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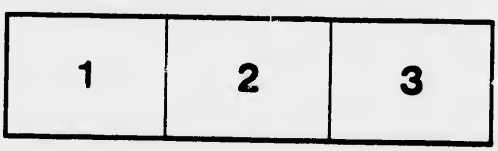

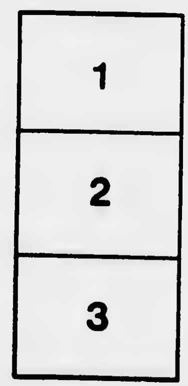

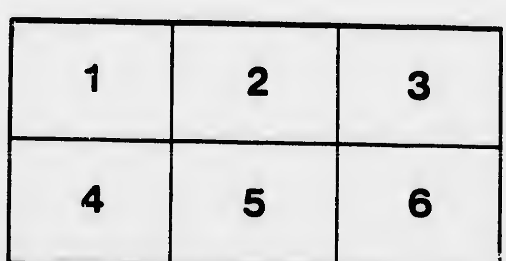

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REPORT

OF

E. H. KEATING, C. E.,

UPON THE

PRELIMINARY SURVEY OF THE

Windsor Water Works.

WINDSOR, N. S.
C. W. Knowles, Printer.
1881.

Windsor Water Works.

Halifax, 13th September, 1881.

EDWARD DIMOCK, ESQ.,
Warden of Windsor.

SIR :—The preliminary surveys for the Windsor Water Works, having been made by Mr. C. E. W. Dodwell and the plans placed in my hands for the purpose of examination and reporting upon the feasibility of introducing into the town a copious water supply for domestic, sanitary and manufacturing purposes and for the suppression of fires. I beg to submit to you the following report :

On the 12th of August last, in company with yourself and some of your Town Councillors. I went over the greater part of the two proposed pipe lines. The surveys had been commenced at a point on Fall Brook a short distance above "The Falls," about four miles from Windsor. Our observation extended up the brook to Mill Lake, some four and a quarter miles beyond the starting point of the surveys.

From the lower end of Mill Lake, Fall Brook runs for about three quarters of a mile through level swampy land at the termination of, which a rough wooden dam has been constructed for milling or logging purposes.

From measurements taken at the sluceway through this dam it is estimated that the discharge of water at that point was at the time of our visit at least 2000 gallons per minute. The brook falls gently from the dam for about half a mile, then flows nearly level for another half mile, and from thence continues to fall rapidly towards Windsor. As far as I can learn no gaugings have ever been taken of the water flowing through this brook, nor is the drainage area known. From information, however, furnished by the person who accompanied us as guide, and who appeared thoroughly familiar with the country and every point along the course of the stream, it appeares that during the dryest weather there is never less than about half the amount of water running through it, which was to be seen on the day of our inspection. At "The Falls" from rough measurements taken on the same day the discharge was estimated to be about 1,500 gallons per minute or 500 gallons less than was passing through the sluce 3½ miles further up the stream. The discripancy is due to the fact that at an intermediate point a quantity of water is diverted into another channel. The foregoing measurements although they can only be regarded as very rough approximations are nevertheless sufficient to establish the fact that an abundant water supply can be obtained from this source for all the probable requirements of Windsor, even when it shall have grown into the magnitude of a city.

The supply therefore being practically unlimited the next question to be considered is the quality of the water. Upon this subject I do not feel in a position to express any decided opinion. To all outward appearances it is a good soft water, and although somewhat tinged with a brown color, it is not more so than that delivered into some other towns. It is decidedly better than the water supplied to some Canadian cities with which I am acquainted, being free from any smell or disagreeable taste.

The only proper method of settling the question of quality would be to subject a sample to the test of a chemical analysis. Possibly the construction of the storage reservoir at the head of the pipe line may have the effect of removing some of the discolouration as the reservoir will act to some extent as a settling pond.

The point selected for the construction of the dam is a very favorable one a short distance above the falls. The bed of the stream at this point is 170 feet above high tide, and the valley is so narrow that a dam of from 18 to 20 feet in height can be cheaply constructed, if suitable clay for puddling can be obtained within a reasonable distance. A hard gneissoid rock underlies the soil a few feet below the surface, so that it will probably be necessary to incur a little expense in blasting through it for the base of the puddel wall of the dam, for the gate house and for the channel leading to and from it, as it would not be advisable to conduct the water through or under the dam.

The pipe line (Line A.) which follows along or near the main road for the greater portion of the distance into Windsor, is not so favorable as the more direct line (Line C.) crossing the hill near the plaster quarries. It is about 3000 feet longer than the latter, and I can see no good object to be gained by its adoption unless there are likely to be witnin a short time a sufficient number of water takers along the line to pay annually a sum exceeding the interest on the additional cost.

The present population of Windsor is stated to be about 2,500, out of which number the water supply would not probably extend to more than 2,000. If Windsor is likely to increase in population it would not be prudent to estimate on furnishing a supply to less than double this number of persons, and the usual quantity of water which it is customary to assume each individual will consume and waste, is 60 gallons per day. In large towns the quantity of water which may be required for extinguishing fires is far less than that needed for domestic and other purposes. In small places as in the case of Windsor this rule is reversed.

The surface of the water in your reservoir will be about 130 feet above the highest part of the town. If we assume for the present that 30 feet of pressure will be lost by the friction of the water through the pipes, there will remain an effective head of 100 feet. A one-inch jet playing on a fire from a head of 100 feet will discharge about 150 gallons per minute, and it would be well to allow for at least two such jets playing upon a fire simultaneously.

I know of no method of arriving at the probable quantity of water which you are likely to require for manufacturing purposes, the amount therefore can only be assumed. In all probability an allowance of 60,000 gallons per day will be sufficient for many years to come.

The total quantity of water which you will require may therefore be estimated as follows:

Domestic supply to 4,000 persons, at 60 gallons per head per day,	240,000 gals.
Supply to manufactories, say	60.000 "
	300,000 "
Or nearly....	210 gals. per minute.
Add for extinguishment of fires..................................	300 " " "
Total quantity of water required..................................	510 " " "

Pipes of different sizes laid on the direct route (Line C.) would discharge the following quantities of water:—

A 6-inch	pipe	would	deliver	212	gallons	per	minute.
" 7	"	"	"	"	311	"	"	"
" 8	"	"	"	"	435	"	"	"
" 9	"	"	"	"	585	"	"	"
" 10	"	"	"	"	758	"	"	"
" 12	"	"	"	"	1190	"	"	"

In arriving at these results the water in the reservoir has been assumed to stand at an elevation of 185 feet above high tide. The length of the main is about 16,300 feet from the reservoir to the town summit on King street which is 56½ feet above tide level, and which point governs the delivery of water in the pipes. It is evident that no more water can be delivered into the town than the main will discharge at that point.

The head necessary to overcome the friction of the water in mains of different sizes discharging 510 gallons per minute is as follows:

An 8-inch pipe requires 178 feet head, or 49 5 feet more than is available.
A 9-inch pipe requires 98½ feet head, leaving 30 feet presure for fires.
A 10-inch pipe requires 58 feet head, leaving 70½ feet presure for fires.
A 12-inch pipe requires 23½ feet head, leaving 105 feet presure for fires.

A 6-inch main will give you a good domestic supply, it will not however afford any protection from fires without the aid of steam fire engines and in the course of a few years the engines would not be able to draw sufficient water from the plugs to be of effective service. The smallest main which it would be judicious for you to put down would be one of 9 inches diameter. It would not however—after a time—give a good fire pressure to buildings in the highest parts of the town. A 10-inch main would not cost very much more, it would give you all the fire pressure you need in the highest districts and would be the best size of pipe for you to adopt if your means will not admit of your laying a larger one. A slight saving could be effected by laying a compound main which would consist of a 10-inch pipe for about 8,000 feet or to a little beyond the summit near the plaster quarries, and a 9-in. pipe for the remainder of the distance. A main of this description will discharge 650 gallons per minute, or 936,000 gallons per day. The head necessary to overcome friction is about 78½ feet, leaving 50 feet, or about 21½ lbs. pressure on the square inch for fire pressure at the town summit on King street when the population shall have doubled and the works shall be drawn upon to the full capacity estimated. As a matter of course, for the first few years, while the works are new, the pressure will be much better than that above stated. As this compound main will give you all the water you require for domestic, sanitary and manufacturing purposes for some years to come, an excellent fire pressure in the lower and intermediate parts of the town and a fair fire pressure in the highest portions, I have assumed that it will be adopted and the estimate of the cost of the works is made upon this data. A 10-inch main for the whole distance would however be better and the increased fire pressure which it would afford would well repay you for the small additional expense involved.

The cost of your works will depend largely upon the price of iron at the time the order for pipes is given.

With iron pipes selling in Great Britain at $30 per ton, the cost of the same delivered along the pipe line may be taken as below:

Cost per ton in Great Britain........................	$30.00
Duty..	7.50
Freight...	4.00
Commission, inspection, wharfage, truckage and allowance for breakage, etc...........	3.30
Total cost per ton delivered along the line......	$44.80, or 2 cts. per lb.

This estimate is greater than the cost will be if the pipes are ordered now while iron is at a low figure. It may however rise suddenly at any moment, in which case the above estimate may be pretty near the actual cost. During last December iron pipes such as you require were quoted in London at from £4. 17. 6., to £5. 0. 0., per ton of 2240 lbs., and if when you give your order they can be had at such low rates the saving effected will be about $4,000, as you require about 620 tons. In order to provide against possible contingencies it is safer to base the calculations upon the higher estimate which I have consequently done.

The subjoined table will give you the weights, cost and safe head of water for pipes of different sizes and thickness:

Diameter of pipe.	Thickness of metal.	Weight of one pipe 9 feet long.	Average weight of pipe per foot.	Cost of pipes delivered along line per foot.	Total cost per foot, including digging and laying with lead joints.	Total cost per foot, including digging and laying with wood joints.	Safe head of water.
in.	in.	lbs.	lbs.	$	$	$	feet.
4	3-8	160	18	.36	.62	——	600
6	3-8	230	26	.52	.84	.77	400
8	7-16	350	39	.78	1.13	1.05	350
9	7-16	394	44	.88	1.28	1.17	300
9	1-2	450	50	1.00	1.40	1.29	350
10	7-16	430	48	.95	1.38	1.27	250
10	1-2	500	56	1.12	1.54	1.43	300

From an inspection of the last column in this table it will be seen that as far as the head of water at your command is concerned you may safely use thin pipes provided there is the certainty that they are good castings of regular thickness throughout, as it is clear that the thinest portion of the casting limits its strength. The principal risk in using thin pipes is the danger of their being fractured in transhipment and removal to the trenches. The saving however effected by their use is so great that the breakage of a few of them would not be a matter of much importance. It is by no means an uncommon occurrence to find in cutting through a pipe supposed to be 5-8ths of an inch in thickness that one side is 7-8ths and the other 3-8ths thick, sometimes the difference is even greater in pipes which until cut were supposed to be perfect in section, as they had withstood for years high pressures and the ordinary shocks to which in practice nearly all pipes are subjected.

The usual method of jointing water pipes is with molten lead which is afterwards caulked in solidly. Each joint will take about the following weight of lead:

Diameter of pipe, 4 in., 6 in., 8 in., 9 in., 10 in.
Weight of lead per joint, 4 lbs., 9 lbs., 10 lbs., 14 lbs., 15 lbs.

This makes a good and safe joint when well done, it is however expensive and there is always the risk of careless workmen allowing the lead to run through the joint and into the pipe thus obstructing the flow of water. A few weeks ago when engaged in scraping out a 6-inch main supplying Mount Hope Lunatic Asylum with water, a large number of obstructions of this kind were found, and in one case so much lead had been allowed to run past the joint that the main was about half filled up. A piece of about 30 lbs. weight was also recently taken out of a 15-inch main in this city.

Wooden joints have been in common use in this city for more than 30 years and where the work has been faithfully done they have stood well and are as tight and perfect now as when first executed. There have been however a very great number of failures and old joints are even now sometimes blown out. As the pressure in your pipes will not be excessive such joints will answer the purpose if you can get good and faithful workmen to do the work. They will not answer at all if the work is done by contract as it is sure to be slighted in that case. The best method and the one which I would recommend is the use of "turned and bored" joints: they are superior to either of the others, and are cheaper than the ordinary lead joints. The cost on the whole of your works will not probably exceed $500 more than if the wooden joints are used, whereas the cost of the leaden joints above the wooden ones would be about $2,500.

The entire length of your main by the direct route will be abont 17.800 feet, and by the accompanying plan the distribution pipes are arranged in the following manner:

Name of Street.	8-in. pipe Lgt. in ft	6-in. pipe Lgt. in ft.	4-in. pipe Lgt. in ft.
Streets in suburbs south of the town summit.		1,000	
King st..........	1,800		
Water st................	1.200	400	
Avon st		480	
Chestnut st		270	
Albert st.......		2,030	800
Stannus st		1.750	
Gerrish st...		1.820	
Victoria st..........		940	
Gray st......		1,250	550
Street to railway crossing		1,300	
Totals.	3,000	10,240	1,350

By this arrangement no fire hydrant will be supplied off a pipe of less than 6 inches diameter, to which it is advisable you should adhere.

I may be accused of extravaganes in making provision for such a comparatively large number of fire hydrants as are shown upon the plan, viz. 41, but I may remark that as the buildings are so scattered you need every one of them in order to be thoroughly protected against the ravages of fire. Each hydrant, represents an engine ready for use at a moment's notice, and if you should place fewer of them and at greater distances apart there might when needed be delay in getting sufficient length of hose to reach a building on fire, besides which there would be considerable loss of pressure from the friction of the water passing through long lengths of hose.

The following estimate of the cost is for a compound main of 10 and 9 inches diameter, it embraces the whole cost of the works, including all the distribution pipes and fire hydrants shown upon the plan and also the branch service pipes laid to the houses for their domestic supply.

ESTIMATES.

4.000 feet	of 10 inch pipe,	1-2 inch thick,	at	$1.43	$5,720
4,000 "	10 "	" 7-16 "	" "	1.27	5,080
5,000 "	9 "	" 1-2 "	" "	1.29	6,450
4.800 "	9 "	" 7-16 "	" "	1.17	5.616
3.000 "	8 "	" 7-16 "	" "	1.05	3.150
10.240 "	6 "	" 3-8 "	" "	.77	7.885
1,350 "	4 "	" 3-8 "	" "	.62	837

Analysis of the Water of Fall Brook.

SAMPLE FURNISHED BY THE TOWN COUNCIL OF WINDSOR.

Solid Constituents..................	0.35 grains in a gallon.
Free Ammonia......................	0 01 parts in a million.
Albuminoid Ammonia............	0.02 " " " "
Chlorine	Trace, but not, an appreciable amount.

There was no appreciable amount of suspendid mechanical impurities.

Of the solid constituents, 0.20 grains in a gallon consists of organ.c matter (almost entirely vegetable); and the remainder (0.15 grains in a gallon) is mineral matter. In this last small amount there were none (or no appreciable amounts) of the following: Sulphate of Lime; Carbonate of Lime; Salts of Magnesia: Chloride of Sodium; although there was of Silica and Silicates.

The sample of the water sent is discolored, being of a yellowish tint from the presence of vegetable matter, and this is its most conspicuous feature, excepting that of its purity.

In fact, it may be said to contain little else than rain water; even the amount of Chlorine, Ammonia, and Albuminoid Ammonia are less than is frequently found in newly fallen rain—the washings of the atmosphere.

The water is remarkably soft, owing to the absence (particularly) of Sulphate and Carbonate of Lime. For steam purposes it can be regarded as nearly pure,—incrustations in boilers occuring only after great lapse of time.

From the sanitary point of view, it may be stated that few towns are so fortunate as to be able to get a supply of water of such purity. Even the discoloration is of no importance, and would likely be lighter in summer.

River water generally contains several grains of solid matter in a gallon. Of many analyses seen, the purest that I have noted contained 0.2 grains of solid matter in a gallon. Fall Brook contains 0.35 grains in the same quantity, and may be placed amongst the purest of River Waters; especially, as the quantity of Albuminoid Ammonia is so small—for even if this very objectionable impurity were present to three times the present amount, it would still be classified amongst very pure potable waters.

It must be noted that the summer supply might not yield quite the same results to analysis. Yet if the water were likely to contain much foreign matter in summer, it would not have been found to be so pure as at present.

J. W. SPENCER, B. A. Sc., PH. D., F. G. S.
ANALYST.

King's College, Windsor, N. S., Dec. 16th, 1881.

41 hydrants, with branch pipes complete and set at..........	.65	2,665
Special castings and pipes of extra thickness in special places........................		500
Dam, allow...........................		1,500
Gate-house and screen-chambers, inlet and outlet to ditto, waste weir and bywash		1,500
Stopcocks, 1-10", 1-9", 2-8", 18-6", 3-4", 1 3", set......		662
Add for rock excavations, brook diversion small embankments and deep cutttings		1,500
Say 200 house service branch pipes at $9		1,800
Supertendence, engineering and contingencies..		3,135
Total probable cost of works complete......		$48,000

The foregoing is an estimate for the cheapest system which it would be advisable for you to adopt, and provides for jointing the pipes with wooden wedges.

The estimated cost of the entire works with a 10-inch main laid the whole way—as recommended—is $49,200, and with a 9 inch main $47,000. If "turned and bored" joints are adopted, as recommended, about $500 must be added to the estimates, and if lead joints are used add $2,500.

Arrangements have been made upon the plans for the insertion of "hatch boxes" at suitable places, so that your whole system of pipes can be readily cleaned out in after years in the event of their being corroded to any extent. This be done by putting scraping machines in the pipes at the "hatch boxes." These machines are propelled by the force of the water alone, and by providing "hatch boxes" as suggested, the cost of cleaning out the pipes at any time will be extremely small. A record of the correct positions of these openings in the pipes must, of course, be carefully kept.

With regard to cement pipes or pipes of wrought iron and cement I have only to say that I know of no engineer of eminence ever having recommended their use, or of any place of importance having adopted them for general use. With cast iron you are dealing with a well tried article and with a certainty, while with a combination of wrought iron and cement you are dealing with an uncertainty and consequently one which I cannot recommend.

Your obedient servant,

E. H. KEATING.

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