THESIS

A REPORT
ON
A SYSTEM OF WATER WORKS FOR OTTAWA, ILL.

FOR THE DEGREE OF

C. E.

School of Civil Engineering.

F. H. Eno.

1894.
A REPORT

ON A SYSTEM OF WATER WORKS FOR THE CITY OF OTTAWA ILL.

In the course of the writer's professional business he was called upon to investigate the conditions surrounding the City of Ottawa, Illinois and design a system of water works for that city. The following text has been compiled from the data collected and work done at that time. The writer presents this more with the idea that it may suggest a few points of interest to young engineers in designing water systems for small cities, rather than with the idea of it being of any value to older engineers.

A brief description of Ottawa and its surroundings may not be out of place at this point. Ottawa is the County seat of La Salle Co. and is situated at the confluence of the Fox and Illinois Rivers about eighty miles south west of Chicago. The population is 12000 or 13000. It is quite a manufacturing center for an inland town, having several glass manufacturies, two organ manufacturies, buggy, tile and terra cotta works, machine shops and many other branches of industry. The Michigan Canal with one or two branches runs through the city. The Illinois River and the canals are thoroughly polluted by Chicago sewage. While the Fox River is used as a sewage carrier for the towns of Yorkville, Aurora, Batavia, Geneva, St. Charles, Elgin and many minor places to the northward of Ottawa. The main portion of Ottawa lies in the bottom lands along the Illinois and Fox Rivers, but South
Ottawa, which constitutes one ward of the city, lies on the table land eighty or one hundred feet above the town and on the south bank of the Illinois River.

The whole valley is underlaid with the St. Peters sandstone which crops out in many places in Ottawa, and in a large section of the city lies within eighteen inches to four feet of the surface. The city is over several artesian strata which may be reached at from 290' to 400' to the first stratum and at various other depths down to 2500'.

THE REPORT

The problem presented to an engineer in designing a system of water supply for a city, is, first to find a source of pure supply and sufficient volume, second to design a system of efficient distribution, and third to secure economy in design and construction.

THE SOURCE

The source must furnish pure water, or water that at small expense can be made healthful. It must furnish a sufficient supply not only for present needs but for future growth and demand. It must be a continuous supply even in the driest season. Of two or more sources offered, one of which may be impure, the purer should be taken even at wide variance in cost. The individual and collective health of the community is of far more value than
the first cost of obtaining a pure water supply.

By examination the engineer will probably find two or more sources from which he may take the supply. The following are some of the more common sources:—artesian wells, springs, lakes, rivers, water bearing gravel strata, filtration beds near bodies of water, impounding reservoirs, etc., etc..

On examination at Ottawa three possible sources are found, the Fox River, water bearing gravel beds, and artesian wells. It takes but a cursory glance at the map of Illinois to cause all considerations of the river to be abandoned because of contamination from the neighboring towns north and east of Ottawa. The question may be asked, cannot this river water be made as wholesome as any other water, and because of it being soft water will it not be better for domestic and mechanical uses? Yes, it can be purified but at increased cost to the system and with some uncertainty as to the wholesomeness attained.

It may be well to mention a few methods commonly in use to purify water. Filtration chambers are used frequently to purify river water. These are subsurface galleries or chambers, so constructed in the sand and gravel banks along river courses or near lake shores that the water from the adjacent river or lake will filter through the sand, up through the bottom or sides of the chamber, and from the chamber be pumped to the mains, or reservoir. The process of filtering through the sand clears the water of all particles held in suspension, and many soluble im-
purities are changed by the intimate contact with oxygen and other elements while passing through the sand into harmless salts or other compounds not dangerous to health. The objection to this method is the limited supply which can be obtained from a given amount of gallery surface. Besides, after long use, the sand becomes clogged and the supply first obtained is considerably lessened. There are some impurities, however, in water contaminated with sewage which are dangerous to health, and which are not easily removed by filtration through limited sections of sand.

For the three reasons just mentioned this method was not considered in the Ottawa supply.

Artificial sand beds are sometimes used but are subject to much the same trouble as the natural filter. There are various mechanical filters which could be used but all with the objection of considerable added first cost and an increased annual expense, which when considered in reference to the other two sources to be found in Ottawa make it undesirable to use the river water.

The gravel beds which are located on the heights in South Ottawa furnish a supply of pure, soft water, which, so far as can be ascertained from surface wells, is continuous and abundant. In the driest seasons known the surface wells sunk into this gravel bed have not varied in supply. To obtain a supply from this source either a long sub-surface collection chamber can be constructed in the gravel stratum, or a large well or group of wells sunk into it. As the increasing population demands more
The chief objection to this source is found with the people themselves. South of the desired location for the collecting galleries, about one half mile, and upon slightly higher ground, is located the City Cemetery. Many citizens believe that there is great danger of contamination from this direction. After a careful examination I believe there is no danger from this source. The residents in this locality claim the flow of water in the gravel bed, wherever they enter it, is from the east to the west. Even if it were not so, water filtered through one half mile of sand and gravel would remove all disease germs.

But with this feeling in the minds of the people it would mean great financial loss to the owners of the system if this gravel bed should be used. It is upon the water takers that the income depends and any such feeling against the supply would prevent many from using the water. Hence, this source is also undesirable. This leaves the remaining source, artesian wells, for the supply of the city. The water obtained from the artesian wells is clear, healthful water but is hard and very poor for mechanical uses. But as there are two canals and two rivers through the city from which the manufacturing concerns already draw their water for mechanical purposes, this will not present a serious drawback to using artesian well water for the City supply. The flow obtained from one hundred or more wells in and near the city varies from 35 to 250 gallons per minute with an average of 70 to
100 gallons per minute. These wells are all five inch holes with
two and one half or three inch casing run down to lime rock, with
an average depth of 380 to 400 feet. Basing my judgement on
these figures and what I can learn from other places I should
think that three ten inch holes with eight inch casing would
furnish 1,200,000 gallons per twenty four hours. These wells
to be connected to a central receiving well and the water to be
pumped from that into two storage reservoirs and a stand pipe.

The location of the wells as decided upon by the city,
also locates the pump house; this will be discussed in the proper
place in regard to its effect upon the economy of running expenses.

DESIGN OF THE DISTRIBUTION SYSTEM.

In designing a system for any city, the machinery and
pipe mains should be of ample capacity for the present demand and
so designed that as the demand increases new machinery and addi­
tional mains can be added from time to time without reconstructing
the system already in use.

The volume of water necessary for fire purposes is about
75 per cent of the entire supply pumped during a fire; hence if
the system be designed for ample fire protection plus one third
more for domestic supply it will be sufficient for all purposes.
Therefore if the system for Ottawa is proportioned for ten fire
streams of one hundred and fifty gallons each per minute, and a
domestic supply of five hundred gallons, or a total of two thous­
and gallons per minute, this will govern the size of the pumping machinery needed and the proportions of the mains. To pump this volume will require two one and one half million gallon pumps and the boiler capacity necessary to lift this weight of water against the fire pressure which will be assumed at one hundred and twenty pounds per square inch.

The supply to be obtained from artesian wells is always limited to a certain extent, therefore, to prevent lack of supply in case of fire it is best to provide storage room for sufficient water to use on such occasions. If a supply sufficient to furnish two thousand gallons per minute for five hours, be stored, it is probable this will be more than will ever be called into use. This would be six hundred thousand gallons, which, if stored in reservoirs, would take one reservoir twenty feet deep and seventy-two feet in diameter, or two reservoirs twenty feet deep and fifty feet in diameter. The preference should be given to the two reservoirs for this reason; the water in the two can be kept from growing stale by occasional change, whereas, if but one reservoir was built it would never be safe to empty it in order to clean and refill with pure water.

To overcome lost head produced by friction and the difference in elevation between South Ottawa and the main town, it is deemed advisable to place the stand-pipe on the hill in South Ottawa.

In designing the system of mains it may be of interest to
discuss the two methods, - Circulating System versus Direct System. Volume and pressure are the two important points governing the size of supply mains. These can be obtained by either method but I wish to prove that it is far more economical to employ the circulating system. A circulating system is one in which the mains are so connected as to leave no dead end, or in other words, use of water at any point causes more or less movement in the water through the entire system. The direct system is one having a main trunk supply and branches from which terminate in dead ends. A dead end signifies a branch water main in which the water can enter but from one end. The one advantage of the direct system is the minimum length of pipe required to furnish fire protection to every district in the city. On the other hand, stale water, sand, freezing, etc are defects incident to the dead ends of the direct system. Besides these disadvantages the cost per foot is greatly in excess of that of the circulating system. Equal pressure and volume can be obtained with smaller pipe if laid as in the circulating system. It takes more lineal feet of pipe but at the same time more lineal frontage is secured for possible takers. For illustration assume a built up area of thirty square blocks as shown in diagram I. For convenience in calculation assume the block to be 1000 feet square from center to center of streets. Let the direct system be indicated by red lines and the circulating system by green. Choose a point S and require ten fire streams of 250 gallons each to be thrown from the
adjacent hydrants, add to this the domestic supply of 500 gallons. This makes 3000 gallons per minute to pass through the mains, upon which to calculate head lost by friction. In the direct system, the maximum lost head caused by friction may be obtained by calculating the friction to hydrant H in diagram I. By Shedd's tables, this amounts to 57.1 feet lost head caused by friction. If the 16 inch main was reduced to a 12 inch main the friction would be increased to 163.9 feet. Now compare the result with the circulating system. 2400 gallons per minute can be carried from A to B in a 12 inch pipe with a lost head of 15.54 feet; from B to J to I, 325 gallons in a 6 inch pipe with a lost head of 68.74 feet; and so on through the various mains as shown in table I.

<table>
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<th>TABLE NO. I</th>
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<tr>
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<tr>
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<tr>
<td>System</td>
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### Table No. I (Cont'd.)

<table>
<thead>
<tr>
<th>System</th>
<th>Location</th>
<th>Size</th>
<th>Length</th>
<th>No. Gals</th>
<th>Lost Head</th>
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<tbody>
<tr>
<td>Circulating</td>
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<td>6&quot;</td>
<td>4000 &quot;</td>
<td>300</td>
<td>33.44 &quot;</td>
</tr>
<tr>
<td></td>
<td>A to M</td>
<td>8&quot;</td>
<td>4000 &quot;</td>
<td>650</td>
<td>36.00 &quot;</td>
</tr>
<tr>
<td></td>
<td>M to F</td>
<td>6&quot;</td>
<td>2000 &quot;</td>
<td>450</td>
<td>37.64 &quot;</td>
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<tr>
<td></td>
<td>F to G</td>
<td>6&quot;</td>
<td>1000 &quot;</td>
<td>275</td>
<td>7.03 &quot;</td>
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<tr>
<td></td>
<td>M to N</td>
<td>8&quot;</td>
<td>1000 &quot;</td>
<td>200</td>
<td>0.85 &quot;</td>
</tr>
<tr>
<td></td>
<td>N to I</td>
<td>6&quot;</td>
<td>3000 &quot;</td>
<td>200</td>
<td>11.16</td>
</tr>
<tr>
<td></td>
<td>A to D</td>
<td>16&quot;</td>
<td>3000 &quot;</td>
<td>3000</td>
<td>16.95</td>
</tr>
<tr>
<td>Direct</td>
<td>D to E</td>
<td>16&quot;</td>
<td>3000 &quot;</td>
<td>3000</td>
<td>16.95</td>
</tr>
<tr>
<td></td>
<td>E to G</td>
<td>12&quot;</td>
<td>1000 &quot;</td>
<td>2400</td>
<td>15.54</td>
</tr>
<tr>
<td>System</td>
<td>G to H</td>
<td>8&quot;</td>
<td>1000 &quot;</td>
<td>600</td>
<td>7.66</td>
</tr>
<tr>
<td></td>
<td>G to F</td>
<td>10&quot;</td>
<td>1000 &quot;</td>
<td>600</td>
<td>2.45 &quot;</td>
</tr>
<tr>
<td></td>
<td>G to I</td>
<td>12&quot;</td>
<td>1000 &quot;</td>
<td>700</td>
<td>1.32</td>
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</table>

Maximum lost head in circulating system is from A to D to G 86.  

Maximum lost head in direct system is from A to D to G to H 57.1

The maximum lost head in the circulating system is 86 feet on line A, D, G with the following quantities of water to throw from the different localities: at I 700 gallons, - H 630 gallons, - E 600 gallons, - F 575 gallons, - G 550 gallons, a total of 3055 gallons per minute. Now comes the comparison as to size of pipe, length of pipe, and total cost of mains.

Table II shows the number of feet of each size of pipe
together with the cost in each system.

### TABLE NO. II

<table>
<thead>
<tr>
<th>System</th>
<th>Size</th>
<th>Length</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Circulating</td>
<td>6 inch</td>
<td>43000 feet</td>
<td>$21500</td>
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<tr>
<td>System</td>
<td>8&quot;</td>
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<td>3000&quot;</td>
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<td></td>
<td></td>
<td></td>
<td>71000&quot;</td>
</tr>
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<td>13000&quot;</td>
<td>$6500</td>
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<tr>
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<td>8&quot;</td>
<td>13000&quot;</td>
<td>8060</td>
</tr>
<tr>
<td></td>
<td>10&quot;</td>
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<td>3000&quot;</td>
<td>3180</td>
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<td>16&quot;</td>
<td>6000&quot;</td>
<td>10260</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>41000&quot;</td>
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</table>

This table shows that the circulating system has 31000 feet more pipe than in the direct system at an additional cost of $7080.00. If there were ten consumers for each extra 1000 feet, and each consumer averaged $10.00 per year, this would increase the annual revenue by $3000 or equivalent to an investment at six per cent of $50000. It is needless to say that I have adopted the circulating system for Ottawa.

Convenience in location of valves and hydrants is one requisite of an efficient system. Valves should be neither too few nor too many. Too few, acting as a menace to good fire protection in case a break should occur in the system. Too many,
confusing the workmen and becoming expensive. To obviate confusion all valves should be set uniformly in reference to street or curb lines. The same is true in regard to locating hydrants.

As a matter of interest I append table III showing the population of several cities, the miles of pipe in their water system, the size of pipe, number of hydrants, number of valves, cost of plant, and annual expenses, as given in the reports to "Fire Protection and Water Supply" Magazine for 1893. From this table an idea may be obtained of the number of hydrants and valves generally used per mile of main laid.

ECONOMY OF DESIGN AND CONSTRUCTION

Good machinery is probably one of the first requirements of economy. Much depends upon choosing the make of boiler that will give the highest evaporation per pound of coal burned; and upon the right proportion of the boiler to the work to be done. A boiler should never be over loaded. Proper firing, utilizing condensation and hot water feeders, etc. all unite in a great saving by the end of a year.

The cheapest pump is seldom the most economical, soildity of structure, area and mechanism of the valves, simple or compound, single or duplex, are the questions that are pertinent to economical results in a plant. Even the make up of the pump house counts with regard to the amount of coal consumed in the winter. The location of the pump house has also something to do with saving
expense. Everything else being equal the best location is near a railroad side track, thus saving in first cost of setting up the machinery, and an annual saving on price of coal in the bin.

The system should be so designed that it may be extended at any time without relaying or increasing the original mains. In small towns it is generally most economical to design the system so as to pump intermittently, saving attendance and fuel expenses. This may be accomplished by using a stand pipe or elevated reservoir. Combination water and Electric Light plants are economical because of saving in fuel and attendance.

The location of the wells and pump house at Ottawa is not an ideal one having been influenced by the fact that the city already owned land near the river and desired it to be used for water works purposes. However there are circumstances in favor of the location. First, by a short suction pipe being laid into the river all doubt as to ample fire protection is allayed. Second this location is such that by the addition of filters the river water may be used to increase the regular supply without other alteration to the plant should it be found necessary. I may mention one more item to aid in economy. Meter all supplies. The experience of all cities that have adopted this system has been that the volume of water pumped is very considerably lessened.

C O S T

In making an estimate of the cost of the system I have availed myself of all the later work in this line which I could
find in progress, as well as figures by contractors of known integrity and experience. Never-the-less in work of this nature, with the uncertainty of the quantity of rock to be encountered, and the difficulty of canal and river crossings, it is necessary to remember that this is an estimate. Pipe laid in ground is estimated at the following prices per foot:

- Four inch pipe at $ .42
- Six inch pipe at .50
- Eight inch pipe at .62
- Ten inch pipe at .85
- Twelve inch pipe at 1.06
- Sixteen inch pipe at 1.85
- Twenty inch pipe at 2.65

Hydrants at $35.00 each set in place. Valves and boxes at the following rates from four inch to sixteen inch respectively, $11.00, 15.00, 21.00, 29.00, 31.00 and 48.00.

- Rubble masonry at $5.00 per Cu. Yd.
- Brick Masonry at $10.00 per M.
- Concrete at $8.00 per cubic yard.
- Pipe per ton $20.00, Specials, $45.00.
- Earth excavation at 30 $ per cubic yard.

**ESTIMATE.**

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<th>Description</th>
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<td>Pipe System</td>
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<td>1982 tons, feet 100,325</td>
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<tr>
<td>Real Estate</td>
<td>2500.00</td>
</tr>
<tr>
<td>5 acres and 2 lots</td>
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<tr>
<td>Hydrants and valves</td>
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<tr>
<td>Two Reservoirs 50' x 20' roofed</td>
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<tr>
<td>Two Boilers 16' x 60', tubes</td>
<td>4000.00</td>
</tr>
<tr>
<td>Three Wells and Deep Well Pumps</td>
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<tr>
<td>Two Duplex Pumps, cpy.1 1/2 mill.gal.</td>
<td>7000.90</td>
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<tr>
<td>Item</td>
<td>Amount</td>
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<tr>
<td>Bro't forward</td>
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<tr>
<td>Stand Pipe 15' x 100'</td>
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<tr>
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<td>River and Canal Crossings</td>
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<td>Rock Excavation 12,000 Cu. Yds. at 1.65</td>
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<td>Superintendant and Engineering Expenses</td>
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<td>Contingencies</td>
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<td><strong>Total</strong></td>
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<tr>
<td>City</td>
<td>Popul'n</td>
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<tr>
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<tr>
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<td>Evansville, Ind.</td>
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<td>Lewiston, Me.</td>
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<td>Popul'n</td>
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<td>Hagerstown, MD</td>
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<td>Canton, IL</td>
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MAP OF OTTAWA, ILL.

SHOWING

System of Water Mains.

designed by
F.H. ENO.

EXPLANATION.
Waterworks to be set at every street intersection where pipe line is shown.
Four values, or more, of the miles of pipe, will be listed.

QUANTITIES

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<th>Size</th>
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<td>Hydrants</td>
<td>140</td>
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<tr>
<td>Valves</td>
<td>75</td>
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Ottawa, Ill. Water Works.
designed by
F.H. ENO.
Ottawa, Ill. Water Works.

designed by
F.H. ENO.
PLAN & DETAIL
STANDPIPE & WATER WORKS
OTTAWA, ILL.
donigned by
F.H. ENO.
Reservoir.
Ottawa, Ill. Water Works.
designed by
F.H. ENO.

Scale 1/2 in. = 1 ft.
OTTAWA, ILLS.,

WATER WORKS

SPECIFICATIONS

FOR

FURNISHING MATERIALS

AND

CONSTRUCTING A COMPLETE SYSTEM OF WATER WORKS

FOR THE

CITY OF OTTAWA, ILLINOIS.
SPECIFICATIONS
FOR
OTTAWA WATER WORKS BUILDING

MASON WORK

EXCAVATION:

Excavate the ground to the depth shown on sections for foundation walls and chimney; the earth taken out will be filled in around building as will be directed.

RUBBLE STONE:

Shall be used for foundation walls of size and dimensions as shown up to the top of first story joist.

Rubble stone shall be laid flat bedded, well bonded, in cement mortar; one-fifth of the stone extending through the entire thickness of the wall. The first layer of stones shall be large flat ones, well selected for footing course. Leave holes in foundation walls as will be directed by the Superintendent for pipes, drains, etc. Foundations for front steps shall be built as directed.

CEMENT:

Cement for mortar shall be made of one-third Utica or Louisville cement and two-thirds sand.

CUT STONE:

Cut stone shall be furnished and set by the contractor.
for the mason work; this includes door sills and window sills, caps, coping on chimney and water table on two sides of pumping room as shown, also bottom step. Imitation for water table course on boiler room shall be made by levelling off rubble stone above ground, selecting a stone about seven inches in thickness.

**BRICK WORK:**

Brick work shall be of good common brick well burned, laid close with flush and solid joints, neatly struck, bonded and tied in every fifth course. Hollow tile may be used at option of City Council. Brick arches over all openings and sills; fill in solid all walls back of cut stone, and around doors and window frames.

**ANCHORS:**

Anchors 1 1/2 x 1/4" x 1' 6" shall be put in every eight feet wherever necessary.

**CEMENT FLOORS:**

Shall be laid in boiler room and in basement of Engine room. In the engine room set plugs for wainscoting four feet above the floor, furring strips for plastering above. Mason shall carefully follow detail plans for Boiler and Pumping Engine foundations.

**CHIMNEY:**

Chimney shall be built as shown on drawings 5/8" iron rounds shall be built in the inside of chimney flue, to be used as ladder in cleaning.
PROVIDE:

Provide all needed materials, set window and door frames in brick work, attend to other mechanics when required, clear out scaffolding and refuse when work is done, and do all the work to its entire completion in the best workmanlike manner.

CARPENTER WORK.

LUMBER:

Lumber must be of good quality, well seasoned for its different purposes, and kiln-dried for doors, windows, trimmings etc.

JOISTS:

Joists common pine 2" x 10" set 12" between centers resting on machinery foundations and outer walls, well bridged with cross bridging of 2" x 4" pine, spiked at each end with two ten-penny nails.

ROOF:

Roof shall be constructed as shown by drawings. Trusses and purlins as shown. Rafters shall be 2" x 4", 16" between centers as per drawings. Rafters shall be covered with common board except on eaves where matched and beaded stuff 1" x 6" B flooring shall be used. Roof of pumping and boiler rooms shall be covered with good quality slate laid on tar felting and fastened with galvanized iron nails. Furr out for cove in ceiling with boards. In engine room and vestibule ceil up over head with 1" x
3" Georgia pine. Wooden cornice shall be made of Georgia pine at the top of the brick walls as shown by details. Fuel room shall be covered with a lean-to roof made of 2" x 8" and common boards. Tin roof.

**GUTTERS:**

Gutters shall be plain box gutters made according to detail, covered with IX tin of first quality.

**TIN:**

Tin shall be used of good quality for gutters, valleys, deck on roof and wherever needed to make a water tight job. Down spout, gable mould and gutter mould shall be of galvanized iron.

**FURRING:**

Furring strips shall be put on the walls of the engine room for plastering, and grounds for wainscoting and finish.

**FLOOR:**

In engine room and vestibule lay common boards on joists and tar paper with strips of wood above each joist, well nailed. finishing floor 2 1/2" Oak smooth for oil finish securely secret nailed.

**WAINSCOTING:**

1" x 3" Georgia pine four feet high shall be used all around the walls of the engine room and vestibule and finished with a suitable mould for capping on top.
TRIMMING:

For the windows and doors of the engine room shall be 1"x 5" pilaster trim. of Ga. pine with base block.

WINDOWS:

As per drawings of clear Ga. pine for engine room, white pine for sash of windows in boiler room, check rail sash 1 3/4" thick hung with balanceweights on strong hemp cords over 2" pulleys. All visible parts shall be clear Ga. pine for all finish in engine room. Hanging stile 1 1/8" thick, 13/4" bead on the outside; on the inside finish with a stool 1 1/8" thick Ga. pine with mould beneath. Linings of same material.

DOORS:

Doors shall be made as indicated on drawings, hung and fitted complete; outside front door as elevation shows, made of 1 3/4" clear pine, outside rear door double thick with panels of 1 3/8" matched and beaded clear, pine set together diagonally; inside doors 1 3/4" thick shall be made of Ga. pine for engine room, chamfered, five paneled. Stairs as shown on plans shall have 1 1/4" treads, 7-8" risers.

PAINTING AND GLAZING:

PAINTING:

Paint all the inside and outside wood and metal work with two coats of best white lead and linseed oil, except engine room, which shall receive three coats of hard oil on ceiling,
wainscoating and trimming.

GLAZING:

Glaze all windows with American glass double thick.

PLASTERING:

Two coat work on outside walls of engine room and vestibule; the first coat to be carried down to the floor.

CRESTING:

Cast iron creasing around deck securely fastened.

VENTILATORS:

Two ventilators shall be framed in roof of boiler room, all faced with galvanized iron with roof of corrugated iron.

FRONT STEPS AND PLATFORM:

Steps on 3-2" X 12" stringers, treads 1 1/2", risers 7/8" with solid nosing. Platform floor 1 1/4" plank with leaded joints. Gas pipe rails and cast iron posts as indicated.
SPECIFICATIONS

FOR

OTTAWA WATER WORKS PUMPING MACHINERY

PUMPING ENGINES:

Two duplex, compound, pumping engines each of one and one half million gallons capacity when working at a piston speed of one hundred feet per minute shall be set up on masonry foundations in the engine room of the Water Work's Building, and their suction pipes connected with the Artesian wells, the storage reservoirs and their discharge pipes with the distribution system of the city, so that one or both can be used at will.

The pumping machinery shall be of good design and of best materials and workmanship, complete in all parts, and so designed as to give effective and economical results, both when working under the ordinary domestic pressure of 70 lbs. to the sq. inch, or a fire pressure of 120 lbs.

The two pumping engines will be alike in all essential respects each having two high pressure cylinders of 12 inches diameter, two low pressure and expanding cylinders of 22 inches diameter, and two pump cylinders with inside packed plungers of 11 1/2 inches diameter in separate castings of ample strength, and with 18" stroke.

The cylinders must be of sufficient thickness to admit of reboring.
Valves must be of approved construction and of ample areas, valve seats etc., to be of best U. S. gun metal.

Steam and exhaust pipes carried to outside of engine room with all necessary connections and fillings for operating Feed, Pump, Heater and Purifier; also fittings to admit live steam to expanding cylinder.

The discharge pipes from each pump to be 10" diameter and to connect at an acute angle with a main discharge of 20" diameter which shall be extended to the junction of 16" and 8" street mains in front of building.

All necessary tools, gauges and appliances needed for operation of such machinery, whether specified or not to be provided.

A gauge board with best quality steam, water and vacuum gauges to be set upon well of engine room and an automatic counter placed on each engine. Counters and gaugers to be nickel plated.

The machinery to be of high finish, all steam surfaces and steam pipes to be covered. Steam cylinders to be lagged with hard wood, cabinet finish, and all unfinished exposed surfaces inside engine room to be thoroughly and suitably painted.

Provision shall be made for suitable connections with steam pipe for heating the building. The Feed Pump shall be duplex and ample capacity for feeding a battery of two 75 H.P. boilers. The heater shall be of ample capacity and of approved pattern.
All necessary special castings and valves to be used in connecting engines with the suction and discharge pipes so that all the combinations required in use of the machinery can be readily secured.

Lay and connect all needed drain and over flow pipes with sewer outside of building. Complete entire work in full readiness for successful operation. The foundations of the pumping engines shall be of solid stone or brick masonry of suitable size with holding down bolts. Top stones to be not less then 8" in thickness.
SPECIFICATIONS
FOR
OTTAWA WATER WORKS BOILERS

BOILERS:
To be of the Horizontal-Tubular Type and Two (2) in
Number, 60" in Dia., and 16 ft. long.

TUBES:
Each boiler is to contain 46 Tubes 4" in Dia., and 16 ft.
long.

DOMES:
Each boiler shall have a steam dome 36" in Dia., and 36"
high.

MATERIAL:
All material used in the construction of the boiler shall
be Park Bros'. Flange Steel having a tensile strength of 60,000
lbs. to each sq. inch of section. Each sheet to bear the name
of the Maker, Brand and Tensile strength. Tubes to be of the
best American make made of lap-welded charcoal iron uniform in Dia.
and length, perfectly straight and free from defect of any kind.
All braces to be made of Ulster Iron and rivets to be Burden's
best.

THICKNESS OF MATERIAL:
Sheals of boilers to be 5/16" in thickness, heads to be
1/2" in thickness. Domes to be 3/8" thick.
CONSTRUCTION:

Shell of each boiler to be made in five sheets; to have three sheets on the top and two on the under side with the Horizontal seams brought well up out of the fire. The seam on the bottom of the boiler shall be lapped away from the fire. All flanging shall be done in a neat and workmanlike manner, and all circular plates shall be flanged by machinery. This will insure an even turned flange and a perfectly round and flat head. All rivets shall be 3/4" in Dia. The Horizontal seams shall be double-rivetted, the balance of seam single-rivetted. Spacing for single rivetted seams 2" centers, for double rivetted seams 2 3/4" centers. Rivet holes to be made to come fair without the use of drift-pin, and in no case to exceed the diameter of the rivet more than 1/16 of an inch. The rivets to be sufficiently long to fill the holes completely and form a large and strong head. All tube holes to be drilled and neatly chamfered on the outer face. The tubes to be set with an expander and beaded over with a beading tool. Tubes to be long enough to allow a strong head at both ends.

BRACES:

To be made of the material before stated. Each head of boiler to be braced to its respective shell, solid crow-feet braces.

LUGS:

Three lugs to be rivetted to each side of boiler, every
lug to be provided with a cast iron plate and three wrought iron rollers of a heavy pattern, best cast iron and well secured to boiler.

**FLANGES:**

Necessary flanges for steam and safety valve connections to be rivetted on. Also for 6" blow-off pipe.

**MAN-HOLES:**

On top of each boiler to be placed a man-hole with an opening 11 inches by 15 inches. In the front head under the flues to be placed another man-hole with an opening 10 inches by 16 inches. The latter to be of the improved Eclipse Style in one head.

**TESTING:**

After the boilers have been completed they must be tested to a cold water pressure of 150# to the sq. inch, and made tight under the pressure. A certificate of inspection showing that boilers have been constructed in compliance with these Specifications to be furnished.

**BREECHING:**

One sheet iron breeching to be furnished 15 ft. long, and having an area one quarter larger than the combined area of both boilers. This breeching to be made of No. 12 iron and to be erected in place. Two 16" extensions to be furnished made of 1/4" Boiler Iron secured to boilers with the aid of lugs and studs. An uptake from each extension to breeching with damper and
frames to be furnished.

**FRONTS:**

The two boilers to be set in one battery and one double 60" fire front to be furnished. These to be full fronts of heavy and ornamental pattern with double flue doors. Double fire and ash doors complete with two sets of bearing bars, two soot doors and frames, seven wall binders and all necessary rods and two skeleton arches for smoke return fire doors and liners. Butmans' or Kirkwwods' Pat. Grates to be furnished.

**STEAM-FITTINGS:**

Each boiler to be provided with one 3 1/2" ball and lever safety valve, one large size combination body, with 1 1/4" connections. One 6" dial brass body steam gauge, one 3/4" glass water gauge, three 3/4" gauge cocks. One 2" blow-off cock, one 1 1/2" globe valve, and one 1 1/2" check valve.

**DELIVERY:**

These boilers to be delivered at the Ottawa, Ill. Water Works, on foundations erected by Company, and substantially enclosed in brick-work with all internal parts exposed to the flames, such as furnace, bridge and back walls faced with fire brick.
SPECIFICATIONS
FOR
Furnishing Cast Iron Coated Water Pipes and Special Castings
FOR
OTTAWA WATER WORKS.

All pipe and the necessary special castings to be furnished on board cars at the Railroad Depot, Ottawa, Ill.

The pipes to be made with hub and spigot joints, to be truly circular with inner and outer surfaces concentric.

The hubs shall not be unnecessarily large, nor the spigot ends of special castings too large to enter the hubs of straight pipe.

No pipes will be received the weight of which is less than two per cent or more than four per cent from standard weight given above.

The metal used to be such as to admit of drilling and cutting, tough and of even grain without mixture of cinder or other inferior iron and shall be remelted.

All castings shall be free from scabs or defects. No plugging or filling to be allowed. All to be thoroughly cleaned and no lumps or rough places shall be left in the barrels or sockets.

All pipes or castings of whatever form shall be subjected to a test of hydrostatic pressure of three hundred pounds per
square inch and shall pass a careful hammer inspection, and after being cleaned shall be coated inside and outside with coal pitch varnish of best quality at a temperature of 300 degrees Fahrenheit.

All the pipes and other castings must be delivered in all respects sound and conformable to the contract, any defective piece will be liable to rejection whenever discovered until the final completion of contract.

Special castings shall be delivered at the same shipment with the pipe for which they are intended to be used.

All pipe to be first class in every respect.
SPECIFICATIONS
FOR
OTTAWA WATER WORKS STANDPIPE

FOUNDATIONS:

Excavate to a depth of seven feet a circular pit twenty-three (23) feet in diameter. The first layer to be of concrete of gravel, broken stone and hydraulic cement mortar to a thickness of fourteen (14") inches. Upon this build as per plans with rubble stone laid in hydraulic cement mortar large flat blocks for the bottom and the outer edges of the courses. Leave an opening as shown on plans, for the inlet pipe and cover it with an arch of three (3) courses of hard burned brick. The top course of the foundation to be of large stones not less than twelve inches in thickness with outer edge cut to a diameter of nineteen feet. The top to be cut to a level and holes carefully drilled for the bolts.

All hold-down bolts to be built in the foundation from bottom to top as the work progresses, and carefully kept in position by template. Joints between stones in the top course to be pointed with Portland cement.

STAND PIPE:

The stand pipe shall be fifteen feet in diameter and one-hundred feet high above foundation and be made of plates of wrought iron having a tensile strength of not less than 50,000 lbs.
The stand-pipe to be made in twenty uniform sections or rings each five feet in height. The thickness of plates in the four lower sections to be one-half inch, in the next three sections 7/16 of an inch, in the next three sections three eighths of an inch, in the next five sections five sixteenths of an inch, and in the next five sections one fourth of an inch. The bottom to be made of plates three eighths of an inch thick. A casting five feet in height to be placed on top of stand pipe. An angle iron three inches by three inches shall be placed around the top of shell and rivetted firmly in place. An iron ladder shall be placed on the outside reaching the entire distance of shell. A man-hole with plate, yoke and frame and a connection for a water main shall be provided and rivetted fast to the stand-pipe. Six cast iron brackets or lugs shall be rivetted to the outer circumference of the stand-pipe at the bottom and six hold-down bolts, two inches in diameter shall be laid in the foundation from bottom to top and be securely fastened to the brackets.

The vertical seams of the lower fifteen sections of the stand-pipe shall be double rivetted, other seams single rivetted.
Two circular reservoirs shall be constructed on the Water Works premises near the Artesian Wells. Each of these shall have an internal diameter of fifty feet (50') and be excavated to the rock or to such depth as shall furnish from excavation sufficient material to form their banks. The depth of each reservoir, when complete shall be twenty feet (20'), and the interior shall be lined with a wall of brick masonry of hard burned brick laid in hydraulic cement mortar. This wall shall be twelve inches thick at the top and shall be increased by regular slope to twenty-four inches at the bottom. The filling back of this wall and the embankment shall be thoroughly compacted and built in layers of not exceeding eight inches in thickness.

The top of the embankment shall be six feet in width and the slope to the natural surface of the ground shall be one and one-half horizontal to one vertical.

The bottom of the reservoir shall be made water tight, and the masonry walls be washed with Portland cement to render them thoroughly water tight. Over each of these reservoirs there shall be constructed a conical roof covered with sheathing boards.
felt and shingles. A trap door with back shall be provided in the roof of each and steps leading from it to the bottom of the reservoir.
SPECIFICATIONS
FOR
OTTAWA WATER WORKS HYDRANTS AND VALVES

All hydrants shall be of improved design, post hydrants with cast iron base, stand pipe and frost jacket, if used.

The inside diameter of stand-pipe to be not less than four inches nor less than 1/2 inch in thickness.

All working posts, valve seats, screws, etc., to be of brass. Each hydrant to have two two and one-half inch brass nozzle for hose connection, and one four inch brass nozzle for steam connection. Nozzle to have cast iron caps secured by chains to eye bolts to the body of hydrant.

All hydrants to be tested by hydraulic pressure of 250 pounds per square inch before acceptance.

Hydrant must be delivered on cars at Ottawa, Ills.

VALVES

All water gates or valves must be of approved pattern of best quality double gates with composition faces and working parts. Every valve must be subjected to a test by valve pressure of three hundred pounds per square inch. Extension valve boxes with covers must be placed over all valves.

Valve and boxes must be delivered on cars at Ottawa, Ill.
SPECIFICATIONS
FOR
OTTAWA WATER WORKS ARTESIAN WELL

Three Artesian Wells shall be drilled on the Water Works premises and shall be thoroughly cased so as to shut out all seepage from upper strata. The bottom of these wells shall be near the bottom of the St. Peters Sandstone. Each well shall be started at top with a diameter of eight inches, and shall be reduced in size only as necessity shall require.

A receiving well eight feet in diameter and twenty-five feet in depth shall be constructed at a convenient point near the pumps and to this each of the wells shall be connected by syphons reaching nearly to the bottom of the receiving well, with stop valves as needed.
HAULING:

All pipes, special castings, hydrants and valves are to be unloaded from cars promptly as required by Railway Co., and the pipe carefully inspected and tested by hammer so as to detect any split or broken pipe, taking note of each imperfect piece with number of car on which it was loaded and making report of same. Imperfect hydrants and valves to be also reported and safely stored.

Pipes and special castings to be carefully handled and placed along the side of streets where mains are to be laid with bells and spigots pointing as directed. The contractor to be responsible for any pipe, casting, hydrant or valve which may be injured or found broken after being accepted by him from the Railroad Co.

All extra pieces or parts of pipe not laid in the system to be deposited at the yards of the Company.

TRENCHING:

All trenches are to be excavated upon lines and grades given by the engineer. The bottom of trench to be five feet below the grade of street, or natural surface of the ground. When trenches are not five feet deep the contractor will be required
to cover his pipes sufficiently to protect them from frost at his
own expense.

While the work is in progress and until completed the
contractor will be required to protect his trenches, pipe, etc.,
both by day and by night, and save the city and Co., harmless from
any accident that may occur from failure to comply with any city
ordinance, or to maintain proper signals and barricades.

The bottom of trenches must be taken out regularly so as to
give an even bed for the pipe, with holes as required for
caulking, with width sufficient to allow of convenient access to
the pipes for caulking.

If sheeting and bracing is required all such must be
furnished by the contractor and removed as the trenches are filled.

All culverts, side walk, pipes, pavements, etc., disturbed
in the progress of the work must be restored to the conditions
they were in before being so disturbed. Great care must be taken
to excavate the hydrant connection, trenches upon the lines in-
dicated by the engineer.

PIPE LAYING:

Before laying in trench the interior of each pipe must
be thoroughly cleaned. In the trench secure careful alignment
and bring the spiggot end of each pipe to a close bearing in the
hub of adjacent pipe. Place special castings where directed,
cutting pipe when it is necessary to do so. Joints to be made
by skilled workmen, first ascertain that there is a sufficient
space all around the pipe and then packing the joints with gaskets, leave a space of at least two inches for lead. Before running lead, carefully wipe out joints. Fill with one pouring keeping the melting pot within sixty feet of the work as it progresses.

Caulking must be done skillfully with suitable tools so as to make a tight joint without straining the hub.

The lead after driven to be flush with face of socket.

Plug the end of pipe line before leaving the work at night.

BACK FILLING:

In filling the trenches pack the earth under and around the pipes. Fill trench completely and compact thoroughly to prevent settlement.

When pipes have to be laid across any railroad, notice must be given to the Superintendent and time given to remove or shove up track.

All rubbish or refuse of every description created by the prosecution of the work must be removed from street without unnecessary delay, and the travel and use of streets must be impeded as little as possible.

Any imperfect or unfaithful work must be corrected upon requirement of the engineer. No inspection of work shall relieve the contractor from any of his obligations to perform sound and reliable work as herein described.

After the pipes are laid and hydrants connected they will be tested with a water pressure of 150 lbs. to the Sq. in.
In setting hydrants care must be taken to secure the effective work of the drip in each case, and if in clay ground a sufficient quantity of gravel must be placed around the hydrant. A block of stone or brace must be put behind the hydrants so as to protect the joints from being drawn underpressure.

Valve boxes to be furnished by the Water Company, must be set over all valves and safely covered so as not to interfere with travel. Great care must be used to set hydrants upright and properly faced, and in the exact location and grade specified by the engineer.

The contractor shall keep the work in good repair for six months after the date the water is let in and the work accepted and shall at his own expense promptly repair all leaks and imperfections. The work to be delivered in good condition at the end of that time.

All the work must be done to the satisfaction of the engineer and all materials and workmanship shall be subject to his inspection and rejection.

When pipes are to be laid inside of the curb line, as will be the case on some paved streets, the City of Ottawa will clear the line of all obstruction, such as telegraph poles, lamp posts, etc. but the contractor must restore all walks, etc. as heretofore provided.
Rock work where, in the engineer's judgement, it is necessary to blast will be measured in trench, and paid for as an extra, at stipulated price per cubic yard.

The right to reject any or all bids is reserved.