REPORT OF COMMITTEE

ON

WATER SUPPLY

OF THE

TOWN OF WAYLAND

APPOINTED AT

ANNUAL TOWN MEETING

MARCH 24, 1903

NATICK, MASS.,
PRESS OF NATICK BULLETIN
1903

BOARD OF HEALTH REPORT

Reply of the State Board of Health to an Application from Messrs. Henderson, Williams and Connelly for Advice in Relation to the Improvement of the Water Supply of Wayland, under the Provisions of Section 117 of Chapter 75, of the Revised Laws of Massachusetts.

COMMONWEALTH OF MASSACHUSETTS

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, April 27, 1903.

To Messrs. Walter B. Henderson, Chester B. Williams and John Connelly, Special Committee of the Town of Wayland.

GENTLEMEN:—The State Board of Health received from you on March 31 an application requesting the advice of the Board as to the improvement of the water supply of Wayland, in which you state that the town is planning to expend $2,000 in cleaning the present reservoir and removing mud from the bottom, and that you are considering the question of extending the present system to supply the centre of the town; and in response to your application the Board has caused the reservoir and its surroundings to be examined by its engineer and has considered the results of numerous analyses of the water of this source made recently and in past years.

It appears from the information available to the Board that water can be drawn at present either directly from the reservoir or from a filter gallery extending along the shore of the reservoir for a distance of about 400 feet, with two branches extending beneath the bottom of the reservoir.

The results of analyses show that the water of the reservoir is generally highly colored and contains frequently an excessive quantity of organic matter, and that it is often objectionable for drinking and other domestic purposes on account of a disagreeable taste and odor. The objectionable quality of the water of the reservoir is evidently due principally to the character of the reservoir, which is very shallow and contains much organic matter in its bottom.

The water of the filter gallery contains less organic matter than water taken directly from the reservoir, but this water, which is derived largely from the pond by filtration through the ground, is generally effected by an excessive quantity of iron, due to the imperfect filtration of the water, and by a disagreeable taste and odor which render it objectionable for domestic purposes.

The water of the filter gallery cannot probably be improved by any changes that it is practicable to make either in the reservoir or in the gallery itself. The waters of other filter galleries in the state which have been constructed, like this one, beneath, or in very close proximity to, the shores of the pond, stream or reservoir, have in all cases been found to be objectionable on account of the presence of an excessive quantity of iron, as in this case, and the only means of improving the water of the filter gallery, if it is to be continued in use, will be to filter it through sand in such a way as to remove the excessive quantity of iron.

The water of the reservoir can doubtless be considerably improved by a thorough cleaning of the bottom and the removal of all mud, stumps and other organic matter from the area covered by water and by the drainage of swamps on the watershed, but the cost of removing a sufficient portion of the organic matter in this reservoir to have a noticeable effect in improving the quality of the water would doubtless be very much greater, judging from the information available to the

Board, than the sum mentioned in your application.

It will be impossible to clean the reservoir without drawing out the water, and the flow of the brook above the reservoir would not be sufficient during the summer season to supply the village while the improvement was being made, so that a temporary supply from some other source would be necessary.

The Board has also considered the suggestion of extending the works so as to supply the central village of Wayland. It appears from such information as is available to the Board as to the capacity of your storage reservoir, the size of its water-shed and the quantity drawn from the source at present, that the capacity of this source in a very dry season is but little, if any, in excess of the quantity now being used by the village of Cochituate alone, and if the supply should be extended to the central village of Wayland it is likely that an additional quantity of water would soon be required from some other source to meet the requirements of the town in a dry season, especially since a considerable quantity of water is liable to be used from your present source for running the pumps to increase the pressure needed for fire purposes.

Considering the probability that the present source would soon prove insufficient for the supply of Wayland should the extension now proposed be made, and considering that, even if the reservoir should be thoroughly cleaned and the swamps on its water-shed drained, the quality of the water of this source would still be likely to be objectionable, the Board would advise that you make investigations of the feasibility and probable cost of obtaining a supply of ground water from some source in the neighborhood of the village. A good ground water supply would be far more satisfactory for all domestic purposes than the water of your present source, even after all the improvement practicable had been made therein, on account of the freedom of ground water at all times from color, taste and odor and its lower temperature in the summer season.

The Board would advise that, in making further investigations, you secure the assistance of an engineer of experience in

matters relating to water supplies, and when you have made further investigations the Board will, if you so request, give you further advice in this matter.

By order of the Board,

SAMUEL W. ABBOTT,
Secretary.

CIVIL ENGINEER'S REPORT

CAMBRIDGE, August 10, 1903.

FRANCIS SHAW, ESQ.,

Chairman Committee on Wayland Water Supply.

DEAR SIR:—Agreeably to your request of June 27, 1903, I have examined the water works system of the town of Wayland now supplying the village of Cochituate with water, and obtained such information relating thereto as was possible, and beg leave to report upon the four points referred to in my letter of June 22d, 1903, as follows:

First. "As to the present capacity of the works and any suggested means for increasing the supply."

In the report of the Engineer made at the time the works were constructed, dated March 1, 1879, the area of the water-shed contributing to the supply is given as 425 acres. In the absence of any other data I have used this figure in the calculations. For many years the City of Boston has kept accurate measurements of the amount of water actually flowing off from the water-sheds of the different sources of its water supply, the "yield" or "run off" as it is called. These measurements have now been continued so long as to be an excellent guide as to what yield or run off may be expected from a similar area in this vicinity.

It has been found, however, that as the area of the water-shed diminishes in size, the yield or run off per square mile diminishes, particularly in the dry months of the year. Observations on small areas of less than one square mile seem to

show that not over 75 percent of the Sudbury River yield can be expected on small areas.

It is also a well known fact that it is not the yield of a wet or even an average year which fixes the capacity of a supply, but the yield during the *dry season of the dryest year*, such seasons as, for instance, 1880, 1883 and 1899.

The size of the reservoir has also an important effect on the capacity of a works, as from it, in the dry season, may be drawn the surplus water stored during periods of rains. The total capacity of the reservoir is given in the report already referred to as 16,000,000 gallons. 12,000,000 gallons of this is contained in the upper five feet. Below this point it is not likely that the water would be suitable for use. Of this 12,000,000 also, over 3,000,000 gallons is contained in the basin above the filter dyke or dam which should be eliminated from the supply, as will be explained further on. This leaves the available storage as 9,000,000 gallons. A daily consumption of 120,000 gallons for a year like 1883 would exhaust this storage, and is about the measure of the capacity of the works at the present time. This would seem to be confirmed by the experience of the summer of 1899 when the reservoir was nearly emptied. This would provide for a consumption of 60 gallons daily per capita for a population of 2,000 people, as shown by table "A." The population of the town of Wayland is given in the Census reports for 1900 as 2,303 for that year, a large proportion of which is located in the village of Cochituate.

As to any means of increasing the supply from this source. This could only be done by raising the dam and so increasing the storage. The shores about the main or lower basins are, at its upper end, low and flat. The large spring on the land of Mr. Rice is only 1.70 feet above the present water level in the reservoir, and any increase in the height of the water would overflow areas of swampy land, making a condition of which too much already exists. If the upper basin were raised as is suggested further on, it is possible that at some seasons of the year this water might be fit for use, particularly during the dry time when the water is said to be at its best. If this should

prove to be the case it would increase the storage capacity about 5,000,000 gallons, or over 50 per cent., and would raise the capacity of the works to 150,000 daily, as is shown by the table "B."

Second. "As to the present quality of the supply and any suggested means for improving it."

An examination of the water-shed shows that the danger from general sewage contamination is very slight. While the chemical analyses show rather large quantities of "chlorine" and albuminoid ammonia," these cannot be due to sewage pollution. The only house from which danger might be likely to come is that of Mr. Fiske at the Reservoir. Great precaution should be taken here that in a case of typhoid fever or similar disease no contamination could possibly enter the water supply. The principal objection to the water seems to be its high color and at times disagreeable taste. The main cause of the high color and bad taste in the water seems to be the vegetable matter derived from the low swampy land through which some of the water has to pass. This is particularly true of the west brook discharging into the upper basin, which comes through a large swamp just before entering the basin. A recent analysis, made at my request by the State Board of Health, shows this water to be much higher in color than other water from points in the basin. See Table "D." If the basin were of size and depth sufficient to retain the water a good length of time, it would undoubtedly improve both in color and in quality by sedimentation and bleaching.

The water for consumption is drawn, not direct from the reservoir, but from a filter gallery in the ground below the bottom. It is a curious fact that this filter now seems to have lost its efficiency as, while in 1890 and 1891 it removed about one-half the color, since 1897 it seems to be removing but little, as is shown by the Table "C."

The present level of the water in the basin seems to be higher than was originally intended, as the overflow at the wasteway is raised some six or eight inches. While this increases the amount of water held in storage, it also increases the amount of shallow flowed land on the margin of the basin and also places the water level dangerously near the top of the dam. *The level of the water should be restored to its original height, and the low muddy shores at the upper end of the main basin improved by excavating the mud and raising the shores, facing the slopes with clean gravel.*

Two methods of improving the quality of the water coming from the west brook are feasible. The dyke now partially separating the upper from the main basin could be finished so as to completely prevent the water in this basin reaching the lower or main basin. The swamp through which the water comes to the basin could then be improved by carrying a drainage ditch along on the edge of the swamp near the margin of the hard land. The purpose of this ditch would be to intercept the water flowing from the upland on to the swamp and carry it directly to the basin, not allowing it to stand on the swamp and obtain its high color and large amount of vegetable impurities as it does at present. A considerable improvement in the quality of the water should follow this treatment. A new ditch connecting this brook, before it enters the basin, with the brook now entering the main basin near the highway could then be dug and the water turned directly into it, eliminating thus the shallow upper basin from the supply entirely.

Or, the dyke could be completed and made higher so as to raise the water in the upper basin about three feet, increasing by this the storage capacity about 5,000,000 gallons, and the depth of water three feet. From this dyke or dam a pipe 14 inches in diameter could be laid along the bottom of the reservoir through the main dam and discharging below into the wasteway. Through this pipe the water of the upper basin could be discharged below the dam, or if at certain seasons of the year it should be found desirable and fit, it could be turned into the lower basin and used. This would probably occur during the summer, when the need would be greatest Also a connection could be made at the lower end with the pipe supplying water to the turbine water wheel used to increase the

water pressure for fire purposes, and the inferior water used for power, saving that of better quality for domestic use.

The heavy foliage and brush should all be cut away from the shore line for a distance of at least 50 feet, so that leaves and vegetable matter may not be carried into the basin.

Third. "As to any other source of supply."

From what has been said in the first section of this report it seems plain that the capacity of the works, as now constructed, has been reached. The increased storage capacity provided by the carrying out of this plan would augment the daily capacity of the works and so prolong its life, as shown by Table "B."

There are other available sources of supply within the town which could undoubtedly be made use of; such as water from Cochituate Lake, from wells near Sudbury River, from some brook, or perhaps from the aqueduct of the Metropolitan Water Supply. The disadvantage of all these sources is that the water would have to be pumped to a reservoir, and so, of course, the annual cost of operation and maintenance would be higher than if it were obtained by gravity, as is now done. While the present works cannot be expected to yield in a dry year but about 120,000 gallons daily in the dry season, it should be remembered that this occurs but seldom and is continued for only a few months. During the rest of the time the supply should be ample for many years. For this reason it would seem to be best to supplement the present supply with an auxiliary supply to be used only as occasion may demand. This can very readily be done by installing at or near Lake Cochituate a pumping plant, to be driven by an electric motor or gasolene engine, and pumping into the present piping system, letting the surplus water pumped flow into the Reservoir. This water can readily be obtained direct from the lake or from driven wells on the margin, it being understood that the town now has the right to take water from this source. Such a plant has been found inexpensive to install, economical to operate, and suffers little from depreciation due to intermittent running.

Fourth. "As to any extension of the distribution system to the centre of the town so as to supply takers there."

Under the present conditions of quality and capacity of supply, any considerable extension of the distribution system, and so increase in consumption of water, could not be recommended. If, however, an auxiliary supply is provided, as has already been suggested, there is no reason why the system could not be carried to the centre of the town, a distance of about three miles from the present pipes. I have been unable to obtain a plan or profile of the highway connecting the two localities but there seems to be no physical difficulty in obtaining a feasible route on which to lay a main pipe to supply the inhabitants of the centre of the town. When this is done the pipe laid should be of ample size, as it has generally been found that the demand for a town water exceeds the first expectation, even if the rates are somewhat high.

RECOMMENDATIONS.

My recommendations for work to be undertaken at once are as follows.

First. That the filter dam or dyke now extending nearly across the basin be raised and extended so as to hold the water in the upper basin three feet higher than at present. [This will necessitate the construction of a short marginal dyke so that the water will not flow on to the land of Mr. Francis Shaw] *or what would be better still, the raising of his roadway to take the place of the dyke.*

Second. That a pipe 14 inches in diameter be laid from this dyke to and through the main dam to carry the water from the upper basin either into the lower basin or below it at will.

Third. That the shallow flowage at the upper end of the lower basin be improved by excavating from the bottom and sides and raising the shores.

Fourth. That the shores and margin of the reservoir be stripped, and kept free, of all brush, trees and foliage, for a distance of 50 feet from the water line if possible.

These several improvements are shown upon a plan which accompanies this report.

An approximate estimate of the cost of the work here recommended is as follows:

Approximate Estimate

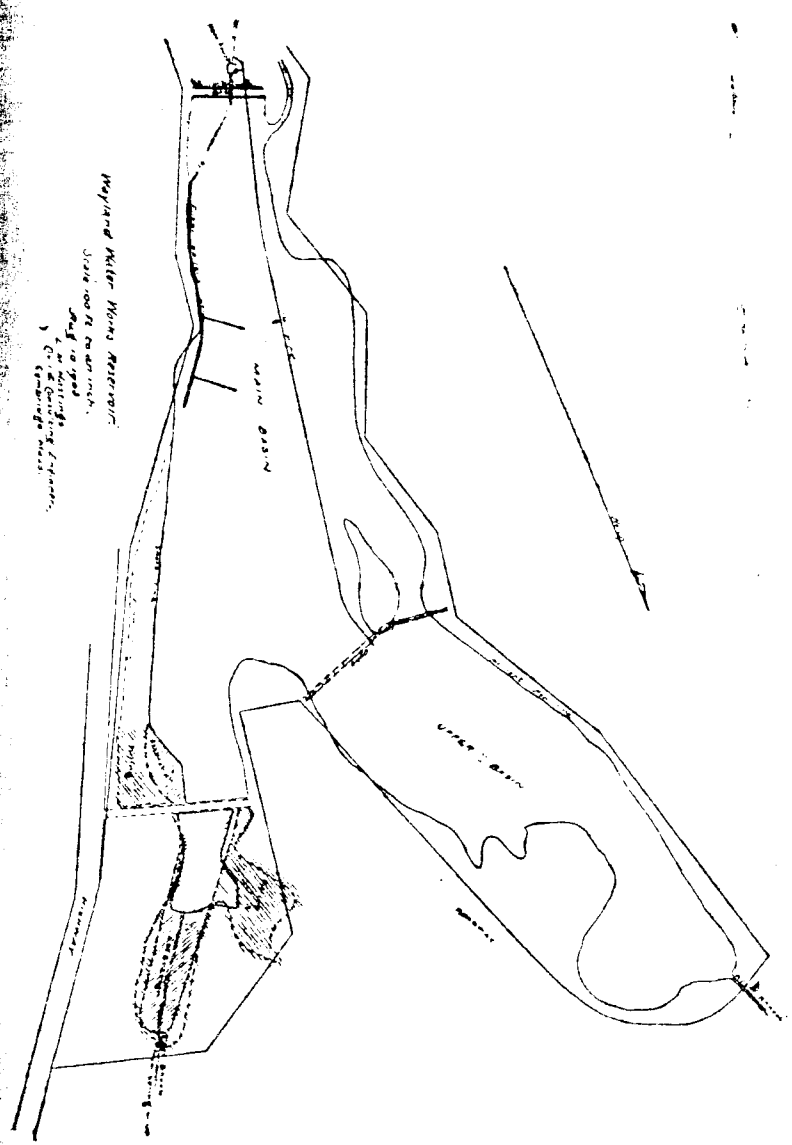
Raising and enlarging dyke	$650 00
Raising roadway in Mr. Shaw's land	300 00
Clearing 3 acres land of wood at upper end basin	300 00
14-inch cast iron pipe from dyke to below main dam about 1050 feet long with gates and fittings	2500 00
Excavating about 2500 cubic yards at upper end of main basin	750 00
	$4500 00
Add for contingencies 10 per cent.	450 00
Total	$4950 00

If it is not thought best to connect the 14-inch pipe with the turbine water-wheel in the gate house a saving of about $300 could be made on the above estimate. The usefulness of this connection will depend upon the number of fires which occur and the consequent amount of water used for power.

Very respectfully,

L. M. HASTINGS,

Civil and Consulting Engineer.



"A"

Showing present capacity of works

	Expected yield 2-3 Sq. mile at 75 percent Sudbury River yield of 1883	Daily consumption Gallons	Daily draft on storage	Monthly draft on storage
Jan.	67,500	120,000		
Feb.	516,500	"		
Mar.	805,500	"		
April	675,000	"		
May	469,000	"		
June	150,000	"		
July	57,500	"	62,500	1,937,000
Aug.	39,000	"	81,000	2,511,000
Sept.	45,500	"	74,500	2,145,000
Oct.	93,000	"	27,000	837,000
Nov.	102,500	"	17,500	525,000
Dec.	96,500	"	23,500	728,000

Total draft on storage, . 8,684,000

12,400,000 gals. in Res. to 5 feet below full basin

3,400,000 " in upper basin

9,000,000 " in lower basin available

"B"

Showing capacity if upper basin is raised 3 feet

	Daily consumption	Daily draft on storage	Monthly draft on storage
Jan.	150,000		
Feb.	"		
Mar.	"		
April	"		
May	"		
June	"		
July	"	92,500	2,872,500
Aug.	"	111,000	3,441,000
Sept.	"	104,500	3,135,000
Oct.	"	57,000	1,767,000
Nov.	"	47,500	1,425,000
Dec.	"	53,500	1,658,500

14,299,000

9,000,000 gals. in lower basin

5,000,000 g'ls. { in up'r basin if dyke is raised 3 feet

14,000,000

FROM ANALYSES BY STATE BOARD OF HEALTH.

"C"

Comparison of Color

	Reservoir	Filter Gallery
1890	0.98	0.42
1891	0.68	0.37
1892		0.26
1896		0.33
1897	0.79	0.74
1898	0.95	0.83
1899	0.45	0.39
1900	0.69	0.68
1901	0.92	0.92
1902		0.80

"D"

	Color	Residue	Free Ammonia	Albuminoid Ammonia	Chlorin	Oxygen Consumed	
1891	.84	4.40	.0048	.0280	.23	.98	Reservoir at Wasteway
1892	.90	5.60	.0068	.0292	.29	1.04	E. Brook
1896	1.36	5.05	.0080	.0356	.24	1.42	Upper Basin
1897	1.72	5.95	.0084	.328	.27	1.72	W. Brook
1899	0.03	6.18	.0002	.0045	.43	.07	Newton*
1900	0.02	4.23	.0041	.0631	.25	.07	Lowell*
1901	0.42	5.78	.0030	.0221	.45	.61	Cambridge

*These two waters are from under ground supplies.