REPORT

TO THE

COMMON COUNCIL OF THE CITY OF CLEVELAND,

ON THE

SUBJECT OF WATER WORKS,

FOR SUPPLYING

PURE AND WHOLESOME WATER TO THE INHABITANTS,

ACCOMPANIED WITH

GENERAL PLANS FOR CARRYING THE PROJECT INTO PRACTICE;

TOGETHER WITH A

SUPPLEMENTARY REPORT

SUGGESTIVE OF

A THOROUGH SYSTEM OF SEWERAGE,

IN CONNECTION WITH WATER WORKS.

CLEVELAND:

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1853.

REPORT

ON THE

SUBJECT OF WATER WORKS.

CINCINNATI, FEBRUARY 28th, 1853.

To the Honorable,

The Mayor and Common Council of the city of Cleveland:

GENTLEMEN:—In accordance with a resolution of Council, directing that the services of a hydraulic engineer be procured, to project and report plans of Water-Works adapted to the peculiar locality and wants of the city of Cleveland, the Committee on Water-Works deemed it proper to favor me with the order to execute that important work, which I now have the honor to lay before your Honorable Body.

During the time the Water-Works project was under consideration, I had frequent opportunities to consult and advise with the Committee, composed of Messrs. WM. CASE, WM. J. WARNER, J. P. KIRTLAND, and CHAS. WHITTLESEY, appointed by Council to institute enquiries with reference to, and report upon the best mode of supplying the city of Cleveland with water; and having with them, at various times, examined the source of supply, and locations for different purposes, in view of the construction of Water-Works, and subsequently having given the subject of the Committee's Report a careful investigation, with regard to the mode of supply, character and capacity of the Water-Works recommended by them, of which I highly approve, placed me in possession of all the information required to mature plans for the practical accomplishment of that project.

The data furnished in that Report, from which estimates were made for Works ample to supply 100,000 inhabitants with water, have been

adopted as the basis of this, as well as the mode by which water was to be supplied. From which, you will discover that the general plans of the Water-Works herewith submitted, are, in character, identical with those recommended by the Committee. However, in consequence of the since unprecedented rise in the price of materials, especially that of iron, which enters largely into the construction of Water-Works, new estimates have been made upon a different but correct basis, making a considerable discrepancy in the estimated cost of the Works.

The value, uses, and importance of a bountiful supply of pure and salubrious water to any city, is a subject which has been so repeatedly and ably discussed, especially by the recent Committee, as to render any additional testimony unnecessary from me in favor of its introduction into the city of Cleveland. Therefore, the most direct course will be pursued to arrive at the results aimed at by the Water-Works Committee, instructing me to mature plans of Water-Works to be submitted and reported upon, in connection with some general plan of sewerage, at as early a day as practicable.

SOURCE OF SUPPLY.

The preliminary steps taken by the Committee, to procure a supply of pure and wholesome water, led to the examination of the different sources in and about Cleveland, and specimens of each were subjected to analysis, resulting, by general consent, in the choice of Lake water, as the purest available source. And, as the citizens of Cleveland, long accustomed to cisterns and wells, free from any influence vitiating the qualities of the water, are naturally sensitive upon questions of purity connected with a new source of supply, it was an object with the Committee, to select a site for the pump-house as remote from Cuyahoga River and its discharges, and from the influence of town drainage, and turbidness of the lake-shore, as due regard to economy of constructing the Works would permit. Partly to accomplish that object, an aqueduct or delivery pipe of 40 inches diameter, and 1500 feet long, was proposed to be laid in the Lake to connect with the pumps; and lastly, the pump-house was to be situated so far from Cuyahoga River as to divert water from a source perfectly pure. With reference to supply, purity of water and the means of keeping its qualities unimpaired, are questions which naturally arise, and conjecture with regard to influences affecting that

supply, often occasions much unnecessary concern. With reference to Cleveland, the most prominent difficulty presenting itself to the citizens, is to obtain pure water near the city, unaffected by town drainage, and the discharges of Cuyahoga River. The influence which town drainage may have, with other effects upon the source of supply, is so intimately associated, in the minds of the people, with notions of cleanliness and health, as to be regarded a matter of paramount importance connected with this project of Water-Works, and it is a subject of interest and sanitary enquiry, which has for many years claimed the special attention of the public and scientific men.

Taking the results of careful investigation, reported by different respectable bodies, as evidence upon which to base an opinion, and considering all the circumstances connected with the supply of water for Cleveland, as compared with that for other cities, made the subject of investigation, and in view of the precautionary measures taken to provide a pure and wholesome supply of water by the plan proposed, the citizens have no occasion to fear that the lake water may ever be contaminated from the causes explained to a degree impairing its pure and healthful qualities, at the point where the water flows into the aqueduct pipe for the supply of the pumps.

Knowing that these considerations weigh heavily upon the minds of many taking an active part in the measure, who are anxious to forward the introduction of so important an element of life as a pure and abundant supply of water to their city, and in support of the opinion just expressed, I have been induced to cite your attention to a few instances connected with water supply and drainage of towns, as corroborative testimony and as cases clearly in point.

At Cincinnati, a city of 160,000 inhabitants, the aqueduct pipe extends but 350 feet from the pumps to the channel of the Ohio River, to procure water which is perfectly free from the impurities incident to the shore.

At Pittsburgh and Alleghany-City, pure water is obtained at the channel of the river, in the same manner, and at no greater distance from the shore.

At Philadelphia, the water supplied by the Fair Mount Water-Works, is taken without aqueduct pipe immediately from the shore of the Schuylkill, in a state of purity, which has been classified under the head of analysis, as water of the first quality.

Further investigations with reference to this subject have been made, to ascertain the extent to which water may be affected by the causes already considered, leading to the examination of different sources of supply to populous towns. The following marked instance is brought to your notice, showing the practical results of varied experiments on the same body of water, made the subject of a test. At the city of Paris, (France) an enquiry was instituted by the General Board of Health, with reference to water supply and its effects upon health, resulting in the chemical analysis of waters taken from the Seine, one mile above, and one mile below the city limits.

The report upon these interesting experiments, evidenced the fact that water taken one mile below the city, notwithstanding in its passage from one point to the other, the water was charged with the filthy purgings of an immensely populous city, yet it was not materially affected in its quality, in consequence of previous polution. These are important facts, and go far to show to what degree *pure* water acts as its own corrective. The self-purifying properties of water being such as to exert a strong healthy effort in throwing off, by rapid dilution and deposition, every impurity with which it may be charged.

Feeling as I have expressed, the importance which the citizens of Cleveland attach to procuring a bountiful supply of pure and wholesome water, and taking into account all the circumstances connected with the supply for the city, and incidental to it, as affected by drainage, and considering the natural purity of the source, depth of water, and distance from Cuyahoga River, and from the shore of the Lake, at which the supply is obtained, together with the advantages resulting from the adoption of the sites proposed for pump-house, and from its close proximity to the reservoir and the nearness of this latter to the district to be supplied, by which direct and short lines of water pipes, from point to point, may be connected with the greatest possible economy of construction, commanding the most effective and abundant supply of water, I am induced to endorse the opinions of the Committee, relative to the source and means of procuring the supply, and would recommend the adoption of such measures as would accomplish the project to which the plans herewith submitted are made to conform.

ENGINE OR PUMP HOUSE.

The site chosen for the engine-house, is a lot situated at the foot of Frontier street, where the house will be erected as near the shore of the Lake as may be practicable to secure permanent foundations. The plan of engine-house conforms to the peculiar arrangement of the engines, stand-pipe, and boilers, and with regard to convenience, economy of space, and construction, is as well adapted to the purpose as any that could be adopted.

The engine-house has an entire front of 105 feet length. The main body of the building containing the engines, measures 46 feet in front by 55 feet in width, and is two stories of 40 feet height to the cornice. The side wings of the house for boiler rooms, measure each 29½ feet in front and 52½ feet wide, and are one story high.

In the construction of the engine-house, the utmost care must be taken, and no pains or expense spared to insure solid foundations to prevent settling. Piles are first to be driven, and on these, concrete and timber are to be laid, to prepare for laying the stone foundations, on which to erect the house walls and machinery.

The material for the walls to be brick, and the caps, sills, and cornice to be stone, and the roof will have an iron truss support, with metalic covering to guard against fire.

To enclose the stand-pipe and prevent freezing, a steeple is elevated on the house, framed with timber, having a ceiling and exterior staving of boards, which is lastly protected from fire with a covering of thin metal. A flight of continuous spiral steps, filling the space between the stand-pipe and ceiling of the steeple, form the lateral stay, and afford means of access to a look-out which caps and ornaments the top, 170 feet above the surface of the Lake.

PUMPING ENGINES.

The plan recommended as best adapted to the purpose of pumping, is represented in the drawings submitted, showing the section, elevation, and ground plan of a purely Cornish-engine. This engine is peculiar to Cornwall, whose long practical experience, and the highest order of mechanical genius, have brought it to such a state of perfection for

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elevating water, as to have justly established for it, a character for unparalleled success, and economical working, that no other pumping engine has ever attained.

It is estimated by very exact calculation from the results of the best pumping engines of Cornwall, that under precisely similar circumstances as compared with the maximum working of the ordinary double action crank motion plan of engine, that the minimum working of the Cornish-engine elevates at least double the quantity of water to a given height, for an equal consumption of fuel, that the ordinary pumping engine does.

As the chief merits of any motive power consist in its simplicity of construction, with faithful and economical working, the Cornish engine combine these good qualities in an eminent degree. In the following, some very interesting statistics in confirmation of the good character given this engine, are furnished.

From official returns made by the New River Water Company at London, it was ascertained that during the year 1849, a Cornish pumping engine supplied 10,000,000 of gallons of water per diem, for every 100 bushels of coal consumed, which is nearly eight times the quantity of water furnished under the same circumstances for an equal consumption of fuel, by any known high pressure pumping engine, and nearly four times that furnished by the best condensing engines.

The East London Water Company, using Cornish engines for supplying water, effect with their power about the same results of economy as the New River Company, and the work accomplished by both is equivalent to furnishing 80,000 tenements each with 250 gallons per day, for every 100 bushels of coal used to create the power employed. This extraordinary working can only be appreciated by a just comparison with that performed by the ordinary pumping plan, which would have required 600 bushels of coal to accomplish the same work.

In an able report of Mr. McAlpine, addressed to the Water Commissioners of the city of Albany, may be found a table of reference, showing the comparative expense of working different kinds of pumping engines in Europe and America. He states that the Cornish engines used at Harlem effected an average duty equal to raising 75,000,000 lbs. one foot high, for every bushel of coal burnt. And one of the mining engines at Cornwall attained a duty of 100,000,000 lbs. raised to the same height for the same consumption of fuel. Now taking the average

duty of several ordinary pumping engines for comparison from the same table, but 20,000,000 lbs. was raised one foot high for every bushel of coal used, which is but one-fifth that done by the Cornish engine. In 1851, during my sojourn in Europe, especially at the English metropolis, I had frequent opportunities afforded me, through the politeness of different hydraulic engineers, to witness the operations, and examine several Cornish engines in use. These examinations, with my own personal observations of the working of the engines, placed me in possession of much useful and reliable information upon the subject of enquiry and interest to me. And I would state that the plan of pumping engines projected for the Cleveland Water-Works, embody all the modern improvements of the purely Cornish engine, which I procured at that time.

For these Water-Works, two pumping engines are planned of such dimensions and power as to supply by day light, or in sixteen working hours, 3,000,000 gallons of water, at an elevation of 160 feet. The engines have an excess of power given them, which may hereafter be brought in requisition to work enlarged pumps for increasing the supply as the future wants of the city may demand. The steam cylinders are each 70 inches diameter of bore and 10 feet stroke of piston, working single action pumps, with plungers, each 30 inches diameter, and 8¾ feet stroke, through the intervention of an unequal beam. Each engine has an independent battery of 3 boilers, 6 feet diameter, and 28 feet long, and both engines form a junction with a stand-pipe, 48 inches diameter, and 170 feet high, which connects with a pump main (supplying the reservoir,) 3900 feet long.

For the purpose of arriving at the lift or working load on the engines when pumping, the levels of reservoir grounds caused to be made, and were furnished by the committee in their report are assumed here, as 100 feet above Lake Erie, and as 60 feet above the surface of the grounds, will be the maximum height of water at the reservoir, makes 160 feet head in addition to the friction occasioned by the propulsion of water through the pump-main to the reservoir—takes into account the resistence to be overcome by the power of the engines. And the pump plunger being 30 inches diameter and 8¾ feet stroke, for impelling 3,000,000 gallons of water through a 24 inch pump-main 3900 feet long, during day-light, or in 16 working hours, furnish the data for calculating the required power of the pumping engines.

From the data given, the load on the engine is computed at 60,000 lbs urged against the pump plunger, which making 9 7-10 down strokes per minute, will require the exertion of 144 horse power to supply 3,000,000 gallons of water in the time required. On 3,000,000 wine gallons of water delivered at the height, and in the time, and in the manner specified, is raising 24,062 lbs. of water at the reservoir per minute. And estimating the friction due to the working of the engine and the passage of the water through the pump-main, is equal to raising 3,970,230 lbs. one foot high in one minute. Then by adopting the same standard of horse power as computed above, there is again exhibited an expenditure of 144 horse power to accomplish the work. It should be remembered however, that this is computing the greatest expenditure of power necessary for supplying 100,000 inhabitants with water, allowing 30 gallons per day to each inhabitant.

The showing of the working expenses, for fuel, power, labor and incidentals per day, for supplying 3,000,000 gallons of water as required, may be determined as follows: The best tables of reference, as established by practical experience, rate the consumption of fuel when working Cornish engines, at 3 lbs of coal per hour for every horse power employed in pumping water. Then 144 horse power employed for 16 working hours, at 3 lbs of coal per hour, per horse power, makes 6,902 lbs per day; and for 365 days 1145 tons, which at 28 bushels per ton, make 32,060 bushels at 10 cents.....$3,206,00

Chief Engineer $2,50, and Assistant $1,50 per day.....		1,095,00
Two Firemen at $1,00	"	730,00
One laborer at "	"	365,00
Repairs, oils, yarns, &c.....	.....	1,500,00

Aggregate expense per annum.....$6,896,00

This estimate makes the expenses incurring at the engine house for creating and maintaining power to supply 3,000,000 gallons of water $18,89 per day. To present a fair comparison of the cost of power for elevating water by the different modes of steam application, the engines of the Pittsburgh Water-Works, referred to by the Committee, may be instanced as raising 2,500,000 gallons of water 150 feet high, for 275 bushels of coal consumed, which is a pumping engine, if employed at

the Cleveland Water-Works at the same rate for coal, would cost in the item of fuel alone $33,24 per day, to furnish 3,000,000 gallons of water. Or $14,35 per day for fuel alone more than the total expense of fuel, labor, repairs, &c., at the engine house by the Cornish plan. This statement presents the striking contrast of effect and economy which distinguishes the working of the Cornish engine from that of all other pumping engines in use.

According to the arrangement of engines and boilers, the steam furnaces for each engine will contain a battery of 3 boilers, the dimensions of which have already been given. Each furnace will be constructed of brick, surmounted with a cornice of iron, and all the room of the boiler house will be occupied by the furnace but 12 feet in front of the fires for the deposit of coal. The smoke from the furnaces will be conveyed through flues of brick, extended out doors, uniting at a chimney stack 130 feet high, situated mid-way the engine house, on the side fronting the Lake.

Having given a general discription of the engine-house and machinery, it may be well to explain the process of supply.

The water for the supply of the city, is derived from the source at deep, pure water in the lake, and conveyed through the aqueduct pipe to a pump well within the engine-house, where the water is raised by the engines and impelled through the pump-main which delivers it at the Reservoir, from where it is supplied to the town.

In answer to the question often asked, Why is it necessary to have the pumping engines duplicated? I would state, that the indispensable necessity of such engines, for a system of supply, dependent upon power alone, where Water-Works are limited in capacity of reservoir, as at Cleveland, arises from the circumstance that a reserve engine must, at a moment's notice, always be had in readiness to supply the place of the working one when out of order, to maintain a reliable and constant supply of water. And the engines should be of the same capacity and character, and work alternately, (week about) for the reason that in practice it is found that engines standing idle suffer more injury from corrosion and neglect, than by working in good order. And it is evident that the same practice which works one pumping engine effectually, should be adopted for working the other; thus schooling the operators of the pumping machinery to a most perfect system of skilfull management.

Hence, the necessity of two engines not of a different character but duplicated, as recommended.

RESERVOIR TOWER.

From want of elevated lands to construct a reservoir on the surface of the ground, in the immediate vicinity or limits of the city, a Tower and Tank was resorted to, as the only means practicable to attain the requisite head of water for the supply of the town. Capacity of reservoir is regarded as an object of paramount importance, in the construction of Water-Works, as the great receptacle for the storage of water, providing for the contingency of accident to the Works, and for furnishing a continued supply while all necessary repairs may be made. For aqueduct constructions, such as the Croton, or for Works of limited facilities or resources of supply, capacity of reservoir is an indispensable requisite. But for Cleveland, without summit grounds, on which to construct a capacious reservoir, a different system of supply must necessarily be adopted. By that system, the certainty of a permanent supply of water is made reliable, by substituting the lake for an inexhaustible reservoir and source of supply in one, as furnished by nature, where the head of water on the distribution pipes is derived not from the natural reservoir, but artificially from a Tower containing in a Tank, a reserve supply only for night consumption, and for the emergency of fire, and where an uninterrupted supply is furnished by means of "efficient and unfailing power." The great desideratum "is power;" if that be unquestionable, the adopted mode of supply for the city of Cleveland, as here recommended, will be as secure and reliable as any other, for all Water-Works are subject to the contingency of accident, and these are not more so than those of a different character.

The Tower will be a round brick massive structure, 117 feet diameter and two stories high, measuring 79 feet to the top of the parrapet wall' To be covered with an iron truss roof, for preventing the deposit of soot or dirt, (with which the atmosphere may be charged) to discolor or impurify the water in the Tank, and to so enclose the Tower by the roof, that heat may be applied, if not sufficiently protected from the weather, to prevent injury to the Tank, by frost or the formation of ice. The roof will be surmounted with an observatory, commanding a view of the whole city, and a fine prospect of the Lake.

The exterior wall of the Tower encloses a series of equidistant concentric walls, 2 feet thick and 40 feet high. The top of the concentric walls receive numerous iron truss girders, built in as the walls are carried up, diverging from the centre, in the form of a web, and these form with the walls, the support to a round boiler plate tank, 100 feet diameter and 22 feet high, for containing 1,000,000 gallons of water, at 20 feet depth. When the water in the Tank is at the maximum depth, (20 feet) a head of 60 feet will be produced, and furnish a supply of water, at the fourth stories of the highest buildings on the summit level, which head will be uniformly augmented by the gradual descent from the Tower to the lower levels of the city, producing, at some points, 140 feet head, where jets of water may be thrown over the highest houses, by attaching fire hose to the water pipes.

The fixtures and attachments belonging to the Tank, are as follows: There is connected with the bottom of the Tank, by means of a flange and screw bolts, a 24 inch pipe, which forms the reservoir terminus of the pump-main, and is termed the inlet pipe. There is also attached to the bottom of the Tank, in the manner described, a 20 inch pipe, so reduced as to connect, on the outside of the Tower, with the 16 inch main, supplying the city. The 20 inch pipe is termed the outlet pipe. In connection with the Tank there is an overflow pipe, 20 inches diameter, attached 20 feet above the bottom, and extending outside the Tower, to run the water to waste in the event of pumping too long. A short 20 inch pipe, with a stop-cock, is attached to the Tank, to connect with an additional supply-main to the city, when required. In addition to these fixtures, three stop-cocks or water-gates are provided, to shut off and let on water at pleasure, and all the fixtures and attachments above described as connected with the Tank, have been projected of a size to allow for such increase supply of water, as the future wants of a very large population may demand.

There will be a single entrance to the Tower, at a portico, fronting on Euclid street, and by means of winding steps, and an iron lattice foot bridge, for crossing the Tank leading to a central stairway of spiral iron steps, the ascent is effected to the top of the Tower, landing within the observatory, 90 feet above the surface of the ground. An intermediate gallery around the bottom of the Tank, affords the convenience for inspecting and repairing the work, as occasion requires.

Considering the important office which the Reservoir Tower performs, as one of the important functions of the adopted system of supply, renders it absolutely necessary that all the materials and workmanship throughout the construction, should be of such excellent quality and character, as to insure the erection of a sound, durable, and permanent structure, and with this view, sufficiently large allowance has been made in the estimates to meet every expense. The architectural design of the Reservoir Tower presents an imposing structure, divested of unnecessary embellishment, yet has a novel and handsome appearance, and will be an ornament to the city.

The discrepancy found by comparing the estimates for reservoir grounds, in this report and that of the Committee, arises from a larger allowance made here for grounds to construct two or three additional Towers, should the future necessities and safety of the city require greater supply of water for night consumption and for the contingency of fire.

Should the Council or citizens desire it, the grounds about the Tower may be brought, in time, to a very high state of improvement. These grounds should be enclosed with a neat iron fence, having gravel walks laid out, which should be adorned with shrubbery and shade trees. In front, and in the middle of the walk, leading to the portico of the Tower, may be placed a fountain to play a jet of water at pleasure, from 1 foot to 50 feet high. Such embellishments would give fine effect to the appearance of the Tower, and lend great attraction to the spot, as a place of public resort.

DISTRIBUTION.

The boundaries of the district to be supplied with water, as apportioned by the Water-Works Committee, are Erie street on the East, Eagle street on the South, Cuyahoga River on the West, and Lake Erie on the North. The whole extent of distribution to supply that portion of the city of Cleveland lying within the limits described, embraces 11 miles of water pipes of different lengths and capacity, instead of 10 miles of pipes, as estimated by the Committee that reported. It may be proper to state that the Committee professed to furnish only an approximate cost of the Water-Works, whereas here more exact estimates may be expected from being based upon reliable data, although in both cases,

the works estimated were intended to be of a very superior character. The difference in the cost of water pipe exceeds $10,000.

The diameter of bore and length of water-pipe for each street are designated as follows:

The supply main 16 inches diameter, and the principal artery to the whole system of supply, extends 4,400 feet on Euclid street, from Front tier street to the Public Square, where, by a reducing pipe it connects with a 10 inch main. A 4 inch collateral pipe to the 16 inch main extends its whole length, 4,400 feet, for attaching service pipe on Euclid street.

On Erie street a 10 inch main connecting with the 16 inch main, extends 3,830 feet, from Eagle street to Lake street.

On the South and West of the Public Square a ten inch main extends 1160 feet, from Euclid street to Superior street.

On Superior street an 8 inch main extends 3850 feet on Erie street to River street, and branches at Vinyard street, extending 1020 feet to Division street.

On Miami street a 6 inch main extends 950 feet, from Kinsman street to Hume street.

On Pittsburgh street a 6 inch main extends 850 feet, from Eagle street to Huron street.

On River street a 6 inch main extends 2350 feet, from Front street to Superior street.

On Water street a 6 inch main extends 2080 feet, from Superior street to Front street.

On Merwin street a 6 inch main extends 440 feet, from Superior street to the Canal.

On Huron street a 6 inch main extends 1680 feet, from Ontario street to Euclid street.

On Prospect street a 6 inch main extends 1760 feet, from Ontario street to Erie street,

On Division street a 6 inch main extends 770 feet, from Merwin street to Vinyard street.

On St. Clair street a 6 inch main extends 3900 feet, from River street to Erie street.

On Lake street a 6 inch main extends 3350 feet, from Water street to Erie street.

On Bond street a 4 inch pipe extends 440 feet, from Superior street to Lake street.

On Wood street a 4 inch pipe extends 1150 feet, from Rockwell street to Lake street.

On Ontario street a 4 inch pipe extends 2310 feet, from Huron street to Public Square.

On Seneca street a 4 inch pipe extends 2150 feet, from Michigan street to Lake street.

On Bank street a 4 inch pipe extends 1460 feet, from Superior street to Lake street.

On Union street a 4 inch pipe extends 720 feet, from St. Clair street to Superior street.

On Merwin street a 4 inch pipe extends 480 feet, from the Canal to Division street.

On Eagle street a 4 inch pipe extends 1500 feet, from Kinsman street to Erie street.

On Bolivar street a 4 inch pipe extends 1330 feet, from Erie street to Kinsman street.

On Champlain street a 4 inch pipe extends 1140 feet, from Lot 76 to Ontario street.

On Michigan street a 4 inch pipe extends 590 feet, from Seneca street to Ontario street.

On West street a 4 inch pipe extends 630 feet, from Merwin street to Vinyard street.

On Rockwell street a 4 inch pipe extends 1940 feet, from Erie street to Public Square.

On Centre street a 4 inch pipe extends 1110 feet, from Water street to Seneca street.

On York street a 4 inch pipe extends 1120 feet, from Wood street to Erie street.

On Light House street a 4 inch pipe extends 950 feet, from River street to Water street.

On Front street a 4 inch pipe extends 1440 feet, from Water street to River street.

The aggregate length of pipes of the same bore, allotted to the different streets specified as above, are as follows.

One line of	16	inch	pump main	.....	4,400 feet.
Two "	10	"	mains	.....	4,990 "
" "	8	"	"	.....	4,870 "
Ten "	6	"	"	.....	18,110 "
Eighteen	4	"	pipes	.....	25,860 "
					58,230 "

Total length of water pipes 58,230 feet, or 11 miles.

APPENDIX.

ESTIMATE OF THE COST OF CONSTRUCTING THE WORKS.

AQUEDUCT, OR DELIVERY PIPE IN THE LAKE.

1000 cubic yards dredging	25c	$250,00
1000 " " excavation	20c	200,00
1000 feet lineal 40 inch chain aqueduct pipe, ⅜ inch boiler plate, 162,750 lbs	8c	1,320,00
Piling, crib-work, and laying aqueduct pipe		5,200,00
50 cubic yards of stone masonry	$4 00	200,00
2000 brick, laid for archway	8 00	1,600,00
		$20,470,00

ENGINE HOUSE.

1192 cubic yards of excavation for house and pump well	20c	$238,40
450 piles and driving	$2 50	1,125,00
690 square yards of concrete	80c	480,00
15,000 feet board measure timber	$8 00	120,00
1020 cubic yards stone masonry for foundations and pump well	5 00	5,100,00
350,000 brick and laying	8 00	2,800,00
Stone water table, sills, caps, cornice, &c		1,660,00
5,000 brick, pavement for boiler house	6 00	30,00
Lumber, carpenter and joiner work		3,300,00
Painting and glazing		300,00
13,933 lbs. iron truss, for roof	8c	1,042,64
9,727 lbs. iron sheet, for roof	10c	972,70
30,000 lbs. columns, brackets, and cornice	3c	900,00
		$18,068,74

ENGINES AND STAND PIPE.

One Cornish engine and boilers		$32,500,00
One reserve duplicate do do		32,500,00
163 feet boiler plate stand pipe, ⅜ inches thick, 48 inches diameter, 33,000 lbs	8c	2,640,00
		$67,640,00

FURNACES AND CHIMNEY STACK.

90 cubic yards excavation	$ 0.20	$	18,00
64 piles and driving	2.50		160,00
16 square yards concrete	0.80		12,80
2000 board measure timber	8.00		16,00
40 cubic yards stone masonry	5.00		200,00
290,000 brick and laying	8,00		2,320,00
Stone water table, coping and chimney top			225,00
			$2,951,80

PUMP MAIN.

3,900 feet lineal 24 inch pipe, 585 tons	$50.00		$29,250,00
Labor and lead, laying same per foot	1.50		5,850,00
			$35,100,00

RESERVOIR TOWER.

1,500 cubic yards excavation	$ 0.20	$	300,00
1,300 piles and driving	2.50		3,250,00
750 square yards concrete	0.80		600,00
4,500 feet board measure timber	8.00		360,00
720 perch stone masonry	4.00		2,880,00
2,050,000 brick and laying	8.00		16,400,00
Stone water table, caps, sills, cornice and coping			6,200,00
75,549 lbs iron truss girders, support to tank &c.			4,603,00
280,000 lbs boiler plate tank, including bands and stay rods	$ 0.08		20,400,00
11,097 lbs iron truss for roof	0.08		887,76
9,200 square feet sheet iron covering	0.12		1,104,00
50,450 lbs. cast brackets, columns and gutter &c.,			2,081,00
Two 20 inch stop-cocks and fixtures, waste pipe			2,560,00
Lumber and carpentry			2,300,00
Painting and glazing			500,00
			$64,425,76

DISTRIBUTION.

Water pipes, stop-cocks and hydrants, 430 feet outlet pipe, connected with tank, 20 inch diameter, 40 tons	$50 00		$2,000,00
Erecting and laying same, per lineal foot	1 20		480,00
4,400 feet supply main, 440 tons	50 00		11,000,00
Lead and labor for laying, per foot lineal	0 90		3,960,00
4,900 feet of 10 inch main, 170 tons	50 00		8,500,00
Lead and labor for laying, per foot	0 50		2,495,00

4,870 feet of 8 inch main, 130 tons	$50 00		6,500,00
Lead and labor for laying, per foot	0 45		2.191,50
18,110 feet of 6 inch main, 330 tons	50 09		16,500,00
Lead and labor for laying same, per foot	0 37		6,700,70
25,860 feet of 4 inch pipe, 300 tons	50 00		15,000,00
Lead and labor for laying same, per foot	0 30		7,758,00
4 stop-cocks, 16 inches diameter	200	00	800,00
10 " 10 " "	75	00	750,00
10 " 8 " "	65	00	650,00
50 " 6 " "	40	00	2,200,00
104 " 4 " "	30	00	3,120,00
Boxes and covers for 178 stop-cocks	5	00	890,00
Handling, draying and delivery, including laboring hands in construction of works			10,000,00
Omitted, 200 hydrants	30	00	6,000.00
			$316,151,50

REAL ESTATE.

Lot on Lake shore for engine house	$10,000,00
Lot on Euclid street for reservoir tower	20,000,00
	$30,000,00
	$346,151,50

RECAPITULATION.

Aqueduct, or delivery pipe in the Lake	$20,470,00
Engine house	18,068,74
Engines and stand pipe	67,640,00
Furnaces and chimney stack	2,951,80
Pump Main	35,100,00
Reservoir Tower	64,425,76
Distribution stop-cocks, hydrants, &c.	107,495,20
Real estate	30,000,00
	$346,151,50
For contingencies and Superintendence add 10 per cent	34.615,15
Total cost of Works	$380,766,65

39- 65432

SUPPLEMENTARY REPORT,

SUGGESTIVE OF A THOROUGH SYSTEM OF SEWERAGE, IN CONNECTION WITH WATER SUPPLY FOR THE CITY OF CLEVELAND, CONSIDERED AS A SANITARY MEASURE.

In compliance with a request made by the Water-Works Committee, to add some suggestions, explanatory and recommendatory of a general plan of sewerage, in connection with water supply for the city of Cleveland. The following brief remarks are appended to the Water-Works report:

As a sanitary measure, water supply and a perfect system of sewerage, bear such intimate relation, as joint measures for promoting cleanliness and comfort, as well as for improving the sanitary condition of towns, that the two systems, being naturally efficacious, in their good effects, may be properly regarded and treated, as inseparable and the same measure. However, to do justice to the subject, and as preparatory to making plans and a full report, an accurate contour survey of the city should be made, with a plot of the town, showing the contour lines and relative levels, of all established grades for every street and crossing in the city; to be accompanied with working plans, drawn to scale, comprehending all the particulars throughout the whole system of pipage and sewerage, for general reference in laying down water pipes, adapted to the head of water, and necessities of the locality to be supplied. Giving the inclinations, shape and capacity of the different sewers, to carry off any amount of surface drainage required. The report should embody special information with reference to the materials to be used in the peculiar construction of the different sewers, and their foundations, as adapted to the geological formations through which these underground channels may pass, including the cost per foot, lineal, of all sewers and drains of different capacity and material. Giving the most approved form of such sewers and drains, with the mechanical contrivances in practical use, that may be necessary, such as Gully-Gratings, Stink-Traps, (to prevent the escape of obnoxious gases from the sewers) House-

drains, Sewer Ventilators and Sluice-gates connecting with the water pipes, for flushing or scouring the sewers, including explanatory notes, with all useful information and specifications for constructing any part, or the whole of the work, in conformance with the one general and specified plan.

It would be further necessary to ascertain, by a series of experimental gaugings and observations, continued for the term of one year at least, if not already known; what is the annual amount or average quantity of rain-fall, which may be available for surface washing, by natural means, together with the maximum depth and quantity of water falling, in a given time, on a given surface or area of ground, during the heaviest periodic storms, which must be conveyed away by underground drainage, after first serving in the useful process of cleansing the streets, and which afterwards is made subservient to the purpose of effectually scouring the sewers.

It is also important that each sewer and drain should be constructed of a size and capacity adequate only to the maximum service required for passing off the extra volume of water, with which the sewers and drains may be charged, without causing injury to the subterraneous works. As it is found, by practical experience, that all sewers of too large capacity, as well as being unnecessarily expensive, are ineffectual as drains, from the sluggish movement of the liquid current within, causing deposit of solid matter, which clogs up the passages, to the serious detriment of drainage, and places them in a condition to be no more effective in carrying off a superabundant supply of water, or liquid matter, than sewers of considerable less capacity and cost.

It is equally important also to provide a copious supply of water by artificial means, (as by Water-Works, to make the system of sewerage complete) should the necessity arise for its application, as it unquestionably will, for scouring the sewers and drains during dry seasons of the year, by opening sluice-gates on the water pipes connecting with the sewers, which gates should be designated on the general plan of the Works, and plot of the town, at such points and intervals as would be necessary to connect the water pipes with the sewers, to have the greatest washing effect with the least quantity of water supplied. The washing or flushing of sewers may be measurably accomplished by the double process of cleansing the streets, at the same time, and with perhaps good

effect and economy, as compared with scavenger labor to produce the same results. By making attachments to the water pipes, and applying, with one hand employed, the jet and spray, in the removal of refuse and garbish from the streets, acting partially on the surface, would, to a certain degree, serve the purpose of rain-fall in cooling the air, then draining into the sewers would produce an active current towards carrying off their contents and materially obviate the necessity of flushing-sewers and exhausting the water pipes to the extent that would be necessary by underground sluice-gates, as already explained and generally practiced.

The combined system of Water-Works and Sewerage, should be conducted by one Board of Control, and the joint Works may be prosecuted simultaneously, under one superintendance with perhaps better system and economy to the city than separately.

And as a conciliatory measure, I would recommend, with a view to allay public prejudice, as much as possible, with regard to Lake water, as a source of supply, from where it is to be derived, that the following plan be adopted as most effectual in preserving the water for supply of the town, in all its present purity, free from the influence of sewerage.

I would propose that the system of arterial pipage and sewerage suggested, be planned in the usual manner, and as described, so that the smaller drains shall supply the larger, gathering and collecting all the water dispersed in various ways over the entire city, into still larger channels of conveyance, made tributary to two principal arteries for intercepting all the offal, refuse and stagnant accumulation, liquid and solid, cast into these subterraneous channels by surface drainage; and these last form the main features of the system proposed. One of the intercepting sewers should extend from East to West on the bank of the Lake, and the other extend from North to South, on the bank of Cuyahoga River, having a direction given them for the conveyance and final disposal of their contents at favorable points, below low water mark, in the river, so remotely distant from the source of water supply as to prevent the possibility of town drainage or sewerage having any appreciable effect on the quality of the water supplied. And as a further protective measure, stringent ordinances should be passed and enforced, prohibiting the deposit of nuisances anywhere along the Lake shore, within the corporate limits of the city.

In conclusion, it is hoped that the foregoing suggestions may be acceptable, and prove in the end of some practical benefit, as considered with reference to Water-Works at least. And should the plan for uniting the two measures in one general system have any merit as a proposition, you as the proper judges, will no doubt readily perceive and appreciate its full value, if any advantages may be derived from its application, which if practicable at all, contemplates so many desirable results. Notwithstanding however strong my faith may be, confidently believing in the practicability of the project, I nevertheless would have you receive the opinions offered as all others of like nature should be received, with a great degree of caution, as involving a momentous question, and a large expenditure of public money, which demands the grave consideration of the administrative body, before deciding upon or adopting any definite plan, until the subject shall have undergone the most searching investigation, and enquiries shall have been extended to obtain practical information from reliable sources. And until thorough examination of works similar to those intended, shall have been made, to collect facts, data, and information from the experience of others, and to improve where other works were found faulty, for mature plans, that would safely insure carrying the contemplated project into successful operation.

Reviewing the whole subject as presented, if considered in the light the matter should be regarded by the citizens and Common Council as a measure conducive to general cleanliness and comfort, and as exercising an active agency in the development of health, industry and business, it will be found, since one branch of the system furnishes a pure and healthful element of life, the other branch operates as effectively in the removal of filth, and physical causes inducing disease, and in combination, are productive of the salutary effects which habits of cleanliness, with the enjoyment of fresh air and pure water supplied in abundance, would have, in lending animated spirits and cheerfulness of appearance to the inhabitants, and a bright and lively aspect to the city, promoting alike the happiness of life and the prosperity of the place. And considering the importance of this measure, involving as it does, so many questions and conditions incidental to, and connected with the scheme, the subject requires much more time and attention than has been allotted for making due and careful investigations, and to prepare

well digested plans with reliable information, treating the subject in a manner which its importance demands. And with reference to it, I would respectfully suggest that the whole matter be made the subject of a separate and very full report.

Respectfully submitted,

THEODORE R. SCOWDEN, *Engineer.*