk of from four to five feet in section,—not calculating upon any head.

This quantity would give a perpetual supply to 2,880 pipes, the bore of which should be equal to $\frac{1}{4}$ of an inch square, and supposing the water were permitted to run only twelve hours each day, it would supply 5,760 houses with a quantity more than ten times their possible consumption. As the aqueduct, before it reached Philadelphia would gain a very considerable head, the same supply would be received, but in less time. A more detailed calculation is at present unnecessary: this is enough to show

show that the spring produces water in sufficient quantity.

The spring has never been known to increase in wet or to diminish in dry seasons. Its temperature is, as I am well informed, lower than that of most other springs, being only forty-two or forty-three degrees of Fahrenheit, and the water issues in such quantities that it maintains a warmth above the freezing point, in a course of three miles down the Schuylkill, keeping the river open for canoes in the severest winters. Even the winter of 1796 did not affect it. To the information which I received of this fact, from several most respectable men in the neighbourhood, I can add that it was open as far as I could see it, on the twenty-seventh of this month, when every other part of the river was frozen over.

The practicability of bringing this spring to the city is ascertained by the practicability of the canal, near the proposed bank of which it rises. Its level is four feet higher than that of the canal, it would go over better ground, the distance would be shorter, and it is to the south and eastward of all the rocky knolls. I have good reason to think that the distance would not exceed twelve miles.

In executing this work, only two objects of indispensable consideration occur.

I. To prevent the quantity of water from being diminished by evaporation or absorption.

II. To preserve its temperature, both in summer and winter.

Both these ends would be attained, by conducting the water in a close tunnel (say an elliptical culvert of three feet by six feet)—three feet at least under the surface of all the natural ground, provided with the necessary air-holes, and air-traps,—and carrying it in light aqueducts of segment arches across all the

vallies, avoiding every attempt at a forced canal of earth.

The expence of bringing the water as far as the city would not exceed 275,000 dollars.

It is evident, that in this work the water would never freeze, nor yet acquire any perceptible degree of heat. Only while passing along the aqueducts, it would lose, in winter, and gain heat, in summer.

But supposing even that the aqueducts amount to a mile in length, and that the course of the water be only two miles an hour, it would never be exposed to an atmosphere hotter or colder than itself, for more than thirty minutes. We have seen that it will retain a temperature above the freezing point for near three miles, though it has passed a mill, and is mixed with the colder water of the Schuylkill. As the aqueduct would be in short lengths, the water would re-acquire in the tunnels, the temperature it might lose in the open air.

Should the mill-spring at any time be found insufficient, the aqueduct, once constructed, might receive, in its course, supplies from all the neighbouring springs, which rise in levels sufficiently elevated; and perhaps convey water to the city, sufficient in quantity to render the Steam-engine on the Schuylkill unnecessary.

Even when the first supply arrives, the engines may be dormant, from the month of November to the beginning of August.

I have now to consider the works necessary in the city itself.

In the *first instance*, they will consist of wooden pipes of four inches bore, leading from center square in the following arrangement:

I. Four pipes down Market-street,—supplying at their extremities, ranges of cross pipes of three inches

inches bore, running north and south, in Water-street, Front-street, Second and Third-streets. These pipes will lie under or near the gutters. From them will branch laterally the leaden pipes which supply each house. The detail of cocks, public spouts, fountain and fire plugs, would be particularly attended to. These four mains will be served from the basin in center-square, and they must be so connected, as at option to be served also from the reservoir upon the Engine-house.

II. Four pipes down Chesnut, and four down Arch-street, to supply the cross streets upon the same principle, as high as Eleventh-street. If no more could be accomplished in the first year, it would be sufficient, as the pumps above Eleventh-street furnish as yet very good water.

If time permit, *before*, and certainly *after*, these pipes are in operation, the east and west pipes must be doubled so as to serve separately, one the north, the other the south streets. In the course of time, they ought to be replaced by cast iron pipes of nine inches bore.

This may be done gradually, beginning with the longest.

In all the pipes, plugs or cocks will be fixed which, when drawn, will throw up fountains playing to a height proportionate to the elevation of the reservoir, the lower cock being previously closed. A main of four inches bore, for instance, will, when closed at the lower extremity, throw up, in different parts of the same street, twelve fountains of an inch diameter each, and thus the whole city may be alternately cleansed and cooled.

In case of fire, these fountains will fill the engines without manual labor, by the proper application of a hose. This is of itself an object worthy of the whole expence of distribution.

The pipes ought to lie at least two feet below the pavement. Wooden pipes require much attention and repair. I cannot in the short time allowed me, furnish any probable calculation of the annual expence of these repairs. The experience of the London new river company shows, that notwithstanding their frequency, the water can be supplied, and all the works kept up at a small annual water-rent, reserving a very large income to the company.

Neither can the original expence of laying down the pipes be very exactly calculated, without better information than I have been able to procure. My enquiries however lead me to believe, that the pavement may be opened, the pipe manufactured and laid down, and covered again, for half a dollar a foot, allowing for plugs, cocks and hoops.

On this supposition, and allowing 10,000 feet of pipe (or nearly two miles) to Front-street, 8,000 feet to the three next, 5,000 each as high as Eleventh-street, and 35,000 in the east and west mains, the whole amount will be 104,000 feet, making 52,000 dollars.

This expence would distribute water through all the crowded parts of the city, and render the pumps wholly unnecessary.—The expence, of laying the water by small leaden pipes from the main to the private houses, should be borne by the individuals. It would amount to fifty cents per foot, and in no case exceed twenty-five or thirty dollars, an expence which I think every family would cheerfully incur to avoid the inconveniences arising from the necessity, as at present, of sending their servants to the pumps.—For these pipes, a rent would be paid.—The poorer inhabitants would supply themselves from the public plugs, without any charge. I think half the expence of laying down the main pipes, *i. e.* twenty-five cents per foot, if assessed upon the city, would not be objected to. The rich would

would pay in proportion to their fronts,—the poor would be slightly affected; the expence in fact would fall upon the landlord. Corner houses should pay only for one front. This assessment would pay the whole expence, one half being levied on each side of the street. If a tax is to be levied on the city for the work, a lighter and a juster could not perhaps be devised. It would in fact be the *purchase money* of health and convenience, and occur only once. Every new house, would pay its share, as it was built, and thereby contribute to the future repairs.

But I ought to apologize for these suggestions. I have made them only to show, that the effort, which it is proposed to make, is much within the powers of this wealthy city.

Recapitulation of expence:—

Erecting the Engines and bringing water from Schuylkill to Center-square,	} 75,000
Bringing the Mill-spring to the city, -	275,000
Distributing the water throughout the city—first expence, - - - - -	} 52,000
	<hr/>
	Dollars 402,000
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A further expence will be necessary to extend the distribution to every distant part of the town. This may be executed in A^o.1800. The expence cannot easily be ascertained.

I will furnish you, at any time you please, with the detail of my estimates, which I believe will not be found short of the reality.

In order to ascertain the probable proceeds of the works, I will suppose, that of six thousand houses, four thousand families will supply themselves with water from the main. The water-rent which I paid while residing in London, in a house of twenty-four feet front, was thirty-six shillings, sterling, or eight

eight dollars. Fixing ten dollars as the *first* average rent,—which, as the funds become prosperous, may be annually lowered,—this alone would produce an annual rent of 40,000 dollars, independently of extra supplies to brewers, distillers, or very large families.

40,000 dollars rent, at 6 per cent. per annum, is equivalent to a capital of - - -	}	Dollars. Cts. 666,666 66
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I will now add a few remarks upon the following propofals, which have been supposed to be worthy of confideration, and which indeed are the only schemes that have come to my knowledge, that deserve attention.

- I. To complete the canal immediately.
- II. To conduct Wiffahikon-creek to the city.
- III. To erect water-works to be driven by one of the two rivers.
- IV. To collect water from any practicable source, and bring it over hill and dale in wooden, or perhaps, in iron pipes, to Philadelphia.

If,—and I presume it will not easily be disputed, the three requisites of (1st.) *immediate* utility,—(2^d.) permanence,—and (3^d.) security against *frost*, be indispenfible, I may difmifs these propofals in a few words.

- I. The first is deficient in the first, and, I fear, in the last.
- II. The second, (if at any time the water were fufficient) in the first and last.
- III. The third in the second and third.
- IV. The fourth in permanence, and, I think, in efficiency.

I. As to the canal,—I am convinced that the very eminent and acknowledged abilities of the Engineer Mr. Weston, could overcome any obstacles which art dare combat; and that a work, in which he has already done himself so much honor, would not want completion if it depended upon his genius or his industry.—If, therefore, the work could be accomplished in time, it certainly would render great part of the expence, which I have proposed, unnecessary. But, from what I have heard, doubt may be entertained of the possibility of the necessary expedition. But I confess myself very imperfectly informed. I fear the ice would embarrass the winter-supply for culinary use,—but to every other purpose its waters would be amply adequate.

II. Wiffahikon-creek has, I believe, not a sufficient quantity of water. Besides, to get the water upon a proper elevation, it would be necessary to purchase two mills, and then to bring the water to town over very unfavorable ground. The creek has been, even this winter, almost frozen to the bottom, and yielded little water.

III. The examples of London, (London bridge works,) Versailles, (Marly,) and Bremen, would forever deter me from attempting works to be driven by a river subject to ice and freshes. The expence of keeping up the timber-work is enormous, and equal to re-building once in seven years. To give such works *power*, they must be unwieldy. *Cranks*, which are their necessary appendage, are the very worst things in mechanism.—In the Delaware or Schuylkill, the works might stand still six hours in twenty-four:—perhaps during the raging of a fire.—I once saw several houses in London burn down, while the works were waiting for the tide. This happens not unfrequently.—In winter they would be wholly useless.

IV. To

IV. To bring water, in pipes of any description, a yard further than necessity requires, is very bad œconomy. All water has more or less sediment, and pipes cannot be cleansed without taking them up. It is difficult often to find where the fault lies. Metal pipes are very liable to injury from the frost, and in a long extent every part could not be equally secured. Wooden pipes, like every thing else that is wooden, are a perpetual source of expence, repair, and interruption. The inconvenience attending them in distributing the water must be borne, because it cannot be avoided,—but where it can be avoided, it ought not to be borne.

By the length of this letter, you will see that I have endeavored to comply fully with your request,—by the want of detail, you will observe that I have been straightened in time.

I am, Sir,

With great esteem,

Your's faithfully,

B. HENRY LATROBE.

To JOHN MILLER, Esquire, *Chairman* }
of the Committee of the Select Council }
of the city of Philadelphia.

POSTSCRIPT.

POSTSCRIPT.

I AM induced to add still the following remarks, as connected with the subject of my letter.

I. *Prejudice against River-water.*

Although most men prefer spring, to river water, it may be doubted, whether the latter be not the most wholesome. It is certainly supposed by Physicians to be more generally free from noxious ingredients. The Indians, I am informed, from motives of health now grown into habit, never drink water from a spring, when they can procure it from a stream. London is entirely supplied with river water. It is taken from the Thames in different places, from the New River, and from the river Lee; and has nothing to boast of the cleanliness of its aqueducts. The water is received in each house in wooden, or leaden cisterns, where it deposits a black impalpable mud. When boiled the new New River water crufts the vessels with a calcareous precipitate, so as in time to choak the spouts of the tea kettles. I believe that the country, in which the river rises, has a basis of chalk. The water must, therefore, be similar to that of the Schuylkill in quality, though very inferior in purity. The houses in London are supplied only once in two days. The water then runs about three hours. Yet during some years residence in London I thought it very pleasant, and I am certain it is very wholesome. It is preferred to the water of any spring in the two cities and suburbs, and those that have any fame, (such as St. Paul's, or Aldgate,) owe it to
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their coldness, not their superior salubrity. I must remark, that I never knew a deficiency of water in my family, notwithstanding the distant intervals between the supplies. The cisterns always ran over during the last hour of the water's coming in.—This shows how sufficient our own resources are.

In this hot climate, however, cool water is more valuable than in London, and, perhaps, absolutely necessary.—The Mill-spring seems to possess every desirable quality, in a degree which our most sanguine wishes could scarce have expected.

II. *Fountains.*

The Engine proposed for Center-square, may be considered as a necessary and unavoidable expence, by whatever means the water be brought to town. It may be rendered an ornament to the city. Its use is to supply water to the higher levels of the town, and fountains to all the streets. They are the only means of cooling the air. The air produced by the agitation of water is of the purest kind, and the sudden evaporation of water, scattered through the air, absorbs astonishing quantities of heat,—or to use the common phrase, creates a great degree of cold. Coal mines, which are troubled with foul air, are supplied with pure air by the simple means of pouring a small stream of water through a trunk, down the shaft into a cask. The air extricated in the trunk and cask, is conveyed by means of pipes to distant parts of the works. When the shaft is deep it will blow out so strongly, that a man cannot stand against it. The water blast, used in Switzerland in the furnaces, which is produced by the same simple means, is the strongest that can be devised, and on account of the purity of its air, partakes of the superiority of the chemical oxygen furnace.

As to the mechanism of the fountains, it consists merely of a short wooden pipe, set perpendicularly into the main, and stopped by a cock, which is turned, when the fountain is not in use. The *name* produces an idea of great expence, but they may be realised at a very small one.

III. *Public Baths.*

I have often wondered, that while in many despotic countries, all ranks of men have been provided with the convenience, and the wholesome pleasantness of public baths, fountains, and porticoes, the American people do not indulge themselves, in the smallest gratification, as salubrious, as it is innocent, of this kind. Our abstinence is commendable, as it arises from industry, and our attention to more serious pursuits, but highly blameable as it injures our health. We retain indeed both in our buildings, our diet, and our modes of life, the habits of our Northern ancestors, and have not yet learned how to live healthily in a hot climate. In the city of Philadelphia, I think baths almost an absolutely necessary means of health. When the engine in center square is at work it will with great ease supply a requisite number of baths. I mention this only as a hint. It might be worth while to look forward to some such thing in the arrangement that may be thought of, provided the preparation may be made without expence. I think it may. Such baths would be a source of a large revenue and perhaps it might not be bad policy in the citizens of this primary metropolis of North America, to counterbalance the fashionable inducements which point to the Potowmac, by conveniences, and advantages which cannot for many years be thought of in a city, which is at present almost destitute of dwellings.

IV. *Steam Engines.*

For want of the necessary information of what can be executed in this city,—which I have not had time to procure,—some uncertainty in the estimates, in which the Steam Engines are concerned, must be expected. I have said nothing of their power, because it is perfectly at your option from the supply of five hundred to any higher number of gallons per minute. I have no doubt but that this city can produce Smiths capable of constructing very efficient Engines, under proper direction.

The annual expence of each Engine, and repairs, will not exceed three thousand dollars.

