# PRELIMINARY REPORT

ON THE BEST MEANS OF

# Supplying the City of Peoria

# WITH WATER.

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PEORIA:
DAILY TRANSCRIPT STEAM PRESS PRINT.
1864.

# REPORT OF COMMITTEE.

*To the Mayor and Aldermen of the City of Peoria, in Council Assembled:*

Your Committee to whom was referred the matter of supplying the City with water, have had the same under consideration and ask leave to report:

That they have examined carefully the report of O. Chanute, which is hereto attached, directed to the Hon. Wm. A. Willard, under whose advice Mr. Chanute made careful surveys and estimates of the probable cost in erecting works and laying down pipes that would afford an adequate supply of water, for the more densely settled portions of the City, for a number of years. Your Committee have come to the conclusion to adopt said report for the consideration of the City Council.

It is desirable that the city have the control of the Water Works, as is the custom in our sister cities of the United States. And it is believed, that six per cent. bonds can be sold at par at the present time, having 30 years to run, for the sum of Two Hundred Thousand dollars; which, if judiciously expended, would go far toward putting the works in operation, as recommended by Mr. Chanute. Another plan is for the city to issue guaranteed six per cent. stock, a considerable portion of which, it is believed, could be sold at par. Then in order that the city may control the works and water, they will have to retain a majority of the stock; and in order to pay for the same, the city must issue and sell bonds, as aforesaid, to get the money to pay for the stock held by the city.

Another increase of expenditures in connection with Water Works must be provided for. Some sewers, to carry off the water, must be built, about the time the Water Works go into operation at a cost of $30,000 or $40,000. It is presumed that bonds to the amount of $300,000 will have to be sold, to complete both sewers and Water Works; which will increase the taxes of the city not less than $18,000 per annum, for some years, until the revenues from the water takers shall reduce the same; which ultimately may pay a considerable portion of the interest, on the bonds issued for the Water Works.

Your Committee, so far as they have been able to discover, find that a majority of the principal tax payers are willing to be taxed for a supply of water, adequate for all purposes; and believe that the time has arrived that the city should take action on the subject, and when duly authorized, issue bonds as recommended, or a six per cent. guaranteed stock; and if a majority of the stock should be taken by individuals—the stockholders should have control of the works.

Your Committee would recommend, that the reports be received and placed on file, and that 1,000 copies of the same be printed in pamphlet form, for distribution among the tax payers of the city of Peoria, at the lowest price bid for the same on book paper, to cost $83. Also that the Charter be so amended at the next session of the Legislature as to authorize the city to issue the requisite amount of bonds to complete the works, provided a majority of the voters in the city shall vote in favor of the issuing of the required amount of bonds for that purpose.

All of which is respectfully submitted.

ISAAC UNDERHILL,
FREDERICK BOHL,
P. R. K. BROTHERSON,
M. B. LOUGHLIN.
} Committee.

# REPORT OF O. CHANUTE.

PEORIA, April 11, 1864.

HON. W. A. WILLARD:

*Dear Sir:*—The advantages of furnishing an abundant supply of pure water for the use of towns are now too well understood to require any argument or discussion. For many years all parties in Peoria have been agreed as to the importance of erecting Water Works at the earliest practicable time, while differences of opinion have existed only as to the best sources of supply, and the probable cost of the works and returns upon the investment.

With a view therefore, rather of gathering preliminary information than of advocating or perfecting any particular plan, the following observations and estimates are submitted, so as to give a basis for discussing and ascertaining the best means of accomplishing the object desired.

### LOCATION OF THE CITY AND PROBABLE DEMAND.

The plateau upon which the city of Peoria is built is a gravel or drift deposit, rising gradually from the river to a general elevation of 82 feet above low water at the base of the bluffs; which are from 100 to 125 feet higher, and present a slope of about 30° towards the town. The width of the plateau varies from less than ¾ of a mile at the upper part of the city to that of 1½ miles at its lower extremity. The difference between the high water of 1858 and the low water of 1856 amounts to 21 feet 11 inches; and all elevations will hereafter be given from this latter point, which will be assumed as low water.

The town is now supplied with water from cisterns, wells, and some 12 springs which break out at the base of the bluffs; and from the best information which can be obtained, the average daily consumption does not exceed from 6 to 7 gallons per day for each individual of the population.

How far this falls short of the quantities used in other cities supplied from Water Works, will appear from the following table, which is taken from Mr. E. S. Chesbrough's report to the Water Commissioners of Chicago in 1861.

DAILY AVERAGE OF WINE GALLONS OF WATER SUPPLIED TO DIFFERENT CITIES.

| *Name of City.* | *Date.* | *Population.* | *Gallons supplied.* | *Av'g Per Inhabit'nt* | *Authority.* | *Remarks.* |
|---|---|---|---|---|---|---|
| New York,..... | 1860. | 814,277 | 42,000,000 | 51.6 | A. W. Craven. | Estim't'd occa'ly |
| Philadelphia,..... | " | 568,034 | 20,398,197 | 55.9 | H. P. M. Birkenside. | " " |
| Baltimore,..... | " | | | 25 | J. S. Sater, | |
| Boston,..... | " | 177,902 | 17,238,000 | 96.9 | J. Slade. | |
| St. Louis,..... | " | 162,179 | 6,500,000 | 40.1 | F. J. Homer. | Used by 100,000 |
| Cincinnati, ..... | " | 160,060 | | 30 | R. C. Phillips. | " ½ pop't'n |
| Chicago,..... | " | 109,420 | 4,690,873 | 42.9 | R. F. Walker. | |
| Buffalo, ..... | " | 84,000 | 4,000,000 | 47.6 | A. R. Ketcham. | L'k'ge at pumps |
| Washington, | " | | | | | Distribution is |
| Georgetown, | " | 69,855 | 1,350,000 | 19.3 | J. S. C. Morton. | insufficient. |
| Albany,'..... | Oct '57 | | | 69 | G. W. Carpenter. | |
| Detroit. ..... | 1859. | | | 30.5 | J. Houghton. | |
| Jersey City, ... | | | | | Geo. H. Bailey and | |
| Hoboken,.... ... | 1860. | 39,000 | 2,006,981 | 51.4 | R. C. Bacot. | |

Nor can the present supply of rain water be materially increased. Allowing 150 square feet of roof surface to each individual (a large estimate), and an average rain fall of 32 inches, the total supply would be.....29 92 gallons or 8.19 gallons per day.
Deducting ¼ for snow and waste.....2.05 " " "

Leaves a supply per head of.....6.14 " " "

Nor can 32 inches be expected to fall every year. The rain fall at Peoria for the last few years, as reported by the Smithsonian Institute and kindly furnished by Dr. Brendel, has been as follows:

| | | | |
|---|---|---|---|
| 1856.....27.902 | inches. | 1860.....34.150 | inches. |
| 1857.....30.453 | " | 1861.....30.290 | " |
| 1858.....53.360 | " | 1862.....48.330 | " |
| 1859.....29.382 | " | 1863.....32.270 | " |

But besides the entire inadequateness of the present supply when compared with the above cities, the almost exclusive use of bituminous coal as a fuel in Peoria, tends to give to water caught on roofs an unpleasant taste and smell; and rain water, having a remarkable affinity for organic and other impurities, although well adapted for washing, is by no means always the most healthy for drinking.

The present population of the city is probably not far from 20,000. As almost all of the large manufactories however, draw their water directly from the river, the consumption will probably not prove as large as the average given above, where both manufactories and shipping are supplied. On the other hand the city is constantly growing, and a much larger population may have to be provided for in a few years. Yet it is not believed best to calculate too much for the future. Not only is it impossible to foresee the requirements of posterity, but by endeavoring to do so, the cost might be so greatly enhanced as to forbid the present erection of the works, with any view to profitable returns upon the investment.

It is believed that 25 gallons per head, or 500,000 per day would

prove ample for the present wants of the city. This would give nearly four times the quantity now thought to be consumed, the manufactories excluded; but in view of the increased uses consequent upon a plentiful supply, and the attending waste; and in view also of the difficulty expected of detecting leaks in pipes laid in the gravel formation of the city, the estimate should be based upon a capacity to supply 1,000,000 gallons daily. This will give 40 gallons a day to 25,000 inhabitants, and whenever more than this is needed, the works should be enlarged.

### SOURCES OF SUPPLY PROPOSED.

So far as I am aware, but three sources of supply have been proposed; they are:

1st. From several copious springs on the other side of the river.

2d. From the springs at the base of the bluffs.

3d. From the Illinois River.

### 1ST.—FROM SPRINGS ON THE OTHER SIDE OF THE RIVER.

When it is considered that these springs are but a few feet above the surface of the river, that they would have to be elevated, and conveyed in pipes across Peoria Lake at least a mile, in a depth of water varying from 7 to 12 feet at low water; that the cost of the pipes and laying alone would be at least $60.000, and might be much more; and that no immediate repairs could be made to them should they break, to say nothing of the many objections that exist to the use of spring water that will be hereafter stated; it is thought this scheme may safely be dismissed without further consideration.

### 2D.—FROM SPRINGS AT THE BASE OF THE BLUFFS.

The following is a list of those springs:

| *No.* | *Names.* | *Elevat'n above low water.* | *Flow in gals in 24 hours.* | *Date of guaging* | *Solid grains per gallon.* | *Remarks* |
|---|---|---|---|---|---|---|
| 1 | Hall's | 106.84 | | | | |
| 2 | Baldwin's | 141.72 | | | | |
| 3 | Underhill's | 140.07 | | | | |
| 4 | Frink's | 147.06 | | | | |
| 5 | Pulsifer's | 144.17 | 728 | Dec30 63 | 28-100 | Probably a fair average. |
| 6 | Howe's | 82.36 | 518 | " | | |
| 7 | Phelps' | 128.91 | 173 | " | | |
| 8 | Bradley's | 120.16 | 855 | " | | |
| 9 | Hickey's | 114.73 | | | | |
| 10 | City W. Works | 117.60 | | | | |
| 11 | Eastman's | | | | | |
| 12 | Aiken's | | | | | |

NOTE.—Springs 1, 2, 3, 4, 9, 10, 11, and 12 are not yet gauged, the storm on the 31st of December and other engagements having prevented the completion of this work. Nor is it believed important to do so, as were all the springs to yield as much as Pulsifer's, only 8,736 gallons would be obtained, where 500,000 are required.

It will be necessary to wait for a time of drought to complete the gaugings, as only a minimum can be calculated upon.

Mr. Pulsifer's spring was selected as a fair average of the whole, and an analytical examination of the water made by Mr. A. L. Matthies whose report is hereto appended. From this it will be observed that the water contains no less than 7 grains of solid matter in 32 ounces, or 28 grains to the gallon, an excessive quantity for a town supply. No quantitive analysis has been made, but the tests show this to be mostly

carbonates of lime, gypsum and a trace of magnesia with an appreciable quantity of carbonic acid.

It will be seen from the guaging of springs that the supply in time of drought would not exceed 10,000 gallons per day and would be entirely inadequate to the present estimated wants of the city.

Even granting that all the springs could be purchased of their owners, probably only 9 of them could be used to advantage; Eastman's and Aiken's being about 1 mile below the city spring, and unavailable on account of the expense required to bring them to the centre of distribution; while Howe's spring had best be neglected on account of its low elevation.

The question, however, occurs whether it be not possible to increase the volume of outflow at a reasonable expense, and in order to ascertain this, it is necessary to examine the formation of the bluffs. They seem to be composed of alternate strata of clay and gravel, generally lying horizontal, and covered at their outcrops on the slopes towards the city by a thick inclined bed of gravel. The rain water that falls on the table lands on the top of these bluffs, filters through the soil until it reaches the top of an impermeable stratum to which the wells on the bluffs are sunk, and flows along this until coming to the edge next to the city, it sinks down through and behind the gravel covering, to a depth which merely leaves it head sufficient to overcome its friction to its final outflow. The earth below this depth is thoroughly saturated with water, and along this inclined water bed, the surplus flows until it discharges itself in springs, either in the bed of the river, or on its immediate banks. Thus, water may be obtained almost anywhere about the city, by digging a sufficient depth to reach this inclined water bed; while even in wells dug upon the very brink of the river, the water, although it rises and falls with the stage of the river, exhibits all the characteristics and hardness of the spring water, and is found unfit for use in steam boilers without being previously heated to precipitate the lime in solution.

Springs occur whenever a tongue of the clay bed of the bluffs projects through the gravel covering, and these being of limited area, the amount of water could only be increased by trenching or tunnelling through the gravel to the upper edge of the clay, and catching the water as it flows out there in a series of drains. This is perfectly practicable, but how expensive an operation it might prove can hardly be estimated until borings are made to ascertain the thickest of the gravel; while the pecular formation above stated, precludes all hopes of obtaining a supply from Artesian wells, except perhaps at a considerable depth; and then it would probably be strongly impregnated with the salts of lime, and with carbonate of iron from the coal fields in the vicinity.

The inquiry also occurs whether spring water is the best for the general purposes of a town supply. It is probably generally preferred for drinking because of its clearness and freedom from matters in mechanical suspension, and its equable temperature; being both cooler in summer and warmer in winter than the atmosphere. It was believed some years ago that the more nearly the water supply approximated to the condition of distilled water, the more healthy it was, but

the theory of the German Chemists now is, that a small quantity of lime, say from 5 to 10 grains per gallon, renders water best adapted to human uses; and they instance the development and strength of all races inhabiting lime stone countries as a fact in support of their theory. Though nearly free from organic impurities, the analysis shows the water of Mr. Pulsifer's spring to hold 25 grains of solid mineral substances in solution to the gallon, a much larger quantity than is found in the water used in our principal cities, and enough to unfit it for household purposes. Not only is the water of all the Peoria springs notoriously hard and very ill adapted for washing, causing a great waste of labor and soap, but it is also the general impression that it is not so well adapted for cooking as a softer water, being decidedly injurious to vegetables. It contains also a certain amount of carbonic acid, enough perhaps to act upon the lead pipes employed in house services, and resulting in a rank poison.

The following table exhibits the result of the analysis of the waters used by various American cities:

SOLID GRAINS OF MINERALS IN VARIOUS WATERS.

| *Cities.* | *Source of Supply.* | *Grains in one wine gallon.* | *Remarks.* |
|---|---|---|---|
| New York, | Croton, | 4.16 | |
| Philadelphia, | Schuylkill, | 4.42 | |
| Boston, | Lake Cochituate, | 1.85 | From surface. |
| Brooklyn, | Long I. Streams, | 1.97 | |
| Jersey City, | Passaic River, | 7.44 | |
| Baltimore, | Jones' Falls, | 5.85 | |
| Washington, | Potomac, | 5.59 | |
| Bridgeport, Ct. | Pequawmock River | 0.99 | |
| Troy, | Mohawk River, | 7.88 | |
| Albany, | Patroon's Creek, | 4.72 | |
| Rochester, | Genesee River, | 11.21 | |
| Rochester, | Lake Ontario, | 4.16 | |
| Detroit, | Detroit River, | 5.72 | |
| Cincinnati, | Ohio River. | 6.74 | |
| Chicago, | Lake Michigan, | 7.23 | Two miles from shore. |

Moreover, unless means were adopted to pump the water, the height of the reservoir would of course be limited by the elevation of the lowest spring used. This is Mr. Hall's spring, which is 107 feet above low water; if the supply were being increased by trenching to the clay, this might be raised a few feet by intercepting the water at a higher level, but that the head of this would not be sufficient to supply water into the second story of the higher houses in town, will appear from an examination of the following table.

LIST OF VARIOUS ELEVATIONS ABOVE LOW WATER.

| | | |
|---|---|---|
| Door sill of old Central Bank Building, | 23 60-100 | feet. |
| Curb stone at corner First National Bank, | 41 44-100 | " |
| Curb stone at southeast corner Main and Adams streets, | 59 89-100 | " |
| Curb stone corner Rouse's Hall, | 72 74-100 | " |
| Curb stone northeast corner Main and Monroe streets, | 84 60-100 | " |
| Curb stone northeast corner Main and Perry streets, | 94 70-100 | " |

The above elevations are on Main street, and the houses are from 30 to 50 feet higher.

| | | |
|---|---|---|
| Top of Court House Cupola, | 140 | feet. |
| Top of Congregational Church, | 142 | " |
| Top of steeple Unitarian Church, | 153 | " |
| Top of steeple Catholic Church (bottom of cross) | 142 50-100 | " |

| | | |
|---|---|---|
| Top of steeple German Catholic Church, | 135 | Feet. |
| Top of roof First Ward School House, | 139 | " |
| Eaves of roof High School, | 147 | " |
| Door sill of residence of N. B. Curtiss, Esq., | 90 | " |
| Door sill of residence of Captain Hall, | 101 38-100 | " |
| Door sill of residence of Mr. Phelps, | 121 60-100 | " |
| Door sill of old Water Cure House on Main street, | 94 63-100 | " |

The following are a few elevations on the bluff:

| | | |
|---|---|---|
| Floor of H. Grove's house, | 180 82-100 | feet. |
| Floor of I. Underhill's house, | 187 01-100 | " |
| Floor of J. Armstrong's house, | 196 89-100 | " |
| Floor of S. Fry's house, | 216 34-100 | " |

When we take into account the loss of head of water by friction in pipes, the advantages of a high pressure at fires, enabling us to flood premises without the use of an engine, and the increased comfort of having the supply in the upper stories, it seems desirable that the surface of the water in the reservoir should not be less than 150 or 180 feet above low water in the Illinois river.

One very serious objection to the supply of a town from springs obtained within its own limits remains to be mentioned. It is sure to become corrupted in time. As population increases, and houses, stables, &c., are built on the top and slopes of the bluffs, the springs will become more and more charged with saline solutions, until they become unfit for use. The analysis of old wells in New York and London has shown as many as 128 solid grains to the gallon.

### 3D.—FROM THE ILLINOIS RIVER.

The use of water from the river would involve the establishment of pumping machinery to elevate it to a sufficient height to flow into the second or third stories of the highest buildings in town, of pipes to convey the water to a reservoir and of a reservoir to store sufficient quantity to enable repairs to be made to the machinery in case of accident. From this, distributing pipes would conduct it wherever required; and as the cost of these would probably be the same for any plan, the only difference in cost would be in the first establishment and working of the pumping works.

There is of course no question about the sufficiency of the supply. Mr. Matthies has made an analysis of the water, which is appended hereto, from which it appears that the water is very much purer chemically than that of the springs. It contains 3.36 grains of organic matter and 4.24 grains of mineral substances to the gallon; total 7.60 grains, or about the same as the water expected to be reached by the Lake tunnel at Chicago. This examination however was made in winter, when the water is probably in its purest state. In the summer and fall months it would contain a larger amount of infusoria and organic substances, while the mineral would remain about the same, and in the spring it would hold a considerable quantity of mud and matter in mechanical suspension which could however be got rid of by filtering or settling the water. The analysis shows the mineral matter to be mostly carbonates of lime, with not enough carbonic acid gas to act upon lead pipes, and the river is upon the whole a satisfactory source of supply.

In determining upon the character of the works and estimating upon any plan, regard should be had rather to what is possible to effect

than to what it is desirable to accomplish. The following estimates therefore are based upon erecting cheap temporary structures in all those parts which can be renewed without interference with the efficiency of the works, and which can hereafter be rebuilt in a more permanent manner should the enterprise prove a financial success; while all the essential parts, such as the pumping mains, reservoir, distributing mains, &c., are so designed that they will be thoroughly built at the start, and can be enlarged without interfering with their working and change of plan, should it be hereafter required.

The cost of the works will of course be governed by the plans which may be adopted, and it will be merely attempted here to state what would prove efficient, and its probable cost.

PUMPING WORKS.

The pumping works, as well as the reservoir, should be located in the upper part of the city, somewhere near the Chicago and Rock Island freight depot. Not only would they then be above the drainage of the town, and fartherest away from the distilleries and soot, but they would also be nearest to the bluffs, distant at this point about 4000 feet, which would materially reduce the cost of the pumping main, while the excellent gravel, both on the bluffs and on the river bank at this point, would give considerable facilities in the execution of the works.

It would be desirable to filter the water before pumping it, so as to purify it from the mud held in suspension in time of freshets, and from the decaying vegetable or animal matter in summer. This might also be accomplished by a settling reservoir on the river bank; yet as it would require a filter measuring 10,000 square feet to pass 1,000,000 gallons daily through three feet of sand, and would cost $6,300, it has been thought best to leave it out of the present estimate, and to take the water from a flexible pipe sunk into the river and furnished with a simple strainer at the end. Should circumstances warrant, a settling reservoir or a filter bed can be constructed at any time after the building of the works.

It is not deemed practicable to pump the water from a well sunk in the gravel on the bank of the river, on account of the formation of the plateau heretofore described. Instead of the river water filtering in we should obtain the sheet water from the bluffs on its way to its outlet in the bed of the river.

A pipe two feet in diameter, reaching 250 feet into the river, and and about 50 feet upon the shore, can be laid for $2,500. 200 feet can be built of wood and permanently submerged, while the portion on shore would have to be of iron. It would be laid in a trench to protect it from frost, and would lead directly to the pumps.

In order to pump 500,000 gallons daily, an engine is required of sixty-five horse power, working eight hours, and sending 1042 gallons per minute through the pipes. Whenever the demand increases up to 1,000,000 gallons, it can be met by working the engine sixteen hours daily, and whenever more is required it will be best to replace it with another. As machinery is apt to break down, it would be well to have a smaller engine capable of doing about half the work of the large one, to use in case of need.

Fuel is so cheap in Peoria, coal selling in ordinary times from $1.50 to $1.75 per ton, and being now from $2.50 to $3.00 per ton for large manufacturers, that the advantages to be gained by using the Cornish engine are more than counterbalanced by its first cost, and that a high-pressure non-condensing engine would prove best adapted to the work. It is suggested that one of Worthington's duplex pumping engines would be the cheapest and most useful. It is thought that one to pump $1042 gallons per minute can be obtained with the boilers for about $7000, and one to perform half that duty with its boilers for $4000. Two sets of boilers would be required as they are quite as liable to get out of order as the engines.

A standing column to equalize the flow of the water will also probably be required, although some works using Worthington's engines are said to have been established without it. It will cost, with the gates, stop cocks, &c., $4.000.

The engine house, office and coal sheds, which can be rebuilt at any time, need only to be cheap, temporary structures of wood, and can be erected for $3500.

The land and contingencies are estimated at $2500.

### PUMPING MAIN.

As in order to obtain sufficient elevation it is necessary to locate the reservoir somewhere about the bluffs, it will require a considerable length of iron pipe to be laid between the pumping works and the reservoir. In the upper part of the city, this will be from 3500 to 4000 feet according to the location. It is desirable that two pipes should be laid, so that in case of accident to the one, the other can be used, yet the cost would be so much greater that it is thought one might be made to answer. The pipe estimated for is 12 inches in diameter, and will convey 500,000 gallons in eight hours with a velocity of 177 feet 4 inches per minute, or 2 955-1000ths feet per second. This is equal to 2.01-100ths miles per hour. A greater velocity than this would be objectionable, as increasing the friction in the pipes, and requiring more power at the works. The flow will not be accelerated when the consumption increases to 1,000,000 gallons, as the engine will work sixteen hours instead of eight; but when it increases beyond this, it can be provided for by laying an additional pipe. It is estimated that at present prices of iron, this pipe, 12 inches in diameter and 5-8 thick, will cost, laid, $4 per foot lineal, or $16,000 for the whole. It would require two pipes 8½ inches diameter to do the same service, at a cost of $5.70 per foot lineal, or $22,800.

In order to force water directly into the distributing pipes, should repairs be needed to the reservoir, the pumping main might be connected at the crossing of some of the principal streets, directly with the larger distributing pipes, and the water used for a short time without passing through the reservoir. Stop cocks would be required at these connections.

### RESERVOIR.

The reservoir would serve both to store and distribute the water. As the base of the bluffs is about 80 feet above low water, it should

be 150 or 180 feet above this latter point in order to ensure a copious delivery all over the city. Indeed the advantages of a high head at fires and in the ordinary house services, are so great as to warrant some additional expenditures to secure them, and the loss of head by friction in pipes will be found to be very considerable as consumption and the consequent necessary velocity increases. A reservoir 180 feet high would force water nearly to the top of the Court House without the aid of a fire engine, and with high service, premises could be flooded in the early stages of a fire, and thus much destruction of property prevented.

In order to give time for repairs of machinery, the reservoir has been calculated to contain 2,500,000 gallons, or five days storage of the estimated consumption at first. This would require it to be 130 feet square at the mean area of the water, which it is proposed to have twenty feet deep. Although a circular or oval shape would require less material in order to enclose the same contents, it is thought better to make it square for convenience in adding to it; it will hold but 2½ days supply of the estimated increased consumption, and will require enlargement. It can be located either directly on top of the bluff, and the material excavated a sufficient depth to form the embankments, or in one of the ravines, by building retaining walls across it and dressing down the natural slopes. This latter plan would however probably require that a drain should be made under the entire length of the reservoir, in order to pass the drainage of the ravine, and is not found to be the cheapest in estimating upon it.

The estimates have been made for a reservoir 90 feet square on the bottom, and 182 feet square on the top, which will be three feet above the water and twelve feet wide. It is contemplated after removing the material inside to a sufficient depth, and at slopes of two horizontal to one vertical, to form a retaining wall of puddled clay three feet thick; to cover this with three feet in thickness of clean gravel, and then to pave the sides with weather bricks set on edge, and laid in hydraulic cement. The outer slopes which would also be two to one, and the top of the inner slopes nearly as far down as the water, would be neatly sodded. In order to secure enough material for the embankment which will be eight feet high, it will be necessary to excavate fifteen feet in depth. No middle wall has been estimated for as is usual, it being believed that the reservoir will require enlargement, by adding another similar on one side, before serious repairs are required, and the city can be supplied partially by the connections with the pumping main, while trifling repairs are being made. The ordinary gate chambers, valve pits, waste sewers, &c., will be required and can be built of brick.

## DISTRIBUTION.

The most serious expense, however, will be found to be the distributing pipes to convey the water to the consumers. The town outside of its business limits is so sparsely built up and spreads over so much ground, that a greater proportional outlay will be required than in other cities. In order to supply the population below the bluffs, and between Voris street on the north, and Maple street on the south, it

would alone require 143,850 lineal feet of pipes, or 27¼ miles costing not less than $256,000.

On the other hand some advantages would be gained from the fact that none of the streets are paved, and that all the excavation would be of an easy character; but this would also operate to make leaks in the pipes difficult to find, and might occasion great waste.

The practice obtains in other cities, after the works are established, to lay no pipes down except in such localities as are likely to pay rates amounting to ten per cent. on the cost of the pipes and laying, and under this rule it is estimated that not more than two-thirds of the population of Peoria can be reached and served profitably.

Other cities, among them Philadelphia and Detroit, have made use of wooden pipes, costing not more than one-quarter as much as iron, and under low pressure they are said to do well, while they will last fifteen or twenty years in clay soils, and eight or ten in sand. Should the works be built, it would be well to have the matter thoroughly investigated, as well as the merits of various patent cheap pipes of cement, clay, &c., so as to save as much expense as possible at the start. This saving would however be only temporary, the cheap pipes must eventually give out, but perhaps not before increasing population would warrant more permanent expenditures.

In accordance with these views, the following estimates have been prepared. Of course they are to a certain extent vague, as they must be until locations and plans are adopted, and the character of the work decided on. Yet they have been purposely made large, and are believed ample to cover the first cost of establishing the works.

ESTIMATES OF COST OF PEORIA WATER WORKS.

| *Quantities.* | *Work.* | | *Amount.* | *Amount.* |
|---|---|---|---|---|
| | PUMPING WORKS. | | | |
| 100 | Lineal feet cast iron pipe laid | @$10 | $1000 | |
| 200 | Lineal feet wooden pipe laid | @$ 4 | 800 | |
| | Pump Reservoir | | 700 | |
| 1 | Worthington steam pump and boilers | | 7000 | |
| 1 | " " " " | | 4000 | |
| | Foundation for engines, pits, &c. | | 1500 | |
| | Standing column, gates, stop cocks, &c. | | 4000 | |
| | Engine house, office and coal shed | | 3500 | |
| | Land and contingencies | | 2500 | |
| | Total Pumping Works | | | $25,000 |
| | PUMPING MAIN. | | | |
| 4000 | Lineal feet iron pipe 12 inches in diameter laid, | @ $4 | 16000 | |
| | Stop Cocks at connections | | 500 | |
| | | | | 16,500 |
| | RESERVOIR 2,500,000 GALLONS. | | | |
| 8000 | Cubic yards excavation and embankments | @ 50c | 4000 | |
| 3500 | " " clay puddle wall | @ 1 50 | 5350 | |
| 2000 | " " gravel covering | @ 35c | 700 | |
| 31500 | Square feet brick pavement | @ 15c | 4725 | |
| 300 | Cubic yards brick masonry | @$12 | 3600 | |
| | Gates, valve pits, sewer, &c. | | 5000 | |
| | Land and contingencies | | 4625 | |
| | Sodding slopes | | 1000 | |
| | Total Reservoir | | | 29000 |

ESTIMATES OF COST OF PEORIA WATER WORKS.—(*Continued.*)

| *Quantities.* | *Work.* | | *Amount.* | *Amount.* |
|---|---|---|---|---|
| | Engineering and office expenses, charge say half to works and half to distribution | | | 5000 |
| | Total cost of the works | | | $76,500 |
| | DISTRIBUTION. | | | |
| 3000 | Lineal feet of 12 inch main laid | @$ 4 00 | $20°0 | |
| 10000 | Lineal feet of 8 inch main laid | @ 2 50 | 25000 | |
| 12000 | Lineal feet of 6 inch pipe laid | @ 2 00 | 24000 | |
| 35000 | Lineal feet of 4 inch pipe laid | @ 1 50 | 42500 | |
| 10000 | Lineal feet of 3 inch pipe laid | @ 1 25 | 12500 | |
| 100 | Hydrants and setting | @ 35 00 | 35000 | |
| 100 | Stop Cock | @ 40 00 | 4000 | |
| | Engineering and office expenses, half | | 5000 | |
| | Total Distribution, | | | $123,500 |
| | Total estimated cost | | | $204,000 |

This however, provides for works very far from complete and with a limited distribution, reaching not over two-thirds of the population, and must not be regarded as the ultimate cost. It is however predicated upon the present very high prices of labor and material, and a fall in these would reduce the estimates to the extent of such fall. As the requirements of the future, and the prices that may then rule, can hardly be estimated upon, no estimates are given of what expenditure may hereafter be required, but it is believed that a population of 40,000 can be supplied with 2,000,000 of gallons per day, or 50 gallons per head, at a cost not exceeding $400,000, including the foregoing estimated expenditure.

No wooden pipe has been included in the estimates; should any be used it would probably be to extend the above provided distribution, and as the cost would be only 35 or 40 cents per foot laid, it would either be gladly paid for by parties desiring to avail of the water, or increase the present expenditures in a very inconsiderable degree. It should be principally used at the base of the bluffs where the head of water would be least.

Should the works be built, much will depend upon the plans and judgment of the Engineer, but it is believed that by securing the necessary ability and experience in this kind of work, and laying cheap temporary pipes in all locations where larger ones will eventually be needed, the works can be built and an efficient distribution obtained at a cost inside of the foregoing estimates.

## COST OF WORKING AND REVENUE.

The cost of pumping 500,000 gallons per day is estimated to be as follows :

| | *Per Day.* | *Per Annum.* |
|---|---|---|
| 104 Bushels of coal, @10c, | $10 40 | $3796 |
| Wages of one Engineer, | 2 25 | 821 25 |
| Wages of one Fireman, | 1 50 | 547 50 |
| Oil, tallow and small stores, | 50 | 182 50 |
| Ordinary repairs of machinery, | 1 00 | 365 00 |
| | 15 65 | 5712 25 |
| Say for superintendence add collecting bills, | | $2500 |
| Say for ordinary repairs of works, | | 600 |
| Interest on $204,000, @7 per cent., | | 14280 |
| Total estimated expense, | | $23,092 25 |

This would amount to an annual charge of $1.15 per head on a population of 20,000, or if only two-thirds of that population were reached to $1.73 per head. Assuming each family to consist of five persons, this would be at the rate of $8.65 water rate to each house-holder.

It cannot be expected however that all of the population reached by the distributing pipes would avail of the water, particularly if the taking should be entirely voluntary on their part, as would be the case if the works be built by a private company. On the other hand, some revenue would be raised for the use of the water at fires, and for the larger quantities consumed by small manufactories, hotels, stables, baths, &c.

As population increases however, and more water is used, the cost will be in a decreasing ratio. Estimating that an additional expense of $76,000 be incurred for distributing pipes, and a population of 30,000 supplied, the cost of pumping 1,000,000 gallons per day would be:

| | *Per Day.* | *Per Annum.* |
|---|---|---|
| 204 bushels of coal, @10c., | $20 80 | $7582 00 |
| Wages of two Engineers, | 4 50 | 1642 50 |
| Wages of two Firemen, | 3 00 | 1095 00 |
| Oil, tallow and small stores, | 75 | 273 75 |
| Ordinary repairs of machinery, | 1 50 | 547 50 |
| | 30 55 | 11150 75 |
| For superintendence and repairs 50 per cent. increase, | | 4650 00 |
| Interest on $300,000, @7 per cent., | | 21000 00 |
| Total estimated expense, | | $368 00,75 |

or at the rate of $6.13 to each house holder, and the cost would be still further reduced by a fall in prices of labor and coal, as it will be seen that the above is based upon present rates.

It should be borne in mind that the above estimates are purely of the cost of working. For the first few years, much larger sums might and probably would be expended, as the works in all likelihood would be put into operation before even the incomplete construction here contemplated were finished; and considerable sums of the means provided might remain to be spent to place the works in an efficient condition. The temporary structures would also have to be rebuilt in 12 or 15 years.

Should the inquiry relative to wooden and other pipes result favorably, the cost of the distribution could be materially reduced, and a fall in the price of iron would also sensibly affect this.

For many reasons it were best that the works should be owned and controlled by the city; and indeed almost all water works in this country have been so built. It seems just that inasmuch as an abundant supply of water benefits the whole population in greater health, safety and comfort, all should bear a portion of the expense. The city alone has the control of the streets in which the pipes are to be laid. Its authorities alone can make the necessary municipal regulations to prevent waste, and alone can lay such taxes as to induce the use of the water by such persons as would refuse it altogether, or supply themselves from their neighbor's hydrant if the taking were voluntary on their part, as must be the case if the works be built by a private company. The city besides, having no profit to make, could be content with a smaller rate than must needs be charged by a com-

pany, while a portion of the cost of working can be reduced by putting the superintendence and collection in the hands of the city officials.

The use of water at fires would in any event have to be paid for by the city, and it may be thought just that the Insurance Companies should bear a portion of the cost, either in the shape of taxes or otherwise; while unless the whole cost of the works be defrayed by private stock subscriptions, the city can probably borrow money at a lower rate of interest than a private corporation engaged in an enterprise which is not established as a financial success.

Again, if the works be built by a private company, additional legislation will be required, while the city is believed to have ample power to begin at once the erection of the works.

An abstract of the laws passed upon this subject has been made by Mr. Cochran and is hereto appended.

I leave to others of my fellow citizens of Peoria the pleasing task of pointing out the importance of providing an ample supply of the best water that can be obtained, and the blessings that will follow in its wake; as well as that of devising the best means of bringing about this result. My aim will have been accomplished if I succeed in arousing public interest in this matter, and in forwarding, even in the remotest manner, the execution of the works.

Respectfully submitted.

O. CHANUTE,
*Civil Engineer.*

# APPENDIX.

## Analysis of Water by A. L. Matthies.

PEORIA, ILL., April 4, 1864.

On the 30th day of December, 1863, I received from Mr. O. Chanute for chemical analysis a certain quantity of water, taken according to his statement from Pulsifer's Spring on the bluff.

The water appears perfectly clear in the glass, tasteless, without odor and pleasant to drink. After some hours standing there appeared at the bottom of the vessel a slightly flocculent sediment.

The specific gravity is 1.0027.

| *Test.* | *Effect.* | *Indicating.* |
|---|---|---|
| Blue Litmustincture, | Slight change towards reddish, | Acids, |
| Soap tincture, | Milky, | |
| Lime water, | Cloudy, flocculent, | Carbonic acid, |
| The cloudy appearance remained upon the addition of more of the water. | | Carbonic alkalies. |
| Chloride of calcium, | Cloudy, | " " (lime,) |
| C. of C. with the boiled water, | Cloudy, | " " and carb. acid, |
| Oxalate of ammonia with the boiled water. | Turbid, | Sulphate of lime or chloride of lime, |
| Phosphate of ammonia in excess of ammonia, | | |
| The last liquid filtered, | Slightly cloudy, | Small traces of magnesia, |
| Nitrate of baryta, | Cloudy, almost imperceptible, | Small traces of sulphates, |
| Nitrate of silver, | White cloudy, slight precipitate | Chlorine, |
| The last filtered, exposed to the light for one day, | Light change in violet, | [substances, Small quantities of organic |
| Neutral acetate of copper, | Clear, | Absence of crenic and apocrenic acids, |
| Yellow ferrocyanate of potassa, | Clear, | Absence of iron, |
| Tincture of gallnuts. | Clear, | " |

Thirty-two ounces of the water evaporated, the residuum carefully dried, left 7 grains solid substances; ignited in a platina vessel to expel the organic matter 6¼ grains, therefore 0,75 grains organic substances.

The water contains therefore, besides, a certain volume of the gas of carbonic acid,

Mostly carbonate of lime.
Less sulphate of lime,
Less chloride of lime,
Less chloride of natrium,
Traces of magnesia,
Traces of organic substances.

It would be very good drinking water, might answer for culinary purposes, but is less adapted for washing and the filling of steam boilers. It belongs to the class of water usually denominated hard.

A. L. MATTHIES.

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PEORIA, ILL., April 4, 1864.

On the 19th day of March, 1864, a quantity of water was taken from the Illinois river, at a place where it enters the Peoria Lake, twenty yards from the bank at a depth of three feet.

In the glass it appeared not perfectly clear. Blue and red litmus-tincture, no change; after twenty-four hours standing, there was a light reddish, yellow sediment perceptible at the bottom of the vessel.

The specific gravity of the water was 1.0004.

| *Test.* | *Effect.* | *Indicating.* |
|---|---|---|
| Soap tincture, | Slightly milky, | |
| Limewater, | Slightly turbid, | Carbonic acid, |
| By addition of more of the water, | " | Carbonic alkalies, |
| Tincture of red brazil wood, | Red color, | " " |
| Chloride of calcium, | Turbid, | " " |
| Oxalate of ammonia, | " | Lime. |
| " with the boiled water, | Slightly turbid, | Chloride or sulphate of lime, |
| The last liquid filtered, | | |
| Phosphate of ammonia in excess of ammonia, | Slightly cloudy. | Traces of magnesia, |
| Nitrate of baryta, | No change, | |
| After 12 hours standing, | Slightly cloudy, | Traces of sulphates, |
| Nitrate of silver, | Cloudy, | Small quantities of chloride, |
| The last exposed for one day to the light, | Slightly violet, | Organic matter, |
| Yellow ferrocyanate of potassa, | No change, | |
| And tincture of gallnuts. | " | Absence of iron, |
| A part of the water evaporated, the residuum with an addition of muriatic acid dried, heated in a platina vessel, dissolved in diluted muriatic acid. | Not perfectly soluble, | Traces of silica, |
| The slight traces of silica in the water may be attributed to the infusoria, many of which have silicious tegumens. | | |
| 16 ounces of the water evaporated to 2 ounces managed with aqua ammonia, canstic potash, and diluted muriatic acid, after the addition of Aqua Ammonia, | Slightly turbid, | Slight traces of Alumina. |

32 ounces evaporated, the residuum carefully dried, left 1.90 grains solid substances, after heating in a platina vessel 1.06 grains, therefore 0.84 grains organic substances.

The results of the analysis are as follows:

The water contained small quantities of the gas of carbonic acid.
The solid substances consists:
Mostly of carbonate of lime.
Less of chloride of calcium.
Less of sulphate of lime.
Traces of magnesia.
Slight traces of Alumina.
Slight traces of Silica.
Organic substances.

The water belongs to the class of water usually denominated soft. It is very well adapted for cooking and washing, and for the use of steam boilers.

The examination of the water in summer or fall, would lead to somewhat different results, and especially would show more organic substances.

A. L. MATTHIES.

# AN ABSTRACT

## Of Laws passed by the Illinois Legislature relative to the Construction of Water Works in the City of Peoria.

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### "AN ACT *To Incorporate the Peoria Water Company.*"

Approved February 20, 1863. In Force, February 1, 1863.

SEC. 1. Provides that Charles Oakley, Augustus O. Garrett, William S. Maus and Norman H. Purple, their heirs and assigns shall constitute corporation.

May have common seal, and alter same at pleasure; shall be capable of purchasing and holding real estate not to exceed in value $15,000 and of conveying same for use of corporation.

SEC. 2. Provides for the election of officers, their qualifications and who shall be for first year.

SEC. 3. The capital stock shall be $5,000.00 with privilege of increasing to $50,000.00. Also provides how the stock may be taken and sold.

SEC. 4. Prescribes duties of President.

SEC. 5. Prescribes duties of Treasurer.

SEC. 6. Prescribes how and when subscriptions of stock shall be paid in,

SEC. 7. Gives the Company full and exclusive power and authority to erect and construct Water Works for the convenience of public in corporate limits of town of Peoria, for and during fifty years, and to conduct same in iron, leaden, or other aqueducts, from any springs or waters within two miles of limits of town, and prescribes that compensation shall be paid to owners of lands over which works shall be constructed, and how it shall be paid.

SEC 8. Gives Company full and exclusive power and authority to conduct water in aqueducts along any of the streets, alleys or highways of town, and within corporate limits, doing as little damage to streets, alleys &c., for time being, and leaving same in as good condition as they were before.

Also giving power to build hydrants and reservoirs in such manner and at such places as best to accommodate those desirous of using water, and with inconvenience to public.

SEC. 9. Gives power to rent and lease water, and privilege thereof &c.

SEC. 10. The Company shall commence construction of works as early as 1st August, 1843, and shall so complete the same year as to have the water ready to be delivered in town of Peoria by 1st August, 1845.

SEC. 11. In consideration of privileges granted the Company shall at all times afford to corporation or the constituted authorities of Peoria the use, free of charge, of any or all the waters so by them conveyed into Peoria, for purpose of extinguishing fires, with reasonable access to hydrants and reservoirs &c.

SEC. 12. Gives Company authority from time to time to appoint such officers not named in act, and to pass and enact laws for government of corporation &c.

SEC. 13. Provides that corporation shall not be dissolved for reason of failure to elect officers on day appointed. And prescribes how, in that event, election shall be held.

SEC. 14. Provides for punishment of those who may injure works during construction or existence of charter.

SEC. 15. "This act shall take effect and be in force from and after 1st February 1843, and shall be taken and considered as public act."

SEC. 16. Provides, that upon neglect or failure of stockholder to pay his subscription within 60 days after notified so to do, stock shall be forfeited, &c.

SEC. 17. "The stockholders of this Company shall be liable in their private capacity for all corporate debts."

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[Special Laws, 1844 and 1845.]

## "AN ACT *To authorize the Town of Peoria to construct Water Works.*"

Approved and in Force March 3, 1845.

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[Special Laws, passed September and January, 1849. Page 16.]

ABOVE ACT REPEALED BY

## "AN ACT *to authorize the City of Peoria to construct Water Works.*"

Approved February 12, 1849, and in Force February 21, 1849.

SEC. 1. Provides that the City of Peoria be authorized to construct Water Works; to take any spring or water within two miles of the city limits, and to conduct same in iron, leaden, or other pipes in aqueducts over any lands, lots, lanes, streets, &c., within or without limits of city for purpose of building reservoir connected with such Water Works, paying the owner of such springs, water, lands, &c., a reasonable compensation &c. Also providing how such compensation shall be made in case of disagreement.

SEC. 2. Giving city power to contract with any person for a term of years, not exceeding ten, to supply water to said reservoir or Water Works, by raising it from wells or Illinois River, or otherwise; to lease said Water Works for any length of time, not exceeding ten years; to appoint an agent or officer to oversee same; collect revenue arising therefrom; to sell the water, or lease privilege of using same. Said contracts, leases, &c., to be made to such persons, and on such terms as City Council may deem most available &c.

SEC. 3. For purpose of enabling city to construct said Water Works, the City Council are authorized to borrow, from time to time, any sum of money for that purpose, and for the payment of said money and interest, to pledge Water Works and proceeds therefrom, and revenue arising from any other source, and the revenue so pledged shall be applied to payment of such interest or sum borrowed, while anything is due thereon, and for no other purpose whatever.

*Provided*, that no sum shall be borrowed at a greater rate of interest than six per cent. per annum, nor shall the interest on the aggregate on all the sums borrowed and outstanding ever exceed one-half of the city revenue from any and all sources whatever within limits of corporation.

SEC. 4. Gives the City Council power to pass all ordinances necessary for carrying into effect provisions of act, to protect works from injury and to punish by fine or otherwise any person for injuring same.

SEC. 5. Repeals act of March 3, 1845, above quoted.

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## EXTRACT *From Charter of City of Quincy, applicable to all Towns and Cities in this State, under "Act to Incorporate Towns and Cities,"*

Approved February 10, 1849.

ART. 5. SEC. 8. The city shall have power to provide the city with water, to erect hydrants and pumps in the streets for convenience of inhabitants.

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## AMENDMENT *City Charter. Approved, February* 4, 1857.

SEC. 1. Gives city of Peoria power to issue bonds not exceeding $100,000, drawing interest not exceeding 7 per cent. per annum, and when said bonds are issued to loan them to Peoria Hydraulic Works, upon taking mortgage upon all property belonging to said Company.

*Provided*, no bonds shall be issued until first submitted to legal voters of city &c.

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## "AN ACT *To Incorporate the Peoria City Hydraulic Company.*"

In Force, February 11, 1857.

SEC. 1. Provided that John Hamlin, John Anderson, N. B. Curtiss, John Johnson, James Daugherty, Horace G. Anderson, John T. Lindsay and Isaac Underhill, their heirs and assigns, shall constitute incorporation under name of "The Peoria City Hydraulic Company."

May have common seal and alter same at plesaure—capable of holding real estate, of purchasing and conveying same not to exceed in value $50,000.

Also provides for election of officers, their qualification and who shall be officers for 1st year.

SEC. 2. The capital stock shall consist of $250,000, with privilege of increasing to $500,000.

Also provides how the stock may be taken and sold.

SEC. 3. Prescribes duties of President.

SEC. 4. Prescribes duties of Treasurer, and how and when subscriptions shall be paid in.

SEC. 5. Same as Section 7 in act of February 20, 1843, except that Company can conduct water "from any point of the Illinois River or Lake Peoria within two miles of corporate limits of city."

SEC. 6. Same as Section 8 in act above quoted, (Feb. 20, 1843.)

SEC. 7. Same as Section 9 in act of Feb. 20, 1843.

SEC. 8. Provides that Company shall commence construction of Water Works as early as one year from the passage of act, and shall so far complete same as to have water ready to be delivered in said city within three years

from passage of act and when work is completed shall at all times keep in the reservoir a full supply of water.

Sec. 9. The property of said Company shall forever remain free from taxation by city of Peoria, and in consideration of this the Company shall at all times afford the city of Peoria &c., and fire companies the use, free of charge, of any and all water for purpose of extinguishing fires, or for convenience and use of fire companies and all reasonable access to hydrants and reservoirs &c. And the Company shall place, at their expense, one fire plug in each block as the pipes are extended, and to such other at cost of city, whenever directed so to do by City Council.

Sec. 10. Gives the Company a lien, for furnishing water to any house under contract, upon house, lot, &c., and prescribes how it may be enforced.

Sec. 11. Same as Section 12 in act of 1843.

Sec. 12. " 13 "

Sec. 13. " 14 "

Sec. 14. " 16 "

Sec. 15. The majority of the Directors of said Company shall be citizens of the city of Peoria.

Sec. 16. Gives the city of Peoria the privilege, at all times, to purchase all the stock of the Company, or less amount, by paying to the owners the actual cost of same, with interest not exceedings 12 per cent. per annum, from time said money is so expended until same is actually paid for. The actual cost to be determined by three commissioners, one selected by Company, one by the City, they to choose a third.

Sec. 17. Act a public one and in force from and after its passage.