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THIRTY-THIRD ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

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1902.

MEMBERS OF THE BOARD.

1901–1902.

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GERARD C. TOBEY, Esq., ... of WAREHAM.
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Chemist.
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Consulting Chemist.
THOMAS M. DROWN, M.D.

Public Health
Gift
Henry F. Vaughan
4-4-44

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GENERAL REPORT.

The following report comprises the general work of the State Board of Health for the year ended Sept. 30, 1901, together with its operations under the food and drug acts for the same period, and under the acts relating to water supply and sewerage during the calendar year 1901.

The first part, paged in Roman numerals, contains a condensed account of the work done under the laws defining the duties of the Board.

The regular work of the Board is performed mainly under the provisions of three separate acts, — an organic act of 1869, establishing the Board; an act of 1882, providing for the inspection of food and drugs; and an act for the protection of the purity of inland waters, of 1886, together with the amendments of these acts, all of which have been embodied in chapter 75 of the Revised Laws of Massachusetts, enacted in 1901.

The second part of this report, paged in Arabic figures, presents the fuller details of the work of the Board under the acts above referred to.

The following members comprised the Board in 1901: —

HENRY P. WALCOTT, *Chairman.*

FRANK W. DRAPER.	GERARD C. TOBEY.
HIRAM F. MILLS.	CHARLES H. PORTER.
JAMES W. HULL.	JULIAN A. MEAD.

No changes have taken place in the membership of the Board in 1901.

GENERAL HEALTH OF THE STATE IN 1901.

From the returns received from local boards of health for the year 1901 it appears that the death-rate of the State during the past year was the lowest ever recorded. The deaths numbered 48,275, and the death-rate upon an estimated population of 2,870,710 was only 16.82 per thousand. The lowest death-rate in any previous year of the past half century was 17 per 1,000 in 1867, and the next lowest was 17.33 in 1859. It is very gratifying to know that, while density of population is one of the chief conditions usually considered as contributing to an increased death-rate, the death-rate of the State has not increased during the past twenty-five years, although the density of the population has nearly doubled in that time.

The following figures are presented for the ten years ended with 1901: —

Massachusetts.

Years.	Population.	Deaths.	Death-rates.	Years.	Population.	Deaths.	Death-rates.
1892, ...	2,339,998	48,762	20.84	1897, ...	2,618,061	47,419	18.11
1893, ...	2,392,216	49,084	20.52	1898, ...	2,679,049	46,761	17.46
1894, ...	2,445,604	46,791	19.14	1899, ...	2,741,470	47,710	17.40
1895, ...	2,500,183	47,540	19.01	1900, ...	2,805,346	51,156	18.24
1896, ...	2,558,443	49,381	19.30	1901, ...	2,870,710	49,275	16.82

In addition to the causes named on the following pages another factor, not of a sanitary character, probably has contributed to the lowering of the death-rate, and that is the increased immigration of the past few years. The death-rate at different ages of life differs very much, that of infants and young children being very high, that of young adults being low, and that of old people again being excessive, so that the addition of large numbers of people to the population at either of these ages has a decided effect upon the general death-rate. By reference to our report of 1894 (Twenty-sixth Annual Report, p. lv., note) it appears that the immigrants added to our population were of the following ages: —

Less than fifteen years of age, ...	22.0 per cent.
From fifteen to forty years of age, ...	67.8 per cent.
All over forty years of age, ...	10.2 per cent.
Total, ...	100.0

This great preponderance (more than two-thirds of the entire immigration) being constituted of persons of young and healthy ages, has a tendency to lower the general death-rate, independently of sanitary conditions. In the course of years, however, as these persons, fifteen to forty years of age, arrive at much older ages, the death-rate may be expected to slowly rise again.

Infectious Diseases.

The death-rate from the principal infectious diseases was generally less than that of 1900. The number of deaths from each of several infectious diseases and from cancer for the five years 1897–1901, together with the death-rate, is shown in the following table, by which it appears that there was an increase in the deaths and death-rates from small-pox, cholera infantum and cancer, and a decrease in the deaths and death-rates from diphtheria, scarlet fever, typhoid fever, measles, consumption, dysentery, whooping-cough, pneumonia and cerebro-spinal meningitis, as compared with those of the previous year.

Deaths and Death-rates from Certain Diseases in Massachusetts, 1897–1901.

	1897.		1898.		1899.		1900.		1901.	
	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.	Deaths.	Death-rates per 10,000.
Small-pox,	4	.015	-	-	14	.05	3	.011	97	.34
Diphtheria and croup,	1,426	5.45	706	2.64	1,047	3.82	1,475	5.26	1,166	4.06
Scarlet fever,	342	1.31	141	.53	235	.86	391	1.39	385	1.34
Typhoid fever,	607	2.32	663	2.47	612	2.23	632	2.25	561	1.95
Measles,	158	.60	82	.31	241	.88	330	1.18	173	.60
Cholera infantum,	2,231	8.52	2,320	8.66	1,964	7.16	2,393	8.53	2,705	9.43
Consumption,	5,431	20.75	5,288	19.74	5,221	19.05	5,199	18.53	5,033	17.54
Dysentery,	209	.80	293	1.09	268	.98	257	.92	223	.78
Whooping-cough,	171	.65	337	1.26	338	1.23	337	1.20	210	.73
Pneumonia,	4,796	18.32	4,206	15.70	4,993	18.21	5,282	18.83	4,772	16.62
Cancer,	1,739	6.64	1,907	7.12	1,838	6.70	1,998	7.12	2,080	7.25
Cerebro-spinal meningitis,	355	1.36	259	.97	240	.88	198	.71	177	.62

The State has been for many years free from great epidemics of infectious diseases, such as are fatal to large numbers of the population. The principal epidemic years in the past century were 1849 and 1872, in each of which the death-rate rose from an average of a little more than 19 per thousand inhabitants to about 22.8 per 1,000, in consequence of an unusual prevalence of several infectious diseases at once.

In the following table a balance is shown between the principal infectious diseases of the past two years: —

Deaths from Certain Infectious Diseases in 1900 and 1901.

DISEASES.	1900.	1901.	Increase.	Decrease.
Small-pox,	3	97	94	-
Diphtheria and croup,	1,475	1,166	-	309
Scarlet fever,	391	385	-	6
Typhoid fever,	632	561	-	71
Measles,	330	173	-	157
Cholera infantum,	2,393	2,705	312	-
Consumption,	5,199	5,033	-	166
Dysentery,	257	223	-	34
Whooping-cough,	337	210	-	127
Pneumonia,	5,282	4,772	-	510
Cerebro-spinal meningitis,	198	177	-	21
Totals,	16,497	15,502	406	1,401

Difference, 995.

By this table it appears that the sum of the deaths from these eleven principal infectious diseases in 1901 was less by 995 than those of the previous year from the same causes.

The improvement in the death-rate from infectious diseases is of much greater importance than the loss resulting from the increase in the death-rate from such diseases as cancer, and the diseases of the heart, kidneys and brain, when the figures of 1901 are compared with those of any of the early years of the last half-century, because the lives saved are more valuable than the lives lost, those of the former class being chiefly of the young who are just entering upon the useful period of life, while the latter are mostly those of old people who have passed that period.

Small-pox.

The number of deaths from small-pox officially registered in the cities and towns was 97 (or, as returned to the State Board of Health, 101), a number comparatively insignificant when compared with the deaths from consumption, pneumonia or cholera infantum, from each of which causes the deaths annually amount to several thousand. Even these deaths might have been prevented had the usual precautions been taken in regard to vaccination.

During the year 1901 small-pox, which had been mildly prevalent in the preceding year, increased, until the close of the year it was prevailing to a greater extent than at any time since the great epidemic of 1872–73.

The causes of this increased prevalence are attributable partly to its continuance with increased severity in other States having direct communication with Massachusetts, partly to the continued arrival of immigrants from foreign countries, of whom the number coming to Massachusetts in 1901 was very large, and chiefly to the general neglect of vaccination throughout the State. Another factor consisted in the greatly increased facilities for transportation from one town to another and from one State to another, as compared with that of previous years.

The number of reported cases by months in Massachusetts in 1901 was as follows: —

In January,	6	In August,	15
In February,	4	In September,	32
In March,	6	In October,	56
In April,	9	In November,	235
In May,	45	In December,	274
In June,	70		
In July,	26	Total,	778

These cases were distributed in 62 cities and towns, as follows: —

Boston,	514	Newton,	4
New Bedford,	38	Tewksbury,	4
Fall River,	22	Palmer,	4
Cambridge,	15	Brookline,	3
Leominster,	13	Dighton,	3
Lowell,	12	Westfield,	3
Worcester,	11	Dedham,	3
Fitchburg,	9	Southbridge,	3
Raynham,	9	West Boylston,	3
Hyde Park,	8	Scituate,	3
Quincy,	6	North Brookfield,	3
Gloucester,	5	Springfield,	2
Medford,	5	Holyoke,	2
Lynn,	5	Marlborough,	2
Adams,	5	Everett,	2
Wakefield,	5	Belmont,	2
Lawrence,	4	Townsend,	2
Somerville,	4	Brockton,	2
Chelsea,	4	Methuen,	2
Malden,	4	Manchester,	2
Braintree,	4	Avon,	2

Huntington,	1	Milton,	1
Dalton,	1	Framingham,	1
Russell,	1	Woburn,	1
Waltham,	1	Plymouth,	1
Franklin,	1	Athol,	1
Enfield,	1	Lee,	1
Cottage City,	1	Westminster,	1
Pepperell,	1	Salem,	1
Concord,	1	Abington,	1
Gardner,	1		
Oxford,	1	Total,	778

It is a noteworthy fact that each one of the places named in the foregoing list is either upon one of the principal lines of railway communication of the State or upon one of the branches of the same.

Nationality. — The nationality of the persons attacked in 1901 was as follows: —

Natives of the United States,	380	West Indies,	3
British Provinces,	146	Other Sea Islands,	2
French Canadians,	36	Russians,	3
Irish,	101	Germans,	3
Portuguese,	40	Negroes,	3
English,	21	Italians,	1
French,	13	Dutch,	1
Scotch,	8	Unknown,	5
Swedes,	7		
Norwegians,	5	Total,	778

Occupations. — The principal occupations of those who were attacked were as follows: —

Housewives,	95	School children, five to 15 years old:	
Laborers,	56	Vaccinated,	16
Factory operatives,	34	Unvaccinated,	76
Clerks and salesmen,	27	Not stated,	1
House servants,	23	Longshoresmen,	9
Teamsters,	21	Housekeepers,	8
Newly arrived immigrants taken ill within 48 hours after arrival,	20	Laundry workers:	
		Vaccinated,	3
Carpenters,	19	Unvaccinated,	5
Mechanics,	13	Railway employees,	7
Waiters,	11	Farmers,	7
Metal workers,	11	Hostlers,	7
Shoemakers,	10	Plumbers,	6
Dressmakers,	6	Mariners,	6
Engineers,	6	Nurses,	6

Physicians,	5	Actors,	2
Book-keepers,	5	Milkmen,	2
Painters,	5	Car cleaners,	2
Masons,	5	Clergymen,	2
Stonecutters,	5	Manufacturers,	2
Cooks,	5	Fishermen,	2
Blacksmiths,	3	Agents,	2
Errand boys,	3	Expressmen,	2
Woodchoppers,	2	Icemen,	2
Paper mill operatives,	2	Stenographers,	2
Telegraph operators,	2	Hotel servants,	2

and one each of persons engaged in 34 other occupations.

A notable incident of this epidemic was the occurrence of small-pox among 8 laundry workers, an occupation which appears to be unusually exposed to this disease, as might be expected from the character of the work. A similar experience was noted in London at the beginning of the present outbreak of small-pox in that city.

The number of paper mill operatives attacked in Massachusetts in the epidemic of 1901–1902 was much smaller than it was in previous epidemics, probably on account of the greater care taken by the mill authorities to carry out the provisions of the acts relating to the vaccination of operatives.

Of the whole number of cases reported in 1901, 358 had been vaccinated at some time in their lives, 407 were unvaccinated, and the facts in regard to 13 were not stated. It was also stated that 251 adults out of the whole number had not been vaccinated since infancy or childhood.

Summary of Several Years.

The following table presents the number of cases of small-pox reported to the State Board of Health from 1883 to 1901 inclusive, together with the deaths from the same: —

Years.	Cases.	Deaths.	Years.	Cases.	Deaths.
1883,	21	5	1895,	1	-
1884,	9	3	1896,	5	-
1885,	32	19	1897,	18	4
1886,	2	-	1898,	12	-
1887,	13	3	1899,	105	14
1888,	32	9	1900,	104	3
1889,	15	6	1901,	778	101
1890,	6	1			
1891,	5	3	Total,	1,407	215
1892,	19	2			
1893,	45	9	Fatality, 15.3 per cent.		
1894,	185	33			

The foregoing table illustrates the extreme irregularity in the prevalence of the disease, the reported cases in each year varying from 1 to 778, and the deaths from 0 to 101.

Sex. — The record of the distribution of the sexes of cases of small-pox has been kept from 1885 to the present year, and shows that the number of males attacked was 750 and that of females was 571, or in the ratio of 132 males to 100 females.

Fatality. — The whole number of cases reported since 1883 was 1,407, and the deaths were 215, or 15.3 per cent.

Condition as to Vaccination. — Of 1,329 reported cases which occurred since and including 1888, 589 were vaccinated, and of these there were 53 deaths; 682 were unvaccinated, and of these there were 112 deaths. In 58 cases the facts in regard to vaccination were not stated, and of these there were 9 deaths.

Ages. — The age of persons reported as ill with small-pox is a matter of much significance when considered with reference to the fatality of the disease, and the existing conditions of the persons attacked with reference to vaccination.

The record of the age incidence of the disease, as it has occurred in Massachusetts, has been kept since 1888, and is shown in the following table: —

Small-pox in Massachusetts, by Ages, and with Reference to Vaccination, 1888-1901.

Ages.	Vaccinated.		Unvaccinated.		Unknown.		Total.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Under 1 year,	1	-	52	15	2	-	55	15
1 to 5 years,	19	-	163	18	2	-	184	18
5 to 10 years,	16	-	78	4	6	-	100	4
10 to 15 years,	29	-	31	-	2	-	62	-
15 to 20 years,	49	3	80	11	6	2	135	16
20 to 30 years,	190	13	166	31	18	5	374	49
30 to 40 years,	144	21	71	22	4	1	219	44
40 to 50 years,	89	11	26	7	5	-	120	18
Over 50 years,	47	5	11	4	3	1	61	10
Age unknown,	5	-	4	-	10	-	19	-
	589	53	682	112	58	9	1,329	174

The following significant facts may be noted in this table: only one vaccinated child under one year of age appears to have been attacked with small-pox, and this child survived, while there were 52 attacks of unvaccinated infants under one year old, and of these 15 died, or 29 per cent.

Among vaccinated persons under fifteen years of age there were 65 attacks and *no* deaths. Among unvaccinated persons under fifteen years old there were 324 attacks and 37 deaths.

Among vaccinated adults over fifteen years of age there were 519 attacks and 53 deaths, or 10.2 per cent. Among unvaccinated adults over fifteen years old there were 354 attacks and 75 deaths, or 21.2 per cent.

It is also a noteworthy fact that 162 school children, or children of school ages (five to fifteen years), were attacked during these fourteen years, and of this number 109, or about two-thirds, were unvaccinated. There were only 4 deaths out of this whole number, since this is the period of life when the power to resist fatal attacks of disease is greatest. All of these 4 who died were unvaccinated.

Out of the 589 who were recorded as having been vaccinated, it was recorded in the returns that 375, or nearly 65 per cent., had been vaccinated in childhood or infancy only, and when the carefully recorded statistics of other countries are considered, it may reasonably be presumed that the 53 deaths of adults recorded as "vaccinated" occurred among this class.

Further information relative to the investigations of the Board in regard to the prevalence of small-pox in the different cities and towns of the State may be found in the latter part of this report, in the portion entitled "Health of Towns."

The Production of Vaccine Lymph. — The existence of an epidemic of small-pox in Massachusetts, of greater proportions than any which has occurred since that of 1872–73, calls for special consideration of the vaccine supply of the State and its method of production. This serious invasion of the State by a disease which is preventable has brought to notice certain radical defects in the supply of vaccine lymph to cities and towns for which a remedy should be provided.

The present supply is obtained from many different sources, both in the State and also from outside the State, principally from the latter. In many instances it has been obtained through the medium of agents, middlemen, or wholesale dealers, in some instances passing through several different hands before it reaches the city or town authorities requiring it for use. Hence it is subject to the invariable delays which attend this method of supply. Delay beyond certain limits allows the product to become more or less inert and finally absolutely worthless, since all vaccine lymph deteriorates with age.

Again, the commercial producers of vaccine lymph are in the habit of labelling or branding their products with a date, usually some weeks or months in advance of the date upon which it is delivered by them to the purchaser, this date being presumably a time after which, in their opinion, it will no longer be proper to use the lymph. *The date when the lymph was produced is not made known to the purchaser.* This practice furnishes an opportunity for fraud.

Investigations of vaccine plants, in the State and out of it, show that many of these establishments are not conducted upon principles conformable to the progress of medical science, and cannot be depended upon to furnish a product uniformly reliable and in sufficient quantities to meet the demands which are sure to arise during epidemics of small-pox.

Vaccine lymph deteriorates with time and becomes inert, consequently it is important that its age should be known to the physician who uses it. All of these conditions can be best fulfilled by producing it within the limits of the State and under State control, in the same manner that has been employed in the production of antitoxin during the past seven years. Of this product over 150,000 packages have been made and distributed through the agency of local boards of health, to the entire satisfaction of the people and with the result of great saving of life. In the interest of economy and efficiency, therefore, it is desirable that both these products should be made and distributed under the supervision of a single authority.

The work of producing vaccine lymph in other countries where the most successful results have been obtained is conducted under government supervision and under competent medical authority. In Germany, where small-pox is practically unknown at the present day, there are at present twenty-two vaccine establishments under the supervision of the general board of health of the empire, producing the lymph for a nation of about fifty millions, an amount sufficient for the vaccination and revaccination of about three million people being produced each year.

In England, a recent commission, after visiting the German establishments, has recommended a similar plan, which is now being carried out.

Diphtheria.

The fluctuations in the yearly prevalence of diphtheria are manifest in various ways beside the annual roll of deaths from this cause. The variable demand for antitoxin (nearly all of that which is used in the State being produced by the State Board of Health) constitutes an index of the prevalence of this disease. The constant succession of requests for culture outfits for determining the character of the disease is another, while the reports of infectious diseases required by the provisions of section 52, chapter 75, Revised Laws, afford further information to the Board as to the prevalence of this disease. From all these sources of information it appears that the death-rate from diphtheria in 1901 had fallen considerably below that of the preceding year, and was but little more than that of 1899. Further information relative to this disease may be found in that portion of the report which relates to the production and use of antitoxin page 483.

Typhoid Fever.

Typhoid fever has for a long series of years shown a gradual and steady diminution in its prevalence, so far as can be determined from the annual number of deaths from this disease.

Wide-spread epidemics from this cause are now practically unknown in Massachusetts since the general introduction of public water supplies, and the epidemics which occur are mostly of a limited character, usually occurring in the autumn, and are traceable in most instances to local causes.

In the last annual report, tables were presented showing the death-rates of the thirty-three cities from this disease by five-year periods for a series of thirty years, in which there had been a fairly uniform decrease since 1871.

The following table presents the death-rates from this cause for 1901 in each city, by which it appears that the mean death-rate of the thirty-three cities was but little more than one-fourth as great as that of the same cities in the five years 1871–75.

Deaths and Death-rates from Typhoid Fever in the Cities of Massachusetts, 1901.

Cities.	Deaths from Typhoid Fever.	Death-rate from Typhoid Fever per 10,000.	Cities.	Deaths from Typhoid Fever.	Death-rate from Typhoid Fever per 10,000.	Cities.	Deaths from Typhoid Fever.	Death-rate from Typhoid Fever per 10,000.
Newburyport,	6	4.1	Fitchburg,	7	2.1	Lynn,	10	1.4
Pittsfield,	8	3.6	Worcester,	26	2.1	Brockton,	6	1.4
New Bedford,	19	3.0	North Adams,	5	2.0	Cambridge,	10	1.1
Haverhill,	10	2.6	Chelsea,	7	2.0	Quincy,	2	0.8
Northampton,	5	2.6	Somerville,	12	1.9	Everett,	2	0.8
Malden,	9	2.6	Taunton,	6	1.9	Beverly,	1	0.7
Chicopee,	5	2.5	Lowell,	18	1.9	Medford,	1	0.5
Boston,	142	2.5	Fall River,	21	1.9	Woburn,	-	-
Salem,	9	2.5	Lawrence,	12	1.8	Marlborough,	-	-
Melrose,	3	2.3	Newton,	6	1.7			
Springfield,	16	2.1	Gloucester,	4	1.6	Total,	400	2.07
Waltham,	5	2.1	Holyoke,	7	1.5			

In two of these cities, Woburn and Marlborough, there were no deaths from this cause, and there was only one each in Beverly and in Medford, while these four cities, with only half their present population, had altogether 82 deaths from this cause in the five years 1871–75.

The total number of deaths from typhoid fever in the thirty-three cities in the thirty-one years, 1871–1901, was 16,698.

The mean death-rates from this cause in these cities were as follows: —

Death-rates per 10,000, 1871–1901.

1871–75,	8.2	1891–95,	3.4
1876–80,	4.2	1896–1900,	2.6
1881–85,	5.1	1901,	2.07*
1886–90,	4.6		

* For the whole State the death-rate from typhoid fever in 1901 was only 1.95 per 10,000.

In the State at large the entire number of deaths from typhoid fever in 1901 was only 561, this being the smallest number ever registered in the State in a single year from this cause since the beginning of registration in 1842.

Consumption.

Another factor in the decline in the general death-rate is the steady and uniform decrease which has been observed throughout the past half-century in the mortality from consumption.

The death-rate from this cause has declined from 42.7 per 10,000 of the population in 1853 to only 17.5 in 1901, a decrease of more than one-half in forty-eight years. The deaths from this cause in 1901 were 5,033, while those of 1872 were 5,556, when the population of the State was but little more than half as large as it is at present. Undoubtedly this decrease in later years is partially due to the wide diffusion of popular information upon the subject, together with the fact that sanitary organizations, both public and private, have turned their attention to the importance of preventing the spread of consumption. The provision of sanatoria for the reception of persons suffering with this disease is also proving to be an efficient means of separating the sick from the well, and thus of removing a fruitful source of infection.

The following table presents the death-rate from consumption in Massachusetts for the first ten years and the last ten years of the past half-century: —

Death-rates from Consumption in Massachusetts per 10,000 Inhabitants.

Two Ten-year Periods.

Years.	Ten Years, 1852-61. Death-rates from Consumption.	Years.	Ten Years, 1892-1901. Death-rates from Consumption.
1852,	39.7	1892,	24.5
1853,	42.7	1893,	23.1
1854,	41.8	1894,	22.3
1855,	41.9	1895,	21.9
1856,	40.8	1896,	21.7
1857,	39.5	1897,	20.8
1858,	38.4	1898,	19.7
1859,	38.9	1899,	19.0
1860,	37.0	1900,	18.5
1861,	36.5	1901,	17.5

Food and Drug Inspection.

The work in this department has progressed throughout the year without interruption, the appropriation for the work and the force employed having been the same as that of the past ten years. The principal items of interest during the year have been an unusual prevalence of adulteration of cider vinegar, in consequence of scarcity of apples. This circumstance led to the introduction from other States of considerable quantities of spurious vinegar, not the pure and legitimate product of apple juice. Other forms of adulteration which have largely increased during the past few years have been the objects of special attention, and are mentioned in that portion of this report which relates to food and drug inspection.

The work of inspection relates to two forms of adulteration, primarily, those which are injurious to health, and secondly, those which are commercial frauds. The former class is comparatively small in numbers and embraces mainly a few articles of food and drugs which are occasionally subject to contamination in consequence of the presence of metallic poisons, and milk which is constantly liable to systematic robbing of its nutritious constituents.

The presence of arsenic in certain drugs has been the subject of careful examination, as in previous years, with the result of marked improvement.

The total number of articles examined by the analyst during the year was 10,325, and the number of prosecutions conducted was 95, of which 90 resulted in conviction. Of these, 65 were for sales of adulterated milk and the remainder were for sales of other kinds of food found to be adulterated.

A full account of the work of the Board in this department may be found at page 423.

Offensive Trades.

During the past year only one case has been referred to the State Board of Health under the provisions of the offensive trades act (chapter 75, section 91, Revised Laws). This was upon the petition of citizens of East Boston and Chelsea, for action in regard to alleged nuisance caused by the New England Gas and Coke Company, situated in Everett near the Mystic River.

The Board investigated the matter and found that there was cause for such complaint. A conference was held with the New England Gas and Coke Company for the purpose of ascertaining whether it was practicable to remedy the nuisance and cause of complaint. At this conference the manager of the company appeared, and agreed to introduce certain changes in the process of manufacture, which, it was believed, would greatly diminish the foul odors which had been the source of complaint.

Manual of Health Laws.

It has been the practice of the Board to publish a compilation of the laws of the Commonwealth relating to public health about once in three years, for distribution to local boards, and for this purpose it was the intention of the State Board to have published such a digest either in 1901 or early in 1902, but the fact that all of the statutes were undergoing revision, under the charge of a commission appointed for the purpose, made it necessary to delay the publication of the manual of health laws until the general revision was completed, in order that the latter should agree with the former in the numbering of chapters and sections, and in its subject matter.

The compilation of this manual is now being made under the authority of chapter 30 of the Acts of 1902, and when completed, copies will be forwarded to local boards of health.

Health of Towns.

In the latter part of the report may be found a summary of abstracts from the annual reports of local boards of health of the different cities and towns. A comparison of these reports with those of the same places published ten years ago shows a marked improvement in the character of the work which has been accomplished from year to year. This improvement is especially manifest in the work of prevention of communicable diseases. Ten years ago but little had been done, except in the large cities, toward enforcing the laws relating to notification of infectious diseases, and in no city was there a special hospital for the isolation of patients sick with diphtheria or scarlet fever, nor was there in any city of the State a laboratory devoted to the study of such diseases and also for providing the means of detecting their existence among the people. To-day the laws relating to the notification and isolation of cases of infectious diseases are carried out even in the smaller towns, at least a dozen of the cities have established isolation hospitals for infectious diseases, and in several of them laboratories have also been established for bacteriological work. In addition to these means of preventing the spread of infectious diseases, the State Board of Health has also provided means for bacteriological diagnosis of infectious diseases, and also a constant and liberal supply of antitoxin for the treatment of diphtheria. It is encouraging to note, coincidentally with these measures, a decided fall from year to year in the death-rate from infectious diseases, as shown upon page 554 of this report.

In addition to these measures the State Board of Health has appointed a competent medical inspector, charged with the duty of aiding cities and towns in investigating the causes of prevalence of infectious diseases and for preventing their spread.

The Bacteriological Department.

One of the most important functions of a general as well as of a local board of health is the control of the spread of infectious diseases. Well directed efforts everywhere in this direction are rewarded with satisfactory results. For the purpose both of affording an opportunity of studying the natural history of those diseases which are clearly preventable, as well as for furnishing to local boards such assistance as is practicable for combating their spread the Board established a laboratory at the Bussey Institution at Forest Hills in 1894, under the charge of Dr. Theobald Smith.

The following lines of work have been conducted in this department during the year 1901 : —

1. The examination of 4,119 cultures of material suspected of containing the germs of diphtheria.

2. The examination of 797 specimens of material suspected of containing germs of tuberculosis.

3. The examination of specimens of blood from typhoid patients.

4. Examination of blood from persons living in malarious districts.

5. The production of 40,211 vials of antitoxin for the treatment of persons suffering with diphtheria, and of those who have been exposed to that disease.

The following table shows the number of specimens examined for the detection of diphtheria, tuberculosis, typhoid fever and malaria since the organization of the department : —

	Diphtheria.	Tuberculosis.	Typhoid Fever.	Malaria.
1896,	1,469	124	–	–
1897,	2,204	236	–	72
1898,	1,591	414	–	132
1899,	3,258	571	–	76
1900,	5,173	746	62	78
1901,	4,119	797	108	91
Total,	17,814	2,888	170	449

In addition to this routine work of the bacteriological department, much additional work was also performed during the year in the investigation of the causes and methods of prevention of the spread of infectious diseases, much time having been directed to the study of malaria in those districts where it was prevalent.

Several of the larger cities have established and equipped laboratories of their own in order to facilitate the work of local boards of health, and it is desirable that each large city should be thus provided with similar means, since the laboratory proves to be one of the most efficient aids in the work of disease prevention.

Sanitary Legislation enacted in 1902.

The following laws and resolves having reference to public health measures were enacted in 1902: —

[Chap. 110.]

An Act to transfer the powers and duties of the inspector and assayer of liquors to the state board of health.

Be it enacted, etc., as follows:

Section 1. The office of inspector and assayer of liquors is hereby abolished.

Section 2. The powers and duties heretofore conferred and imposed on the inspector and assayer of liquors are hereby conferred and imposed on the state board of health.

[Chap. 190.]

An Act relative to vaccination.

Be it enacted, etc., as follows:

Section 1. Section one hundred and thirty-seven of chapter seventy-five of the Revised Laws is hereby amended by striking out in the fifth and sixth lines, the words "being over twenty-one years of age and not under guardianship", so as to read as follows: — *Section 137.* The board of health of a city or town if, in its opinion, it is necessary for the public health or safety shall require and enforce the vaccination and revaccination of all the inhabitants thereof and shall provide them with the means of free vaccination. Whoever refuses or neglects to comply with such requirement shall forfeit five dollars.

Section 2. Section one hundred and thirty-nine of said chapter is amended by striking out the whole of said section and inserting in place thereof the following: — *Section 139.* Any person over twenty-one years of age who presents a certificate signed by the register of a probate court that he is under guardianship shall not be subject to the provisions of section one hundred and thirty-seven; and any child who presents a certificate, signed by a registered physician designated by the parent or guardian, that the physician has at the time of giving the certificate personally examined the child and that he is of the opinion that the physical condition of the child is such that his health will be endangered by vaccination shall not, while such condition continues, be subject to the provisions of section six of chapter forty-four of the Revised Laws or of the three preceding sections of this chapter; and the parent or guardian of such child shall not be liable to the penalties imposed by section one hundred and thirty-six of this chapter.

[Chap. 206.]

An Act relative to diseases dangerous to the public health.

Be it enacted, etc., as follows:

Section 1. The board of health of any city or town which has established or which may hereafter establish within its limits a hospital for the reception of persons having smallpox or any other disease dangerous to the public health, may receive for care and treatment in such hospital persons from an adjoining town who are infected with any of said diseases, provided the approval of the board of health of the city or town into which such persons are to be taken shall first have been obtained.

Section 2. Section forty-six of chapter seventy-five of the Revised Laws is hereby amended by adding thereto the following words: — The removal authorized by this section may be made to any hospital in an adjoining city or town established for the reception of persons having smallpox or other disease dangerous to the public health, provided the assent of the board of health of the city or town to which such removal is to be made shall first have been obtained, — so as to read as follows: — *Section 46.* A magistrate authorized to issue warrants in criminal cases may issue a warrant directed to the sheriff of the county or his deputy, or to any constable or police officer, requiring them under the direction of the board to remove any person who is infected with contagious disease, or to impress and take up convenient houses, lodging, nurses, attendants and other necessaries. The removal authorized by this section may be made to any hospital in an adjoining city or town established for the reception of persons having smallpox or other disease dangerous to the public health, provided the assent of the board of health of the city or town to which such removal is to be made shall first have been obtained.

[Chap. 213.]

An Act relative to compensating cities and towns for caring for persons infected with the smallpox or other disease dangerous to the public health.

Be it enacted, etc., as follows:

Section 1. Reasonable expenses incurred by the board of health of a city or town in making the provision required by law for persons infected with the smallpox or other disease dangerous to the public health shall be paid by such person or his parents, if he or they be able to pay, otherwise by the city or town in which he has a legal settlement, upon the approval of the bill by the board of health of such city or town; and such settlements shall be determined by the overseers of the poor. If the person has no settlement such expense shall be paid by the Commonwealth, upon approval of bills therefor by the state board of charity. In all cases of persons having settlements a written notice sent within the time required in case of aid given to paupers, shall be sent by the board of health or by the officer or board having the powers of a board of health in the city or town where the person is sick, to the board of health, or to the officer or board having the powers of a board of health in the city or town in which such person has a settlement, who shall forthwith transmit a copy thereof to the overseers of the poor of the place of settlement. In case the person has no settlement such notice shall be given to the state board of health, in accordance with the provisions of section fifty-two of chapter seventy-five of the Revised Laws.

Section 2. No person for whose care and maintenance a city or town or the Commonwealth has incurred expense in consequence of smallpox, scarlet fever, diphtheria or other disease dangerous to the public health shall be deemed to be a pauper by reason of such expenditure.

Section 3. Section fifty-seven of chapter seventy-five of the Revised Laws is hereby repealed.

[Chap. 230.]

An Act to authorize the state board of health to publish certain information in the interests of the public health.

Be it enacted, etc., as follows:

Section 1. The state board of health is hereby authorized to publish for general distribution such parts of its annual report and such other matter as it may deem adapted to promote the interests of the public health in this Commonwealth: *provided*, that the expense of such publication is paid out of the appropriation for the general expenses of the board and does not exceed in any one year the sum of five hundred dollars. The board is also authorized to publish not oftener than once in three years, beginning with the year nineteen hundred and two, a manual of the laws relating to boards of health in this Commonwealth, together with such other information upon the same subject as the board may deem expedient, the same to be distributed among the local boards of health throughout the Commonwealth. The cost of such publications shall not exceed five hundred dollars for each edition and shall be paid out of the appropriation for general expenses of the board.

[CHAP. 272.]

AN ACT TO AUTHORIZE THE STATE BOARD OF HEALTH TO PUBLISH RESULTS OF ANALYSES AND CERTAIN OTHER INFORMATION.

Be it enacted, etc., as follows:

SECTION 1. The state board of health shall cause to be published as often as once each month in the official publication of said board, and also, if in its opinion the public health can be served thereby, may cause to be published in one or more papers in Massachusetts, a certificate of the examination or analysis made by authority of said board during the preceding month of any article of food manufactured or offered for sale in the Commonwealth, which is adulterated within the meaning of chapter seventy-five of the Revised Laws; and said board of health shall also cause to be published, with such certificate of examination, a statement of the trade-mark, brand mark or name, with the name and place of business of the manufacturer, which appear upon the package or box containing such adulterated article, or with the name and place of business of the wholesale dealer of whom the goods were obtained.

SECTION 2. This act shall take effect on the first day of July in the year nineteen hundred and two.

[CHAP. 322.]

AN ACT TO REQUIRE MANUFACTURING ESTABLISHMENTS TO SUPPLY THEIR EMPLOYEES WITH PURE DRINKING WATER DURING WORKING HOURS.

Be it enacted, etc., as follows:

SECTION 1. All manufacturing establishments in this Commonwealth shall provide fresh and pure drinking water, to which their employees shall have access during working hours.

SECTION 2. Any corporation, association, firm or person owning, in whole or in part, managing, controlling or superintending any manufacturing establishment in which the provision of this act is violated shall, upon complaint of the board of health of the city or town, or of the selectmen of the town in which the establishment is located, be liable to a fine of one hundred dollars for each offence.

[CHAP. 540.]

AN ACT RELATIVE TO THE LABELLING OF BAKING POWDERS.

Be it enacted, etc., as follows:

SECTION 1. Whoever manufactures for sale within this state, or offers or exposes for sale or sells any baking powder or mixture or compound intended for use as a baking powder under any name or title whatsoever shall securely affix or cause to be securely affixed to the outside of every box, can or package containing such baking powder or like mixture or compound, a label distinctly printed in brevier gothic capital letters, in the English language, containing the name and residence of the manufacturer and the ingredients of the baking powder, mixture or compound.

SECTION 2. Whoever violates any provision of this act shall be punished by a fine of not less than ten nor more than one hundred dollars for each offence.

SECTION 3. This act shall take effect on the first day of April in the year nineteen hundred and three.

[CHAP. 107.]

RESOLVE TO PROVIDE THAT THE STATE BOARD OF HEALTH SHALL INVESTIGATE THE PRODUCTION OF VACCINE LYMPH IN THIS COMMONWEALTH, AND ALSO REPORT A PLAN FOR ITS PRODUCTION AND FREE DISTRIBUTION.

Resolved, That the state board of health is authorized and requested to report to the general court as soon as possible a plan for the production and distribution of pure vaccine lymph for free use in this Commonwealth; and also to report as to the quality of the vaccine lymph in use in this Commonwealth during the past winter and at the present time, and as to the quality of the vaccine lymph produced or sold by private persons or corporations in this Commonwealth, and the methods and conditions by and under which it is produced.

[CHAP. 121.]

RESOLVE TO PROVIDE FOR AN INVESTIGATION AND A REPORT BY THE STATE BOARD OF AGRICULTURE AS TO THE FEASIBILITY AND PROBABLE COST OF PRODUCING VACCINE LYMPH AT THE MASSACHUSETTS AGRICULTURAL COLLEGE, FOR FREE DISTRIBUTION WITHIN THE COMMONWEALTH.

Resolved, That the state board of agriculture is hereby authorized and directed to investigate as to the feasibility and probable cost of producing vaccine lymph at the Massachusetts Agricultural College, for free distribution within the Commonwealth, and to report the result of such investigation, together with such recommendations as the board may consider advisable, to the general court on or before the fifteenth day of January in the year nineteen hundred and three.

Water Supply and Sewerage.

The work of this department is carried on under the direction of the engineer of the Board. During the year 1901 the Board has received 105 applications for advice with reference to water supply, drainage and sewerage and the prevention of the pollution of streams, under the provisions of chapter 375 of the Acts of 1888, entitled "An Act to protect the purity of inland waters and require consultation with the State Board of Health regarding the establishment of systems of water supply, drainage and sewerage," and under the provisions of special acts relative to water supply, drainage and sewerage.

Two new acts passed by the Legislature of 1901 have increased materially the work of this department. These acts are as follows: —

[Chap. 104.]

An Act to provide for examination by the state board of health of the outlets of sewers, and as to the effect of sewage disposal.

Be it enacted, etc., as follows:

Section 1. The state board of health shall annually examine all main outlets of sewers and drainage of the cities and towns of the Commonwealth, and the effect of sewage disposal, and annually report thereon to the general court, with such recommendations for the protection of the interests of persons and property as said board shall deem expedient, and for the prevention of offensive odors and objectionable conditions.

Section 2. This act shall take effect upon its passage. [*Approved March 5, 1901.*

[Chap. 138.]

An Act to prohibit the taking of shellfish from contaminated waters.

Be it enacted, etc., as follows:

Section 1. The commissioners on inland fisheries and game shall, whenever so requested in writing by the state board of health, prohibit the taking of oysters, clams, quahaugs and scallops from the tidal waters or flats of any part of the Commonwealth, for such period of time as the said board of health may determine.

Section 2. The state board of health shall have power to examine all complaints that may be brought to its attention in regard to contamination of tidal waters and flats by sewerage or other causes, to determine as near as may be the bounds of such contamination, and mark the same when

necessary, and to request the commissioners on inland fisheries and game to prohibit the taking therefrom of any oysters, clams, quahaugs and scallops, as provided in section one of this act.

SECTION 3. Whoever takes any oysters, clams, quahaugs or scallops from any part of the tidal waters or flats of the Commonwealth from which the taking of the same is prohibited, as above provided, shall forfeit not less than five nor more than ten dollars for the first offence, and not less than fifty nor more than one hundred dollars for each subsequent offence : *provided*, that the commissioners on inland fisheries and game shall cause notice of such prohibition, with a description or bounds of the premises concerned, to be given by publication in some newspaper published in the town or county in which or adjacent to which are situated the tidal waters or flats from which the taking of oysters, clams, quahaugs or scallops is prohibited as above provided, at least one week before said penalty shall be incurred. [*Approved March 12, 1901.*

A report of the work done under the provisions of chapter 375 of the Acts of 1888 has already been presented to the Legislature in Senate Document No. 14, dated Jan. 10, 1902, and abstracts of the replies of the Board to various applications for advice are given in pages 5 to 114 in this report. An abstract of the work done under the provisions of chapter 104 and chapter 138 of the Acts of 1901 is presented in Senate Document No. 336, under date of May 20, 1902.

In connection with some of these matters investigations have been made which are of general value. In connection with the advice of the Board to the city of Springfield very thorough investigations were made, with the assistance of the Springfield authorities, as to the purification of the water of Ludlow reservoir and of the system of canals from which the greater portion of the supply of the city of Springfield is drawn. The water of Ludlow reservoir has been offensive to taste and smell in nearly every year since it was first used for the water supply of Springfield, in 1875, the cause of the trouble being the presence, during the warmer months of the year, in enormous numbers, of the organism *Anabœna*, while the water of the canals has been objectionable chiefly on account of the color caused by the contact of this water with swamps through which the streams which feed the canal flow. An investigation was made, in response to an application from the city of Springfield for advice as to the practicability of purifying these waters and as to whether Ludlow reservoir was the most appropriate source of water supply for the city. The advice of the Board will be printed in a subsequent report, but the details of investigations made upon the filtration of the water are presented in a report by the chemist in a later portion of this report.

The results of an investigation as to the action of water upon distribution pipes in the town of Attleborough are included in the advice of the Board to that town, which will be found on page 8.

Examination of Water Supplies.

All of the cities and towns in the State having, by the census of 1900, a population in excess of 3,500, except the towns of Blackstone, Barnstable, Chelmsford, Pepperell, Tewksbury, Dartmouth and Dudley, are provided with public water supplies. A public water supply has been introduced during the year in the town of Scituate, and the total number of cities and towns now supplied is 167, having an aggregate population of 91.5 per cent. of the total population of the State, according to the census of 1900.

The total number of sources of supply in use in 1901 was approximately 245. The waters of nearly all of these sources have been examined from time to time during the year by means of chemical analyses, the samples being collected and sent to the laboratory of the Board, usually by the water works authorities in the various cities and towns. Many of the samples examined chemically were also examined microscopically to determine the number and character of the organisms present in these waters. The results of the analyses are kept on file at the office of the Board, and the more important of these results are presented in this report, pages 117–216. In places where the quality of the water has undergone but little change during the year only an average of the results of analyses is presented, but in those places where the water is subject to considerable change from time to time the full results are given. The averages of the results of the analyses of previous years are also given, and in many cases where a change is noted in the quality of the water from year to year the averages for each year are presented in full.

Examination of Rivers.

Samples of water from many of the rivers have been collected at various places to show their condition as compared with previous years, and the results of the various examinations are presented in a chapter on "Examination of Rivers," pages 219 to 255.

The flow of streams during 1901 has been greater than the normal, as shown by the available records. The flow in January, February and March was low, but during the six succeeding months was in excess of the normal. In October and November the flow was somewhat less than the normal, but in December it was unusually high.

No changes effecting an improvement in any of the rivers of the State have been made during the year, and those streams which are badly polluted continue to grow worse with the growth of population and increase of manufacturing industries. At Pittsfield works for the purification of the sewage of the city, now discharged into the Housatonic River, will probably be completed during the coming year, and the sewage of the city will then be diverted from the river, thus removing one of the most serious pollutions upon any of the rivers of the State.

The condition of the Neponset River below Walpole, the Blackstone below Worcester, the Hoosick below North Adams, the north branch of the Nashua below Fitchburg, the Nemasket below Middleborough, the Ten Mile below Attleborough, and many others of less importance, has not been affected by the removal or purification of any of the sewage or manufacturing wastes of the cities or factories using these streams as places of sewage disposal.

In most cases where gross pollution of the streams by sewage exists the sewerage systems are old ones, which were installed previous to 1886, when the first act requiring consultation with the State Board of Health relative to the establishment of systems of water supply, drainage and sewerage was passed. Since that year nearly all sewerage acts have contained provisions requiring the approval of the plans by the State Board of Health before the system could be built. It thus happens that some cities and towns are incurring expense for the construction and maintenance of sewage purification works in order to protect the streams from pollution, whereas other cities and towns, under similar circumstances, are discharging crude sewage into the streams and causing gross pollution.

Lead Poisoning.

Many serious cases of lead poisoning were discovered in the town of Milton in the latter part of the year. This town is supplied with a water containing an excessive quantity of carbonic acid which acts rapidly upon lead surfaces with which it may come in contact. Nearly all of the serious cases of lead poisoning resulting from the use of water taken from public water supplies have occurred in those cities and towns which are supplied with ground waters; but surface waters also act upon lead pipe, and, though the quantity found in surface waters drawn through such pipes has usually been small, there is, nevertheless, danger that injury to health may result even if the water is drawn from a surface source if lead pipe is used in its distribution.

Considering the circumstances, the Board is of the opinion that the use of lead pipe for the distribution of water to be used for drinking and other domestic purposes should be avoided. A water which ordinarily acts but slightly on a lead pipe may, by some change in conditions, take up a much larger quantity of lead than under ordinary circumstances, and a change in the source of the supply of a city or town has been followed by a material increase in the action of the water upon lead service pipes. Pipes coated with zinc are also quickly attacked by many waters. Pipes of tin or of lead lined with tin or of iron lined with tin or with cement when properly made have not been found to have an injurious effect in any way upon the water, and it is entirely practicable to provide service pipes of such material, so that the water will not be injured in passing through them.

Sewage-disposal Systems.

During the year regular examinations were made of the sewage and effluent of nearly all the various sewage-disposal systems now in operation in the State. The remaining systems will be examined during the coming year, and, in order that all of the investigations may be presented at one time, the results of the examinations made in 1901 are omitted in this report and will be presented in a subsequent report in connection with the investigation of the remaining systems.

Purification of Sewage and Water.

The results of investigations made during the year at the Lawrence experiment station upon the purification of sewage and water are presented in a report by the chemist of the Board, pages 271 to 321, the investigations during this year being directed especially to the investigation of systems of purifying sewage at rapid rates. The results of investigations of the Lawrence city filter are also presented as usual. A paper is presented by the chemist upon the stability of the effluents of sewage filters of coarse materials, including investigations upon putrefaction and secondary decomposition, — matters of great interest at the present time in connection with methods of rapid purification of sewage. A paper is also contributed by the biologist at the Lawrence experiment station upon the bacteriological studies at the station with special reference to the determination of B. coli.

The Sanitary Condition of the Sudbury and Concord Rivers.

The State Board of Health, acting under the provisions of chapter 65 of the Resolves of the General Court of 1900, entitled "A Resolve directing the State Board of Health to investigate the sanitary condition of the Sudbury and Concord rivers and of the meadows adjacent thereto," made the necessary investigation, and submitted the following report to the Legislature, May 20, 1901 (House Document, 1380, session of 1901).

Report of the State Board of Health upon the Sanitary Condition of the Sudbury and Concord Rivers.

To the General Court of Massachusetts.

In accordance with chapter 65 of the Resolves of the General Court of 1900, the State Board of Health presents the following report upon the sanitary condition of the beds, shores and waters of the Sudbury and Concord rivers and of the meadows adjacent thereto, and upon a plan for the removal of dangers to the public health found to exist therein.

After personal examination of the territory and a public hearing to all persons interested, the Board organized for a careful study of the existing conditions, and finding a source of serious pollution, caused experiments to be made in order to determine the most practicable way to dispose of this pollution, that it might no longer endanger the public health.

The general conditions of these rivers and of their branches are fully set forth in the report of Mr. Goodnough, chief engineer of the Board; and Mr. Clark, the chemist of the Board, reports upon how the waste liquors from the Saxonville Mills may be treated to prevent the pollution of the Sudbury River from this source. From these studies we find one section of the Sudbury River, extending from the Saxonville Mills to Farm bridge in Wayland, a length of 6 miles, contains polluting matter from manufacturing wastes and from sewage to such an extent as to be, in the upper portion of this section, offensive to the senses, and, in the opinion of this Board, detrimental to the health of those living near the river.

As the lower end of this section is reached, the evidence of the pollution becomes less, probably due to sedimentation and dilution; and neither personal observation, chemical analysis nor inquiries of those who boat upon the river during the boating season has given evidence that such pollution as could affect the health of those living near the river exists below Canal bridge in Wayland.

The latter condition was also found to exist in the Concord River, which is the name of the stream after it receives the water of the Assabet River. Some parts of the Assabet River have been found to be objectionably polluted; but when this water reaches and mingles with that of the Sudbury River, we find the mixture unobjectionable to the senses and containing by chemical analysis much less polluting matter than the water in any river which we have found reason to regard as detrimental to the health of those living in the valley.

If the amount of pollution of the Assabet River were allowed in the future to continue increasing, it might become sufficient to be detrimental to those living in the Concord River valley; but it should first be limited by reason of the injury to those in its own valley.

The portion of the Sudbury and Concord rivers in the 29 miles above Billerica dam which is now in condition to menace the public health is limited to that portion above Canal bridge in Wayland, and this pollution is due principally to the manufacturing wastes at Saxonville.

It has been suggested by some of the citizens of Wayland that the offensive condition of the river above Farm bridge may be obviated by lowering the Billerica dam and the Fordway bar, and thus make the river at Wayland a running stream instead of a stagnant pond; but this suggestion is based upon a misconception of the actual conditions in the river at present and those that would exist if the proposed change were made. There is now at certain stages of the river in summer a fall in the surface of 2 feet in the 26 miles from the polluted section to the Billerica dam, and the velocity of the water in the stream through Wayland and Sudbury at such time is hardly perceptible, but amounts to about one-third of a foot in a second. If the Billerica dam were removed to the level of the water on its down-stream side, and the Fordway bar were excavated to the same level, the effect at Wayland would be to lower the water there to some extent; but its effect upon the velocity of the stream could not be estimated to increase the velocity there beyond twice its present velocity, and, while it would then be perceptible, the water would have a speed of less than one-quarter of the speed with which a man ordinarily walks. This effect of increasing the speed of flow could have no appreciable influence in removing the deleterious effect of the pollutions added to the stream 6 miles above the village of Wayland, but might produce the result of extending their influence farther down the stream.

The only practicable means of removing the deleterious effect of the impurities now added to the stream is, in the opinion of this Board, to exclude them from the stream, and the best way to do this has been the subject of extended study. The results of these studies are presented in the appended reports of the chemist and the chief engineer of the Board; and it is the judgment of the Board that the mill wastes should be collected in settling tanks at the mills, and the liquid pumped to the Framingham sewage-disposal area and mixed with the domestic sewage of the town, that the combined liquid may be purified by filtration. The fats which rise to the surface in the settling tanks and the sediment which settles to the bottom should be removed when necessary, and be disposed of by the mill authorities in such a way that they cannot enter the river. When the village of Saxonville has sewers, the sewage should be conveyed to the same pumping station and be pumped with the liquid from the settling tanks to the filtering area of the town.

The meadows along the Concord and Sudbury rivers are but little above the level of the water in the stream, large areas being less than a foot above the ordinary summer flow of the water, and considerable areas are even with the water, and others are continually covered with water throughout the season, except during a very dry summer. These conditions are such as to suggest a probable source for the distribution of malaria, if this disease were found to exist or to be increasing in the vicinity. Dr. Theodore Chamberlin of Concord and Dr. Frank L. Morse, medical inspector of the Board, were requested to collect data and give the results of their studies upon this subject.

From the data collected it appears that until within about twenty years only a single case of malaria is now known to have existed in the vicinity of the Sudbury and Concord meadows; and in the year 1885, when it first appeared in the town of Framingham and prevailed to the extent of 196 cases, reported between the months of June and October, we learn of no cases adjoining these meadows in the valley below Framingham.

There appears, then, to be no cause in the condition of the meadows previous to this time to generate malaria. It had been introduced near the upper end of the meadows on three different years, with the aggregate number of 8 cases; but in the year 1885, with the epidemic in the adjoining town in the same valley, no cases are reported in the portion of the valley containing the meadows. But few cases are reported near the meadows until 1890, since which time there are reported 191 cases near the meadows on both sides of the river in the first 10 miles of its length below Saxonville, in a population of about 500; and in the same period of eleven years 8 cases are reported bordering the meadows, in the next 6 miles of the river's length, in a population of 185. Farther down the river few cases are recorded previous to 1895, and not many until 1898, since which time it has prevailed at Concord and at Billerica; but in both cases the evidence tends to show that it was introduced into these towns by the laborers engaged in digging up the streets when constructing the water works and sewerage systems, and its spread about these towns was associated with these works. Upon the completion of the works in Billerica the number of cases rapidly diminished; while in Concord the effect of the work continued through last year, and we must wait through another season to learn whether it also diminishes here. There is yet no evidence that the prevalence of malaria is intimately associated with the meadows except in the upper reaches, where we find the water of the river polluted to such an extent that we should regard it a menace to the health of those living near the river.

We consequently advise the exclusion of this pollution from the river in the manner indicated.

It is well known that malaria when introduced to a district is communicated from person to person by a kind of mosquito, and that these mosquitoes grow in pools of stagnant water, and that a very small pool may be the home of a very large number of mosquitoes. Where such pools do not exist, malaria does not spread. In the case before us, 4,000 acres of meadows lie, during the summer, within about a foot of the water in the river and in some places under the water, and these meadows spread out for half a mile from the river or from a stream entering the river. The water of the river can, by a large expenditure of money, be lowered so that by proper drainage the area of the meadows may, during the growing season, be uncovered and be cultivated; but the material of which these meadows are composed will hold a large quantity of water and allow a very small quantity to percolate through it, so that, if the river were lowered sufficiently to enable the meadows to be cultivated, we are not confident that summer showers would not cause pools to be formed in depressions upon the surface or in the long ditches, in which water would stand long enough to breed the mosquito that communicates malaria from person to person. With this doubt of the efficacy of such a remedy, and with no evidence that, where the water of the river is sensibly unpolluted, the prevalence of malaria is associated with the meadows, and with evidence that malaria does occur in regions adjacent to the parts of the meadows which are subject to the overflow of a polluted stream, we advise that measures be taken immediately to remove this pollution, and leave the efficacy of a lowering of the river's bed an open question for future study, after this upper section of the river has been purified.

(Signed) HENRY P. WALCOTT,
FRANK W. DRAPER,
JAS. W. HULL,
CHAS. H. PORTER,
JULIAN A. MEAD,
GERARD C. TOBEY,
HIRAM F. MILLS,
State Board of Health.

Examination of Sewer Outlets.

Acting under the provisions of chapter 104 of the Acts of 1901 the Board made such examinations as are authorized by the statute and made the following report upon the same to the General Court, May 20, 1902. (Senate Document, 336, 1902.)

To the General Court of Massachusetts.

By the provisions of chapter 104 of the Acts of the year 1901, the State Board of Health is directed to examine all main outlets of sewers and drainage of the cities and towns of the Commonwealth, and the effect of sewage disposal and annually report thereon to the General Court, with such recommendations for the protection of the interests of persons and property as the Board shall deem expedient for the prevention of offensive odors and objectionable conditions, and the Board herewith presents its report upon the examinations made under this act during the past year.

Report.

There are 92 cities and towns in the State having systems of sewerage available to a considerable portion of their population. Of these, 23 are included in the metropolitan or Boston main drainage districts, 12 have outlets discharging directly into the sea or into tidal waters, and the remaining 57 discharge their sewage into inland streams. In a portion of the latter the sewage is previously thoroughly purified, so that the effluent does not produce a noticeable effect on the stream, and in other cases the sewage is partially purified; but 35 cities and towns discharge crude sewage directly into inland waters in the State, without any purification whatever.

In addition to the cities and towns which have fairly complete systems of sewers, there is a considerable number of places where there are one or more sewers in a small section of a town, or where storm-water drains exist which are used as outlets for sewage. There are also numerous other cases in which a few houses discharge at some common outlet.

Among the most serious sources of pollution of the inland waters of the State are the polluted wastes and drainage from certain manufacturing processes, such as tanneries, wool-scouring establishments and paper mills. In some cases the quantity of polluted drainage from manufacturing processes is as great as the quantity of sewage of a large town, and this sewage often contains an even larger quantity of putrescible organic matter in a given volume than ordinary domestic sewage. Outlets for such drainage are, therefore, of material importance in connection with an investigation of this kind.

A large portion of the information necessary to determine the conditions existing at the various outlets has been collected, and a number of the outlets have been examined. It has not been practicable, however, to make a complete examination of all the sewer outlets of the State during the past year. The outlets along the seashore, by which flats or tidal waters which are sources of shellfish used extensively for food were liable to be polluted, were deemed to be of great importance, on account of the direct injury to health that might result from the use of contaminated food; and the work of the Board during the past year has been directed principally to an examination of the conditions about sewer outlets into the sea and tidal waters.

The cities and towns having partial or complete systems of sewerage which discharge into tidal waters along the seacoast of the State are the following: —

Newburyport,	Hull,
Beverly,	Plymouth,
Salem,	New Bedford,
Lynn,	Fairhaven,
Nahant,	Taunton,
Revere,	Fall River.
Boston and metropolitan districts,	

In the city of Gloucester, while there is no general sewerage system, sewage from numerous buildings is discharged into streams or drains provided for the removal of storm water, and a similar condition exists in a part of the village of Nantucket, where a drain is utilized as a sewer outlet for a portion of the village.

The sewage of the north metropolitan sewerage district is discharged at Deer Island on the northerly side of the entrance to Boston Harbor, and the sewage of the Boston main drainage and south metropolitan districts is discharged at Moon Island in the southerly part of the harbor. These two outlets constitute the main sewer outlets of the city of Boston and 22 other cities and towns included in the north and south metropolitan districts. These outlets were examined by the Board in 1900, and their condition reported to the Legislature in a special report of that year, entitled "Report of the State Board of Health upon the discharge of sewage into Boston harbor."

There are, in addition, independent sewer outlets not connected with the metropolitan or Boston main drainage districts through which sewage is discharged into the waters of the metropolitan district. The principal of these outlets are at East Boston and Chelsea. A considerable population along Beacon Street on the borders of the Charles River in Boston is not connected with any intercepting sewer, and the sewage from about 1,000 people in this section is discharged into the Charles River at all times.

In the lower portion of the north metropolitan and Boston main drainage districts, — that is, in Somerville, Cambridge, Charlestown, Everett, Chelsea and East Boston in the north metropolitan district, and in Brookline and Boston in the south metropolitan and Boston main drainage districts, the sewers are constructed largely upon the combined plan, and receive both sewage and storm water; and, since the capacity of the main sewers is insufficient for removing all of the water entering the sewers at times of storms, together with the sewage, a portion of the mingled sewage and storm water is allowed to overflow at times of rain into adjacent waters. There are many of these overflow outlets into the Charles, Mystic and Neponset rivers and their tributaries and into Boston harbor within the towns and cities mentioned.

All of the principal sewer outlets along the seacoast have been examined during the past year, and, as already indicated, the conditions about these outlets have been considered thus far mainly with reference to the effect of the sewage upon the flats and tidal waters from which shellfish are taken for food. In connection with this examination many samples of shellfish have been collected from various localities and sent to the Lawrence Experiment Station for analysis.

The analyses have consisted in a determination of the presence or absence of the colon bacillus, the characteristic organism of sewage. In collecting the samples from the various flats and waters in which they occur it has been the custom in most cases to collect with the sample of shellfish a sample of the water upon or near the flats, and analyses have been made both of the water and the shellfish. In most cases also the water found inside the shell of the fish has been examined separately.

The results of the examinations of various sewer outlets and the results of the analyses of samples of water and shellfish made by the Board during the past year show that shellfish are collected for use as food from polluted flats and waters about many sewer outlets, and shellfish taken from the neighborhood of these outlets show the presence of the characteristic sewage organism. The places at which the most serious pollution of the flats has been found and where the colon bacillus has been found to be present in a considerable proportion of the samples of shellfish and waters examined are the following: the flats near the mouth of the Merrimack River at Newburyport and Salisbury; the flats in Lynn harbor; the flats and shores on the southeasterly side of East Boston and Breed's Island; the flats in the Charles River; the flats about Savin Hill and at the mouth of the Neponset River; the shores of Moon Island and Moon Head and the causeway between; the shores on the southwesterly end of Long Island; the westerly shore of New Bedford harbor and the upper end of Clark's Cove in New Bedford; and the flats adjacent to the city of Fall River.

It is not practicable, with the information which has thus far been obtained regarding the effect of the sewage discharged into tidal waters at these places, to determine definitely the limits at each place within which shellfish are liable to be polluted and beyond which they may safely be taken for use as food, though in some cases such limits can be definitely assigned.

The flats along the Merrimack River at Newburyport and Salisbury just above the mouth of the river are exposed to pollution by the waters of the river, into which large quantities of sewage are discharged at Lowell, Lawrence, Haverhill and other places along its course. The extent to which this pollution affects the shellfish taken from these flats has not been definitely determined. A portion of the flats on the Newburyport side of the river are further exposed to serious pollution by sewage from the sewer of the city of Newburyport, but the area in which pollution from this sewer affects the flats from which shellfish are taken remains to be determined.

The flats of Lynn harbor, from which considerable numbers of shellfish are collected, are exposed to pollution by sewage from the main sewer outlet of the city, the contents of which are discharged at all times directly into the harbor. Judging from the examinations that have been made, it is possible that sewage from this outlet affects adjacent flats in the Saugus and Pines rivers. A further investigation will be necessary to determine to what extent the shellfish in flats in the neighborhood of this outlet are affected by sewage.

The clam flats along the Winthrop shore and in the neighborhood of Apple Island do not appear to be affected by sewer outlets at the present time; but there are several sewer outlets near the East Boston and Breed's Island shores by which it is evident, from the examinations that have been made, that some of the shellfish of this region are affected.

The Mystic River receives sewage through storm overflows in Somerville, Charlestown, Chelsea and Everett. Shellfish are collected from flats in the river which are located above most of the sewer outlets, though on account of the movement of the tides, sewage from these outlets is probably carried to the flats from which the shellfish are taken.

The Charles River, as already indicated, receives sewage directly from houses along Beacon Street, and receives also the sewage overflowing at times of storms from sewer systems in Boston and Cambridge. The results of examinations of shellfish from the flats in the Charles River show that they are affected by sewage, and a large proportion of the samples examined contained the colon bacillus.

In Dorchester Bay and along the southerly shore of the city of Boston above the mouth of the Neponset River there are numerous overflows from combined systems of sewers through which sewage is discharged at times of storms into these waters, and examinations show that shellfish, which are taken in considerable numbers from flats in the neighborhood of Savin Hill, are affected by the sewage.

The Neponset River is a highly polluted stream throughout the fresh-water portion of its course, and also receives sewage through sewer overflows at times of storms in the tidal portion of its course. The shellfish which are taken from the estuary of this river in considerable numbers are evidently affected by sewage.

A very large proportion of the samples of clams collected for analysis from the neighborhood of the main sewer outlet of the Boston main drainage and south metropolitan systems at Moon Island and from the shores of Moon Head and the causeway to Moon Island have been found to contain the characteristic sewage organism. Clams collected from the shores of the south-westerly half of Long Island, both on the north and on the south, are also found to be affected by the discharge of sewage from Moon Island; and several of the samples of shellfish collected from these shores have been found to contain the colon bacillus. At Spectacle Island, where a considerable number of clams are collected, the shores appear to be greatly polluted by refuse discharged there, which affects the shellfish.

In all of the places thus far described in the northerly part of the State practically the only shellfish collected are clams, which are cooked before being eaten. Quahaugs and oysters, which are consumed in the raw state as well as when cooked, are not found in any considerable numbers in the northerly part of the State, though oysters are planted at some places where they will be available for immediate use. Quahaugs are collected along the southerly shores of the State and from the islands in great numbers. They are generally of comparatively small size, and are known also under the name of "little neck clams."

Large numbers of shellfish (clams and quahaugs) are collected from New Bedford harbor and from Clark's Cove, in the southerly part of the city. The sewage of New Bedford is discharged through numerous outlets all along the westerly shore of the harbor in front of the city, and there are several outlets into the northerly end of Clark's Cove. The shellfish of New Bedford harbor and the northerly end of Clark's Cove are affected by the sewage discharged from the city sewers, and a large proportion of the samples of shellfish from these places have been found to contain the characteristic sewage organism. Sewage is discharged into the easterly side of the harbor by the town of Fairhaven, but the quantity so discharged is small compared with the quantity discharged by the city of New Bedford. It is possible that there may be some places in New Bedford harbor above the sewer outlets where shellfish are unaffected by the discharge of sewage, but it will take time to determine these areas with certainty.

The Taunton River and Mount Hope Bay receive the sewage of the cities of Taunton and Fall River. The Taunton sewerage is discharged at present partly into the Mill River and partly into the Taunton River just below the city, several miles above the points at which shellfish are taken in considerable numbers. The quantity of sewage thus far discharged into the sewers in Taunton appears, from information furnished by the city, to be considerably less than the quantity which will discharge into them as soon as the works are somewhat further developed and the connections made.

At Fall River the sewage is discharged at many outlets all along the shore of Mount Hope Bay in front of the city. Considerable numbers of clams are collected along the shore in close proximity to some of these outlets, where they are evidently affected by sewage.

The places above described include those at which the most serious danger to the public health has thus far been found to exist on account of the pollution of shellfish used for food by sewer outlets discharging into tidal waters. Further investigations are under way at many of these places to obtain more definite information as to the limits within which serious danger of the pollution of shellfish may exist, and investigations are also being made at many other places.

Routine Work of the Board.

During the year ended Sept. 30, 1901, meetings were held by the Board at least as often as once a month. Meetings of such of the standing committees were also held as were necessary for the transaction of special business. Hearings were held at the office of the Board with reference to the sewerage and sewage disposal of Wakefield, Jan. 3, 1901, of that of Fitchburg, April 2, of Franklin, May 2, and with reference to the question of taking ice from Ell Pond in Melrose, April 4. A conference was held with the New England Gas and Coke Company on September 20 with reference to the odors escaping from their works at Everett.

The Board visited the new dam in construction at Clinton and the north dike of the Wachusett reservoir on September 18.

The office of the Board has been open throughout the year, as prescribed by the Public Statutes, chapter 21, section 10, "for the transaction of its authorized business." Advice has been very frequently given at the office and by mail to local boards and to individuals in regard to sanitary matters, and many visits have been made by the officials of the Board to cities and towns for the purpose of making investigations and giving advice.

The office of the Board is virtually a central station for the distribution of the antitoxin produced by the Board, and for the various culture tubes, receptacles and other means employed for the diagnosis of disease. For this purpose the office of the Board has been open daily throughout the year, and the existence of a central office of this character has proved a most efficient aid to those boards of health which could not maintain local laboratories of their own.

STATISTICAL TABLE FOR THE YEAR ENDED SEPT. 30, 1901.

Whole number of samples of foods and drugs examined during the year,	10,325
Samples of milk examined (included in the foregoing),	6,247
Whole number of samples of food and drugs examined since beginning of work in 1883,	127,839
Whole number of samples of milk examined since beginning of work in 1883,	69,863
Number of prosecutions against offenders during the year,	95
Number of convictions during the year,	90
Amount of fines imposed during the year,	$1,874 70
Number of packages of antitoxin of 1,500 units each issued to cities and towns,*	40,211
Number of bacterial cultures made for the diagnosis of diphtheria in cities and towns,*	4,119
Number of examinations made for diagnosis of tuberculosis,*	797
Number of examinations of blood made for diagnosis of malarial infection,*	91
Number of examinations of blood made for the diagnosis of typhoid fever,	108
Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 302, Acts of 1893,†	27,009
Number of postal-card returns of mortality for cities and towns received and recorded,† about	2,000
Number of annual reports of cities and towns received under the provisions ‡ of Acts of 1894, chapter 218,†	90
Force employed in general work of Board at central office, State House: —	
Secretary,	1
Medical inspector,	1
Clerks,	3
Total,	5
Force employed at central office, State House, Boston, for food and drug inspection, chemists and assistants,	2
At Amherst,	1
Inspectors,	4
Total,	7
Force employed at laboratory (Bussey Institute): —	
Pathologist,	1
Assistants,	6
Total,	7

* For the year ended March 31, 1902. † For the calendar year 1901.
‡ Cities and towns having a population of more than 5,000 in each.

Under the Provisions of Chapter 375, Acts of 1888.

Applications for advice from cities, towns and others: —	
Relating to water supply,	56
Relating to ice supply,	12
Relating to sewerage and drainage,	29
Relating to pollution of streams,	3
Miscellaneous,	5
Total,	105

Number of samples of water examined chemically and microscopically at the laboratory, Room 502, State House,	3,562
Number of samples of sewage and effluent from sewage purification works examined chemically at the laboratory, Room 502, State House,	663
Number of samples of sewage and water examined chemically and bacterially at the Lawrence Experiment Station,	2,206
Number of samples of sand examined chemically and bacterially at the Lawrence Experiment Station,	99
Number of samples of sand examined mechanically at the Lawrence Experiment Station,	65
Number of samples examined for B. coli communis at the Lawrence Experiment Station,	3,978
Additional samples examined bacterially at the Lawrence Experiment Station,	3,384
Total number of samples examined,	13,957

Force employed at central office: —		
Chief engineer,	1	
Assistant engineers,	5	
Stenographers and clerks,	3	
Messenger,	1	
	—	10
At laboratory, Room 502, State House: —		
Chemist,	1	
Assistant chemists,	5	
Biologist,	1	
Stenographer,	1	
	—	8
At Lawrence Experiment Station: —		
Assistant chemists,	2	
Bacteriologists,	2	
Other assistants and laborers,	2	
	—	6
Total ordinary force,		24

The number of applications for advice under the provisions of the acts relating to water supply and sewerage, received since July, 1886, when these acts first went into operation, is as follows: —

1886,	8	1895,	52
1887,	22	1896,	65
1888,	28	1897,	59
1889,	38	1898,	75
1890,	23	1899,	79
1891,	53	1900,	104
1892,	56	1901,	105
1893,	51		
1894,	53	Total,	871

APPROPRIATIONS.

The appropriations for the year 1901, as recommended by the Board in the annual estimates made under the provisions of chapter 41 of the Acts of 1885, were as follows: —

For the general expenses of the Board,	$23,000 00
For the inspection of food and drugs,	11,500 00
For the protection of the purity of inland waters,	34,000 00
Total,	$68,500 00

EXPENDITURES.

The expenditures in 1901 under the different appropriations were as follows: —

Appropriation for general expenses of Board,	$23,000 00

General Expenditures, Sept. 30, 1900, to Sept. 30, 1901.

Salaries,	$9,317 68
Travelling expenses,	898 29
Stationery,	124 09
Printing,	1,770 46
Books, subscription and binding,	499 71
Advertising,	89 12
Express charges,	211 39
Extra services,	356 41
Messenger,	103 30
Postage and postal orders,	700 05
Telephone and telegraph messages,	71 62
Typewriter supplies,	43 45
Amount carried forward,	$14,185 57

Amount brought forward,	$14,185 57	
Special investigations,	335 00	
Translations,	10 40	
Sundry office supplies and incidental expenses,	627 65	
Laboratory supplies,	1,441 85	
		$16,600 47

Expenditures at Pathological Laboratory at Forest Hills.

Salaries,	$2,817 26	
Travelling expenses,	56 10	
Purchase of animals,	311 25	
Board of horses,	2,155 50	
Food for animals,	87 29	
Apparatus, chemicals and laboratory supplies,	679 52	
Ice,	28 18	
Postage,	2 46	
Stationery,	10 92	
Rental of telephone and messages,	210 60	
Typewriter and typewriting supplies,	116 00	
Express,	17 15	
		6,492 23
Total,		$23,092 70

Under the Provisions of the Food and Drug Acts during the Year ending Sept. 30, 1901.

Appropriation,	$11,500 00
Salaries of analysts,	$4,825 00
Salaries of inspectors,	4,452 53
Travelling expenses and purchase of samples,	1,895 11
Apparatus and chemicals,	953 18
Printing,	7 01
Special investigations,	23 00
Services (cleaning laboratory),	104 00
Express,	6 21
Sundry laboratory supplies,	44 85
Books,	9 24
Extra services (stenographer),	21 25
Total,	$12,341 38

Appropriation.

For carrying out the provisions of the act to protect the purity of inland waters, and to require consultation with the State Board of Health regarding the establishment of systems of water supply, drainage and sewerage,	$34,000 00

Salaries, including wages of laborers at Lawrence Experiment Station,	$25,700 02
Apparatus and materials,	3,521 06
Rent of Lawrence Experiment Station,	150 00
Use of tools and office, Lawrence Experiment Station,	198 53
Travelling expenses,	1,859 00
Express charges,	929 80
Books, stationery and drawing materials,	449 89
Maps and blue prints,	117 69
Postage stamps,	5 00
Printing,	210 58
Collecting samples,	18 05
Messengers, telegrams and telephone messages,	15 67
Services, reading gauges,	120 00
Analysis of gas,	40 00
Total,	$33,335 29

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Water Supply and Sewerage.

ADVICE TO CITIES AND TOWNS.

ADVICE TO CITIES AND TOWNS.

Under the provisions of chapter 375 of the Acts of 1888, entitled "An Act to protect the purity of inland waters, and to require consultation with the State Board of Health regarding the establishment of systems of water supply, drainage and sewerage," the Board is required

"from time to time to consult with and advise the authorities of cities and towns, or with corporations, firms or individuals either already having or intending to introduce systems of water supply, drainage or sewerage, as to the most appropriate source of supply, the best practical method of assuring the purity thereof or of disposing of their drainage or sewage, having regard to the present and prospective needs and interests of other cities, towns, corporations, firms or individuals which may be affected thereby. It shall also from time to time consult with and advise persons or corporations engaged or intending to engage in any manufacturing or other business, drainage or sewage from which may tend to cause the pollution of any inland water, as to the best practicable method of preventing such pollution by the interception, disposal or purification of such drainage or sewage: *provided*, that no person shall be compelled to bear the expense of such consultation or advice, or of experiments made for the purposes of this act. All such authorities, corporations, firms and individuals are hereby required to give notice to said Board of their intentions in the premises, and to submit for its advice outlines of their proposed plans or schemes in relation to water supply and disposal of drainage and sewage; and all petitions to the Legislature for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of the said Board thereon."

During the year 1901 the Board has given its advice to the following cities, towns, corporations and individuals who have applied for such advice under the provisions of the general act of 1888, or under special acts relating to water supply and sewerage.

Official communications were made during the year under the provisions of acts relating to water supply as follows: —

Andover.
Arlington.
Arlington (Stephen Symnes Hospital).
Attleborough.
Attleborough (E. A. Robinson estate).
Attleborough (J. M. Fisher & Co.).
Braintree (three).
Bridgewater.
Cambridge (Reversible Collar Company).
Cambridge (Randall Hall Association).
Chicopee.
Cohasset.
Colrain (Griswoldville).
Dalton.
Easthampton.
Framingham (Dennison Manufacturing Company).
Franklin (two).
Georgetown (Perley Free School).
Goshen (Highland House).
Holyoke.
Holyoke (Chemical Paper Company).
Lawrence (Atlantic Cotton Mills).
Lawrence (Hamblet Machine Company).
Lenox (two).
Lexington (three).
Lynn.
Manchester.
Natick.
Northampton.
North Andover (Town Farm).
North Attleborough (Country Club).
Northbridge (Whitin Machine Works).
Norwood (Winslow Bros.).
Palmer (Three Rivers).
Peabody.
Salem (two).
Salem (St. James School).
Salisbury.
Somerville Iron Foundry.
Southborough.
Southbridge (two).
Springfield (two).
Tewksbury (State Hospital).
Tyngsborough.
Walpole.
Waltham.
Westborough.
West Springfield.
Wrentham.

Official communications were made during the year under general and special acts relating to sewerage and sewage disposal, as follows: —

Amesbury.
Barnstable (State Normal School at Hyannis, two).
Billerica.
Boston (Hospital for Crippled Children at Bumkin Island).
Brookline (Hospital for Contagious Diseases).
Dedham.
Fitchburg.
Franklin (three).
Lancaster (two).
Manchester (Magnolia).
Marion.
Methuen.
Metropolitan Water and Sewerage Board.
Newburyport.
Northampton.
Norwood.
Norwood (Winslow Bros.).
Pittsfield.
Plymouth.
Reading.
Revere.
Rutland (Massachusetts Sanatorium).
Salem.
Swampscott.
Taunton.
Wakefield.
Wellesley (Dana Hall School).
Westborough Insane Hospital.
West Springfield.

Replies were made in answer to applications from the following authorities for advice relative to the pollution of ponds, streams and other bodies of water: —

Cambridge, Somerville, Arlington and Belmont (Alewife Brook).
Colrain (Griswoldville).
Harwich.
Haverhill.

Replies were also made during the year in answer to applications from the following authorities and individuals for advice relative to sources of ice supply: —

Bridgewater.
Chicopee.
Danvers.
Holyoke.
Melrose (three).
Pittsfield (Morewood Lake Ice Company).
Shelburne.
South Hadley (Charles Huot, two).
South Hadley (H. E. Gaylord, two).
Walpole.
Warren.

Rules and regulations for the sanitary protection of sources of water supply were made for the following authorities: —

Water Commissioners of Danvers.
Water Commissioners of Haverhill.

The Board was requested to examine a certain proposed location for a State colony for the insane, under the provisions of section 4 of chapter 101 of the Acts of 1886; and, while this subject is not embraced directly in the provisions of chapter 375 of the Acts of 1888, questions of water supply and sewerage are involved to such an extent that it is deemed proper to include the matter in this report.

Water Supply.

The following is the substance of the action of the Board during the past year, in reply to applications for advice relative to water supply: —

Andover. The board of public works of Andover applied to the State Board of Health Aug. 16, 1901, requesting information as to the cause and possible remedy for a disagreeable taste and odor in the public water supply from Haggett's Pond. The Board replied to this application as follows: —

Sept. 5, 1901.

The State Board of Health received from you, on August 16, a communication stating that the water of Haggett's Pond had a disagreeable taste and odor and was offensive to consumers, and requesting information as to the cause of the trouble and possible remedies therefor.

In response to the application, the Board has caused the pond and its surroundings to be examined by one of its engineers, and chemical and microscopical examinations to be made of the water, both at the source and as supplied to consumers. The results of the examinations show that the offensive taste and odor of the water of Haggett's Pond at the time the complaint was made were very probably due to the presence of large numbers of the organism *Synura*, which has been known to cause very disagreeable tastes and odors in other water supplies. The cause of the presence and growth of such organisms in surface waters is not definitely known, but their numbers are apparently dependent largely on the supply of organic matter contained either in the bottom of the pond or in the water which enters it. Pollution finding its way into Haggett's Pond from the uses made of its shores would tend to increase the growth of such organisms.

The Board knows of no practicable way of improving the pond or its water-shed to such a degree that it would be likely that the presence of such organisms could be prevented or their numbers materially reduced. These organisms, while making the water very disagreeable, are not known to cause sickness; but the sources of pollution around the pond, particularly in summer, when picnic parties and temporary residents are upon its shores, render the water unsafe for domestic use. To insure safety, it would be necessary for the town to take police control of the shores and prevent the entrance of sewage into the pond, either from the resorts of sojourners or the permanent residences.

When plans for water works for the town of Andover were first under consideration, application was made to this Board for its advice regarding the use of water from this pond. To this application the Board replied as follows: —

The Board, having examined the territory to which the town is limited by chapter 437 of the Acts of 1887 for such source, finds the water of Haggett's Pond to be of good quality and abundant in quantity. The appearance of vegetable growths near the inlets of the dark-colored brooks which flow into the pond, and the finding of objectionable microscopic organisms in the water at a considerable distance from the shore, indicate to the Board that seasons are likely to occur when the water will have a disagreeable taste and odor. To guard against this probable objection, the Board would advise the town to make the necessary borings and examinations, to ascertain if a large bed of open sand or gravel cannot be found on the southerly or easterly side of the pond, below the level of the water, from which water may be pumped in sufficient quantity to supply the town, after it has filtered about one hundred feet from the pond. This arrangement would insure an excellent supply of water for the town, if the further precaution be taken of having the water which is stored kept from the light.

It does not appear that the investigations suggested by the Board were ever undertaken.

In view of the bad taste of the water at times, and the danger now existing that the pollution by sewage to which the water of the pond is exposed may cause serious injury to the health of the inhabitants of the town, the Board would advise that investigations be made, as suggested in the communication quoted above, to determine the feasibility of obtaining a sufficient supply of good water from the ground at some suitable place in the neighborhood of the pond, in order that the use of water taken directly from the pond may be avoided. If a satisfactory supply of water cannot be obtained from the ground, it may be feasible to purify the water of the pond and remove the taste and odor by filtration.

Should you decide to make tests with a view of obtaining a ground-water supply, the Board will make such examinations of samples of water as may be necessary, and will, upon application, give you further advice when you have the results of investigations to present.

ARLINGTON. An application was received June 14, 1901, from the board of health of Arlington, for the advice of the Board relative to the quality of the water of two springs in that town, and as to the question whether it would be practicable to restore their condition and make them safe for use for domestic purposes. The Board replied to this application as follows: —

JULY 11, 1901.

The State Board of Health received from you, on June 14, 1901, an application for advice regarding the use of water from two springs in Arlington, one located on Summer Street and used for the supply of the town almshouse, and the other on Pine Street. You also request advice as to whether it is possible to restore the condition of the latter spring so that the water may be safely used for domestic purposes.

In response to your request, the Board has caused the springs and their surroundings to be examined and samples of their waters to be analyzed. The results of the analyses show that the water of both springs has at some time been very highly polluted by sewage and not thoroughly purified in its passage through the ground to the springs, and the Board regards these springs as unsafe sources from which to take water for drinking. There appears to be no practicable way by which the waters of these springs, or either of them, may be rendered safe for drinking.

ARLINGTON. An application was received Sept. 17, 1901, from the trustees of the Symnes Hospital, for advice relative to the use of a spring for the purpose of supplying the hospital with water. The Board replied to this application as follows: —

Nov. 7, 1901.

The State Board of Health received from you, on September 17, a communication stating that the trustees of the hospital propose to use as a source of water supply for that institution a spring, from which the buildings at present belonging to the hospital are supplied through a small lead pipe, and that they desire the advice of the Board as to the quality of the water and the suitability of the source for this purpose.

The Board has caused the spring and its surroundings to be examined by one of its engineers, and a sample of the water to be analyzed, and the quantity of lead present in the water after passing through the supply pipe to the buildings to be determined. The results show that the water has at some time been slightly polluted by sewage, but at the present time is being quite well purified in its passage through the ground before reaching the spring. There are indications, however, that the purification of the water may not be as thorough at all times as it is at present, and it is possible that the water of the spring may be very unfavorably affected at times by drainage from the cultivated lands about it. The water also takes up lead in small quantities from the pipe through which it is now supplied to the buildings. The water pipes of the town of Arlington are laid in the neighborhood of the hospital, and it appears to be practicable to obtain an adequate supply of water from the town works; and, considering the circumstances, the Board would advise that the use of water from this spring for the supply of the hospital be avoided.

ATTLEBOROUGH. An application was received from the water board of Attleborough, Dec. 19, 1898, for the advice of the State Board of Health relative to the presence of an unusual amount of iron in the public water supply after passing through the iron service pipes of the town. The Board, on Jan. 24, 1899, presented a statement of the results of the studies made up to that time, and on Feb. 7, 1901, made a final reply to the application as follows: —

Feb. 7, 1901.

In response to an application from you for advice as to the result of studies made by this Board with a view to eliminating iron from the public water supply of the town of Attleborough, the Board, on Jan. 24, 1899, presented a statement of the results of investigations which had been made up to that time. The results showed that the water, as it was drawn from the well used for the supply of the town, was clear, nearly colorless and odorless, and was also soft and in other respects of excellent quality for drinking and domestic uses; but it was found that the water as drawn from the pipes in various parts of the distributing system in the town contained an excessive quantity of iron, and, since the quantity of iron present in the water of the well had always been insignificant, it was evident that iron was taken up by the water in its passage through the pipes.

The cause of the action of the water upon the pipes was found to be the presence of large quantities of carbonic acid gas and oxygen, and various means of removing these substances from the water were tried; but, while it was found to be feasible to remove the carbonic acid, it was also found, in several of the processes tried, that so much oxygen would remain that the water would continue to act upon the pipes, and probably take up enough iron to injure its quality. The experiment of adding lime to the water had also been tried, and investigations on this line have been continued; but no practicable way of treating the water has been found that could be depended upon at all times to prevent its action upon the pipes without involving danger of injuring its quality.

Further investigations, made soon after this reply was sent you, indicated that the trouble with the water was almost wholly due to its action upon the service pipes, nearly all of which were of galvanized iron, and not to action on the cast-iron mains; and it was suggested to you to try the effect, at various places where complaint of the quantity of iron in the water had been made, of changing the service pipe, and introducing a service pipe of some other metal, or one lined with some substance that would prevent the water from coming in contact with the iron.

In accordance with this suggestion, you have replaced several service pipes of galvanized iron where such complaint had been made of the character of the water at nearly all times, and where analyses showed the presence of excessive quantities of iron in the water, with pipes lined with cement or tin; and after a long period of use it appears that no further trouble from iron has been observed in the water, and only an insignificant quantity is found by analysis.

As a result of its investigations, both at Attleborough and many other places, the Board is of the opinion that trouble from iron in the water of the Attleborough water supply can be largely and probably wholly avoided by discontinuing the use of galvanized-iron service pipes, such as those which have been used in the past, and using pipes lined with cement, or some other substance not acted on to any noticeable extent by the water.

The Board would especially caution you against the use of lead or lead-lined pipe for services in connection with this water; since carbonic acid and oxygen, when present in water in such quantities as are found in the Attleborough supply, have been found to take up lead in large quantities from pipes of that metal when they are used as service pipes, and many severe cases of lead poisoning in other places in the State have been traced to the use of such waters through lead service pipes.

While the expense of changing all the service pipes in the town would be considerable, it nevertheless seems probable that this will be the least expensive way of avoiding further complaint from the presence of an excessive quantity of iron in the water. It may be said, also, that trouble from iron has probably not yet occurred in a large proportion of the service pipes to such an extent as to make the water seriously objectionable; and it is probable that, by replacing a portion of them in the beginning, and gradually replacing the remainder as complaint occurs, trouble from the presence of iron in the water would soon be prevented.

ATTLEBOROUGH. An application was received March 20, 1901, from the manager of the estate of E. A. Robinson of Attleborough, for the advice of the Board relative to the quality of the water of driven wells used by the tenants of the estate and by the employees in the factories of the estate. The Board replied to this application as follows: —

MAY 2, 1901.

In response to your request for advice as to the quality of the water of three driven wells upon the estate of E. A. Robinson at Attleborough, which is now used by the tenants of certain factories and by their employees for drinking, the Board has caused the wells and their surroundings to be examined by one of its engineers, and a sample of the water to be analyzed. The wells are located near the central portion of the main village of Attleborough, and the ground water is exposed to pollution by sewage and other waste matters. The results of the analysis show that the water is hard and has been greatly polluted by sewage, though subsequently well purified in its passage through the ground. The water is clear, colorless and odorless, and the analysis does not indicate that the water as drawn from the wells at present is unsafe to use for drinking purposes; but changes in the height of the ground water or other circumstances may at any time render the water unsafe, and the Board does not recommend its continued use for drinking purposes.

ATTLEBOROUGH. An application was received from J. M. Fisher & Co. of Attleborough for the advice of the Board relative to the quality of the water used by their employees for drinking purposes. The Board replied to this application as follows: —

OCT. 3, 1901.

In response to your request for advice as to whether the water of a well used for the supply of your employees and others in Attleborough is suitable for drinking, the Board has caused the well and its surroundings to be examined, and a sample of the water to be analyzed. It appears that the well has already been examined by this Board earlier in the year, in response to another request, to which the Board replied as follows: —

The results of the analysis show that the water is hard and has been greatly polluted by sewage, though subsequently well purified in its passage through the ground. The water is clear, colorless and odorless, and the analysis does not indicate that the water as drawn from the wells at present is unsafe to use for drinking purposes; but changes in the height of the ground water or other circumstances may at any time render the water unsafe, and the Board does not recommend its continued use for drinking purposes.

The recent analysis shows no improvement in the quality of the water over its condition at the time the previous examination was made, and the Board sees no reason to modify the advice quoted above.

BRAINTREE. An application was received July 10, 1901, from the board of health of Braintree, for the advice of the State Board of Health as to the propriety of closing a cemetery which is located on the shore of the pond used as a source of public water supply. The Board replied to this application as follows: —

AUG. 26, 1901.

In response to your request, received July 10, for the opinion of this Board as to the advisability of closing Lakeside Cemetery, located on the north-easterly side of Little Pond, the Board has caused the locality to be examined by its engineer.

The results of the examination indicate that the cemetery as used at present does not constitute a serious menace to the health of those who may use the water of the Braintree water works for drinking. The attention of the Board has, however, been called, in connection with this investigation, to other circumstances relating to the water supply of Braintree. It appears that the yield of the filter-gallery was insufficient for the requirements of the town in dry weather during the past two years, and the Board is informed that water has been taken directly from Little Pond for the supply of the town. The Board is also informed that some of the material between the gallery and the pond has been removed and replaced with coarser material, and that it is proposed to remove still more of the material at present lying between the filter-gallery and the pond and replace it with other material through which water will filter more readily.

An examination of the water-shed of the pond shows that the sewage from the large population on its water-shed is discharged into vaults and cesspools, some of which are very close to the shores of the pond, and analyses of the water show that it is being polluted by sewage.

The results of analyses of samples of water collected from your filter-gallery and pumping station, and from Little Pond, from time to time, show that much of the water pumped for the supply of the town comes from Little Pond, either directly or after being only partially purified by filtration through the ground; and bacterial examination shows the presence of unpurified sewage in the water both of the pond and of the filter-gallery.

In the opinion of the Board, the condition of the Braintree water supply is a great menace to the health of the people to whom this water is supplied; and the Board would advise that the inhabitants who use the water be notified that, until its quality is known to be safe, it should not be used for drinking unless it has been rendered safe by boiling.

The following communication was also sent to the water commissioners of Braintree on the same day: —

In connection with a request of the board of health of Braintree for advice with reference to closing a cemetery near Little Pond, the Board has caused a careful examination to be made of the conditions affecting the water supply of Braintree. The results of the examination and of analyses of the water of the filter-gallery and Little Pond from time to time show that much of the water pumped for the supply of the town comes from Little Pond either directly or after being only partially purified by filtration through the ground; and bacterial examinations show the presence of unpurified sewage both in the water of the pond and of the filter-gallery.

In the opinion of the Board, the condition of the Braintree water supply is a great menace to the health of the people to whom this water is supplied; and the Board would advise that you notify the inhabitants who use the water that, until its quality is known to be safe, it should not be used for drinking unless it has been rendered safe by boiling.

Braintree. A communication was received from the water board of Braintree, Oct. 8, 1901, relative to certain changes which had been made in the filter-gallery of the water works supplying the town, and requesting to be informed as to whether the water of the filter-gallery could then be used with safety for drinking purposes. The Board replied to this application as follows: —

Nov. 7, 1901.

The State Board of Health received from you, on Oct. 8, 1901, a communication relative to certain changes at the filter-gallery of the Braintree water works, near Little Pond, in which you state that you have removed the coarse filling from a trench running from the filter-gallery wall to the pond, and have placed two rows of sheet piling across the trench, about two feet apart, filled between with sand, and have covered the shore with sand, with the intention of shutting off all water from entering the filter-gallery except as originally through its bottom; and you request to be informed as to whether, in the opinion of the Board, the water of the filter-gallery may now be used with safety for drinking.

In response to your request, the Board has caused several samples of the water of the filter-gallery to be analyzed, and the results of these analyses indicate that the quality of the water is much better than it was found to be at the time the previous communication was sent you, and that it is not very different from its quality at the time it was proposed to add the tubular wells to the works in 1896.

In response to an application made by your board in that year, this Board advised that the purity of the water of the filter-gallery was dependent largely upon the purity of the water of Little Pond, and that the presence of a dense population upon land sloping toward the filter-gallery and in its immediate neighborhood was also a menace to the purity of the water.

The population in the neighborhood of the filter-gallery has increased since the time the communication mentioned was sent you, and the conditions have grown, on the whole, somewhat more unfavorable since that time. In the opinion of the Board, the water of the filter-gallery and wells at the present time is probably not unsafe for drinking; but, owing to the circumstances attending the pollution of the pond and of the filter-gallery, the water is liable to become unsafe for drinking at any time.

The Board would again urge that you take measures, without delay, to secure an adequate supply of good water, since the yield of the present filter-gallery and wells is insufficient for the supply of the town in the drier portion of the year, and the water of Little Pond, the only other source now available for use, is not safe for drinking.

Bridgewater. An application was received June 6, 1901, from the board of health of Bridgewater, alleging that frequent complaints had been made as to the quality of the water furnished by the Bridgewaters Water Company, and requesting that an analysis of the water be made. The Board replied to this application as follows: —

July 11, 1901.

In response to your request for an examination of the quality of the water furnished to the town of Bridgewater by the Bridgewaters Water Company, concerning which it appears that numerous complaints have recently been made, the Board has caused the sources of supply and their surroundings to be examined by one of its engineers, and several samples of their waters to be analyzed.

It appears from this examination that the sources now in use by the company are three large wells on the north-westerly side of the Town River, in Bridgewater, in one of which there is a deep tubular well; a group of tubular wells in their neighborhood, nearly all located between these wells and the river; and, finally, a group of tubular wells about one thousand feet down stream from the pumping station. Water from the tubular wells in the neighborhood of the large wells is drawn directly from the ground by the pumps at the same time that water is being drawn from the large wells, so that it is not practicable to get a separate sample of water from these sources. Water from the tubular wells down stream is pumped into one of the large wells.

Analyses of the water of the various sources of supply made in this and in previous years have shown that the water of the three large wells originally used is naturally of good quality, and the addition of the tubular wells between these wells and the river did not materially change the general quality of the water supply of the town; but after the system of tubular wells down stream was added to the other sources of supply the quality deteriorated considerably, owing to an excessive quantity of iron in the water of the tubular wells.

The presence of iron would impart a disagreeable taste and odor to the water. It is possible also that growths of organisms may occur in the open iron tank used in connection with the distributing system which would also give the water a noticeable taste and odor.

In one of the samples collected from the most easterly of the large wells there was a noticeable odor of hydrogen sulphide, but this odor was not subsequently detected either in the samples of water from this well or from faucets in the town.

The results of the examination indicate that the complaints as to the quality of the water are due to one, or possibly all, of the causes mentioned. Any trouble from growths of organisms in the distributing tank can be effectually prevented by covering the tank so as to exclude all light. The large quantity of iron present in the water of some of the sources may not be injurious to health, but, besides imparting to the water a disagreeable taste and odor, the iron renders the water objectionable for many uses, and it is desirable that the use of water containing an excess of iron be avoided. It is probable that in this case the iron can be removed from the water by filtration without special difficulty, at a small expense. Water containing hydrogen sulphide is offensive for drinking, but it can possibly be removed from the water by aeration.

It appears that the capacity of the sources at the present time is barely sufficient to furnish the quantity of water required by the towns now supplied; and, considering the poor quality of much of this water, the Board considers it advisable that investigations be made with a view to securing an ample quantity of good water for the supply of the town at all times.

CAMBRIDGE. An application was received Jan. 23, 1901, from the Reversible Collar Company of Cambridge, for the advice of the Board as to the quality of the water of a tubular well which had been driven for the purpose of obtaining a water supply for drinking and general use. The Board replied to this application as follows: —

JUNE 6, 1901.

In response to your application for advice relative to the quality of the water of a tubular well which you desire to use as a source of water supply for drinking purposes for one hundred and fifty employees, the Board has caused the well and its surroundings to be examined and several samples of the water to be analyzed.

The results of the analyses all indicate that the water has at some time been polluted by sewage, and not thoroughly purified in its passage through the ground to the well. The water also contains an excessive quantity of mineral matter, consisting largely of sodium carbonate; and, considering all the circumstances, the Board does not advise the use of this water for drinking purposes.

CAMBRIDGE (Randall Hall Association). The president of the Randall Hall Association applied to the State Board of Health March 1, 1901, for advice as to a proposed supply of water for drinking purposes to be taken from a tubular well near the building of the association. The Board replied to this application as follows: —

APRIL 4, 1901.

In response to your application of March 2, 1901, requesting the advice of the Board as to a proposed plan for securing a water supply for the Randall Hall Association by sinking a tubular well near the present tubular well, close to the building of the association, the Board has caused the locality to be examined by one of its engineers, and samples of the water of your present well and other wells in the neighborhood to be analyzed. The results of an analysis of a sample of water taken from the present well show that, while this water is clear and nearly colorless, it is quite hard, and has evidently at some time been polluted by sewage and not thoroughly purified in its subsequent passage through the ground to the well.

The new well, like the present well, would be located in a populous region; and, in the opinion of the Board, it is not likely that a water of better quality would be obtained from the proposed new well than that now being furnished by the present well. The Board does not, therefore, advise an attempt to obtain a water supply for the association in the manner now proposed.

The Board would suggest that, if the object of securing an independent supply of water is due to any objectionable quality of the public supply that may be caused by the presence of organic matter, or a disagreeable taste and odor such as is sometimes noticeable in water drawn from surface sources, it will be practicable for the association to secure a water of excellent quality at all times by filtering such portion of the supply as may be necessary to use for drinking purposes through a properly constructed sand filter. Such a filter may be seen in operation at the State House.

CHICOPEE. An application was received from the board of health of Chicopee for the advice of the State Board of Health relative to the quality of the water of a spring used for drinking purposes at the works of the Lamb Manufacturing Company in Chicopee. The Board replied to this application as follows:—

FEB. 7, 1901.

In response to your application of Jan. 10, 1901, for advice as to the quality of the water of a spring located at the works of the Lamb Manufacturing Company in Chicopee, the Board has caused the surroundings of the spring to be examined by one of its engineers, and a sample of the water to be analyzed.

The spring is located between the canal and the Chicopee River, at a place where the canal is about one hundred and twenty-five feet from the edge of the river, and at a considerably higher level. Sewage from a portion of the city and from towns farther up stream is discharged into the river above the entrance to the canal, thus directly polluting the canal water. The results of the analysis indicate that the water of the spring is largely derived by percolation from the canal through the ground toward the river, and the water has not been purified in its passage through the ground.

Under the circumstances, the Board regards the water of this spring as unsafe for drinking, and would advise that its further use be prevented.

COHASSET. An application was received Oct. 10, 1900, from the Cohasset Water Company, for the advice of the Board relative to an additional water supply for that town from certain sources which were indicated. The Board replied to this application as follows:—

MAY 8, 1901.

The State Board of Health received from you, on Oct. 10, 1900, an application for advice with reference to an additional water supply for Cohasset; and subsequently you indicated Bound Brook in North Scituate and Lily Pond in Cohasset as possible sources of additional supply, and requested advice as to the purification of these waters, which are highly colored with vegetable matter.

Soon after your application was received the Board caused these and other possible sources of additional water supply for Cohasset to be examined by its engineer, and samples of their waters to be analyzed. It was found that the water of Bound Brook is very highly colored, and evidently receives considerable pollution from the village of Beechwood, located on its water-shed.

The water of Lily Pond also, like that of Bound Brook, is very highly colored, and would doubtless be objectionable in summer, if used as a direct source of water supply, on account of an unpleasant taste and odor. Lily Pond is situated nearer the village than Bound Brook, and its natural water-shed contains only a very small population. It was found, however, that

Bound Brook below the village of Beechwood sometimes backs up into the pond; but the danger of pollution from this source could apparently be prevented at no great expense by the construction of a low dam at the outlet of the pond.

Examinations were also made of streams between Scituate Hill and Turkey Hill, in the north-westerly part of the town, where it was found that it would be practicable to construct small storage reservoirs; but the cost of such works would probably be larger than the cost of taking the water of Lily Pond, and the quality of the water might be but little if any less unsatisfactory.

It appears that investigations with reference to obtaining a supply of ground water have been made by you, in accordance with the advice of the Board in previous years, but that no place has been found from which an adequate supply of good ground water can be obtained.

The results of the examinations made by the Board at this and previous times indicated that the best practicable way of obtaining an additional water supply for the use of Cohasset would be to take water from Lily Pond, and purify it by removing as much as possible of the color and organic matter before supplying it to the town; and soon after your application was made, experiments were begun by the Board upon the purification of the water of Lily Pond by filtration, using the pond water sent in by you from time to time. These experiments were made in the winter season, and no opportunity has been offered as yet for experiments upon this water during the summer season at the time when this source would be used; but the results of the investigations as a whole indicate that it will be practicable to greatly improve the quality of this water by very slow filtration, so that, when mingled with water now supplied to the town, the quality of the supply as a whole will be about the same as that of many towns now supplied with water from surface sources.

Experience in many places with filter-galleries and wells located beside ponds or streams of highly colored water has shown that, while much water from the neighboring pond or stream finds its way into the wells, the color of the water from the surface source is almost completely removed from the water in its passage through the ground. Tests of the soil in the land about Lily Pond made by means of wells do not show any place at which the soil is sufficiently porous to make it practicable to secure a supply of water by means of wells or a filter-gallery; but the experience at other places indicates that it may be practicable to distribute the water of Lily Pond upon the ground in the region about your present wells, and increase considerably their yield without unfavorably affecting the quality of the water. More favorable conditions for obtaining an additional supply in this way appear to exist on the northerly side of the railroad, west of Sohier Street, not far from your present main pumping station, where tests have shown that the soil in a part of this region consists of a layer of peaty soil for a depth of three feet, beneath which is a deep stratum of sand, and then gravel at a depth of about twenty feet beneath the surface and just above ledge. Other areas in this region have a smaller depth of peat at the surface, and in some places there is none. The ground water in this region is apparently influenced by the pumping from your present wells; but wells in this locality would be likely to yield naturally a small additional supply of water, and it is possible that if wells should be put in at this place and water distributed upon the ground in their neighborhood, avoiding, however, applying it to peaty areas, a large yield of ground water could be obtained.

In view of the circumstances, the Board would advise that works be constructed to pump water from Lily Pond to the neighborhood of your present main pumping station, and that a test be made of the feasibility of distributing these waters upon the ground about your present wells, if suitable soil exists there through which water may filter to the stratum from which the wells are now supplied; and if the conditions at this place are not favorable, that wells be put in west of Sohier Street and north of the railroad, and an attempt be made here also to secure a large yield of water by distributing the Lily Pond water upon the ground about the wells. At the same time, it is desirable that further experiments be made upon the removal of the color and organic matter from the water of Lily Pond by filtration. Should you decide to carry out this plan, and bring the water of Lily Pond to the neighborhood of the pumping station, the Board will assist you in experiments upon the filtration of this water by making such analyses of the water as may be necessary, and will, upon application, give you further advice in the matter when the results of further tests are available.

COLRAIN. On March 27, 1901, the Griswoldville Manufacturing Company applied to the Board for its advice as to the propriety of taking water for the supply of the village of Griswoldville from McClellan Brook. The Board replied to this application as follows: —

MAY 2, 1901.

In response to your application of March 28 for advice as to the use of McClellan Brook, so called, in Griswoldville, as a source of water supply for that village, the Board has caused the source to be examined by one of its engineers, and a sample of the water to be analyzed. Your plan as outlined provides for taking the water of McClellan Brook in the neighborhood of the place where it crosses the abandoned road from Griswoldville to Greenfield; and, since a considerable tributary enters the main stream a short distance below this point, and this tributary could readily be used in connection with the main stream, a sample of the water of the tributary has also been analyzed. The results of the analyses show that the water of both streams is clear, nearly colorless and odorless, and would be of good quality for the purposes of a public water supply. The water-sheds contain no dwelling houses, and are apparently free from danger of sewage pollution. While it is not practicable to tell, from an examination made at this season of the year, how large a quantity of water these sources may yield, it seems probable, from the information now available, that the stream and its main tributary would yield a sufficient quantity of water for all the needs of the village; and there is a good opportunity for the construction of a small storage reservoir on the main stream, in case a larger supply of water should be found necessary than the natural flow of the brook will furnish.

The Board is of the opinion that McClellan Brook, including its main tributary on the south, is an appropriate source of water supply for the village of Griswoldville.

DALTON. An application was received May 1, 1901, from the water commissioners of the Dalton Fire District, for the advice of the Board relative to a proposed additional water supply from certain brooks in the town of Windsor. The Board replied to this application as follows: —

MAY 8, 1901.

The State Board of Health received from you, on May 1, 1901, an application, under the authority of chapter 375 of the Acts of 1888 and chapter 241 of the Acts of 1901, requesting the advice of the Board as to plans for an additional water supply for the district, and the approval by the Board of the use of May Brook and Whitmarsh or Tyler Brook as sources of additional water supply for the district.

The Board has caused the sources mentioned in your application to be examined by its engineer, and samples of the water to be analyzed. The results of the analyses show that the water of May Brook at the time the sample was collected, on April 17, had a little less color than the water of the reservoir from which your present supply is drawn, and was somewhat better in other respects, though not quite so soft. The water of Whitmarsh or Tyler Brook, which it is proposed to divert into May Brook, has more than twice the color of the water of your present source of supply, and contained a greater quantity of organic matter, as indicated by the albuminoid ammonia. It is difficult to judge, from the results of a single analysis at this season of the year, what the quality of the water would be at other seasons; but it is understood that this water is to be used only as an additional supply in the summer season, and it seems probable that the quality of the water of these brooks will be at least as good as at the present time, though it may be slightly harder.

The flow of May Brook in the drier portion of a dry season, judging from the information available to the Board, is a little more than one-third as great as the flow of the brooks from which your present supply is drawn;

and the flow of this stream alone, used in connection with your present sources, would be a material addition to the water supply of the district.

The flow of Whitmarsh or Tyler Brook is said to be considerably larger in the summer season than that of May Brook; but, on account of the color and organic matter present in the water of this brook, it will be desirable to divert only so much of it into May Brook as may be necessary. The color and organic matter present in the water of Whitmarsh Brook is doubtless due to the slow passage of the water through swamps; and if this water should be seriously objectionable from this cause, it can doubtless be improved by draining the swamps and preventing the water from standing thereon. There are a few dwelling houses within the water-sheds of these streams from which the water might possibly be polluted; and it is important that, while these streams are in use, the danger of the pollution of the water from the dwelling houses within their water-sheds be prevented.

The Board is of the opinion that May Brook, supplemented when necessary with water from Whitmarsh Brook, is an appropriate source of public water supply; and recommends the use of these streams, with the precautions suggested, as sources of additional water supply for the Dalton Fire District.

EASTHAMPTON. An application was received Oct. 4, 1901, from the water commissioners of Easthampton, for the advice of the Board relative to a proposed addition to the water supply of the town by taking water from the north branch of the Manhan River. The Board replied to this application as follows: —

Nov. 7, 1901.

The State Board of Health received from you, on Oct. 4, 1901, an application for advice with reference to a proposed additional water supply for Easthampton, in which you state that you propose to petition the next Legislature for the right for the town of Easthampton to take water from the north branch of the Manhan River, at a point near what is known as the Kingsley bridge or a point above, but that no further plans have yet been prepared for the development of a supply from this source.

The Board has considered your proposed plan of increasing the water supply of Easthampton, and has caused the present and proposed sources to be examined by its engineer, and samples of their waters to be analyzed.

Bassett Brook, the present source of supply, furnishes usually a water having but little color, and which rarely contains a large quantity of organic matter. It appears that the quantity of water which this source is capable of furnishing has been found to be insufficient for the supply of the town in the drier portion of a recent dry season, and it is evident that, with the present consumption of water, an additional supply is necessary. While no records of the consumption of water have been kept, the indications are that the quantity of water pumped for the supply of the town in past years has been greater than is necessary, but with the present rapid growth of the town it is unlikely that a sufficient reduction in the use or waste of water can be made to ensure an adequate supply from the present source at all times. Under the circumstances, it is desirable, in the opinion of the Board, that a new source be provided.

The source now proposed, the north branch of the Manhan River, above Loudville, would probably furnish an adequate supply of water by gravity for the requirements of Easthampton for a long time in the future; but it will be necessary to provide a reservoir or reservoirs for the storage of water in the summer season, when the use of water becomes greater than the natural flow of the stream. There appear to be suitable sites within the water-shed where storage reservoirs can be constructed without special difficulty. The quality of the water appears to be considerably better than that of Bassett Brook, your present source of supply, and the results of several analyses indicate that the water is usually nearly free from color and contains but little organic matter for a surface water, and is otherwise of good quality for the purposes of a public water supply.

As a result of its investigations, the Board is of the opinion that the Manhan River, above Loudville, is an appropriate source of water supply for Easthampton.

The population upon the water-shed of the Manhan River, above Loudville, is small in proportion to the size of the water-shed, and appears to be decreasing; but it will, nevertheless, be necessary, if this source is used, to guard carefully against the pollution of the water from this population. Examinations made by the Board indicate that the population upon the North Brook branch, above Loudville, is much smaller in proportion to the size of the water-shed than the population in other parts of the valley, and there are apparently favorable places at which storage reservoirs might be constructed upon this stream. The water-shed of the Sodden Brook tributary, above the stream which enters it from the neighborhood of the village of Westhampton, appears also to have a somewhat smaller population per square mile than that of the remaining portions of the water-shed, excluding the North Brook branch. The waters of both these tributaries have been analyzed, and have been found to be of about the same quality as that of the water of the main stream; and, under the circumstances, the Board would recommend that before works are constructed for taking a supply of water for Easthampton from the water-shed of the north branch of the Manhan River, above Loudville, the feasibility of obtaining a supply from North Brook alone, or from North Brook used in connection with Sodden Brook above the stream flowing from Westhampton, be carefully considered.

FRAMINGHAM. The Dennison Manufacturing Company applied to the State Board of Health, Aug. 27, 1901, for advice relative to the quality of the water of a well upon the premises of the company. The Board replied to this application as follows : —

OCT. 3, 1901.

In response to your request for advice as to the quality of the water of a well situated at your factory at South Framingham, the Board has caused the well and its surroundings to be examined, and a sample of the water to be analyzed. The results of the analysis show that the water is hard and contains an excessive quantity of iron, and that it has been at some time slightly polluted and not thoroughly purified in its subsequent passage through the ground.

The water of this well, though not a desirable drinking water, cannot be considered unsafe for drinking at the present time; and further analyses, after pumping has continued for a longer time, will be necessary to enable the Board to advise as to the propriety of its continued use. The Board will make further analyses, if you will cause the necessary samples of water to be collected and returned to its laboratory.

FRANKLIN. The school committee of Franklin applied to the State Board of Health March 13, 1901, for advice relative to the quality of the water of a well used by a public school in that town. The Board replied to this application as follows : —

APRIL 4, 1901.

In accordance with your request for an examination of the water of a well used by the children at a public school on School Street, Franklin, the Board has caused the well and its surroundings to be examined, and a sample of the water to be analyzed.

The results of the analysis show that the water in its present state is clear, colorless and free from odor, but quite hard, and has been greatly polluted by sewage, though subsequently well purified in its passage through the ground. The analysis does not indicate that the water as drawn from the well at present is unsafe to use for drinking purposes; but the places from which the water evidently receives its pollution are so near the well that changes in the height of ground water and in the circumstances attending its pollution may at any time render the water of this well unsafe, and the Board cannot recommend its continued use for drinking purposes.

FRANKLIN. The attention of the Board was called to the danger of pollution of Beaver Pond (one of the sources of water supply of Franklin) by sewage discharged into Mine Brook, and after an investigation of the subject, the Board sent the following communication to the Franklin Water Company : —

JUNE 6, 1901.

The attention of the Board having been called to the danger of the pollution of Beaver Pond, one of your sources of water supply, by sewage discharged into Mine Brook, the Board has caused the locality to be examined recently by one of its engineers, at a time of high water in the brook, and when water from the pond was being used in connection with that of other sources for the supply of the town.

The results of the examination show that the course of Mine Brook lies through a meadow along the easterly side of Beaver Pond, from which it is separated for a distance of several hundred feet only by a low ridge. At the time the examination was made the water had backed up in the brook to such a height that the ridge was submerged, and the brook water could flow directly into the pond in the immediate vicinity of the intake to the Franklin water works. An examination of the water-shed of Mine Brook shows that the stream is not only grossly polluted by manufacturing wastes, but also receives a large amount of direct sewage pollution from water-closets and privies in several factories along its course.

In the opinion of the Board, these conditions are a great menace to the health of the people to whom this water is supplied by your company, and the Board would advise that you take measures, without delay, to secure an adequate supply of water for the town that is free from danger of sewage pollution.

The following communication was sent to the board of health of Franklin: —

JUNE 6, 1901.

A recent examination by this Board of the sources from which the town of Franklin is supplied with water by the Franklin Water Company has shown that there is great danger of serious injury to the health of the inhabitants of the town by the use of the water of Beaver Pond, and the Board has to-day sent a communication relative to the matter to the Franklin Water Company, a copy of which is enclosed.

The Board would advise that the use of water from Beaver Pond be discontinued without delay; but if this is impracticable, the inhabitants should be notified that until the quality of the water is known to be safe, it should be boiled before being used for drinking.

GEORGETOWN. The selectmen of Georgetown applied to the State Board of Health Oct. 4, 1901, for advice relative to the quality of the water used by the Perley Free School for drinking. The Board replied to this application as follows: —

NOV. 7, 1901.

In response to your request for an examination of the drinking water used by the Perley Free School, the Board has caused the well from which the supply is taken and its surroundings to be examined, and samples of the water to be analyzed. It appears that the source from which the water used for drinking is taken is a well located in the basement of the school building, and the water is drawn from the well through a lead suction pipe and pumped to a wooden tank in the top of the building and distributed through galvanized-iron pipes.

The results of the analyses of several samples of water collected from the well, from the tank and from faucets in the building show that, while the water is clear, colorless and odorless, it has evidently at some time been greatly polluted by sewage and subsequently not thoroughly purified in its passage through the ground to the well. The water evidently acts upon the pipes through which it is supplied, and takes up a large quantity of zinc and a small quantity of lead. This water is, in the opinion of the Board, unsafe for drinking, and a supply of water of good quality should be secured without delay. It is important, in the opinion of the Board, that the pipes used in the distribution of the water be of such material that they will not be acted upon by the water, or, if acted upon, will not be liable to take up matters which will injure the health of those who may use the water for drinking.

GOSHEN. An application was received March 12, 1901, from the proprietors of the Highland House in Goshen, requesting an examination of the water of certain wells used as sources of water supply for the hotel. The Board replied to this application as follows: —

MAY 2, 1901.

In response to your request for advice as to the quality of the water of two wells used for the supply of the Highland House, the Board has caused the wells and their surroundings to be examined, and samples of the water to be analyzed.

The results of the analysis of water sent in by you from the well beneath the hotel show that the water has been quite highly polluted by sewage and not thoroughly purified in its passage through the ground. There are sources of pollution in the immediate neighborhood of the well, and the circumstances are such that the Board regards the water unsafe for drinking. The results of the analysis of water from a well at the Annex do not indicate that the water of this well is unsafe for drinking; but, if its use for drinking and other domestic purposes is to be continued, care should be taken to prevent the danger of pollution of the water from any sewage or other domestic wastes, and it is desirable that these wastes be disposed of at a greater distance from the well than at present.

HOLYOKE. The Chemical Paper Company of Holyoke applied to the Board June 29, 1901, for its advice relative to the quality of the water of a driven well on the premises of the company. The Board replied to this application as follows: —

AUG. 1, 1901.

In response to your application for advice as to the quality of the water of a tubular well used as a source of drinking water supply at your works, the Board has caused the well and its surroundings to be examined and a sample of the water to be analyzed. The results of the analysis show that the water has evidently been considerably polluted by sewage, and not thoroughly purified in its subsequent passage through the ground.

Considering the circumstances, the Board does not regard this well as a safe source from which to take water for drinking.

HOLYOKE. An application was received from the board of health of Holyoke, Dec. 18, 1900, for the advice of the State Board of Health relative to the use of the water of a stream known as "Crystal Spring" as a source of water supply for that part of Holyoke known as Elmwood. The Board replied to this application as follows: —

JAN. 21, 1901.

In response to your application of Dec. 18, 1900, for advice as to whether the water of the stream known as Crystal Spring, used to supply about five hundred residents of the district known as Elmwood in Holyoke, is suitable for domestic use, the Board has caused the source to be examined by one of its engineers, and a sample of the water to be analyzed.

The results of the analysis show that the water at the present time, while somewhat hard, is nearly colorless and contains but little organic matter. An examination of the water-shed shows that near its upper end there are two dwelling houses, and a building which has been used in the past as a small-pox hospital for the city of Holyoke; but for several years no cases have been treated at this place, though the building is maintained ready for use. It does not appear that polluting matters are entering directly any of the streams in the water-shed at the present time, and, in the opinion of the Board, the water at present is suitable for domestic use. It is exposed, however, to possible danger of serious pollution from the buildings on the water-shed; and if the use of the source is to be continued, it will be necessary to see that all polluting matters from any of these buildings or from any of the farming operations within the water-shed are kept out of the streams at all times; and especial care should be taken, in case any contagious or infectious disease should appear on this water-shed, to prevent danger to the water supply therefrom.

LAWRENCE (Atlantic Cotton Mills). An application was received July 20, 1901, for the advice of the Board relative to the quality of the water of a well on the premises of the Atlantic Cotton Mills. The Board replied to this application as follows: —

OCT. 3, 1901.

The State Board of Health received from you, on July 20, 1901, an application for advice with reference to the water of a well on the grounds of the Atlantic Cotton Mills, and has caused the well and its surroundings to be examined, and several samples of the water to be analyzed. The results of the analyses have shown that the water varies greatly in character from time to time, some of the analyses indicating that the water entering the well had been considerably polluted by sewage, though subsequently quite thoroughly purified in its passage through the ground before entering the well. Considering the circumstances, the Board does not regard this well as a safe source from which to take water for drinking.

LAWRENCE (Hamblet Machine Company). An application was received July 10, 1901, from the Hamblet Machine Company, for the advice of the Board relative to the quality of the water of a well situated upon the premises of the company. The Board replied to this application as follows: —

OCT. 3, 1901.

In response to your request for advice as to the quality of the water of a well recently driven in the rear of your shop at Lawrence, the Board has caused the well and its surroundings to be examined, and a sample of the water to be analyzed.

The water in its present state is of good appearance, nearly clear and colorless; but it contains considerable organic matter, and is quite hard, while the water of the city supply which is available is soft. The analysis does not indicate that the water supplied by this well at present is unsafe for drinking; but its great hardness is objectionable, and the location is such that there is danger that it may become polluted at any time by imperfectly filtered water from the race or the canal; and the Board advises that, if used for drinking purposes, it should be analyzed from time to time.

LENOX. An application was received from the Lenox Water Company May 20, 1901, for advice relative to an extension of its system of water supply. The Board replied to this application as follows: —

NOV. 7, 1901.

The State Board of Health received from you, on May 20, 1901, an application for advice with reference to enlarging the yield and improving the quality of the water of your present main reservoir, in which your proposed plans are outlined as follows: —

It is proposed to develop the water production in the water-shed tributary to the main reservoir of the Lenox Water Company by connecting the various springs in the water-shed with the reservoir by pipes, so that no water need be lost in dry

times; also to underdrain the land so that the water may not be rendered impure by surface drainage or animal matter; and it is also proposed to build a conduit around said reservoir, so that all objectionable surface drainage may be kept out of said reservoir; and it is still further proposed to take measures to remove, or cause to be removed, from the said water-shed all sources of water pollution.

The Board has caused the reservoir and its water-shed to be examined by its engineer, and has carefully considered the proposed plan of improving and enlarging the supply.

It seems probable, from past experience, that the capacity of your present works is insufficient for the supply of Lenox in the drier portion of a dry season, and a larger supply of water has become necessary. There has apparently been much less cause of complaint of the quality of the water since the reservoir was cleaned, in 1898, than formerly.

If the plan of collecting ground water, including the water of the various springs in the water-shed of your present reservoir, by means of a system of drainage, should be carried out as suggested in your application, it is probable, in the opinion of the Board, that the yield of the water-shed would be increased somewhat in the drier portion of the year, provided the drains were placed at a sufficiently low level as compared with the surfaces of the streams in the water-shed; but the cost of the work would be large in comparison with the small increase in yield of the works that appears likely to be obtainable by this plan, and if any considerable portion of the surface water flowing naturally into your present reservoir should be diverted on account of objectionable surface drainage, the yield of the source might be made much less than it is under present conditions. The ground water that would be collected by the system of drainage proposed would probably be of excellent quality, and somewhat better than the water of the present streams in this water-shed; but ground water collected in the manner proposed would deteriorate rapidly if stored in your present open reservoir, or exposed to light at any place; and it would be necessary, if this plan should be carried out, either to deliver the water collected in the drains directly to consumers without storage, or to provide a covered reservoir for such storage as might be necessary. Since it would still be necessary in the drier portion of the year to use a large proportion of the water of the present reservoir in connection with the ground water, no very material improvement in the quality of the supply would be made by carrying out the proposed plan; and the Board does not advise you to attempt to increase the yield of your water-shed or improve the quality of the water by this plan.

There are several possible methods of enlarging the water supply of Lenox, which should be given careful consideration. It is possible that the yield of the present sources can be increased sufficiently to meet the requirements of the next few years by the construction of another storage reservoir within the water-shed, from which the present supply is taken;

but surveys will be necessary to determine the feasibility and cost of constructing another reservoir in this water-shed, and the probable increase in the yield of the source that can be secured in this way. It may also be practicable to secure an adequate additional supply by constructing a reservoir upon the stream below the present reservoir, and, if necessary, providing pumps to raise this water to your present reservoir during the summer season, when the use of water is greatest. The Board would advise that you cause a thorough investigation to be made, with the assistance of an engineer of experience in matters relating to water supply, of all the available sources of additional supply in the neighborhood of Lenox; and the Board will give you such assistance as it can in these investigations by making the necessary analyses of water, and will give you further advice with reference to increasing and improving your water supply, when you have the results of further investigations to present.

The dwelling houses with out-buildings located on the water-shed of your present sources of supply are liable to cause pollution of the water, notwithstanding the measures you have taken to prevent polluting matters from these places from reaching your reservoir; and it does not appear to be practicable to prevent the danger of pollution from some of the buildings, if they continue to be used as at present. The Board would advise that you take such measures as may be necessary to secure control of these buildings, and prevent danger of pollution of your water supply therefrom.

LENOX. An application was received Aug. 1, 1901, from the board of health of Lenox, requesting information as to the quality of the water of Laurel Lake, with reference to its use by several families as a domestic water supply and as to the use of the lake as a source of ice supply. The Board replied to this application as follows: —

Nov. 7, 1901.

In response to your application for advice with reference to the use of Laurel Lake as a source of water supply for several houses within its water-shed, and as to the use of this lake as a source of ice supply, the Board has caused the lake to be examined, and a sample of its water to be analyzed. The results of the analysis show that the water is nearly colorless, but it contains a large quantity of organic matter, and is very hard, being much harder than the water supply of the town of Lenox. The water-shed of the lake contains a considerable number of dwelling houses, from which polluting matters may enter the lake or its tributaries. The Board is informed that the Lenox water supply is available for the houses referred to in your communication, and, considering the circumstances, the Board does not advise the use of Laurel Lake as a source of drinking water supply for the houses referred to in your application.

The Board is of the opinion that ice which may be safely used for domestic purposes can be obtained from this lake under present conditions by taking ice only from the deeper portions of the lake, at a considerable distance from the mouths of the brooks which feed it and from possible sources of pollution near the shores, and by removing from the ice, when it is harvested, the first inch of ice that forms upon the lake and all of the ice which forms above the first inch, and retaining for use only the clear ice which forms beneath the first inch.

LEXINGTON. An application was received June 14, 1901, from the water commissioners of Lexington, for advice relative to an additional water supply, to be taken from driven wells in the Munroe meadows. The Board replied to this application as follows: —

JULY 11, 1901.

The State Board of Health received from you, on June 14, 1901, an application for advice with reference to an additional water supply for the town of Lexington, to be taken from driven wells at the Munroe meadows, so called, and has caused the locality to be examined by one of its engineers, and samples of water from test wells at the Munroe meadows to be analyzed.

The results of the analyses show that, while the water is clear, colorless and odorless, it is hard, and much of it has evidently been highly polluted by sewage and not thoroughly purified in its subsequent passage through the ground. Experience with wells in similar locations has shown that the water of such sources is likely to deteriorate when a large quantity is pumped from the wells.

A considerable portion of your present supply is of poor quality, and it is very desirable for the town, in securing a new source of supply, to obtain one, if possible, that will be capable of furnishing an ample quantity of good water at all seasons of the year, so that the less satisfactory of your present sources may be abandoned.

While the tests which have been made are not sufficient to indicate definitely the quantity of water which can probably be obtained from the ground in this region, it is, nevertheless, evident from these tests that the porous material is of no great depth, and the indications are that the area from which the ground water would be influenced to flow toward wells in this region is not extensive; and it does not seem probable that sufficient water could be obtained at this place in any case for the supply of the town of Lexington.

Considering all the circumstances, the Board does not advise the town to attempt to obtain an additional water supply from the locality proposed in your application.

LEXINGTON. An application was received Sept. 3, 1901, from the water commissioners of Lexington, for the advice of the Board relative to an additional supply of water, to be taken from a system of driven wells located in the meadow of M. H. Roberts. The Board replied to this application as follows: —

OCT 3, 1901.

The State Board of Health received from you, on September 3, an application stating that you propose to obtain an additional supply of water by a system of wells driven in a meadow owned by M. H. Roberts, in the water-shed of Beaver Brook, and requesting the advice of the Board as to this proposed plan of securing an additional water supply for Lexington.

In response to your request the Board has caused the locality indicated to be examined by its engineer, and a sample of the water from a test well at this place to be analyzed. The results of the analysis show that the water is quite hard, but it is clear, nearly colorless and odorless, and otherwise, in its present state, of good quality for the purposes of a public water supply. Whether it would remain satisfactory when a quantity such as would be required for the supply of Lexington should be drawn continuously from wells at this place cannot be predicted with certainty. The meadow in which the wells are located contains a considerable depth of peaty soil, and is apparently subject to flooding at times of high water in the brook; and water drawn from similar locations has in many cases deteriorated after a longer or shorter period of use, and become objectionable on account of an excess of iron.

The wells yielded water freely when pumping with a hand pump, but the tests thus far made are insufficient to show whether enough water for the requirements of Lexington is likely to be obtained from a system of wells in this region.

With the information at present available regarding the probable quantity and quality of water obtainable from this source, the Board does not advise the construction of works for taking water from wells in this valley; but if you should deem it desirable to make further tests, to determine more definitely the feasibility of obtaining an adequate supply of good water from this region, the Board would advise that you cause a pumping test to be made by pumping from several wells in the neighborhood of the present test wells for a period of at least two weeks, and at a rate as great as would be required from said wells for the supply of the town of Lexington.

Should you decide to make these tests, the Board will upon application make such analyses of samples of water as may be necessary, and will give you further advice in this matter when the results of the tests are available.

LEXINGTON. Another application was received from the water committee of Lexington, requesting the advice of the Board relative to a proposed additional supply to be taken from wells in the meadow of M. H. Roberts in Lexington, and submitting information concerning a pumping test made at this place. The Board replied to this application as follows: —

DEC. 5, 1901.

The State Board of Health received from you, on Dec. 2, 1901, an application for advice relative to a proposed additional water supply for Lexington, in which you state that —

> The plan is to take water from the meadow now owned by M. H. Roberts, situate in the southerly part of the town, northerly from Concord Avenue, southerly from Middle Street and easterly from Waltham Street, by a system of driven wells, and to pump this water directly into the stand-pipe at East Lexington, or into our street mains.

You further state that your present supply is sufficient for the needs of the town excepting for a short time in a very dry season, and that the present source is to be used as a supplementary supply at a time when the yield of the other sources is insufficient. You have also submitted information as to a pumping test which has been made at the Roberts meadow by pumping water from a group of five wells at a rate of about 180,000 gallons per day during a period of a little over ten days. During this test samples of water sent in by you to the laboratory of the Board have been analyzed.

The Board has caused the locality to be examined by one of its engineers, and has considered the results of the pumping test and of the analyses of the samples of water. The information relative to the quantity of water yielded by the wells and the lowering of the ground water during the pumping test indicates that it will be possible to obtain from this region in ordinary years a quantity of water that would form a large addition to your present supply; but a consideration of all the conditions indicates that in dry years the yield of wells at this place might be much less than it was in the recent test.

The results of the analyses of samples of water collected during the test show that the water is clear, nearly colorless and odorless, but it is quite hard, and contains a larger quantity of organic matter than is usually found in a good ground water. Whether the quality would change materially if this source should be used continuously as a source of supply for Lexington, cannot be determined definitely from the results of this test; but, judging from all the conditions, there appears to be considerable danger that the quality of the water will deteriorate after a longer or shorter period of use, and become objectionable for some purposes.

It is unlikely, in the opinion of the Board, that the source now under consideration will be capable of yielding an adequate supply of water for Lexington at all times without using water from the present sources, the quality of some of which is at times very unsatisfactory. Moreover, the quantity of water which the present sources and the source now proposed are likely to yield will not be sufficient for the supply of the town for very many years in the future. After consideration of all the circumstances, the Board is of the opinion that the town can obtain a water of better quality from the metropolitan district than will be furnished either by the present or by the proposed sources, and the town could obtain from the district an adequate supply for an indefinite time in the future. The cost of a supply obtained from the metropolitan district would be less in the end, judging from the information available to the Board, than the cost of taking a supply from the present and proposed works, and making the necessary enlargements when a further supply shall become necessary.

The Board is therefore of the opinion that it will be for the best interests of the town, all things considered, to take a supply of water from the metropolitan district, and discontinue the present works.

LYNN. An application was received from the water board of Lynn, April 23, 1901, for the advice of the Board of Health relative to certain proposed sources and methods for increasing the public water supply of the city. The Board replied to this application as follows: —

JUNE 6, 1901.

The State Board of Health has considered your application for advice with reference to a proposed additional water supply for the city of Lynn, to be taken from the Ipswich River, Martin's Brook and Foster's Pond, and the plans and information submitted therewith, and has caused your present sources of supply and the region from which it is proposed to take the additional supply to be examined by its engineer, and samples of the water of the proposed sources to be analyzed.

The plans submitted provide for taking the water of the Ipswich River at a point near the pumping station of the Reading water works in the town of Reading, and conveying it by canal, pipes or conduit to Beaver Dam Brook, a tributary of the Saugus River, one of the present sources of water supply of the city of Lynn. They also provide for taking water from Martin's Brook in the town of Wilmington, near the place where the Salem and Lowell branch of the Boston & Maine Railroad crosses the brook, and conveying it by canal, pipes or conduit to Lubber Brook, a tributary of the Ipswich River, near the Wilmington station of the Boston & Maine Railroad, through which it will flow to the point where it is proposed to divert water from the Ipswich River. It is proposed to divert the water of Foster's Pond, a tributary of the Shawsheen River in the town of Andover, into Martin's Pond, and thus utilize the water of Foster's Pond in connection with the Ipswich River source. You further state: —

The plans for additional water supply also include the raising of the dam of the storage basin of the Lynn water works known as Walden Pond to a height of 42 feet above its present height, and the raising of the dam of the storage basin of the said water works known as Breed's Pond to the same level; the cleaning of the present bottom of Walden and Glen Lewis ponds, either by excavation or covering with sand or gravel, and the cleaning of the areas flooded by raising the dams. The plan contemplates raising the dam of Walden Pond 20 feet at once, the further increase in height of this dam and the raising of the dam at Breed's Pond to take place as the needs of the city may require. These storage basins, enlarged as aforesaid, will be filled from Hawkes Pond.

It appears to the Board, from a comparison of the consumption of water in Lynn during the past few years with the estimated capacity of the present sources of water supply, consisting of Birch, Breed's, Walden, Glen Lewis and Hawkes ponds and the Saugus River above the dam at Montrose, that the consumption of water has nearly equalled the capacity of these sources in a very dry season, and that an additional supply will soon be necessary. Some of the sources of supply now in use furnish water of such poor quality that it is very objectionable for some purposes during portions of the year, and the water of all of the sources is quite highly colored and contains a large quantity of organic matter. The quality of the water of several of the reservoirs could be materially improved by cleaning the bottoms of the reservoirs, but this work cannot be safely undertaken until an additional supply is available.

The proposed source of additional supply, the Ipswich River above the Reading pumping station, including Martin's Brook and Foster's Pond, will, in the opinion of the Board, furnish a quantity of water considerably greater than will be needed by the city of Lynn for many years in the future, if used in connection with the present sources of supply developed as now proposed. Foster's Pond is outside of the water-shed of the Ipswich River, and while at some future time it might be a desirable storage reservoir for Lynn, it is not needed for the present nor likely to be needed by Lynn for many years in the future; and under the circumstances the Board does not deem it necessary or desirable that this pond be used at the present time as one of the sources of water supply for the city of Lynn.

The water-shed of the Ipswich River contains the growing town of Wilmington, and it will be necessary to provide for the proper disposal of the sewage of this town, and for the disposal of the sewage from a tannery located there which is now discharged into the river not far above the proposed intake.

The results of analyses of water from the Ipswich River, collected recently, and of analyses of the water made in previous years, all show that this water is very highly colored, and contains a large quantity of organic matter; and, if used in its natural state as a source of public

LEXINGTON. An application was received Sept. 3, 1901, from the water commissioners of Lexington, for the advice of the Board relative to an additional supply of water, to be taken from a system of driven wells located in the meadow of M. H. Roberts. The Board replied to this application as follows: —

OCT 3, 1901.

The State Board of Health received from you, on September 3, an application stating that you propose to obtain an additional supply of water by a system of wells driven in a meadow owned by M. H. Roberts, in the water-shed of Beaver Brook, and requesting the advice of the Board as to this proposed plan of securing an additional water supply for Lexington.

In response to your request the Board has caused the locality indicated to be examined by its engineer, and a sample of the water from a test well at this place to be analyzed. The results of the analysis show that the water is quite hard, but it is clear, nearly colorless and odorless, and otherwise, in its present state, of good quality for the purposes of a public water supply. Whether it would remain satisfactory when a quantity such as would be required for the supply of Lexington should be drawn continuously from wells at this place cannot be predicted with certainty. The meadow in which the wells are located contains a considerable depth of peaty soil, and is apparently subject to flooding at times of high water in the brook; and water drawn from similar locations has in many cases deteriorated after a longer or shorter period of use, and become objectionable on account of an excess of iron.

The wells yielded water freely when pumping with a hand pump, but the tests thus far made are insufficient to show whether enough water for the requirements of Lexington is likely to be obtained from a system of wells in this region.

With the information at present available regarding the probable quantity and quality of water obtainable from this source, the Board does not advise the construction of works for taking water from wells in this valley; but if you should deem it desirable to make further tests, to determine more definitely the feasibility of obtaining an adequate supply of good water from this region, the Board would advise that you cause a pumping test to be made by pumping from several wells in the neighborhood of the present test wells for a period of at least two weeks, and at a rate as great as would be required from said wells for the supply of the town of Lexington.

Should you decide to make these tests, the Board will upon application make such analyses of samples of water as may be necessary, and will give you further advice in this matter when the results of the tests are available.

LEXINGTON. Another application was received from the water committee of Lexington, requesting the advice of the Board relative to a proposed additional supply to be taken from wells in the meadow of M. H. Roberts in Lexington, and submitting information concerning a pumping test made at this place. The Board replied to this application as follows: —

DEC. 5, 1901.

The State Board of Health received from you, on Dec. 2, 1901, an application for advice relative to a proposed additional water supply for Lexington, in which you state that —

The plan is to take water from the meadow now owned by M. H. Roberts, situate in the southerly part of the town, northerly from Concord Avenue, southerly from Middle Street and easterly from Waltham Street, by a system of driven wells, and to pump this water directly into the stand-pipe at East Lexington, or into our street mains.

You further state that your present supply is sufficient for the needs of the town excepting for a short time in a very dry season, and that the present source is to be used as a supplementary supply at a time when the yield of the other sources is insufficient. You have also submitted information as to a pumping test which has been made at the Roberts meadow by pumping water from a group of five wells at a rate of about 180,000 gallons per day during a period of a little over ten days. During this test samples of water sent in by you to the laboratory of the Board have been analyzed.

The Board has caused the locality to be examined by one of its engineers, and has considered the results of the pumping test and of the analyses of the samples of water. The information relative to the quantity of water yielded by the wells and the lowering of the ground water during the pumping test indicates that it will be possible to obtain from this region in ordinary years a quantity of water that would form a large addition to your present supply; but a consideration of all the conditions indicates that in dry years the yield of wells at this place might be much less than it was in the recent test.

The results of the analyses of samples of water collected during the test show that the water is clear, nearly colorless and odorless, but it is quite hard, and contains a larger quantity of organic matter than is usually found in a good ground water. Whether the quality would change materially if this source should be used continuously as a source of supply for Lexington, cannot be determined definitely from the results of this test; but, judging from all the conditions, there appears to be considerable danger that the quality of the water will deteriorate after a longer or shorter period of use, and become objectionable for some purposes.

It is unlikely, in the opinion of the Board, that the source now under consideration will be capable of yielding an adequate supply of water for Lexington at all times without using water from the present sources, the water supply, it would be very objectionable for many domestic purposes. The presence of this high color and large quantity of organic matter in the water of the Ipswich River is due to the slow passage of the water through swamps, of which there are large areas within this water-shed. It has been found practicable in many cases to greatly improve such waters by draining the swamps and preventing the water of the uplands from coming in contact with the vegetable matter therein; but, judging from the information available, it does not appear to the Board to be practicable, on account of the slight fall in the streams, to improve the quality of this water in this way.

Another way in which such waters have been greatly improved is by storage for a long period in a reservoir free from organic matter. The proposed plan of additional water supply for the city of Lynn includes the enlargement of Walden Pond by raising the dam 20 feet, thus greatly increasing its depth and storage capacity; and it is proposed to clean and improve the bottom of this reservoir, so that the water stored therein will not come in contact with mud or vegetable matter.

The sides of the proposed new reservoir will generally be very steep to a considerable depth; and if these proposed improvements shall be carried out in a thorough manner, the Board is of the opinion, judging from the experience with other reservoirs in the State, where the conditions are similar, that, if Walden Pond shall be filled with water from the Ipswich and Saugus river water-sheds, pumped from Hawkes Pond, and the sewage pollution which the waters of these streams now receive is prevented, a large proportion of the color of the water will be removed, and a water be supplied from this reservoir which will be of better quality than that supplied from present sources, and will rarely be objectionable on account of a noticeable taste or odor.

Your plan includes raising the dam of Breed's Pond so as to enlarge the capacity of that reservoir also; but it is understood that this portion of the plan is not to be carried out for the present. The waters of Breed's and Birch ponds are usually highly colored, and are often objectionable on account of a disagreeable taste and odor. The completion of the new Walden reservoir would afford an opportunity for drawing off these ponds, and thoroughly removing the mud and organic matter.

The quality of the water that will be obtained by the city of Lynn after carrying out the plans now proposed is not likely to be at all times satisfactory, owing to the poor quality of the water of the rivers from which the main supply will be drawn; moreover, there are large and growing towns just outside the borders of the water-sheds of the Saugus and Ipswich rivers, the growth of which into these water-sheds may make it difficult to prevent their serious pollution, and the filtration of the water is likely to be found necessary.

The only other feasible way in which Lynn can obtain an adequate water supply would be to take water from the metropolitan district. There is no doubt that the water that will be furnished from the works of the metropolitan district will be of much better quality than that which can be furnished from the proposed works of the city of Lynn after completion, unless the water shall be filtered. The estimates of cost submitted are not presented in sufficient detail to enable the Board to advise whether a supply might not be obtained from the metropolitan district at a less ultimate expense than by the plan now proposed. The Board would, therefore, advise that, before the proposed works for taking water from the Ipswich River and enlarging and improving the present reservoirs are begun, a careful investigation be made and estimates prepared of the probable cost of all the work to be done in taking water from the Ipswich River and cleaning and improving the present reservoirs and water-sheds, including the cost of preventing the pollution of the water by sewage-disposal systems for the valleys upon the water-sheds, and of filtering the water of the present and proposed sources. When the results of these investigations are available, the Board will, upon application, give you further advice as to the most appropriate source of water supply for the city of Lynn.

MANCHESTER. An application was received from the water commissioners of Manchester, April 4, 1901, for the advice of the Board relative to the addition of several driven wells to those already existing, for the purpose of increasing their supply of water. The Board replied to this application as follows: —

MAY 2, 1901.

The State Board of Health received from you, on April 4, an application for advice with reference to an additional water supply for the town of Manchester, containing the following outline of your proposed plans: —

> An addition to our present plant, consisting of about 20 two and one-half or three-inch driven wells, at or near the present driven wells, as shown on a plan herewith submitted; connected by an improved method to a ten-inch main, laid 8 feet below the surface of the ground, all in working order, to siphon into the present dug well, with a gate and the opening to allow a connection with the pumps as a provision for pumping directly from the driven wells with our present pumping plant at any time in the future that we may wish.

The application was accompanied by a plan showing the location of the present driven wells in the neighborhood of your main well, and the location of the pipe line to which it is proposed to connect 20 three-inch wells at such a level that the water from these wells will flow into the large well.

It appears from the information furnished by you that your present supply is drawn from the large well near the pumping station during the greater portion of the year, but that in the summer season a supplementary supply is pumped from wells in the vicinity of the Coolidge Spring, so called, located about 500 feet from the large well, and discharged into the large well near the pumping station; and it further appears from the records furnished by you that in the driest month of 1899 an average of 166,000 gallons per day out of the 262,000 gallons used were drawn from the supplementary supply, leaving about 96,000 gallons as the quantity supplied from the large well; and in 1900, out of the 341,000 gallons per day used on an average during the driest month, 252,000 gallons were pumped from the supplementary source, and only about 89,000 were yielded by the large well near the pumping station. At the time of the construction of the large well, the yield not being sufficient for the supply of the town, tubular wells were driven in its bottom and others were afterward added, so that there are now 11 of these wells, extending to a depth of approximately 60 feet below the surface of the ground. The new wells proposed in your application are to be located in a line of about 400 feet in length, and the greatest distance of any of the wells from the present large well will be 250 feet, and some of the wells will be only 35 feet from the present well. A test of the effect of pumping from the large well upon the level of the water in the present tubular wells made in October last, and observations upon the height of water in Crafts Spring, indicate that the ground water in the neighborhood in which it is proposed to locate the new wells is influenced at the present time by pumping from the large well.

The Board has caused the locality to be examined by one of its engineers, and samples of the water of several test wells in the locality in which it is proposed to construct the additional collecting system to be analyzed, and has carefully considered the plans and other information submitted.

The results of the analyses indicate that the ground water at the place where it is proposed to locate the new wells is of about the same quality as that furnished by your present large well.

If the wells should be put in, as proposed, the area from which the ground water will be influenced to flow toward the works may be extended somewhat, and it is also possible that under these conditions a slightly larger quantity of water may filter into the ground from the brook; but, so far as can be judged from the evidence furnished the Board regarding the tests that have been made, it is likely that the only material gain in the yield of water to be expected after the new wells are put in will be due to the greater quantity of water that may be drawn from storage in the gravel strata penetrated by the wells. The indications are that these strata are not of any very great depth or extent; and, under the circumstances, the Board is of the opinion that no material enlargement of the quantity of water obtainable from your water works in a dry season will be made by the construction of the wells proposed in your present application, and the Board does not at present advise the attempt to enlarge the supply of water in this way, even though the works will cost a comparatively small sum.

The population of the town and its growth as a summer resort appear to be increasing rapidly, and the use of water, especially during the summer months, is already very large and is also increasing. If it is not deemed practicable or desirable to reduce the quantity of water used by the town during the summer months within such limits that the present works will be capable of supplying the necessary quantity, the Board would advise that you secure an additional supply from some source which will furnish an adequate quantity for the present needs of the town, and will be capable of being readily developed in the future as needs may require.

Under the circumstances, the Board would advise that you cause a thorough study to be made of available sources of ground-water supply, with the assistance of an engineer of experience in matters relating to water supply. The Board will assist you in these investigations by making such analyses of the water as may be necessary, and will give you further advice in the matter when you have the results of further investigation to present.

NATICK. The water board of Natick applied to the State Board of Health Feb. 13, 1901, for advice as to the cause of the bad taste and odor of the water of Dug Pond, and as to a remedy therefor. The Board replied to this application as follows: —

MARCH 7, 1901.

In response to your request for an examination of the water of Dug Pond, and information as to the cause of the disagreeable taste and odor of the water and as to a remedy therefor, the Board has caused the pond to be examined, and several samples of the water to be analyzed both chemically and microscopically.

The results of these analyses show the presence in the water of certain microscopical organisms of kinds which have been known to cause disagreeable tastes and odors in the waters of many ponds and reservoirs, and the offensive taste and odor noticeable in the water of Dug Pond are undoubtedly due to the presence of these organisms.

The present trouble will doubtless disappear soon after the ice breaks up, if not before; but the results of examinations of the water of this pond for many years, made by the Board, indicate that troubles of this sort have occurred frequently, and it is probable that the water will continue to be objectionable from time to time from these causes. The Board knows of no way by which the presence of such organisms in the water of Dug Pond can be prevented; and, while it is not known that their presence has an injurious effect on those who use the water, it is not desirable to use a water affected in this way if it can be avoided, and, moreover, in this case the water is unsafe for drinking on account of sewage pollution. It is probably practicable, by filtering the water, to remove these organisms, together with the tastes and odors caused by them, and to render the water safe for drinking; but Dug Pond is already inadequate as a source of water supply for Natick, and investigations have shown that it is practicable to obtain an adequate supply of water of excellent quality from the ground near Lake Cochituate, north of the town, at a reasonable cost.

Under the circumstances, it is not desirable, in the opinion of the Board, to attempt to improve the quality of the water of Dug Pond; but it is very desirable to secure, as soon as possible, an adequate supply of good water from some suitable source, and thereby not only avoid further trouble from offensive tastes and odors in the water, but also avoid the danger to the health of those who use the water of the public supply which now exists by reason of the pollution, by sewage, of the main feeder of the pond from which the supply is drawn.

NORTHAMPTON. The water board of Northampton applied to the State Board of Health Jan. 26, 1901, for advice relative to an additional water supply for the city. The Board replied to this application as follows: —

MARCH 7, 1901.

The State Board of Health has considered your application for further advice with reference to an additional supply of water for the city of Northampton, and the plans and reports of your engineers submitted therewith.

Since the last reply of the Board was made, you have caused the water-sheds of the various possible sources of future water supply for the city, therein mentioned, to be examined, and favorable sites for storage reservoirs in these water-sheds to be surveyed, to determine the approximate capacity of the sources and the probable cost of each; and you now present the following plan for obtaining an additional water supply for the city: —

The plan proposed is to take the water of West Brook in Whately, near the chapel in West Whately; to conduct it thence by pipe to the water-shed of Beaver Brook; to build a storage reservoir on Beaver Brook; and to convey the water thence by pipe to a reservoir to be built on Day Brook in Leeds, or to the present main pipe in Leeds.

The sources which have been examined by you are, in general, as follows: —

1. West Brook in Whately, to be used in connection with Beaver Brook and Day Brook;

2. The east branch of Mill River, above Williamsburg;

3. The west branch of Mill River, above Williamsburg;

4. The north branch of the Manhan River, near the junction of North and Sodden brooks in Westhampton.

Your investigations show that each of these sources is capable of being developed by the construction of storage reservoirs so as to furnish an ample supply of water for a very long time in the future.

Regarding the quality of the water of these sources no additional information of value has been obtained, and the conditions as regards the flow of the streams have not materially changed since the last reply of the Board. The results of the analyses of the waters of the various sources which have thus far been made indicate that the waters of West Brook, the east and west branches of Mill River and the north branch of the Manhan River are of good quality for the purposes of a public water supply, and none of the sources has a distinct advantage over any of the others in respect to the quality of its water. The water of Beaver Brook, which it is proposed to use in conjunction with the West Brook plan, is of somewhat less satisfactory quality than that of either of the other streams, but its water-shed is comparatively very small, and the quality of its water can probably be improved at no great expense.

The estimates of the probable cost of the various schemes submitted by you indicate that the cost of securing an additional supply by what may be called the West Brook plan, as outlined in your application, would be less than the cost of taking a supply from either the east or west branches of the Mill River or from the north branch of the Manhan River.

Judging from the estimates of probable cost and the other information that has been submitted, and the examinations that the Board has made, the Board is of the opinion that West Brook, used in connection with Beaver Brook as proposed, will be the most appropriate source of additional water supply for Northampton.

Your plan includes also the construction of a storage reservoir on Day Brook, a very small stream, the water-shed of which is contiguous to that of Roberts' Meadow Brook; and it appears that the level of high water in the proposed reservoir on Day Brook would be the same as that of the middle reservoir, so called, on Roberts' Meadow Brook, the source from which the city is now supplied.

If the Day Brook reservoir should be constructed, it would be practicable to postpone the taking of water from West Brook for a time; but if, on the other hand, the proposed reservoir on Beaver Brook should first be constructed, and water taken from West Brook as proposed, it would be many years before an additional storage reservoir would be necessary; and, while the first cost of constructing the reservoir on Beaver Brook and taking water from West Brook would be greater than the first cost of the reservoir on Day Brook, the final expense to the city would, in the opinion of the Board, be somewhat less than it would be if the Day Brook reservoir should be constructed in the beginning; and for this reason the Board does not advise the construction of the proposed reservoir on Day Brook at present.

While a 16-inch pipe from the proposed reservoir on Beaver Brook to the city will be ample for conveying from this source all the water that will be required in addition to that furnished by the Roberts' Meadow Brook source for many years, there will doubtless be a certain advantage to the city at times in taking all of the supply from the Beaver Brook and Whately sources and avoiding the use of water from Roberts' Meadow Brook; and, considering the comparatively small extra cost of a larger main pipe than now proposed, it seems desirable, for the reasons stated, to provide a main pipe of larger size in the beginning. It is also desirable that provision be made whereby water taken from West Brook can be delivered directly to the city without mingling with the water of the Beaver Brook reservoir.

NORTH ANDOVER. An application was received from the overseers of the poor of North Andover, Nov. 11, 1901, for the advice of the Board relative to the quality of the water of a well used at the town farm for drinking purposes. The Board replied to this application as follows: —

DEC. 5, 1901.

In response to your request, received Nov. 11, for advice as to the quality of the water of a well used for drinking purposes at the town farm in North Andover, the Board has caused the well and its surroundings to be examined, and samples of its water to be analyzed. The results of the analyses show that the water is very variable in character, but that it is evidently subject to pollution by sewage at times and is not fully purified before entering the well.

In the opinion of the Board, this well is an unsafe source from which to take water for drinking..

NORTH ATTLEBOROUGH. An application was received from the president of the North Attleborough Country Club for the advice of the Board relative to the quality of the water of a well upon the premises of the club. The Board replied to this application as follows: —

AUG. 1, 1901.

In response to your request for advice as to the quality for drinking purposes of the water of a well located on the grounds of the North Attleborough Country Club, and used by the public for drinking, the Board has caused the well and its surroundings to be examined, and a sample of the water to be analyzed. The results of the analysis show that the water is excessively hard, and the quantity of organic matter present is much larger than is found in good ground waters. The hardness may be due to lime recently put into the well, and it is possible that, if the well should be thoroughly cleaned out and a considerable quantity of water pumped from it, the quality of the water would improve. The Board would therefore advise that the well be cleaned out, and will then make a further examination, if you so request.

NORTHBRIDGE (Whitin Machine Works). An application was received June 4, 1901, from the Whitin Machine Works, requesting the advice of the Board as to the best practicable method of increasing the water supply of Whitinsville. The Board replied to this application as follows: —

JULY 11, 1901.

The State Board of Health received from you, on June 4, 1901, an application requesting its advice as to the best practicable method of increasing the water supply of Whitinsville, accompanied by a plan providing for the construction of a storage reservoir on Cook Allen Brook, at a point a little over a mile from the place where the stream enters Whitin's Pond, and for the construction of a pipe line from this reservoir to the village. The proposed reservoir, according to the plan, will have an area of about 10 acres and a capacity of about 43,000,000 gallons.

The Board has considered the plan and has caused the locality to be examined by its engineer, and samples of the water of Cook Allen Brook to be analyzed. The results of the analyses show that the brook water, while somewhat colored, is very soft and contains but little organic matter, and an examination of its water-shed shows that there is at present only one dwelling house upon it which is not under the control of the company, and this house is near the extreme upper limit of the water-shed, so that the source can be protected from pollution by sewage without special difficulty.

The water of many storage reservoirs in the State, such as that now proposed for Whitinsville, has been objectionable at times on account of a disagreeable taste and odor, caused by the presence of organisms in the water; and it is possible that the water of the proposed reservoir will at times have a noticeable taste or odor from this cause. It appears, however, that it is a part of your plan to prepare the reservoir thoroughly for the storage of water by the removal of all soil, mud and organic matter from the area to be flowed, and the chances of trouble from taste and odor in the water will be very greatly reduced if this work shall be done in a thorough manner.

A good ground-water supply is more satisfactory than a surface supply, such as that proposed from Cook Allen Brook, because of its freedom at all times from color, taste and odor, and because of its lower temperature in the summer season. The character of the soil in the region about Whitin's Pond appears to be favorable, judging from surface indications, for obtaining a ground-water supply suitable for the village; but it is likely that such a supply would be somewhat more expensive, on the whole, than the proposed supply from Cook Allen Brook, on account of the necessity for pumping.

In the opinion of the Board, the source which you propose to use is capable, after the reservoir is constructed, of furnishing an ample supply of good water for the present needs of Whitinsville, and there does not appear to be any other source from which a more satisfactory supply of water can be obtained by gravity.

NORWOOD. An application was received from Winslow Bros. of Norwood, May 3, 1901, for the advice of the Board as to the quality of the water of a tubular well which it was proposed to use for drinking purposes. The Board replied to this application as follows: —

JUNE 6, 1901.

In response to your application for advice as to the quality of the water of a tubular well which you propose to use for drinking purposes in your factory at Norwood, the Board has caused the well and its surroundings to be examined by one of its engineers, and samples of the water to be analyzed.

The results of the analyses show that the water is of good appearance, being clear and colorless, but it has an unpleasant odor when drawn from the ground, and is excessively hard. The well is located within a few feet of the drains which receive the tannery waste, and is not far from the settling basins for this drainage. Under the circumstances, the Board does not consider this well a safe source of drinking water supply, and does not advise its use.

PALMER (THREE RIVERS). An application was received from Pasquale Cascella of Three Rivers, June 13, 1901, for the advice of the Board relative to the quality of the water of a spring in that town. The Board replied to this application as follows: —

JULY 11, 1901.

In response to your request for advice as to the quality of the water of a spring in Three Rivers, from which you propose to sell water for drinking, the Board has caused the spring and its surroundings to be examined, and a sample of the water to be analyzed. The analysis shows that the water is soft and otherwise of good quality for drinking, and the source is not at present exposed to any danger of pollution by sewage.

In the opinion of the Board, this spring is a safe source of drinking water supply.

PEABODY. An application was received Aug. 1, 1901, from the board of health of Peabody, requesting the advice of the State

Board of Health relative to the quality of the water of a well situated in the basement of a school-house in West Peabody, and used for drinking purposes. The Board replied to this application as follows: —

Oct. 3, 1901.

In response to your request for advice relative to the quality of the water of a well at a school-house in West Peabody, the Board has caused the locality to be examined, and samples of the water to be analyzed. It appears that the water now used in this school is drawn from a tubular well sunk in the bottom of a larger well which was formerly used for the supply of the school. The water of the larger well was found, upon examination, to be highly polluted by sewage, and unsafe for drinking. The water of the new well is turbid and highly colored, and contains an excessive quantity of organic matter and iron; and, considering the circumstances, the Board does not consider this well a suitable source from which to take water for drinking, and would advise that its further use be discontinued.

Salem. An application was received July 11, 1901, from the Salem water board, for advice as to whether it would be better to keep the Longham basin full or empty during the summer months. The Board replied to this application as follows: —

Aug. 1, 1901.

The State Board of Health has carefully considered your request, received July 11, for advice as to whether it will be best during the summer months to keep the Longham basin full of water, or to allow it to remain empty, and has examined the information available with respect to the character of this reservoir and its water-shed, and the quality of its water. Numerous analyses of the water of Longham Brook have shown that its quality is best in the winter or early spring months, at the time when the greatest quantity of water is flowing in the stream. The water is collected in a very shallow reservoir, the bottom of which, according to recent surveys by your board, is covered with a layer of mud averaging two and one-half feet in depth; and water remaining in the reservoir, especially during the summer season, takes up very large quantities of organic matter. Regarding a proposed reservoir on this stream and the methods by which it would best be utilized for increasing the water supply of Salem, the Board advised you as follows, on April 4, 1893: —

The surveys of this reservoir have not yet been completed, and it is not feasible to tell from observation alone what its character will be. It seems probable, however, that, unless a very large amount of money is spent in its preparation, the water would deteriorate to a very considerable extent by standing in it, and that, at the present time, it would be better to construct a dam having only suffi-

cient height to turn the water into the lake. Even a low dam at this place will flow the water back for a long distance up the valley of the Longham Meadow Brook; and, if the reservoir is to be kept filled at all seasons of the year, it should be prepared to receive this water by the removal of all soil and vegetable matter and the deepening or filling of the shallower portions. If, however, the reservoir should be filled to divert water into the lake only in the winter and spring, it is not improbable that satisfactory results may be obtained by a less expensive preparation.

It may be feasible, by ditching or otherwise draining the swampy lands or ponds upon the water-sheds of these brooks, to greatly improve the quality of the water flowing in them; and the Board would advise that this question of the improvement of these sources should be investigated.

Experience with this and similar reservoirs has shown that, if the water should be drawn off in the spring, a growth of grass would soon appear over nearly the entire bottom of the reservoir, and become very rank as the season advances. If the reservoir should be filled in the fall or early winter, without removing the grass, this organic matter would have a very unfavorable influence upon the quality of the water collected in the reservoir during the winter; but if all the grass and other vegetation growing on the bottom of the reservoir should be cut late in the year and removed entirely from the reservoir, and the reservoir should then be flooded, preferably after the ground had frozen in the early winter, it is probable that water could be obtained from this source during the winter and spring which would not be materially affected by storage in the reservoir. By carrying out the plan herein outlined, it is likely, in the opinion of the Board, that water of better quality will be obtainable from this source than by keeping water in the reservoir during the summer.

It will be necessary, as the population of the cities grows and the use of water increases, to take a larger and larger quantity of water from this stream, and ultimately take the whole flow of the stream and utilize all the storage available in the reservoir; and when this becomes necessary, the water, unless greatly improved over its present state, will have a very unfavorable effect upon the quality of the water of Wenham Lake. Longham reservoir is a very unsatisfactory basin for the storage of water, but it can be greatly improved by removing the mud and organic matter from its bottom. Very little gain will be made by improving the reservoir, however, unless the quality of the brook water stored in the reservoir can be greatly improved. The water of Longham Brook is naturally of a very poor quality, owing to long contact with vegetable matter in the meadows and swamps through which it flows; and, as stated in previous replies of the Board, it is important that its quality be improved as far as practicable by draining the meadows and swamps, so that it may not seriously injure the quality of the water of Wenham Lake. It appears that some work in draining the meadows has already been done, but further improvement could apparently be made by more thorough drainage; and the Board would advise that all the improvement possible be made in this stream now, when the work can be done at times when it is not necessary to use the water.

If you will submit surveys of these meadows and swamps, and plans for their drainage, the Board will, upon application and receipt of the plans, advise you concerning them.

SALEM. An application was received Dec. 20, 1901, from the Salem water board, for advice with reference to the regulation of the practice of fishing in Wenham Lake, one of the sources of water supply of the city. To this communication the Board made the following reply: —

JAN. 3, 1902.

Under rule 14 of the rules and regulations adopted by the State Board of Health for the protection of the purity of the water of Wenham Lake, fishing in the lake is prohibited except by regulation or permit of your board.

The State Board of Health is of the opinion that the protection of the purity of your water supply requires that indiscriminate fishing in Wenham Lake should be prevented; but the Board believes that fishing can be permitted in the lake if it is carried on under proper regulations to insure the prevention of the pollution of the water by persons so engaged.

SALEM. An application was received Nov. 8, 1901, from the board of health of Salem, for the advice of the State Board of Health relative to the quality of the water used for drinking at the St. James School. The Board replied to this application as follows: —

DEC. 5, 1901.

In response to your request for an examination of the water of a well at St. James School in Salem, and advice as to its quality for drinking, the Board has caused the well and its surroundings to be examined, and samples of the water to be analyzed. The results of the analyses show that the water has been very highly polluted by sewage, and only partially purified in its passage through the ground to the well. The well is located in a thickly populated region, close to the North River, which is a very foul stream; and, in the opinion of the Board, the water of this well is liable to be very injurious to the health of those who may use it for drinking.

The Board would advise that further use of water from this well for drinking be prevented.

SALISBURY. An application was received Dec. 27, 1900, from E. P. Shaw and E. P. Shaw, Jr., for the advice of the Board relative to a proposed water supply for the town of Salisbury. The Board replied to this application as follows: —

JAN. 22, 1901.

The State Board of Health received from you, on Dec. 27, 1900, an application for advice with reference to a proposed water supply for the town of Salisbury, in which you state that "it is proposed to obtain water from dug or driven wells, some of which are already dug or driven, situated in said town of Salisbury, near the road leading from Salisbury Square, so called, to Salisbury Beach, so called."

In response to your application the Board has caused the locality described by you to be examined by one of its engineers, and samples of water from one of the two test wells which have been driven at this place to be analyzed. The results of the analyses show that the water of this well is affected by the presence of a small quantity of salt water. The water is excessively hard, which would make it very objectionable for many domestic uses; and, if the quantity of water which would be needed for the supply of Salisbury Beach should be pumped from the ground at this place, it is probable that the quantity of salt in the water would increase to such a degree that the water could not be used for drinking.

The Board does not, therefore, advise the use of water from wells in this locality for the supply of any portion of Salisbury; but would advise that you cause further investigations to be made, with the assistance of an engineer of experience in matters relating to water supply, with a view to securing an adequate supply of water for the locality mentioned in your application.

In making further investigations, it will probably be necessary to locate wells at a greater distance from the sea than in the case of the present wells, and at the same time at a sufficient distance from the neighboring villages to avoid danger that the quality of the water will be affected by sewage.

SOMERVILLE IRON FOUNDRY. The Somerville Iron Foundry applied to the Board Feb. 19, 1901, for advice relative to the quality of the water of a driven well at their works. The Board replied to this application as follows: —

APRIL 4, 1901.

In response to your application of February 20, for advice as to the suitability for drinking purposes of the water of a well located at your works in East Somerville, the Board has caused the locality to be examined by one of its engineers, and a sample of the water to be analyzed. It appears from this examination that the well is located in a densely populated part of the city. The analysis shows that the water, while nearly clear and colorless, is quite hard, and has evidently at some time been highly polluted by sewage and not thoroughly purified in its subsequent passage through the ground to the well.

The Board does not consider this well a safe source of drinking water supply, and would advise that the use of water from this source for drinking be prevented.

SOUTHBOROUGH. An application was received Oct. 23, 1901, from the school committee of Southborough, for the advice of the Board as to the quality of the water of certain wells proposed as sources of supply for a public school. The Board replied to this application as follows: —

DEC. 5, 1901.

In response to your request for advice as to the quality of the water used for the supply of the high school in Southborough, and as to whether water that may be safely used for drinking can surely be obtained from any of three wells indicated by you and located not far from the school, the Board has caused the wells and their surroundings to be examined, and samples of water collected from the present source and from one of the three wells indicated by you to be analyzed.

The water of the tubular well from which the school is at present supplied was found to be excessively hard, and has evidently at some time been greatly polluted by sewage and not subsequently thoroughly purified before entering the well. In the opinion of the Board, this well is not a safe source of drinking water, and its further use should be prevented.

Two wells on land of Dr. C. P. Jones, south of the school grounds, were indicated as possible sources of future supply for the school. A sample from one of these wells, from which water is pumped by means of a windmill, shows that this water also has been greatly polluted by sewage, and, in the opinion of the Board, this well is an unsafe source of drinking water supply. The water of the other well has not been analyzed, since it is so close to the one examined that there is no reason to think that the quality of the water would be materially different. The third well indicated by you is located on the school grounds and was formerly used as a source of supply, but has been abandoned. This well is exposed to danger of pollution from cesspools near by, and it is not advisable to take a supply of water from this well for the use of the school.

SOUTHBRIDGE. The attention of the Board was called Sept. 27, 1901, to certain springs in use in Southbridge as sources of water supply, and the Board was requested to examine the same. In consequence of this examination, the following communication was addressed to the board of health of Southbridge: —

DEC. 5, 1901.

The attention of the Board having been called to certain springs used as sources of water supply by several families in the village of Southbridge, and now or formerly controlled by the Southbridge Aqueduct Company, the Board has caused the springs and their surroundings to be examined, and a sample of the water to be analyzed.

The results of the analysis indicate that the water receives considerable sewage pollution, and, considering the location of the springs and their surroundings, the Board would advise that the further use of water from these springs for drinking purposes be discontinued.

SOUTHBRIDGE. An application was received from the Southbridge Water Supply Company, June 19, 1901, for the advice of the Board relative to the quality of the water of the Glover Spring, which it was proposed to use as one of the sources of water supply of the company. The Board replied to this application as follows: —

JULY 11, 1901.

In response to your request for advice as to the quality of the water of the Glover Spring, which you desire to use as one of the sources of water supply of the Southbridge Water Supply Company, the Board has caused the spring and its surroundings to be examined by one of its engineers, and a sample of the water to be analyzed. The results of the analysis show that the water in its present state is clear, colorless and odorless, but is quite hard, and has been greatly polluted by sewage, though subsequently well purified in its passage through the ground. The analysis does not indicate that the water flowing from the spring at present is unsafe to use for drinking, but the places from which the water evidently receives its pollution are so near the spring that any change in the circumstances attending its pollution may at any time render the water unsafe, and the Board cannot recommend the use of this spring as a source of drinking water supply.

SPRINGFIELD. An application was received from the board of health of Springfield, Aug. 8, 1901, for the advice of the Board relative to the quality of the water of certain springs used for drinking purposes. The Board replied to this application as follows: —

OCT. 3, 1901.

In response to your request for advice as to the quality of the water of the Ingersoll Grove and Hygeia springs in Springfield, the Wilbraham Mountain Spring in Wilbraham, and the Iroquois Spring in West Springfield, the Board has caused these springs and their surroundings to be examined, and several samples of the water of the various springs to be analyzed.

The water of the Iroquois Spring in West Springfield was found to contain considerable organic matter and iron, though there is no evidence of pollution by sewage. If this spring should be protected from the entrance of surface water, and be covered so as to prevent matters from falling into it, it would be a safe source of drinking water supply.

The Ingersoll Grove Spring, so called, has already been examined by the Board, in response to an application received last year, and several additional samples have been analyzed since that time. In its previous communication the Board stated: —

Examinations made by the Board indicate that the water of this spring in its present state is safe for drinking; but it is desirable, on account of the situation of this spring, that analyses of the water be made from time to time, in order that any deterioration in its quality may be detected.

The results of further analyses indicate a very slight deterioration in quality since last year, but not sufficient to indicate that the water is unsafe for drinking.

The water of the Wilbraham Mountain Spring, so called, has been analyzed several times recently by the Board, and the results show, in all cases, that the water is somewhat hard, and has been at some time considerably polluted by sewage, but subsequently well purified in its passage through the ground before reaching the spring. This water, while showing deterioration in some respects, has contained less organic matter recently than was found to be present in the earlier samples, and the recent examinations do not indicate that the water is, in its present state, unsafe for drinking. In the case of this spring it is desirable, however, that analyses of the water be made from time to time, and its use discontinued should deterioration in the quality of the water take place. Water taken from this spring and sold in the city is evidently polluted in the process of collection and delivery, owing to lack of proper care in handling.

The Hygeia Spring water is drawn, it appears, from two tubular wells, one 200 feet in depth and the other 425 feet in depth. The results of the analyses indicate that the water of these wells is probably not unsafe for drinking at the present time, but it has evidently been considerably polluted by sewage, and changes in circumstances attending its pollution may render it unsafe for drinking, and the water should be analyzed from time to time, in order that its use may be discontinued should its quality deteriorate.

Springfield. An application was received Nov. 7, 1901, from the Springfield water board, for the advice of the State Board of Health as to the propriety of continuing the experiments which had been undertaken with the view of improving the quality of the water of the Ludlow reservoir. The Board replied to this application as follows: —

Dec. 5, 1901.

Your communication relative to the further continuance of the experiments upon the filtration of water at Ludlow has been referred to the

Board, and, after a general consideration of the results of the investigations thus far and of the character of the water of the Ludlow reservoir during the present year, as compared with its character in previous years, it is deemed desirable by the Board that the present investigations should be carried on, at least until they have covered a full year. The investigations began practically at the beginning of the present year, but complete observations were not begun until the latter part of February. It is advisable, in the opinion of the Board, to continue the experiments at least until that time, in order that observations for a full year may be available. If, in the mean time, new conditions should arise not previously met with during these investigations, it may be desirable to continue them for a longer time.

TEWKSBURY (State Hospital). The superintendent of the State Hospital at Tewksbury applied to the State Board of Health July 17, 1901, for its advice relative to a proposed new water supply to be taken from wells near the present pumping station. The Board replied to this application as follows: —

AUG. 1, 1901.

In response to an application for advice with reference to a proposed new system of water supply for the State Hospital at Tewksbury, to be taken from a system of driven wells in the low ground near your present pumping station, the Board has caused the locality to be examined by its engineer, and samples of the water from three tubular test wells at this place to be analyzed.

The soil in the region about the pumping station and the place where the wells are located, judging from surface indications and the test wells thus far driven, is coarse and porous, and, in the opinion of the Board, the indications are favorable for obtaining a large quantity of water from the ground at this place.

The results of the analyses show that the water of two of the wells is of excellent quality for all the purposes of a public water supply. The water of the third well is of less satisfactory quality and is affected by an excessive quantity of iron, which would render it objectionable for many purposes.

The wells are located close to Strongwater Brook, in a small piece of meadow land where there is a deep layer of peaty soil at the surface, and it is to this condition that the excessive quantity of iron noted in the water of one of the wells is doubtless due.

It appears to be practicable to locate works for collecting ground water in this region in such a way as to secure good water, and avoid danger that its quality may be affected by the peaty areas referred to; and the Board would advise that additional test wells be driven in this region, and that a test be made by pumping from a group of several wells at a rate as great as would be necessary for the supply of the hospital, and for a period of at least a week, in order to determine the feasibility of obtaining a sufficient supply of good water for the hospital. It is important that the wells be located with care, and the Board would advise that the work be done under the direction of an engineer of experience in matters relating to water supply.

The Board will assist you in these investigations by making the necessary analyses of samples of water, and will, upon application, give you further advice in this matter when you have the results of further investigations to present.

The present source of water supply of the hospital is of unsatisfactory quality on account of the high color and large quantity of organic matter which it contains, and is, moreover, exposed to pollution by sewage, so that it is liable to be injurious to the health of those who may use it for drinking; and the Board would advise that the use of water from this source be discontinued as soon as it is possible to secure a water supply from some suitable source.

There are several wells within the grounds of the hospital, water from which is used for drinking by the inmates. Analyses of samples from these wells show that the water of all of them has been polluted, and, while it is subsequently purified to a large degree before entering the wells, these wells cannot be considered safe sources of drinking water supply, and should be abandoned as soon as a supply of good water can be obtained.

An examination has also been made by the Board of the method of sewage disposal employed at the hospital. This method consists in discharging the sewage into basins, of which there are several, from which it is distributed over the surface of the ground. Evidently in the winter season and at times of heavy rain in other portions of the year much of this sewage must find its way directly into the neighboring stream. In the opinion of the Board, this is not a proper method of disposing of the sewage of the institution, and is liable to endanger the health of those living in the valley of the brook. The Board would advise that a proper system of sewage disposal be provided with as little delay as possible.

TEWKSBURY (State Hospital). An application was received from the superintendent of the State Hospital at Tewksbury for the advice of the Board, relative to an additional water supply for the institution, further experiments having been made since the date of the last communication of the Board. The Board replied to this application as follows: —

Nov. 7, 1901.

The State Board of Health received from you, on Oct. 15, 1901, an application for advice with reference to a proposed source of water supply for the State Hospital, in which you state that, acting in accordance with the advice of this Board, in a communication of Aug. 1, 1901, you have put in a new system of test wells at a point much further from your pumping station than the first test wells; and you describe the wells recently put in and the results of a pumping test made by pumping from these wells continuously for a period of eight and one-half days at a rate of a little over 800,000 gallons per day between Sept. 25 and Oct. 3, 1901.

The Board has caused the new test wells and their surroundings to be examined by its engineer, and samples of water collected daily during the pumping test to be analyzed. The results of the analyses show that the water is clear, colorless and odorless, and that it is quite soft and in other respects of excellent quality for all the purposes of a domestic water supply, and no material change was noted in the quality of the water during the test. The quantity of water pumped during this test was greatly in excess of the quantity that is necessary for the supply of the hospital; and, while the ground water lowered quite rapidly at the beginning of the test, the indications are that these wells would furnish a sufficient quantity of water for all the needs of the hospital. Moreover, should additional water be required, the indications seem to be favorable for obtaining a larger quantity in the immediate neighborhood, should it be found necessary to do so in the future.

Considering the favorable results of this test, the Board would advise you to construct works for supplying the hospital with ground water from the region in which the test wells are located, with as little delay as possible, since the supply now used is of poor quality, and is exposed to serious danger of pollution by sewage.

If a supply of ground water shall be used in the future, its quality will deteriorate very rapidly if stored in the open reservoirs and tank now in use in connection with your water supply system. The iron tank can be covered at little expense, and should be covered as soon as a ground-water supply is introduced. If it is necessary to retain the reservoirs and to use water from them, they also should be covered so as to exclude the light. If these reservoirs are kept only for use in case of emergency, and are not used frequently or regularly, it may be reasonable to allow them to remain uncovered, to avoid expense.

TYNGSBOROUGH. An application was received April 9, 1901, from the board of health of Tyngsborough, requesting the advice of the State Board of Health relative to the quality of the water of a well used by several families for domestic purposes. The Board replied to this application as follows: —

MAY 2, 1901.

In response to an application for advice as to the quality of the water of a well in the village of Tyngsborough, used by several families as a source of water supply, the Board has caused the locality to be examined, and a sample of the water to be analyzed. The results of the analysis show that the water of the well is slightly colored and contains considerable organic matter, and an examination of the surroundings indicates that surface water from a swamp near by may find its way into the well without complete purification; and, since this surface water is exposed to pollution by sewage, the well cannot be considered a safe source of drinking water. The Board would advise that the use of water from this well be prevented.

WALPOLE. The water commissioners of Walpole applied to the State Board of Health Jan. 18, 1901, for advice as to the probable effect of flooding the land about their driven well system by the construction of a dam, and also as to the effect of constructing a dike to keep out such water from the neighborhood of the wells. The Board replied to this application as follows: —

APRIL 4, 1901.

The State Board of Health received from you, on January 19, an application stating that by the construction of a dam on the Neponset River, below the mouth of Low Brook, in the valley of which your works are located and the creation of a storage reservoir to be used for mill purposes, it is expected that the ground over and about your wells will be flooded to a depth of about 3 feet, and you request the advice of the Board as to the probable effect of such flooding on the quality of the water of the wells. You also submit a plan of a dike by means of which it is proposed to prevent the flooding of the land immediately over and about the wells, and request further the advice of the Board as to the probable effect on the quality of the water of building the dike as proposed, allowing the water outside the dike to rise to a height of about 3 feet above the present level of the land where the wells are situated.

The plan submitted provides for changing the course of Low Brook, on both sides of which the wells are now located, by moving its channel southwesterly from its present location to a new location beyond the wells, and constructing a dike from the higher land near the pumping station around the territory in which the wells are located, in such a manner as to keep the pond water from overflowing this land; but no provision appears to be made for disposing of any water that may enter the area enclosed by this dike.

The Board has caused the locality to be examined by its engineer, and has considered the probable effect of the proposed flooding of the ground over and about the wells upon the quality of the water, and the probable conditions that will exist after the reservoir is filled and the proposed dike constructed.

It appears that the ground in which the wells are located is covered with a layer of peaty soil from 3 to 5 feet in depth, beneath which the material is said to be very fine sand to a further depth of from 21 to 47 feet, the latter extending down to the gravel stratum from which the water is drawn.

There are several instances in this State where a public water supply has been taken from the ground beneath the bottom of a pond or stream; and in all of these cases known to the Board, where the conditions are similar to those which would exist at Walpole if the ground in which the wells are located should be flooded, the water has deteriorated in quality, on account of the presence of organic matter and iron, and in nearly all cases the source has either been abandoned or the water is now filtered; and, judging from the available information with reference to this subject, the indications are that the permanent flooding of the ground over the wells of the Walpole water supply will have after a time, if not in the beginning, such an unfavorable effect upon the quality of the water as to render it objectionable for many domestic uses. The Board would advise, therefore, that the flooding of the land in which the wells are situated be prevented.

If the proposed reservoir should be flowed to the level stated, and the dike should be built as proposed, and provision made for keeping the water from covering the ground about the wells, a material change would nevertheless still be made in the conditions of flow of water through the ground to the wells, and conditions might then be produced similar perhaps to those existing at some of the other ground-water supplies in the State where the works are located close to a stream or pond. There are many instances in the State where filter-galleries, wells or other works for collecting ground water have been located as close to a body of water as would be the case with all but a few of these wells if the proposed dike should be constructed. In some of these cases the works have continued to furnish, in some instances after more than twenty-five years, a water of excellent quality in all respects for domestic purposes. There are other cases in which the water under such circumstances has deteriorated after a longer or shorter period of use, and eventually become objectionable for many uses. It is not possible to predict definitely whether, in the case under consideration, if the proposed plan of diking is carried out and the reservoir filled, the quality of the water of the wells will be unfavorably affected or not, or, if affected, whether it will be injured to such an extent as to make the water objectionable for any domestic uses.

The water which has been furnished by these wells up to the present time has always been of excellent quality, and, since it is not possible to predict the effect of the proposed changes, it is best, in the opinion of the Board, to prevent wholly, if possible, the flooding of the area near the wells.

If this is not deemed practicable or desirable, the plan of diking around the lands in which the wells are located offers the best method of preventing deterioration in the water of the wells; but the danger to the quality of the water can be considerably reduced by placing the dike at a greater distance from the wells than is proposed in the plan submitted, and so reducing so far as possible the area near the wells which will remain covered with water. It appears, from the plan, to be practicable, without greatly increasing the length of the dike, to locate it at least 150 feet from any of the wells; and it also appears to be possible to construct the brook channel from a point a little above Washington Street to the edge of the proposed reservoir, with its bottom a little above the high-water level of the reservoir, so that water will not remain standing in the brook channel.

The Board would therefore advise that, in case it is found necessary to protect the wells by means of a dike, the plans be modified in the manner suggested. If water collects and remains standing over the ground about the wells within the dike, it will be necessary, in connection with this plan, to provide some means of pumping out this water.

While plans and cross-sections of the dike are presented, the details are not sufficient to enable the Board to advise you as to its probable stability, nor is it understood that such advice is desired.

WALTHAM. The board of health of Waltham applied to the State Board of Health for its advice as to the quality of the water of a well in Prospect Hill Park in that city, used by the public for drinking purposes. The Board replied to this application as follows: —

SEPT. 20, 1901.

In response to your request for advice as to the quality of the water of a well in Prospect Hill Park, used largely for drinking by visitors to the park, and which you state is complained of on account of a disagreeable taste, the Board has caused the well and its surroundings to be examined, and samples of the water to be analyzed. The analyses show that the water is somewhat turbid and colored, and that the quantity of organic matter present is slightly larger than is usually found in good ground waters, but in other respects the water is of good quality. The well does not appear to be exposed in any way to danger of pollution by sewage at the present time, and the analyses do not show any evidence of sewage pollution. The well is a shallow one, located near the edge of a swamp, and is sunk through muck, clay and hardpan. The odor of the water and the slight excess of organic matter and color are apparently derived from the soil in which the well is located.

In the opinion of the Board, the water of this well is at present safe for drinking.

WESTBOROUGH. The board of health of Westborough wrote to the State Board of Health, Dec. 5, 1900, requesting the opinion of the Board as to the quality of the water and the ice of Chauncy Pond, and also whether the measures taken by the Lyman School for preventing the sewage of the school from entering the pond were adequate for that purpose. The Board replied to this communication as follows: —

FEB. 7, 1901.

In response to an application received late last year from the board of health of the town of Westborough with reference to the condition of Chauncy Pond and the efficiency of the measures taken by the authorities of the Lyman and Industrial Schools to prevent sewage entering the pond, the State Board of Health caused the locality to be examined, and found that sewage from some of the buildings of the Lyman and Industrial Schools was finding its way in an unpurified state into one of the brooks leading into Chauncy Pond; and an examination has, in consequence, been made of the conditions under which Chauncy Pond water is supplied for drinking and other purposes in the Westborough Insane Hospital, since the entire supply of this institution is now being drawn from this pond.

It appears that for nearly all uses the water is supplied in the condition in which it is drawn from the pond, but a separate system of pipes has been installed in the buildings, through which water which has been heated and subsequently filtered is furnished for drinking. The drinking water supply is drawn from the boiler which is used to furnish hot water to the various wards, and it has not been practicable to determine whether the water is boiled before being drawn for filtration. The water drawn from the boiler is then forced through a sand filter, apparently at a very rapid rate, after which it is supplied in the buildings for drinking.

Bacterial analyses of the water before and after passing through the filter do not show that the filter effects a satisfactory purification of the water, and the chemical analyses indicate that the filter acts only as a strainer, and removes a considerable amount of organic matter from the water, if it is cleaned and the sand is renewed frequently. If all of the water supplied for drinking should first be boiled, the danger of injury to health on account of the pollution of the water would be avoided; but it seems probable that this is not the case, and the filter now in use cannot be depended upon to efficiently remove the dangerous pollution from the water. The chief objection to the present arrangement for supplying water to the hospital, in the opinion of the Board, is the fact that water taken directly from Chauncy Pond, without boiling or filtration, is accessible for drinking in the hospital and is evidently so used at times, and there are indications that recently very serious cases of illness have followed the use of this water for drinking.

On March 30, 1894, in response to a request from the superintendent of the hospital, asking whether, in the opinion of the Board, the water of Chauncy Pond would be suitable for drinking and domestic purposes if filtered, the Board replied as follows: —

The State Board of Health has considered your request as to whether the water of Chauncy Pond would be suitable for drinking and domestic use if filtered, and would state that it is a somewhat difficult matter to filter a water of this character in such a manner as to render it both wholesome and palatable; and the Board therefore would not advise the adoption of this method of obtaining a water supply until an examination made by some competent engineer had shown that it was not feasible to obtain a more satisfactory supply in some other way.

Should you wish to proceed further in the investigations for a water supply, the Board will give you such assistance as it can in the matter.

The Board is not informed as to whether investigations for obtaining a satisfactory water supply in some other way than by the use of water from Chauncy Pond have ever been made; but if not, the Board would again urge that the matter be taken up, and a supply of water secured which will not only be sufficient for all of the requirements of the hospital, but will also be of good quality for drinking and other purposes. Should you undertake an investigation for the improvement of your water supply, the Board will, upon application, give you such assistance as it can in the matter.

WEST SPRINGFIELD. An application was received from the water commissioners of West Springfield, Jan. 29, 1901, for the advice of the Board relative to a proposed additional water supply for the town. The Board replied to this application as follows: —

MARCH 7, 1901.

The State Board of Health received from you, on Jan. 29, 1901, an application for advice with reference to a proposed water supply for West Springfield in which you state: —

After careful investigation of the available sources and the town's needs and financial condition, we have concluded that the source known as Bear Hole Brook is the most practicable if not the only one really available at present. Referring to the engineers' report, Plate II., the water-shed of Bear Hole Brook is shown to have an area of 3.05 square miles above the point where a dam would be built in the future. Red line indicates the shed more distinctly. From the point where dam is shown we would propose to pump to a reservoir on high ground, 5,200 feet distant.

At this reservoir our distribution practically begins. In addition to the data given in the report, we find that the flow of the brook on the day of last summer which marks the driest period known in the vicinity was 1,100,000 in twenty-four hours, and on the day when everything was frozen hardest this winter it was 1,317,000 per twenty-four hours.

We feel sure that this source is, under the circumstances, the best, and respectfully request your approval of it as a supply for the town, if you find it so.

The cost of the work can be closely estimated, and is within the means of the town.

The supply could be immediately used, and the expense could be proportioned very closely to the growing demand.

You also present an outline of works for taking water from the ground in the valley of Pond Brook, which you submit as an alternative in case the other plan, known as the Bear Hole plan, could not be made use of.

The report referred to above is the same as that submitted to the Board in connection with a previous application made on Jan. 5, 1899, and the only additional data that is now furnished the Board relates to observations of the flow of Bear Hole Brook on two days.

In reply to your previous application, the Board advised you as follows: —

Your investigations and the examinations made by the Board do not show any place from which a satisfactory ground-water supply can be obtained within the limits of West Springfield; but the examinations of the Board have shown that on the western side of the mountain range which lies between West Springfield and Westfield, in the valley of Pond Brook, which forms the outlet of Hampton and Horse ponds, the conditions for obtaining a large quantity of water from the ground appear to be very favorable, so far as can be judged from surface indications. If investigations should show that it is practicable to obtain an ample supply of good ground water from this valley, it might be found to be for the best interests of the town to select this source; and it is probable that the cost of works for supplying this water to West Springfield would be less than the cost of works for developing a supply from Bear Hole Brook . . . while a much better water could be obtained.

The Board has given the question of the best permanent source of water supply for West Springfield further careful consideration, and is unable to see any reason for changing its opinion expressed in the reply referred to above.

It appears that, while your present sources are quite inadequate to furnish all the water required by the town in a dry season, you have made provision during the past year to utilize auxiliary sources, including a connection with the water works of the city of Springfield; and the Board is informed that, with reasonable economy in the use of water, the available sources are likely to furnish an adequate supply of water for the town during the time which will be required for making the necessary investigations and constructing works for taking a supply from the source that may be selected, without using sewage-polluted water from the Westfield River.

The Board would again advise that you proceed without further delay to make the investigations in the valley of Pond Brook in Westfield, as advised in its previous reply, a full copy of which is enclosed herewith.

WRENTHAM. The board of health of Wrentham applied to the State Board of Health Oct. 15, 1900, for advice relative to the quality of the water supplied to a public school building for drinking purposes. The Board replied to this application as follows: —

May 2, 1901.

In response to your application for advice as to the quality of the drinking water used for supplying the public school building in the village of Wrentham, the Board has caused the sources available for use for drinking at this building to be examined by its engineer, and samples of the water to be analyzed. The source from which the water used for drinking is usually taken is a well located in the rear of the school building, from which water is obtained by a hand pump.

The results of analyses of several samples of water collected from the well show that the water is clear and nearly colorless and odorless, but that it has at some time been somewhat polluted by sewage, and subsequently very well purified in its passage through the ground to the well. The water evidently acts on the iron pipe connected with the pump through which it is supplied, and water taken from the pump generally contains a considerable quantity of iron.

In the opinion of the Board, the water in its present state may be safely used for drinking; but its condition should be examined from time to time, in order that its use may be discontinued if the quality of the water deteriorates.

The principal source of water supply to the school building for general purposes is furnished under pressure through a galvanized-iron main pipe from a system of tubular wells located at a straw factory in the village, and this water, distributed through lead pipes, is available for drinking at several places in the school building. It appears that this water is also supplied to a public drinking fountain located about half-way between the factory and the school building, and to several dwelling houses in the village, but the pipe to the drinking fountain is separate from the pipe to the school, and is not coated with zinc. Analyses of samples of the water collected from the wells show that it has been considerably polluted by sewage, but subsequently well purified in its passage through the ground before entering the wells. The analyses of samples of water from a storage tank at the factory and from the drinking fountain did not differ materially from the analyses of the water as drawn from the wells in the factory; but samples collected from the school building show upon analysis that the character of the water changes materially in the zinc-coated pipe, and that a large quantity of zinc is taken up by the water in its passage from the factory to the school.

The Board considers this water as at present supplied to the school buildings unsuitable for drinking; and if this supply is to be retained, the galvanized-iron and lead pipes through which it is now supplied should be replaced by pipes of a material which will not be attacked by the water.

As in the case of the water of the well at the school building, the quality of this water is liable to deteriorate if there should be an increase in the sources of pollution in its neighborhood; and the Board would advise that, if its use is continued, its condition be examined from time to time, in order that any deterioration may be detected, and the use of the water prevented if necessary.

Sewerage and Sewage Disposal.

The following is the substance of the action of the Board during 1901 in reply to applications for the advice of the Board relative to sewerage and sewage disposal, under chapter 375 of the Acts of 1888, or for the approval of sewerage systems or the taking of land for sewage disposal, under other acts: —

Amesbury. An application was received April 11, 1901, from the sewer committee of Amesbury, for the advice of the Board relative to a proposed system of sewerage for the town. The Board replied to this application as follows: —

June 10, 1901.

The State Board of Health received, on April 11, an application for advice with reference to a proposed system of sewerage and sewage disposal for the town of Amesbury, containing the following outline of your proposed plans: —

The proposed system is to be constructed as a separate system, except that the sewers already built, as a combined system, will be connected with the proposed system. The new outlet sewer will be built of such a size as to take all the house sewage and a small part of the storm flow. Storm water overflows will be provided through the old outlets for use only during storms which deliver more than the proposed outlet can carry. The main part of the town will drain into the Merrimack River, through a sewer to be laid in the valley of the Powow River. The discharge will be into deep water in the Merrimack River, by means of an iron pipe. Providing the State Board of Health approves, a temporary outlet will be made into the Powow River at or near Patten's Brook.

A second outlet, to provide for the so-called Rocky Hill and Point districts, will be made into the Merrimack River, in the same manner as already described for the main village. This outlet is at a point in the Merrimack River below the outlet of the Powow River.

A third outlet into the Merrimack River will be made, as above described, for a small district at the hat factory.

The proposed system will provide for all parts of the village which will be likely to need sewers for a number of years.

Subsequently plans and a report describing the proposed system of sewerage were submitted by your engineers, Messrs. McClintock and Woodfall. The plans provide for a system of sewerage for the main village of

Amesbury, to be constructed upon the separate plan, which will collect the sewage in a main sewer, beginning near the head of tide water on the westerly side of the Powow River, and extending along the westerly bank of this river across Patten's Brook to the Merrimack River, into which it is proposed to discharge the sewage in a small bay just above the coal wharf on the westerly side of the mouth of the Powow River.

The Board has caused the locality to be examined by its engineer, and has considered the plans and report submitted. The plan for collecting and conveying the sewage to the Merrimack River appears to provide for all districts of the town which are at present in need of sewerage, and the sizes of the sewers are sufficient to allow for a considerable increase in the population in the future.

The locations of the proposed overflows or outlets for mingled sewage and storm water from the present sewers which are constructed upon the combined plan are not shown; but it is evident, from the general location of these sewers, that the mingled sewage and storm water will be discharged into water courses in the midst of the village, — a method of disposal which it is very important to avoid, and which the proposed new system of sewerage should make wholly unnecessary; and the Board would advise that before the construction of the system a careful study be made, to determine whether it is not practicable to largely, if not wholly, separate this sewage from the storm water in the beginning, since the storm water, if unpolluted by sewage, may be discharged into the most convenient water courses.

The proposed plan of disposing of the sewage by discharging it into the Merrimack River is a reasonable one to adopt in this case at the present time. If it shall become necessary to purify the sewage at some future time, as may be the case, works can be constructed on available lands at no great distance from the proposed outlet. It is very important, in the opinion of the Board, that, in discharging the sewage into the Merrimack River, the sewage be conveyed into the current of the river, and to some point from which it is not likely to be carried back upon the shore, at least until after it has become so thoroughly diluted with the water of the river that it cannot be detected; and the Board would advise that, before an outlet is definitely selected, observations of the currents be made by means of floats, to determine the most favorable point of discharge.

You also request advice as to a temporary outlet for the main sewer into the Powow River near the mouth of Patten's Brook. The Powow River from the lower portion of the village of Amesbury to the Merrimack River is a tidal stream, the main channel of which has recently been widened and deepened, but considerable areas of flats are exposed outside of the channel at times of low water. The current of the river runs in different directions as the tide ebbs and flows, and if sewage should be discharged into the stream at Patten's Brook, the heavier portions would be likely to settle upon the flats above and below the outlet, where they would be alternately exposed to the air and covered with water, and in their decomposition would create a very serious nuisance. The Board, therefore, does not advise the discharge of the sewage at this place. It is possible that during the construction of the system, before any considerable quantity of sewage has been diverted into the proposed main sewer and its tributaries, an outlet might temporarily be made at Patten's Brook; but, if so, it should be only for temporary use, and should be discontinued when any considerable quantity of sewage is brought there by the main sewer.

BARNSTABLE (State Normal School at Hyannis). The State Board of Health received from the principal of the State Normal School at Hyannis, Dec. 26, 1900, an application for the advice of the Board with reference to a proposed new location of the sewage filtration beds for the normal school, accompanied with a plan of the location. The Board replied to this application as follows: —

FEB. 7, 1901.

The location now selected appears to be as remote from dwelling houses in the neighborhood as it is practicable to place it without carrying the sewage across the meadows in the rear of the school to lands now used for other purposes; and, in the opinion of the Board, if a sufficient area of filters shall be constructed at this place, in the manner suggested in a previous communication of the Board, dated Dec. 6, 1900, it is not likely that odors from the sewage will be noticeable at any of the houses in the neighborhood.

It is evident, as stated in a previous reply, that the sewage decomposes and putrefies to a considerable extent on account of the long time it remains in the cesspool, causing the sewage to have a much stronger odor as it leaves the cesspool than would be the case if the cesspool were much smaller in proportion to the quantity of sewage. It is desirable that the sewage should be brought to the filters at as high a level as is practicable, so that as large an area of land may be made available as is practicable, and allow for future extensions to the filters. A considerable saving in grade could be made by conveying the sewage to the filtration area now proposed by a more direct line than can be obtained by passing it through the present cesspool, and by providing a tank of smaller depth.

The Board would suggest that the works be laid out and constructed under the direction of an engineer, since it is very important, in order to secure a successful operation of the filters, that the distributing pipes be laid to proper lines and grades, and that suitable care be taken to keep sand and gravel, and other substances which would tend to clog them, out of the pipes, and at the same time afford as free a passage for the sewage as is practicable.

BARNSTABLE (State Normal School at Hyannis). An application was received from the State Board of Education, May 7, 1901, for the advice of the State Board of Health relative to certain plans for a new system of sewage disposal at the State Normal School at Hyannis. The Board replied to this application as follows: —

MAY 8, 1901.

The State Board of Health received from you, on May 7, 1901, an application submitting proposed plans for a sewage-disposal system at the State Normal School at Hyannis, with a request for the advice of the Board as to their probable efficiency in disposing of the sewage. The plan accompanying the application provides for a new sewer, to begin at a man-hole on the old sewer about 160 feet above the cesspool, and follow approximately the old sewer line to a storage tank to be constructed not far from the present cesspool. From this reservoir the sewage is to be discharged automatically by a siphon into an 8-inch pipe, about 250 feet long, through which it will flow to the filtration area.

The filtration area, as indicated on the plan, will consist of three filter beds, having a total area of 4,200 feet; and it is proposed to distribute the sewage upon these beds through pipes 6 inches in diameter, laid 3 feet apart and 2 feet beneath the surface of the beds. The soil at the place where it is proposed to locate the filter beds appears, from the excavations that have been made, to be of excellent quality for sewage-disposal purposes, and no underdrains are deemed necessary.

The plan is substantially that recommended in recent communications of the Board to the principal of the school. The proposed reservoir for storing the sewage has a capacity of about 1,100 gallons, apparently about one-third of the total daily flow of sewage. It would be better to make the tank of smaller capacity, in order that sewage may be discharged at shorter intervals into the subsurface disposal pipes, and the Board would recommend that the capacity of this tank be reduced to about half the capacity now proposed. The details of the tank are not presented, but it will be necessary to provide some means for intercepting such objects as may tend to clog the pipes in the filter beds. With the exception of the size of the tank, the plan is, in the opinion of the Board, a suitable one for the disposal of the sewage of the school; and if sewage is distributed intermittently, using each of the three beds in rotation, it is likely that this filtration area will dispose of the sewage of the school satisfactorily, if the pipes are relaid whenever they become clogged.

BILLERICA. An application was received Sept. 16, 1901, from the treasurer of the Talbot Mills, for the advice of the Board relative to a proposed system of sewage disposal for the village of North Billerica. The Board replied to this application as follows: —

appear to be such that it is necessary to purify the sewage in the neighborhood of the buildings, and the plan submitted is, in the opinion of the Board, well adapted to the purpose. There will be an advantage in so arranging the collecting and settling tank that a pipe may be provided whereby the liquid in this tank may be discharged upon the filter beds when the tank is being drawn off in order to clean it out. It is also suggested that one of the coke beds be divided into two portions, so that when the population of the institution is near the minimum and the small flush tank only is in use, a better distribution of the sewage can be obtained by discharging a larger quantity in proportion to the area of the bed than would now be possible.

It is possible that, if considerable quantities of disinfectants, such as corrosive sublimate, are used in the hospital, they will prevent the successful operation of the filters; and, should it be found that the use of such disinfectants is having an unfavorable effect upon the filters, some means must be provided for preventing difficulty from this cause.

DEDHAM. The sewer commissioners of Dedham applied to the State Board of Health Feb. 2, 1901, for advice relative to a proposed system of sewerage for the town. The Board replied to this application as follows: —

MARCH 7, 1901.

The State Board of Health received from you, on Feb. 2, 1901, an application for advice with reference to a proposed system of sewerage for the town of Dedham, in which your proposed plans are outlined as follows: —

The sewerage system is to connect with the Neponset valley sewer of the metropolitan system at three separate outlets from the local sewers.

The accompanying plan and report, prepared by E. Worthington, C.E., embraces the present construction proposed and the outlines of future extensions.

No overflows are provided. Sewage matter only is to be admitted, and the "separate system," so called, is to be followed.

A portion of Dedham's territory, including what is now Westwood, has been excluded from assessment on the metropolitan system, as it does not drain into the metropolitan sewer.

The application was accompanied by the report and plan of your engineer, showing the location of the proposed sewers and the proposed connections with the metropolitan system. The plan provides for the sewerage of all the portions of the town which appear to be in need of sewerage at the present time; and, since it is expressly provided that there shall be no overflows either at connections with the metropolitan sewer or elsewhere in the system through which sewage can be discharged, the plan appears to provide adequately for preventing the pollution of any stream or water course.

Island in Boston harbor, by an outlet into the main channel, below low water. The Board replied to this application as follows: —

Nov. 7, 1901.

The State Board of Health has considered your application, made in behalf of Mr. A. C. Burrage, for advice as to the disposal of the sewage from a hospital for crippled children, to be built on Bumkin Island in Boston harbor, in which you state that it is proposed to build a sewer from the shore on the north-west side of the island from mean low water into what is called the main ship channel. It appears that the proposed hospital will provide at present for about 150 persons in all.

The Board has examined the circumstances, and is of the opinion that the sewage of the proposed hospital may safely be discharged into the waters of Hingham Bay, on the north-west side of Bumkin Island and near the north-easterly side of the main channel in this bay, at all stages of the tide as proposed, provided that the outlet be carried out as much as 100 feet from the shore at low tide, so that there will be a considerable width of water between the outlet and the shore. The Board would advise that the sewage be passed through a suitable tank, having, in the beginning, a capacity of about 20,000 gallons, with the outlet so arranged that floating matters from the sewage will be retained in the tank.

Brookline. The board of health of Brookline applied to the State Board of Health Aug. 23, 1901, for advice relative to the disposal of the sewage of new hospitals for contagious diseases. The Board replied to this application as follows: —

Oct. 3, 1901.

The State Board of Health received from you, on Aug. 26, 1901, an application for advice with reference to a proposed system of sewage disposal for hospitals for contagious diseases, now under construction in Brookline, and subsequently plans were submitted by the town engineer, showing a proposed method of collecting and disposing of the sewage.

The plans provide for collecting the sewage in a settling tank, from which it will overflow into flush tanks, and thence be discharged upon the surfaces of coke filter beds 5 feet in depth. The effluent from the filter beds will discharge into a swamp.

Information furnished by you indicates that a maximum population of about 70 may be expected in the various hospitals, though usually the number will be much smaller. On account of the probable fluctuations in population at the institution, the works have been so designed that when the population is at the minimum only a single small flush tank will be in use.

The Board has caused the locality to be examined by its engineer, and has considered the plans and information submitted. The circumstances appear to be such that it is necessary to purify the sewage in the neighborhood of the buildings, and the plan submitted is, in the opinion of the Board, well adapted to the purpose. There will be an advantage in so arranging the collecting and settling tank that a pipe may be provided whereby the liquid in this tank may be discharged upon the filter beds when the tank is being drawn off in order to clean it out. It is also suggested that one of the coke beds be divided into two portions, so that when the population of the institution is near the minimum and the small flush tank only is in use, a better distribution of the sewage can be obtained by discharging a larger quantity in proportion to the area of the bed than would now be possible.

It is possible that, if considerable quantities of disinfectants, such as corrosive sublimate, are used in the hospital, they will prevent the successful operation of the filters; and, should it be found that the use of such disinfectants is having an unfavorable effect upon the filters, some means must be provided for preventing difficulty from this cause.

DEDHAM. The sewer commissioners of Dedham applied to the State Board of Health Feb. 2, 1901, for advice relative to a proposed system of sewerage for the town. The Board replied to this application as follows: —

MARCH 7, 1901.

The State Board of Health received from you, on Feb. 2, 1901, an application for advice with reference to a proposed system of sewerage for the town of Dedham, in which your proposed plans are outlined as follows: —

The sewerage system is to connect with the Neponset valley sewer of the metropolitan system at three separate outlets from the local sewers.

The accompanying plan and report, prepared by E. Worthington, C.E., embraces the present construction proposed and the outlines of future extensions.

No overflows are provided. Sewage matter only is to be admitted, and the "separate system," so called, is to be followed.

A portion of Dedham's territory, including what is now Westwood, has been excluded from assessment on the metropolitan system, as it does not drain into the metropolitan sewer.

The application was accompanied by the report and plan of your engineer, showing the location of the proposed sewers and the proposed connections with the metropolitan system. The plan provides for the sewerage of all the portions of the town which appear to be in need of sewerage at the present time; and, since it is expressly provided that there shall be no overflows either at connections with the metropolitan sewer or elsewhere in the system through which sewage can be discharged, the plan appears to provide adequately for preventing the pollution of any stream or water course.

The Board is of the opinion that the plan is an appropriate one for the sewerage of the town of Dedham.

FITCHBURG. An application was received Feb. 1, 1901, from the special commission on sewage disposal of Fitchburg, for the advice of the Board as to a proposed system of sewage disposal for the city. The Board replied to this application as follows: —

JUNE 6, 1901.

The State Board of Health received from you, on Feb. 1, 1901, an application for advice with reference to a proposed system of sewage disposal for the city of Fitchburg, in which you state that it is proposed to construct a main trunk sewer 6 miles in length to intercept the sewage now flowing into the river at Fitchburg and to convey it to some form of disposal works; and you especially request advice as to the disposal of mill wastes now being discharged into the stream. Subsequently, plans and a report were submitted by your engineer, Mr. Freeman C. Coffin of Boston, describing proposed works for the collection and disposal of the sewage of the city, including manufacturing wastes.

The plans submitted provide in general for the collection of all of the sewage and mill wastes, excepting the wastes from the paper mills, in a main sewer beginning at the upper end of the city and following approximately the course of the river to an outlet upon a proposed sewage-disposal area lying just south of the Fitchburg Railroad and contiguous to the town of Leominster, where it is proposed to dispose of the sewage by intermittent filtration through prepared filter beds of sand and gravel. It is proposed to provide strainer beds for cleansing the wastes from the paper mills in the neighborhood of the mills where convenient sites for such strainers are found, and to discharge the water after purification in this way into the river at convenient points. The plans submitted provide for eight sets of these strainer beds for the twelve paper mills, it having been found practicable and desirable in some cases to combine the wastes of two paper mills at one place for purification. The plans also provide for remodelling the present sewerage system of the city, and separating the sewage from the storm water. At the filtration area the plans show 40 acres of filter beds which are intended to meet present requirements as to sewage disposal after the proposed works are completed, and other lands are available for extensions when necessary.

The Board has caused the locality to be examined by its engineer, and has carefully considered the plans and report submitted and has investigated the character of the various mill wastes now discharged into the river.

The results of the examinations of the paper mill wastes and of experiments made by the Board in previous years upon the disposal of such wastes indicate that they can be satisfactorily purified in the manner proposed, and the strainer beds appear to be of ample capacity for present needs, and are conveniently located for the purpose for which they are to be used.

The results of examinations of the wastes from the woollen mills, and the experience with the disposal of wastes from other woollen mills in which the processes carried on are similar to those employed in the mills at Fitchburg, have shown that the most satisfactory method of disposing of these wastes will be in connection with the ordinary sewage of the city; but it is desirable that settling tanks be provided at the mills for some of these wastes, to remove the matters which might tend to cause trouble in the sewers and at the disposal works. The quantity of water used in some of the processes in some of these mills appears to be much larger than is necessary, and it is desirable that the quantity be reduced as much as practicable.

The separation of the storm water from the sewage is one of the most important features of the proposed plan, and should be carried out as soon as possible. The storm water can be disposed of satisfactorily into the river or into local water courses if unpolluted by sewage. It is impracticable to construct all of the drains and sewers needed for the separation of the sewage from the storm water in the beginning, and it will be necessary to provide temporary storm overflows for the disposal of the excessive flow of sewage and storm water at times of rain and melting snow.

The filtration area is well located for the purpose, and contains soil very well adapted to the purification of sewage by intermittent filtration. Excellent filter beds can be constructed at this place, which will provide adequately for the purification of the sewage for the present and for several years in the future, and the area can be enlarged as may be required. It is possible that further investigations may show that a saving in cost of disposal can be effected by a preliminary treatment of the sewage for the removal of solid matters.

The plan in general is, in the opinion of the Board, an appropriate and satisfactory one for the collection and disposal of the sewage and manufacturing wastes of the city of Fitchburg, and, if carried out as proposed, will provide efficiently for the prevention of the further pollution of the north branch of the Nashua River in Fitchburg, and its restoration to a satisfactory sanitary condition there.

FRANKLIN. An application was received April 4, 1901, from the selectmen of Franklin, for the approval of the Board of the purchase and taking of certain land in the town of Franklin for the purpose of purification and disposal of sewage, under the provisions of chapter 124 of the Acts of 1890. After due notice a hearing was held at the office of the Board, May 2, 1901, but no one appeared in opposition to the proposed purchase and taking of land, and the Board approved the same, as stated in the following reply: —

MAY 2, 1901.

In response to your request for the approval by the State Board of Health of the purchase or taking of a certain piece or parcel of land in the town of Franklin, near Timnah Brook, the Board gave notice that a public hearing upon the matter would be given at its office on May 2, 1901, under the provisions of chapter 124 of the Acts of 1890. At this hearing no person appeared to oppose the purchase or taking of the land referred to for sewage-disposal purposes; and the Board hereby approves the purchase or taking by the town of Franklin, for the purification and disposal of a portion of the sewage of the said town, of land on the south-westerly side of the New York, New Haven & Hartford Railroad, near Timnah Brook, about half a mile north-east of the place where it is crossed by Central Street in Franklin, the land being bounded and described as follows: —

Beginning at a stone bound at the north-westerly corner of said land and land of the New England Railroad Company, and thence running north-easterly on land of said railroad company, nine hundred and forty-two (942) feet to a bound at land of the heirs of Joseph G. Ray; thence easterly on said land of said heirs, forty-six and two-tenths (46.2) feet, more or less, to the end of an old dam; thence easterly on the northerly line of said old dam and on land of said heirs to a stone bound on the shore of the pond; thence on other land of this grantor south 59° 41′ 30″ west, one thousand four hundred and forty-seven and fifty-three one hundredths (1,447.53) feet to a stone bound; thence north 30° 18′ 30″ west, three hundred and forty-eight (348) feet to the point of beginning.

The Board, after approving the purchase and taking of the aforesaid land in Franklin, sent the following communication to the selectmen of that town on the same day: —

The Board would respectfully call your attention to the fact that the successful disposal of sewage upon the land, the purchase or taking of which has been approved by this Board in another communication of the same date with this letter, depends largely upon the proper preparation of these lands for the purpose. When the plans showing the method of preparing this land for the purification and disposal of the sewage are completed, the Board is of the opinion that they should be submitted to the Board for its advice, under the provisions of chapter 375 of the Acts of 1888.

FRANKLIN. The selectmen of Franklin applied to the Board July 5, 1901, for its advice relative to a proposed plan of sewage disposal for the town. The Board replied to this application as follows: —

JULY 26, 1901.

The State Board of Health received from you, on July 6, 1901, an application giving notice of your intention to introduce a system of sewerage in the town of Franklin, and requesting the advice of the Board as to a proposed method of disposing of the sewage, shown on a plan submitted.

The plan provides for continuing the present sewer on the southerly side of the railroad through land already under the control of the town to the filtration area approved by this Board upon May 2 last, where the sewage is to be purified by filtration upon four filter beds, having an aggregate area of about 72,000 square feet. These filter beds are to be located partly on the higher land of the filtration area and partly on the low meadow land by using soil from the higher lands.

It appears that it is proposed to construct underdrains in the filter beds upon the lower lands, using the large stones found in the material of which the filter beds are to be built, and that the depth of sand over the underdrains is to be only 1 foot.

The Board has caused the locality to be examined by one of its engineers, and has carefully considered the plans submitted. The proposed area of filter beds is ample for the disposal of all of the sewage flowing from the main sewer at present, and for the disposal of the sewage of the academy and other buildings now discharged on the north side of the railroad, where there is a very serious nuisance.

In extending the sewer to the filtration area, the slope of the sewer may be made less than is now proposed, and the cost of the preparation of filter beds on the higher portions of the area will thereby be reduced.

The character of the filtering material, judging from the test pits at the proposed filtration area, is excellent for sewage-disposal purposes, and it is not probable that underdrains will be needed in the filters to be located on the higher lands. The proposed plan for filters on the lower lands which provides for a depth of only 1 foot of sand over the underdrains is not a proper one, and the Board would advise that the depth of filtering material over the tops of the underdrains be made at least 4 feet.

On account of the coarseness of the material of which the beds will be constructed, care will be necessary to secure a proper distribution of the sewage; and it will be of much advantage, in securing an even distribution, to place the finer material upon the surfaces of the beds.

If the modifications in your plan herein suggested are made, the Board is of the opinion that the sewage of Franklin can be properly purified by this plan, and the further pollution of the brook prevented.

LANCASTER. An application was received May 16, 1901, from the South Lancaster Sanitarium, for the advice of the Board relative to the sewage disposal of the institution. The Board replied to this application as follows: —

JUNE 6, 1901.

The State Board of Health has considered your application for advice relative to the disposal of sewage from the South Lancaster Sanitarium in South Lancaster, and other buildings in its neighborhood, and has caused the locality to be examined by one of its engineers.

It appears that at the present time sewage from the sanitarium, academy and dormitory, together with the sewage from about twenty houses in the neighborhood of Prospect Street, is discharged into cesspools near a small brook, from which it overflows directly into the brook. It appears also that the sewage from several other houses in this neighborhood is discharged upon the surface of the ground, over which it flows toward the brook; and, as the soil appears to be nearly impervious to water, much of this sewage also doubtless enters the brook. The water-shed of the brook is so small and the quantity of sewage discharged into it so large in comparison that the nuisance is evidently a serious one in the summer season. There is no doubt, in the opinion of the Board, that these conditions are a menace to the health of the neighborhood, and it is very important that the sewage be collected and disposed of in some suitable manner with as little delay as possible. The character of the soil in the valley of this brook is such that sewage cannot be disposed of properly in this region unless material for the necessary filters should be brought here. The best method of finally disposing of this sewage will be in connection with a general system of sewerage for the village; and since such a system may be found necessary before long, the sewers or works constructed in this valley should be so constructed that they may form a part of such a general system, and remove all of the sewage which now pollutes this brook.

The Board would advise that an engineer be employed by the town to design a proper system of sewerage and sewage-disposal works for this portion of the village, in connection with a general plan of sewerage and sewage disposal for the whole village; and when a plan has been prepared, the Board will, upon application, give further advice in this matter.

The following communication was also sent to the board of health of Lancaster on the same day: —

A copy of a communication sent by this Board to-day to the superintendent of the South Lancaster Sanitarium at South Lancaster is enclosed. The problem of properly disposing of the sewage of the South Lancaster Sanitarium and of many other buildings in the valley of the brook in question is a serious one, and, in the opinion of the Board, should be committed to an engineer of experience in matters relating to sewage disposal. It is desirable, in the opinion of the Board, as indicated in the reply, that the question of the sewerage of the town in general be taken into consideration, in order that sewers or other works which may be constructed in this valley may form a part of a general system.

MANCHESTER (private estate at Magnolia). An application was received Aug. 3, 1901, from E. W. Bowditch, C.E., acting for Mrs. M. W. Sampson, for the advice of the Board relative to a proposed sewer outlet for her estate, and possibly for one other, into the sea, at Magnolia. The Board replied to this application as follows: —

SEPT. 5, 1901.

In response to your request of August 2 for advice relative to a proposed private sewer from the estate of Mrs. Mary W. Sampson of Magnolia, to discharge at low water in Kettle Cove, the Board has caused the territory to be examined by one of its engineers.

It appears that this sewer is expected to receive only the sewage from the estate referred to, and possibly one other, and that the quantity of sewage will be very small.

As a result of its examination, the Board concludes that, if the quantity of sewage delivered into the sewer shall be no greater than will be furnished by the buildings upon the two estates referred to at the present time, the proposed outlet is a permissible one. This outlet should, however, be considered as temporary only, to be abolished whenever a general system of sewerage is available for this portion of the town of Manchester.

The outlet should be carried out to such a distance that it may always be covered at extreme low water.

MARION. An application was received from the sewerage committee of Marion, July 15, 1901, for the advice of the Board relative to a proposed system of sewerage for the village of Marion. The Board replied to this application as follows: —

NOV. 7, 1901.

The State Board of Health received from you, on July 15, 1901, an application for advice with reference to a proposed system of sewerage and sewage disposal for Marion, and subsequently plans of the proposed system and a report containing a description of the proposed works were presented through your engineer, Mr. Freeman C. Coffin of Boston.

The plans provide for a system of sewers by means of which the sewage of the greater portion of the village will be conveyed to a reservoir and pumping station, to be located near the shore of the harbor north of the village, whence it will be pumped to a filtration area situated about a mile north of the pumping station, and there purified by intermittent filtration, the effluent to be discharged into a neighboring stream. It is not practicable to collect all of the sewage of the village at the main pumping station by gravity, and the plans provide for collecting the sewage from a district in the southern portion of the village at an auxiliary pumping station, from which it will be pumped to the main system.

The proposed sewers are to be constructed upon the so-called separate plan, and all storm water, and, so far as possible, ground water, are to be excluded from the system.

The Board has considered your application and the plans and report submitted therewith, and has caused the location of the proposed works and the character of the soil of the proposed filtration area to be examined by its engineer. On account of the topography and extent of the village and the comparatively small elevation of much of its area above the level of the sea, it does not appear to be practicable to collect all of the sewage at one place by gravity, nor does it appear to be practicable to dispose of it satisfactorily by any method without pumping. It is important to avoid further pollution of the harbor by sewage, and the plan of pumping the sewage to suitable land for its purification, as proposed, is, in the opinion of the Board, the best one for the town to adopt. The proposed reservoir and pumping stations, if properly constructed, will not be objectionable, and no odor need be noticeable from them.

The proposed filtration area is quite remote from any considerable population, and contains soil suitable for the purification of sewage by intermittent filtration. Examinations show that the soil, while in general of excellent quality for the purpose, is in places somewhat fine, and it will probably be found necessary to provide a thorough system of underdrainage for the filter beds. The quantity of sewage which is likely to be received into this system in the beginning, however, and until a public water supply is introduced into the village, is likely to be small, and it is possible that a very limited underdrainage will be sufficient until the quantity of sewage becomes much greater than it seems reasonable to expect in the beginning.

The plans in general are, in the opinion of the Board, well adapted to the collection and disposal in a satisfactory manner of the sewage of the present village of Marion.

MASSACHUSETTS SANATORIUM AT RUTLAND. The superintendent of the State Sanatorium at Rutland applied to the Board July 3, 1901, for advice relative to the operation of the sewage-disposal system of the institution. The Board replied to this application as follows: —

AUG. 1, 1901.

In response to your request for an examination of the sewage-disposal system of the Rutland Sanatorium, and advice as to its operation, the Board has caused the works to be examined by its engineer, and has considered the plans of the works and the method of their operation.

It appears that the chief difficulty complained of is the operation of the flush tank which is located not far from the hospital, and was put in for the purpose of preventing danger of stoppage in the main sewer. This tank, as constructed, consists of a screen chamber, in which are screens for removing from the sewage matters which might clog the sewer, and a flush tank, designed to empty automatically at intervals. The screens are located about midway of the screen chamber, and just in front of them there is a pipe leading to an outlet on lower land near the tank, which was put in to provide a convenient method of removing the screenings. It appears that considerable floating matter collects back of the screens, and that it has been the custom, since the works were first operated, to draw off about once in ten days, through the outlet pipe referred to, the matter which collects back of the screens, together with all of the sewage in the tank that will flow out through this pipe. This matter, after drying, is composted and used as a fertilizer; and it appears that disagreeable odors arise in the course of this process which are sometimes noticeable at the hospital.

In the opinion of the Board, the drawing off of the sewage in the tank and screen chamber in order to remove the floating matter which collects behind the screens in the manner in which it is now done is unnecessary. The matters collected behind the screens can be removed without difficulty by means of rakes, and carried away in carts or wheelbarrows whenever necessary; and the discharge of a large quantity of sewage at this place whenever the screens are cleaned can be avoided. If floating matter collects on the top of the tank, it can be removed either by skimming or by breaking it up so completely that it will pass through the screens and mingle with the remainder of the sewage, and thus flow to the filtration area. It is possible that it may be necessary to clean out the flush tank and to open the blow-off at the lowest point of the inverted siphon on the main sewer, but this will probably not be necessary either at frequent or at regular intervals. The matters removed from the sewage at the screen chamber or flush tank should be carefully disposed of outside of the Nashua River water-shed, to avoid the danger of pollution of the water supply of the metropolitan district.

An examination of the filter beds shows that it is customary to discharge all of the sewage upon one bed for a period of about a week, and then to allow the bed to dry and subsequently scrape its surface. The filters can be kept in a much more satisfactory condition by diverting the sewage to the different beds more frequently, and sewage should not be discharged upon one bed for a longer period than two days. Before the ground freezes in winter the beds should be thoroughly cleaned and then furrowed, and arranged so that sewage will flow upon them without difficulty beneath the snow and ice.

METHUEN. The selectmen of Methuen applied to the Board July 3, 1901, requesting its advice relative to a proposed plan of sewerage and sewage disposal for the town. The Board replied to this application as follows: —

AUG. 1, 1901.

The State Board of Health received from you, on July 5, 1901, an application for advice with reference to a proposed system of sewerage and sewage disposal for the town of Methuen, accompanied by a report of your engineer and plans showing the proposed system and outlet. The plans submitted provide for a general system of sewerage for the main village in the valley of the Spickett River, by which the sewage would be collected into a main sewer following the general line of the river to the neighborhood of the Arlington mills, and thence passing through Ingalls Street to the Spickett valley sewer, so called, of the city of Lawrence, into which it is proposed to discharge the sewage. A plan has also been submitted for a system of sewerage for the valley of Bloody Brook, which will discharge into the Spickett valley sewer of the city of Lawrence at East Haverhill Street.

The Board has carefully considered your application and plans submitted therewith, and has caused the locality to be examined by its engineer. The proposed system of sewers appears to provide adequately for removing all the sewage from portions of Methuen in the valley of the Spickett River and Bloody Brook which are now in need of sewerage, and will provide for a considerable increase in the population of these districts in the future. The plan provides for receiving sewage only into the sewers, and it is important that this portion of the plan be carried out, since the storm water can be disposed of satisfactorily into the local water courses.

In the opinion of the Board, the proposed method of disposing of the sewage of the town of Methuen is the best that it is practicable for the town to adopt.

The Spickett River, between the Methuen boundary line and its mouth, is a polluted stream, which is evidently offensive to those living in its neighborhood. Pollution is caused at the present time chiefly by manufacturing waste, but also by the overflow of sewers from the city of Lawrence, constructed on the combined plan, since at times of storm the Spickett valley sewer is capable of removing only a small proportion of the sewage and storm water discharged into these tributary sewers, and the great bulk of the sewage, mingled with the storm water, flows into the river. There are several dams on the stream which tend to cause a deposit of the sewage matters discharged into the stream.

The discharge of the sewage of Methuen into the Spickett valley sewer will tend to increase the quantity of sewage discharged into the Spickett River between the Arlington mills and the outlet of the Spickett valley sewer; and it is likely that in time some provision will have to be made by the city of Lawrence and the town of Methuen for reducing the quantity of sewage discharged into the stream through these overflows. The present outlet of the Spickett valley sewer is objectionable, and will no doubt in the future have to be extended to deep water in the Merrimack River; and the addition of area to be sewered will shorten the time within which it will be necessary to make the extension.

METROPOLITAN WATER AND SEWERAGE BOARD. An application was received from the Metropolitan Water and Sewerage Board, Aug. 22, 1901, for the approval of a proposed extension of the Neponset valley sewerage system, intended to provide for certain areas in Brookline and Newton. The Board replied to this application as follows: —

SEPT. 5, 1901.

The State Board of Health received from you, on August 22, a plan of a proposed extension to the Neponset valley sewerage system, which provides for a branch sewer extending from the existing Neponset valley sewer in St. Joseph's Cemetery in West Roxbury to and across the boundary line between Newton and Brookline, which you state has been approved and adopted by the Metropolitan Water and Sewerage Board; and you now request the approval of the plan by the State Board of Health, under the provisions of chapter 406 of the Acts of 1895 and chapter 204 of the Acts of 1901.

The application and plan are accompanied by a report of your engineer of sewerage works, showing the location and grades of the proposed sewer and the areas of land in Newton and Brookline for which this sewer is intended to provide a means of sewage disposal. These areas are situated chiefly in the valley of a tributary of the Charles River, which enters that stream a short distance below Cow Bay, and include 450 acres in the extreme easterly part of the city of Newton and about 922 acres in the south-westerly part of the town of Brookline.

The Board has carefully examined the plan and the information submitted therewith, and concludes that the proposed sewer is adapted for the reception and removal of all of the sewage of the portions of the city of Newton and the town of Brookline indicated on the plan for a very long time in the future, so far as can now be foreseen, and the Board hereby approves the proposed plan for the disposal of the sewage of the portions of Newton and Brookline therein indicated.

By the provisions of law, the sewers to be built in these districts must be constructed upon the separate plan, and overflows or waste gates for discharging or disposing of any sewage into local water courses will be unnecessary; and, since none are indicated upon the plan, it is understood that none are to be provided either on the main sewer or tributary systems.

NEWBURYPORT. An application was received April 8, 1901, from the joint committee on sewerage of Newburyport, for the advice of the Board relative to a modification of their existing plan of sewerage and sewage disposal. The Board replied to this application as follows: —

MAY 2, 1901.

The State Board of Health received from you, on April 8, 1901, an application, under the authority of chapter 375 of the Acts of 1888, and chapter 233 of the Acts of 1889, requesting the advice and approval by the Board of a modification of the system of sewerage and sewage disposal of the city, approved by this Board in 1888, in which you state that two plans are under consideration for the disposal of the sewage of the portion of the city north of the neighborhood of Forester Street, by one of which the present intercepting sewer in Merrimack Street will be extended to receive the sewage of this territory, while by the other the sewage of this region would be discharged into the Merrimack River at Currier's wharf. In case, however, it is decided to extend the main intercepting sewer, there is a small area already containing several buildings from which the sewage cannot be discharged into the intercepting sewer by gravity, and advice is also requested as to whether it is best to pump this sewage into the main intercepting sewer or discharge it by gravity into the river at Currier's wharf.

The Board has caused the locality to be examined by its engineer, and has carefully considered your application and the plans submitted.

It is not desirable, in the opinion of the Board, to discharge sewage into the Merrimack River along the city front, unless the sewage should be discharged a long distance from the shore, as local nuisances might otherwise be created. It will be less expensive and more satisfactory, in the opinion of the Board, for the city to continue to extend the main intercepting sewer toward the northerly end of the city than to provide a new outlet for the sewage in this neighborhood, as now suggested. The best plan for extending this sewer appears to be to change the original line, as suggested by you, so that, going northerly at the corner of Forester Street, it will turn into that street, thence across Ashland Street, through Ashland Place and over private lands to Jefferson Street, through which it will return to Merrimack Street. The sewage from the small low area which cannot be discharged into the intercepting sewer by gravity can be raised at small expense so as to discharge into the main intercepting sewer at a convenient point in Merrimack Street near Forester Street, as indicated upon one of the plans submitted. The Board therefore does not advise or approve any change in your proposed sewerage plan which will allow the discharge of any sewage into the river along the city front, as now proposed, but advises that you carry out the plan of pumping the limited quantity of sewage from the low district referred to into the main intercepting sewer.

NORTHAMPTON. An application was received March 13, 1899, from the sewer commissioners of Northampton, requesting the State

Board of Health to extend the time "for the extension of the main sewer from its present outlet into Mill River to the Connecticut River." The Board replied to this application as follows: —

DEC. 5, 1901.

The State Board of Health received from you, on March 13, 1899, the following communication relative to the disposal of the sewage of the city of Northampton: —

The board of sewer commissioners respectfully request your honorable Board to extend, for such time as to your honorable Board may seem proper, the time limited in your order, dated March 22, 1889, for the extension of the main sewer from the present outlet into Mill River to the Connecticut River, the conditions of the occupancy of the land below such outlet remaining unchanged. By vote of the sewer commissioners of Northampton.

The order to which reference is made limiting the time within which the main sewer of the city of Northampton was to be extended from its present outlet to the Connecticut River was dated March 22, 1889, and the time limit expired March 22, 1899.

As soon as practicable after your application was received an examination of the sewer outlets and other conditions affecting the disposal of sewage at Northampton was made, under the direction of the Board. The results of the investigations show that the conditions at the present sewer outlets and along the river below remain at present about the same as in 1889, in that the region has not become more densely populated; but there has been, in other respects, a marked change, because the river has now become grossly polluted below the sewer outlet. In the opinion of the Board, a nuisance of this sort should not be allowed to continue, and the discharge of the sewage of the city into Mill River at any point, either at the present outlet or below, should be discontinued.

In the original plan provision was made for avoiding this condition by extending the sewer to the Connecticut River within ten years from the date of the approval of that plan, unless the time should be further extended by the State Board of Health; and, in the opinion of the Board, the conditions require remedy without delay.

From the present indications, however, there is danger that objection may be made in the future to the discharge of crude sewage into the Connecticut River above the dam at Holyoke; and, under the circumstances, it may be for the best interests of the city either to purify the sewage at the present time, or to make provision for diverting the sewage from the Connecticut River at some future time and purifying it. If it is practicable to divert the sewage of Northampton by gravity to a suitable place of disposal not far from the city, and if this is done presently, the cost of construction of the main sewer to the Connecticut River would be avoided;

and, if the storm water should be separated from the sewage, the expense of purifying the sewage might not be much, if any, greater than the expense of constructing and maintaining a sewer to the Connecticut River, with a suitable outlet at such distance from the banks of that stream that the sewage may become as completely diluted as possible before it can reach the banks.

While it was evident, from an examination of the locality, that sewage from the lowest areas of the city near the present outlets could not be diverted to purification works without pumping, the general contour of the city indicated that the quantity of sewage from such areas might be so small that it could be allowed to discharge into the Mill River without treatment until these low areas become populated. The Board has, therefore, suggested to your commission the desirability of making investigations to determine what portion of the sewage of the city might be diverted by gravity to suitable places for purification, the methods by which it could be purified, and the probable cost of the necessary sewers and works. The Board also offered to make investigations as to the capacity of the soil of the meadows for the purification of the sewage, if you would furnish a specified quantity of the material.

These investigations have been partially made as suggested, and a plan has been received from your city engineer showing the location of main sewers and the elevations of the bottoms of these sewers at various points. Judging from this information, it apparently would be practicable to divert nine-tenths of the sewage of the city to some of the higher lands on the meadows, at no great distance from the city. No samples of the soil of the meadows have been furnished to the Board, as suggested, and consequently definite information as to the quantity of sewage that can be purified upon these lands is lacking; but the results of investigations upon the purification of sewage by similar soils indicate that the sewage of Northampton could be purified upon the higher lands of the meadows by suitable works without great difficulty during all of the year, excepting possibly at times of high freshets. If so large a proportion of the sewage could be diverted to the meadows by gravity, and purified at a reasonable cost as compared with the cost of disposal into the Connecticut River, the Board is of the opinion that it would be for the best interests of the city to adopt this method of disposing of this sewage, since the remaining sewage from low areas might then be allowed for many years to discharge into the Mill River below the city without treatment.

In the opinion of the Board, it would be advisable for you to make the necessary thorough investigations with the assistance of an engineer of experience in matters relating to sewage disposal to determine the feasibility of disposing of the sewage of the city in the manner herein indicated, before proceeding to complete the plan approved in 1889 by constructing a main sewer to the Connecticut River.

If these investigations should be begun without delay and carried out efficiently, the necessary information, including a careful estimate of the probable cost of an outlet in the Connecticut River, could be secured within the next few months. It would then be practicable to determine which method of disposal it will be best to adopt.

Considering the circumstances, the Board hereby extends the time during which the sewage of the city shall be taken out of Mill River to Dec. 1, 1903.

The Board would also call attention to the condition of Mill River above the present sewer outlets. The results of the investigations that have been made by the Board show that the river where it passes through the densely populated portion of the city is badly polluted by sewage, a condition which is due in part to the discharge of unpurified sewage from the insane asylum into a tributary of the river, and to the discharge of manufacturing wastes into the main stream and another tributary, but chiefly to the discharge of sewage overflows from the sewers of the city, which receive storm water and appear to overflow with nearly every rain, and even at times of fair weather when the ground water is highest. It is very important, in the opinion of the Board, that the pollution of the river in the thickly populated part of the city should be wholly prevented by separating the sewage from the storm water, since the storm water can be allowed to flow into the river at convenient points without injury to the stream, and by removing the sewage and objectionable manufacturing wastes to a suitable place of disposal.

NORWOOD. The sewerage committee of Norwood applied to the State Board of Health Jan. 28, 1901, for advice relative to the sewage disposal of the town. The Board replied as follows: —

MARCH 7, 1901.

The State Board of Health received from you, on Jan. 29, 1901, an application for advice as to the disposal of the sewage of the town of Norwood, and subsequently an outline of your proposed plans of sewerage and sewage disposal was received from your engineer, Mr. Freeman C. Coffin of Boston.

The plan provides for collecting the sewage from nearly all of the portions of the town which are in need of sewerage at the present time, including waste liquors from the manufacturing establishments which at present pollute the streams, into a system of sewers from which storm water and ground water are to be excluded so far as possible, and to convey it to a filtration area on the southerly side of the Neponset River, southeast of Pleasant Street, where it is proposed to purify it by intermittent filtration through the areas of gravelly soil indicated on the plan, and to discharge the effluent into the Neponset River.

There are two areas in the town not now densely populated, from which the sewage cannot be discharged into this system by gravity. One of these areas lies near the Neponset River and the mouth of Hawes Brook, and it is proposed to collect the sewage of this area at a small pumping station in the neighborhood of Pleasant Street near Dean Street and pump it into the main system. The other area is in the valley of Purgatory Brook, and it is proposed to collect the sewage from this area at a pumping station near Neponset Street south of Pleasant Street and pump it into the main sewer.

The Board has caused the locality to be examined by its engineer and has considered the outline plans presented.

The lands which it is proposed to use for the disposal of the sewage are well situated for the purpose, and examinations of the soil of these lands by means of test pits indicate that it is very well adapted to the purification of sewage by intermittent filtration. Moreover, the areas suitable for this purpose in this region are ample for the disposal of the sewage of Norwood.

The plan in general is, in the opinion of the Board, an appropriate and satisfactory one for the disposal of the sewage of the town of Norwood.

It is understood that, while the details of the plan are not yet completed, you nevertheless desire the advice of the Board at the present time in view of possible immediate action by the town, and that the plans will be presented in greater detail for the consideration of the Board at a later time.

NORWOOD (Winslow Bros.). An application was received April 17, 1900, from Winslow Bros., for advice with reference to the purification of the wastes from their tannery at Norwood. To this application the Board made the following reply: —

JAN. 3, 1902.

The State Board of Health received from you, early in 1900, an application for advice as to improving the condition of the waste liquors coming from your factory at Norwood, in which you state that you have maintained for some years at a considerable expense a system of settling basins in a crude form, and if it is possible at a reasonable expense to adopt some improved method, you would like to do so. In response to this request the Board has caused examinations to be made to determine the amount and character of the waste liquors discharged from the various processes in the tannery, and has made experiments upon their purification.

The waste liquors discharged from the tannery are chiefly those resulting from the processes of washing and tanning sheep skins and scouring wool, together with a small quantity of spent dyes and waste from the preparation of glue stock, and the sewage from about 300 operatives. From 350,000 to 400,000 gallons per day of the liquors containing the greatest amount of organic matter, including the sewage, are discharged at the present time into settling basins, the effluent from which flows into Hawes Brook. Besides these waste liquors there is a small amount of polluted water, amounting to about 22,000 gallons per day, from the process of washing glue stock, and an indeterminate amount of polluted water from the other processes which leaks through the floors in the building and finds its way into Hawes Brook without passing through the settling basins. There is also a large quantity of water used in rinsing the wool after it has been scoured which is discharged into the brook without passing through the settling basins, and it appears that at times the water from the last bowl of the wool-scouring machine is also disposed of in this way, though at other times it is used in the process of skin-washing and goes thence to the settling basins.

It is evident that the settling basins used in connection with the tannery remove from the sewage a large quantity of putrescible organic matter; but owing to the construction and arrangement of these basins, it would be very difficult, if not impossible, to operate them in such a way as to get the best results from sedimentation.

The investigations made by the Board show that, even if as large a quantity of the organic matter as it is practicable to remove from this sewage by sedimentation should be removed from it, the putrescible matter that would remain in the liquid discharged into the stream would be sufficient to grossly pollute Hawes Brook and the Neponset River.

The experiments that have been made by the Board upon the purification of these wastes show that it is practicable to purify them by filtration through beds of sand and gravel to such a degree that the effluent can be discharged into a stream without causing a nuisance; and there are lands near the factory on the westerly side of Hawes Brook north of the railroad which may be suitable for the purification of the tannery wastes, but it would apparently be necessary to pump all of the liquid, in order to use the parts of this area that may be adapted for the purpose.

There is an area of land east of Pleasant Street and south of the Neponset River, about a mile from the tannery, upon which the waste liquors from the tannery could be delivered by gravity; and examinations of this area have shown that it contains soil suitable for the purification of these waste liquors.

Not long after your application was submitted, the town of Norwood, through a sewerage committee, began investigations as to a system of sewerage and sewage disposal for the town, and the plans, which the Board is informed are now under consideration, provide for the collection of all of the sewage, including the wastes from the tannery, and for purifying it upon these lands. The area which contains soil suitable for the purification of the sewage at this place is ample for all the requirements of the town for many years, including, in addition to the sewage, all the waste liquors from this tannery and other manufacturing establishments.

In the opinion of the Board, the least expensive and most satisfactory method of disposing of the waste liquors from this tannery and preventing the pollution of Hawes Brook and the Neponset River will be to dispose of them in connection with the sewage of the town.

If the town should decide not to proceed with the construction of a system of sewerage and sewage disposal, it is probable that the best method of disposing of the sewage of the tannery, all things considered, would be to discharge it upon filter beds upon the lands referred to near Pleasant Street.

It will doubtless be necessary, in connection with any method of purifying the waste liquors from this tannery, to provide settling basins for the removal of the heavier matters which might cause difficulty in the operation of sewers or filter beds. The present settling basins are not well adapted for use in connection with a sewerage system, and it will be best to substitute for them settling tanks built in a more permanent manner, and so arranged that the sludge can be drawn from them readily at frequent intervals. The present settling tanks, or a portion of them, might serve satisfactorily as sludge beds upon which the matter settled out of the sewage in the settling tanks could be discharged for drying.

The location and arrangement of the settling tanks and their size and capacity will depend upon the plan which may be selected for the disposal of the tannery wastes.

In the opinion of the Board, it is very desirable to prevent the further pollution of Hawes Brook or the Neponset River by the waste liquors of this tannery; and if a sewerage system is not to be constructed in the town in the immediate future which will provide for the disposal of the tannery wastes, the Board would advise that you have plans prepared, by an engineer of experience in the design of works for the disposal of sewage, for removing the polluting liquids which now grossly pollute Hawes Brook and the Neponset River either to the area at Pleasant Street or some other suitable place for purification.

The Board will assist you so far as it can in the preparation of plans, by furnishing such information as it may have relative to the quantity of waste liquors of various kinds to be disposed of, and the means necessary for their purification, and will, upon application, give you further advice in this matter when you have the results of further investigations to present.

PITTSFIELD. The board of public works of Pittsfield applied to the State Board of Health, March 5, 1901, for the approval of plans of sewage-disposal works for the city of Pittsfield. The Board replied to this application as follows: —

APRIL 4, 1901.

The State Board of Health received from you, on March 6, 1901, an application submitting plans of a pumping station, force main and sewage-disposal field for the disposal of the sewage of Pittsfield, and requesting the approval of these plans by this Board. The plans were accompanied by a report of your engineer. The titles of these plans are as follows: —

1. Proposed Sewage Reservoirs, Screen-house and Pumping Station. City of Pittsfield, Mass. Scale 1″ = 20′.

2. Plan and Profile Proposed Sewage Force Main. City of Pittsfield, Mass. Scales, horizontal 1″ = 200′, vertical 1″ = 20′.

3. Topographical Plan of Proposed Sewage Filtration Areas. City of Pittsfield, Mass. Scale 1″ = 50′.

4. Proposed Sewage Filtration Areas, Showing Systems of Distribution and Underdrainage. City of Pittsfield, Mass. Scale 1″ = 50′.

All of these plans are dated February, 1901, and signed by J. J. Van Valkenburgh, C.E.

The plans in general provide for diverting the sewage from the present east and west trunk sewers to a storage reservoir and pumping station, to be located on the north-westerly side of Pomeroy Avenue, north of the east branch of the Housatonic River in Pittsfield, from which it is proposed to pump the sewage through an iron force main 24 inches in diameter to a filtration area to be located between the Berkshire division of the New York, New Haven & Hartford Railroad and the Housatonic River, in the southerly part of the city. At the points at which it is proposed to divert the sewage from the east and west trunk sewers the plans show emergency gates through which sewage can be discharged into the river.

At the filtration area the plans show that provision has been made for the construction of 57 filter beds, having a total area of 48.5 acres, and it is proposed to construct in the beginning 25 acres of these filter beds with carriers, man-holes and underdrains as shown upon the plans.

The Board has caused the locality to be examined, and, having carefully considered the plans and information submitted therewith, hereby approves these plans for the disposal of the sewage of the city of Pittsfield, under the provision of section 1 of chapter 357 of the Acts of 1890.

The emergency gates shown upon the plans at the point where the present east and west trunk sewers will be intercepted will provide for wasting the sewage, in case of necessity, into the river; and in a system like this it is essential that some such provision be made whereby the sewage can be disposed of in case of accident to the pumps, pumping station or force main; but these waste gates, it is understood, will be used only in an emergency, and not in the ordinary operation of the works.

There are several elevations and depressions in the force main from the pumping station to the filtration area. It does not now appear to be practicable to change this line, but it is possible that in the construction of the works it may be feasible to so arrange the grade of this pipe that fewer depressions shall occur, and, if practicable, it is recommended that this change be made. No blow-offs or waste gates are shown; but if provision for emptying the pipe at any point or points between the pumping station and the filter beds is made at places where depressions occur, these outlets must also be considered only as provision for unforeseen emergencies, and not for frequent or regular use.

PLYMOUTH. The selectmen of Plymouth applied to the Board Aug. 14, 1901, for its advice relative to the sewerage and sewage disposal of certain districts in that town. The Board replied to this application as follows: —

SEPT. 5, 1901.

The State Board of Health received from you, on August 16, an application for advice with reference to the disposal of sewage of certain districts in Plymouth, accompanied by plans showing three proposed sewers and outlets, one being entitled "Plan showing proposed sewer outlet at land of Barnabas Hedge;" another, "Plan showing proposed sewer outlet near outlet of Cold Spring Brook;" and a third, "Plan and profile of proposed sewer on Winter Street."

In all cases it appears that the sewers to be connected with these outlets are intended to receive a small amount of roof water in addition to the sewage, but that otherwise surface water is to be kept out of them. The outlets in all cases extend to low water in Plymouth harbor. The present main sewer outlet for the town receives the sewage of the bulk of the thickly settled sections, and it appears that there is a private sewer outlet in existence at the northerly end of the town which provides for many buildings there. Two of the plans now proposed will provide outlets for the sewage of the territory between the districts at present provided with sewers in the central portion of the town and the private sewer system referred to near the northerly limits of the town. The remaining system at the southerly end of the town will provide for a small number of houses on Winter Street in that section which are said to be badly in need of sewerage.

The Board has caused the locations of the proposed outlets to be examined by one of its engineers, and has carefully considered the proposed plans. In the opinion of the Board, it is not desirable for the town of Plymouth to discharge its sewage at several outlets along the shore in front of the town, if it is practicable to collect and dispose of it all in a satisfactory manner at one or two suitable places. While the northerly outlets now proposed are not likely to be noticeable to the inhabitants in the immediate vicinity for many years at least, and while it is permissible in the opinion of the Board, to use these outlets temporarily if necessary, the Board would advise that, before you construct the proposed sewers, the whole subject of the future sewerage of Plymouth be considered, with a view to selecting the best outlet or outlets for the sewage, and avoiding the general pollution of the water of the harbor near the thickly settled parts of the town. It may then be found practicable to construct the proposed sewers in such a manner that, while temporary outlets may be used for the present, the sewage can all be disposed of by some more satisfactory plan in the future, and the pollution of the waters in front of the town avoided.

Regarding the most southerly of the proposed outlets indicated in your plans, the Board is of the opinion that the discharge of any considerable quantity of sewage at this place will be liable to create a nuisance; and that, while the quantity that would be discharged from the sewer as now proposed is small, it is not desirable, if this outlet should be constructed for temporary use, that the system tributary to it be enlarged by the addition of other streets than the one shown on the plan.

It is important, in the opinion of the Board, that studies of the future sewerage of this neighborhood be made as soon as possible, since it seems likely that other districts in this region will soon require sewerage.

READING. An application was received from the sewer committee of Reading, Oct. 2, 1900, for the advice of the Board relative to a proposed plan of sewage disposal for the town. The Board replied to this application as follows: —

FEB. 7, 1901.

The State Board of Health received from you, on Oct. 2, 1900, an application for advice with reference to the disposal of the sewage of the town of Reading, in which you state that you have several plans under consideration, such as entering the metropolitan sewerage system, or disposing of the sewage on filter beds within the limits of the town. Subsequently, a plan of a proposed system of sewerage and sewage disposal, providing for disposing of the sewage upon land in the northerly part of the town, was presented by your engineer. Outlines were also presented of an alternative plan for disposing of the sewage upon land in the easterly part of the town, near the boundary between Reading and Lynnfield.

The plan presented in greatest detail, and which, according to the estimates furnished by your engineer, seems likely from present indications to be the least expensive for the town, provides for collecting the sewage partly by gravity and partly by pumping, into a main sewer which will begin at the corner of Temple and Woburn streets, about 1,000 feet south-west of the Reading railroad station, and, running in a generally north-westerly direction, parallel to the railroad, will convey the sewage to a filtration area located on the south-westerly side of the Boston & Maine Railroad, south of Lowell Street, near the boundary between Reading and Wilmington, where the sewage is to be purified by intermittent filtration.

The route of the main sewer for a considerable distance before reaching the filter beds lies across a low valley, where the sewer will be constructed of iron pipe, in the form of an inverted siphon.

The plan of the proposed filtration area shows 24 filter beds, having an aggregate area of about 12 acres, located upon a tract of gravelly land near a low divide between the Ipswich and Mystic rivers, and about $1\frac{1}{2}$ miles north of the central portion of the village of Reading. It is proposed in the beginning to prepare an area of about $3\frac{1}{2}$ acres for the disposal of the sewage of the town.

The Board has caused the locality to be examined by its engineer, and has carefully considered the plans submitted. Owing to the situation of the town of Reading, on a low divide between the Saugus and Mystic rivers, it is not possible to collect all of the sewage at one place by gravity. It also appears that the head waters of the two streams mentioned have but little fall as they flow away from the main village, and it is not practicable to convey the sewage from the lower portions of the main village in either water-shed to suitable filtration areas without pumping.

Under the circumstances, judging from the information submitted, two pumping stations are necessary, as are proposed in the plan presented; and unnecessary pumping appears to have been avoided by collecting the sewage of the higher portions of the town in such a way that it will flow to the proposed filtration area by gravity.

The sizes of the sewers appear to be ample for the population which they are designed to serve. The inverted siphons are of smaller capacity than other portions of the system, so that it will be practicable to secure a good velocity of flow through them; and their size appears to be as large as it is desirable to provide at the present time, since they can probably be duplicated in the future, if necessary, without special difficulty.

The proposed filtration area in the neighborhood of Lowell Street contains soil of excellent quality for sewage purification, and the depth and character of the soil are such that the filter beds seem likely to require but little underdrainage. The area is sufficient to last for many years, and can be further increased, if necessary, by constructing additional filter beds on the adjacent meadow lands from the available gravelly soil in the immediate neighborhood. It is not necessary that the filters be constructed so near the railroad as is proposed at present; and since there are several houses along Lowell Street on the north-westerly side of the railroad from which the filter beds might be noticeable, it is desirable that when the works are constructed the filters be placed at least two hundred feet south-west from the railroad, and that a dense growth of trees be maintained between the railroad and the filter beds, since, if this should be done, it is unlikely that the presence of the filter beds would be noticeable at any of the houses in the neighborhood, assuming that the buildings located at present on the filtration area or in the immediate neighborhood shall be removed.

The plan as a whole will, in the opinion of the Board, provide an efficient and satisfactory method for the collection and disposal of the sewage of

The Board has carefully considered your application and the plans and report submitted, and has caused the locality to be examined by its engineer. By plan No. 4 the quantity of sewage discharged at each of the two principal outlets used at present would be increased, and a new outlet for a large portion of the town would be made at Pines River. The present sewer outlet at Sales Creek, which was deemed permissible by the Board only as a temporary expedient, does not appear as yet to have been the cause of serious nuisance; but the town is growing very rapidly, and it will evidently very soon be necessary to discontinue the discharge of sewage at this place. Sewage discharged at Cherry Island Bar is first collected in a tank, where the solid matters have an opportunity to disintegrate, and the sewage is discharged chiefly on the outgoing tide. This outlet does not appear as yet to have caused a serious nuisance, though there have been complaints concerning it. The shores for several miles on both sides of the outlet are densely populated in the summer season, and are used for bathing by very large numbers of people. Considering these circumstances, it is not desirable, in the opinion of the Board, to increase the discharge of sewage at this place, unless there is definite evidence that sewage discharged here or at a point further out, to which the outlet can be extended, will be carried away from the shores at all times until thoroughly dispersed.

The Pines River, the proposed place of disposal for the remainder of the sewage of the town (except the two small areas in the north-westerly and north-easterly corners), is a tidal creek having a very small water-shed, and the sea water flows freely in either direction upon the rise and fall of the tide. The river has many branches and tributaries extending to all parts of the marshes, and in the lower portions of its course flows along the westerly side of the Point of Pines, which is used largely as a summer resort, and then into the Saugus River, through which it discharges into the sea. There are extensive flats in the lower portions of the course of the river which are exposed at low tide, and if any considerable quantity of sewage should be discharged into this stream, there is great danger that the shores and flats would be made offensive thereby.

The Board is of the opinion that the proposed plan of discharging the sewage of a large portion of Revere into this river is an objectionable one, and advises that no sewage be discharged into this stream.

Three other schemes by which the sewage of the town may be disposed of are indicated in the report of your engineer. Two of these provide for the disposal of the sewage into the metropolitan sewerage system; and the other, known as plan No. 2, provides for its disposal by discharge into the sea about 1,000 feet beyond the present outlet at Cherry Island Bar. The objections to an outlet for sewage at Cherry Island Bar have already been indicated. Unless further studies shall be made here, which shall show definitely that the sewage can be disposed of by this plan without danger of returning upon any inhabited shore, this outlet cannot be considered a suitable one for the disposal of the sewage of Revere.

It appears that the town is already provided with a partial system of sewerage, by which the sewage is discharged at two principal outlets, one into Sales Creek, just below the Boston & Maine Railroad bridge, and the other into the Atlantic Ocean, near the end of Cherry Island Bar, the southerly end of Crescent Beach. The first outlet receives sewage from the central portion of the town, while the ocean outlet receives the sewage of Beachmont and a portion of Crescent Beach. The sewage which flows to the latter outlet is received into a collecting tank and discharged on the ebb tide.

Plan No. 4, referred to in your application, is outlined by your engineer as follows: —

Fourth Method. — To maintain several different outlets for various portions of the town.

The Beach system, so called, now draining Beachmont and Crescent Beach, to remain as at present, on the principle of "let well enough alone."

The Centre system, as now constructed, to remain as at present, except that an opportunity is now provided whereby, if it at any time becomes desirable to change the outlet, this Centre system and also the southerly and south-westerly portions of the town may drain into the new Chelsea branch of the metropolitan sewer, by obtaining permission and assuming the fair proportion of cost and maintenance. This would be accomplished, so far as the present sewers are concerned, by building a 20-inch sewer about 4,000 feet in length from near the Revere railroad station along Vinal Street and the new Revere Beach parkway to Broadway, and thus to the Chelsea line. The area tributary to the new Chelsea branch of the metropolitan sewer is about 770 acres. Sewers in the vicinity of Broadway and the south-westerly corner of the town would drain directly into the metropolitan sewer at Broadway and Fenno Street.

The remainder of the town to be cared for by an 18-inch gravity sewer, running from Oxford Park south of Revere Street along Broadway to the Pines River. This will care for all the territory — about 1,000 acres — embraced in the watershed north of the hill running through the Harris and Janvrin estates across to near Cushman Avenue and then west to Washington Avenue. This seems to be the only reasonable way to drain this large section except by connecting by gravity with the Eastern Avenue branch of the metropolitan sewer or by a pumping system, as above mentioned; unless it might be termed reasonable to pump the sewage of this section into a high-level sewer, to run by gravity into the present Chelsea branch of the metropolitan sewer, which, on account of cost of maintenance of pumping plant and charges to metropolitan district, would be too expensive by far.

This main sewer will be about 5,000 feet long, will pitch 1 foot to 1,000 feet, and empty into the Pines River at height of about mean low tide. A tide gate will be required on end of sewer, and the sewer will be obliged to hold the sewage during the stage of high tide. This sewer will perhaps have to be duplicated, should it continue to be used until this 1,000 acres has been closely built upon; but that time being probably a considerable distance in the future, we are of the opinion that there will be enough saving by laying a pipe not over 18 inches in diameter to warrant that being done at present, especially as this outlet may prove not to be a permanent one.

The Board has carefully considered your application and the plans and report submitted, and has caused the locality to be examined by its engineer. By plan No. 4 the quantity of sewage discharged at each of the two principal outlets used at present would be increased, and a new outlet for a large portion of the town would be made at Pines River. The present sewer outlet at Sales Creek, which was deemed permissible by the Board only as a temporary expedient, does not appear as yet to have been the cause of serious nuisance; but the town is growing very rapidly, and it will evidently very soon be necessary to discontinue the discharge of sewage at this place. Sewage discharged at Cherry Island Bar is first collected in a tank, where the solid matters have an opportunity to disintegrate, and the sewage is discharged chiefly on the outgoing tide. This outlet does not appear as yet to have caused a serious nuisance, though there have been complaints concerning it. The shores for several miles on both sides of the outlet are densely populated in the summer season, and are used for bathing by very large numbers of people. Considering these circumstances, it is not desirable, in the opinion of the Board, to increase the discharge of sewage at this place, unless there is definite evidence that sewage discharged here or at a point further out, to which the outlet can be extended, will be carried away from the shores at all times until thoroughly dispersed.

The Pines River, the proposed place of disposal for the remainder of the sewage of the town (except the two small areas in the north-westerly and north-easterly corners), is a tidal creek having a very small water-shed, and the sea water flows freely in either direction upon the rise and fall of the tide. The river has many branches and tributaries extending to all parts of the marshes, and in the lower portions of its course flows along the westerly side of the Point of Pines, which is used largely as a summer resort, and then into the Saugus River, through which it discharges into the sea. There are extensive flats in the lower portions of the course of the river which are exposed at low tide, and if any considerable quantity of sewage should be discharged into this stream, there is great danger that the shores and flats would be made offensive thereby.

The Board is of the opinion that the proposed plan of discharging the sewage of a large portion of Revere into this river is an objectionable one, and advises that no sewage be discharged into this stream.

Three other schemes by which the sewage of the town may be disposed of are indicated in the report of your engineer. Two of these provide for the disposal of the sewage into the metropolitan sewerage system; and the other, known as plan No. 2, provides for its disposal by discharge into the sea about 1,000 feet beyond the present outlet at Cherry Island Bar. The objections to an outlet for sewage at Cherry Island Bar have already been indicated. Unless further studies shall be made here, which shall show definitely that the sewage can be disposed of by this plan without danger of returning upon any inhabited shore, this outlet cannot be considered a suitable one for the disposal of the sewage of Revere.

The best method of disposing of the sewage of the town, judging from present information, appears to be to discharge it into the metropolitan system by gravity, if possible, at the most convenient point or points; and, while the expense of this method may be somewhat greater in the beginning, there does not appear to the Board, judging from the information now available, any other plan of disposing of the sewage of Revere which seems likely to be equally satisfactory, or to be in the long run less expensive. The information submitted is not sufficiently complete to enable the Board to judge definitely as to the probable cost of this method of disposal, as compared with the other plans suggested.

The Board would advise that you cause a careful study to be made of the currents in the neighborhood of the proposed outlet at Cherry Island Bar, and an estimate of the cost of disposing of the sewage both at this place and by discharging into the metropolitan system, either by gravity, or, if suitable grades for the sewers cannot be secured, by pumping the sewage after it has been collected by gravity at some suitable place.

It is advisable, also, that the sewerage of areas in the extreme north-easterly and north-westerly portions of the town be considered, and a definite method of disposal for these areas be selected, if practicable, so that a plan may be prepared which will provide for the sewerage of all portions of the town which are likely to require sewerage for a long time in the future. Portions of the plan can then be built as required.

When the results of further investigations are available, the Board will, upon application, give you further advice relative to the disposal of the sewage of the town.

SALEM. An application was received Sept. 11, 1901, from the sewer commissioners of Salem, for the advice of the State Board of Health relative to a system of sewage disposal for the city. The Board replied to this application as follows: —

SEPT. 20, 1901.

The State Board of Health received from you, on September 11, an application for advice with reference to a proposed system of sewerage and sewage disposal for the city of Salem, accompanied by an outline of a proposed plan for the disposal of the sewage, submitted by your engineer.

The plan provides for collecting the sewage of the city at a reservoir and pumping station on the north-westerly side of Cat Cove, from which the sewage will be pumped through a force main 30 inches in diameter, to be laid through Cat Cove and Juniper Cove, and thence passing near Abbott's Rock Beacon to the Middle Ground, so called, and along the Middle Ground to an outlet at the island of Great Haste. By this plan the sewage is to be pumped and discharged only during the first three hours of the outgoing tide. You ask to be informed whether the Board will approve a system of sewage disposal through a 30-inch pipe, with a

temporary outlet, for ten years near Abbott's Rock Beacon, this pipe to be extended to Great Haste at such time thereafter as the volume of sewage discharged may make the suggested temporary outlet undesirable. You also request information as to whether the Board would approve a system of sewage disposal by septic tank treatment with contact filter beds filled with coke, as indicated upon a plan submitted, said tank and beds being located at any point which may be agreed upon, on the shores of Cat Cove, Winter Island or the north shore of Salem Neck, the effluent to be discharged into deep water.

The Board, in response to your application, has caused the locality to be examined by its engineer, and has carefully considered the proposed plans and the available information relative thereto.

The proposed location of the pumping station and of the line of force main from the pumping station to Great Haste appears to be a reasonable one, though the expense may be somewhat greater than would be the case should the pumping station be located nearer the city, and the force main laid to the south of Winter Island.

From a general study of the proposed plans, the Board can see no advantage to be gained by the city of Salem by the construction of a reservoir and the discharge of the sewage only on the outgoing tide. On the other hand, there will be certain definite advantages obtainable by pumping continuously at all times, since this plan will not only probably be less expensive, in any case in the long run, but by this plan the sewage will be discharged in a fresher condition and in much smaller quantities, greatly reducing the danger that the particles may reach any inhabited shore, or that odors may be noticeable in the harbor. For these reasons, and on account of the character of the harbor and the currents, the Board does not advise the discharge of sewage on the outgoing tide only, but advises that the sewage be discharged at all times as fast as it is received at the pumping station.

The Board is of the opinion that Great Haste is a satisfactory outlet for the sewage, but the proposed plan of discharging the sewage temporarily for a period of ten years at Abbott's Rock Beacon does not seem to the Board a desirable one. Only a very few observations on the currents in this immediate neighborhood have been made, but, so far as can be judged, these currents are very slow and weak, and the movement of the sewage would be influenced largely by the force and direction of the wind. Moreover, the nearness of this point to the northerly end of Winter Island and Salem Willows is such that there would be danger that odors from the outlet would be carried to these places by easterly or south-easterly winds. It is possible that a point of discharge might be found near the westerly end of the Middle Ground, so called, at which the sewage might be discharged for a time, before extending the outlet to Great Haste, without producing a nuisance.

Regarding the size of the proposed force main, the Board is of the opinion that for Salem alone a force main 30 inches in diameter, from the proposed pumping station to Great Haste, would probably be sufficient for the removal of the sewage for many years in the future, if the sewage is to be discharged continuously at all stages of the tide.

The Board has considered the plan and detail drawings of a system of sewage disposal by means of a so-called septic tank and contact filter beds submitted with your application. Considering the probable character of the sewage of Salem, there is a doubt as to whether the sewage of the city could be purified in a satisfactory manner by this plan; but it is probable that, with two sets of contact filter beds, by which the sewage would be filtered twice, an effluent could be obtained which might safely be discharged into the deep water of Salem harbor. The cost of works for disposal of the sewage in this way would without doubt be much greater than by the plan of discharging it into the sea at Great Haste; and, considering the circumstances, the Board does not recommend the disposal of the sewage of Salem by this plan.

SWAMPSCOTT. An application was received from the sewerage committee of Swampscott, Sept. 27, 1901, for advice relative to a proposed system of sewerage and sewage disposal. The Board replied to this application as follows: —

DEC. 5, 1901.

The State Board of Health received from you, on Sept. 27, 1901, an application for advice with reference to a proposed system of sewerage and sewage disposal for Swampscott, and subsequently plans and a report were received from your engineer, describing the proposed system and method of disposal of the sewage.

The plan for the disposal of the sewage of the central portion of the town is practically the same as that proposed in the previous application from the sewer commissioners of Swampscott in 1899. This plan provides in general for the collection of the sewage at a point near Humphrey Street, from which it will be pumped to an outlet into the sea in the neighborhood of Dread Ledge. The sewage of the westerly portion of the town in the valley of Stacy's Brook was, by the former plan, to be pumped into the central system; but a further investigation now shows that it is feasible to convey the sewage from the valley of Stacy's Brook into the central system by gravity, at a less expense than by pumping the sewage as proposed in the former plan. The plan for the disposal of the sewage at the easterly end of the town provides for an outlet into the sea 1,800 feet from the shore, close to the boundary line between Marblehead and Swampscott.

The Board has carefully considered your application and the plans and other information submitted therewith, and has caused the locality to be examined by its engineer. Regarding the plan for the disposal of the parts of the town. It may then be found practicable to construct the proposed sewers in such a manner that, while temporary outlets may be used for the present, the sewage can all be disposed of by some more satisfactory plan in the future, and the pollution of the waters in front of the town avoided.

Regarding the most southerly of the proposed outlets indicated in your plans, the Board is of the opinion that the discharge of any considerable quantity of sewage at this place will be liable to create a nuisance; and that, while the quantity that would be discharged from the sewer as now proposed is small, it is not desirable, if this outlet should be constructed for temporary use, that the system tributary to it be enlarged by the addition of other streets than the one shown on the plan.

It is important, in the opinion of the Board, that studies of the future sewerage of this neighborhood be made as soon as possible, since it seems likely that other districts in this region will soon require sewerage.

READING. An application was received from the sewer committee of Reading, Oct. 2, 1900, for the advice of the Board relative to a proposed plan of sewage disposal for the town. The Board replied to this application as follows: —

FEB. 7, 1901.

The State Board of Health received from you, on Oct. 2, 1900, an application for advice with reference to the disposal of the sewage of the town of Reading, in which you state that you have several plans under consideration, such as entering the metropolitan sewerage system, or disposing of the sewage on filter beds within the limits of the town. Subsequently, a plan of a proposed system of sewerage and sewage disposal, providing for disposing of the sewage upon land in the northerly part of the town, was presented by your engineer. Outlines were also presented of an alternative plan for disposing of the sewage upon land in the easterly part of the town, near the boundary between Reading and Lynnfield.

The plan presented in greatest detail, and which, according to the estimates furnished by your engineer, seems likely from present indications to be the least expensive for the town, provides for collecting the sewage partly by gravity and partly by pumping, into a main sewer which will begin at the corner of Temple and Woburn streets, about 1,000 feet southwest of the Reading railroad station, and, running in a generally northwesterly direction, parallel to the railroad, will convey the sewage to a filtration area located on the south-westerly side of the Boston & Maine Railroad, south of Lowell Street, near the boundary between Reading and Wilmington, where the sewage is to be purified by intermittent filtration.

The route of the main sewer for a considerable distance before reaching the filter beds lies across a low valley, where the sewer will be constructed of iron pipe, in the form of an inverted siphon.

The plan of the proposed filtration area shows 24 filter beds, having an aggregate area of about 12 acres, located upon a tract of gravelly land near a low divide between the Ipswich and Mystic rivers, and about 1½ miles north of the central portion of the village of Reading. It is proposed in the beginning to prepare an area of about 3½ acres for the disposal of the sewage of the town.

The Board has caused the locality to be examined by its engineer, and has carefully considered the plans submitted. Owing to the situation of the town of Reading, on a low divide between the Saugus and Mystic rivers, it is not possible to collect all of the sewage at one place by gravity. It also appears that the head waters of the two streams mentioned have but little fall as they flow away from the main village, and it is not practicable to convey the sewage from the lower portions of the main village in either water-shed to suitable filtration areas without pumping.

Under the circumstances, judging from the information submitted, two pumping stations are necessary, as are proposed in the plan presented; and unnecessary pumping appears to have been avoided by collecting the sewage of the higher portions of the town in such a way that it will flow to the proposed filtration area by gravity.

The sizes of the sewers appear to be ample for the population which they are designed to serve. The inverted siphons are of smaller capacity than other portions of the system, so that it will be practicable to secure a good velocity of flow through them; and their size appears to be as large as it is desirable to provide at the present time, since they can probably be duplicated in the future, if necessary, without special difficulty.

The proposed filtration area in the neighborhood of Lowell Street contains soil of excellent quality for sewage purification, and the depth and character of the soil are such that the filter beds seem likely to require but little underdrainage. The area is sufficient to last for many years, and can be further increased, if necessary, by constructing additional filter beds on the adjacent meadow lands from the available gravelly soil in the immediate neighborhood. It is not necessary that the filters be constructed so near the railroad as is proposed at present; and since there are several houses along Lowell Street on the north-westerly side of the railroad from which the filter beds might be noticeable, it is desirable that when the works are constructed the filters be placed at least two hundred feet south-west from the railroad, and that a dense growth of trees be maintained between the railroad and the filter beds, since, if this should be done, it is unlikely that the presence of the filter beds would be noticeable at any of the houses in the neighborhood, assuming that the buildings located at present on the filtration area or in the immediate neighborhood shall be removed.

The plan as a whole will, in the opinion of the Board, provide an efficient and satisfactory method for the collection and disposal of the sewage of

Reading, and is capable of being enlarged sufficiently to serve the town for a long time in the future.

An examination has also been made of the territory indicated for use as a place of sewage disposal under the alternative plan presented by your engineer. This territory lies east of Haverhill Street and north of Pine Street, close to the boundary between Reading and Lynnfield, and is very sparsely populated. Moreover, it does not seem likely that this neighborhood will become more thickly settled than at present for many years. The area is somewhat uneven, and the indications are that it may be necessary to provide a long canal to remove the effluent, if filter beds should be constructed at this place. Nevertheless, the soil is of good quality for the purification of sewage by intermittent filtration, and an ample area for the disposal of the sewage of Reading can be obtained in this region.

The works for disposing of the sewage here would be similar to those proposed in connection with the other plan, though the location of the main sewer would of course be changed, and the cost of works under this plan would evidently be somewhat greater, judging from the estimates of costs submitted, if works should be built at the present time, than the cost of disposing of the sewage at the proposed filtration area near Lowell Street; but it is possible that circumstances may render it desirable to select this location when works shall be built for the town of Reading, and it may be found, upon further and more thorough investigation, that the difference in cost will not be as great as now seems probable.

With regard to disposing of sewage in connection with the metropolitan sewerage system, while definite plans have not been presented, the Board is of the opinion that it will probably be found more expensive for the town to discharge its sewage into the metropolitan system than to dispose of it independently upon land within its own limits; and, considering all the circumstances, the Board does not advise the disposal of the sewage of Reading by this method at the present time.

Revere. An application was received April 11, 1901, from the sewer commissioners of Revere, for the advice of the Board relative to a proposed system of sewerage and sewage disposal for the town. The Board replied to this application as follows: —

July 11, 1901.

The State Board of Health received from you, on April 11, 1901, an application for advice relative to an outlet for sewage into the Pines River and the disposal of the sewage of the town of Revere, in general accordance with a plan of Whitman & Howard, civil engineers, designated by them as plan No. 4, in a report dated Jan. 10, 1901, and submitted with your application. Subsequently plans were submitted by your engineers showing outlines of various schemes by which the town of Revere can be provided with a system of sewerage and sewage disposal.

It appears that the town is already provided with a partial system of sewerage, by which the sewage is discharged at two principal outlets, one into Sales Creek, just below the Boston & Maine Railroad bridge, and the other into the Atlantic Ocean, near the end of Cherry Island Bar, the southerly end of Crescent Beach. The first outlet receives sewage from the central portion of the town, while the ocean outlet receives the sewage of Beachmont and a portion of Crescent Beach. The sewage which flows to the latter outlet is received into a collecting tank and discharged on the ebb tide.

Plan No. 4, referred to in your application, is outlined by your engineer as follows: —

Fourth Method. — To maintain several different outlets for various portions of the town.

The Beach system, so called, now draining Beachmont and Crescent Beach, to remain as at present, on the principle of "let well enough alone."

The Centre system, as now constructed, to remain as at present, except that an opportunity is now provided whereby, if it at any time becomes desirable to change the outlet, this Centre system and also the southerly and south-westerly portions of the town may drain into the new Chelsea branch of the metropolitan sewer, by obtaining permission and assuming the fair proportion of cost and maintenance. This would be accomplished, so far as the present sewers are concerned, by building a 20-inch sewer about 4,000 feet in length from near the Revere railroad station along Vinal Street and the new Revere Beach parkway to Broadway, and thus to the Chelsea line. The area tributary to the new Chelsea branch of the metropolitan sewer is about 770 acres. Sewers in the vicinity of Broadway and the south-westerly corner of the town would drain directly into the metropolitan sewer at Broadway and Fenno Street.

The remainder of the town to be cared for by an 18-inch gravity sewer, running from Oxford Park south of Revere Street along Broadway to the Pines River. This will care for all the territory — about 1,000 acres — embraced in the watershed north of the hill running through the Harris and Janvrin estates across to near Cushman Avenue and then west to Washington Avenue. This seems to be the only reasonable way to drain this large section except by connecting by gravity with the Eastern Avenue branch of the metropolitan sewer or by a pumping system, as above mentioned; unless it might be termed reasonable to pump the sewage of this section into a high-level sewer, to run by gravity into the present Chelsea branch of the metropolitan sewer, which, on account of cost of maintenance of pumping plant and charges to metropolitan district, would be too expensive by far.

This main sewer will be about 5,000 feet long, will pitch 1 foot to 1,000 feet, and empty into the Pines River at height of about mean low tide. A tide gate will be required on end of sewer, and the sewer will be obliged to hold the sewage during the stage of high tide. This sewer will perhaps have to be duplicated, should it continue to be used until this 1,000 acres has been closely built upon; but that time being probably a considerable distance in the future, we are of the opinion that there will be enough saving by laying a pipe not over 18 inches in diameter to warrant that being done at present, especially as this outlet may prove not to be a permanent one.

The Board has carefully considered your application and the plans and report submitted, and has caused the locality to be examined by its engineer. By plan No. 4 the quantity of sewage discharged at each of the two principal outlets used at present would be increased, and a new outlet for a large portion of the town would be made at Pines River. The present sewer outlet at Sales Creek, which was deemed permissible by the Board only as a temporary expedient, does not appear as yet to have been the cause of serious nuisance; but the town is growing very rapidly, and it will evidently very soon be necessary to discontinue the discharge of sewage at this place. Sewage discharged at Cherry Island Bar is first collected in a tank, where the solid matters have an opportunity to disintegrate, and the sewage is discharged chiefly on the outgoing tide. This outlet does not appear as yet to have caused a serious nuisance, though there have been complaints concerning it. The shores for several miles on both sides of the outlet are densely populated in the summer season, and are used for bathing by very large numbers of people. Considering these circumstances, it is not desirable, in the opinion of the Board, to increase the discharge of sewage at this place, unless there is definite evidence that sewage discharged here or at a point further out, to which the outlet can be extended, will be carried away from the shores at all times until thoroughly dispersed.

The Pines River, the proposed place of disposal for the remainder of the sewage of the town (except the two small areas in the north-westerly and north-easterly corners), is a tidal creek having a very small water-shed, and the sea water flows freely in either direction upon the rise and fall of the tide. The river has many branches and tributaries extending to all parts of the marshes, and in the lower portions of its course flows along the westerly side of the Point of Pines, which is used largely as a summer resort, and then into the Saugus River, through which it discharges into the sea. There are extensive flats in the lower portions of the course of the river which are exposed at low tide, and if any considerable quantity of sewage should be discharged into this stream, there is great danger that the shores and flats would be made offensive thereby.

The Board is of the opinion that the proposed plan of discharging the sewage of a large portion of Revere into this river is an objectionable one, and advises that no sewage be discharged into this stream.

Three other schemes by which the sewage of the town may be disposed of are indicated in the report of your engineer. Two of these provide for the disposal of the sewage into the metropolitan sewerage system; and the other, known as plan No. 2, provides for its disposal by discharge into the sea about 1,000 feet beyond the present outlet at Cherry Island Bar. The objections to an outlet for sewage at Cherry Island Bar have already been indicated. Unless further studies shall be made here, which shall show definitely that the sewage can be disposed of by this plan without danger of returning upon any inhabited shore, this outlet cannot be considered a suitable one for the disposal of the sewage of Revere.

The best method of disposing of the sewage of the town, judging from present information, appears to be to discharge it into the metropolitan system by gravity, if possible, at the most convenient point or points; and, while the expense of this method may be somewhat greater in the beginning, there does not appear to the Board, judging from the information now available, any other plan of disposing of the sewage of Revere which seems likely to be equally satisfactory, or to be in the long run less expensive. The information submitted is not sufficiently complete to enable the Board to judge definitely as to the probable cost of this method of disposal, as compared with the other plans suggested.

The Board would advise that you cause a careful study to be made of the currents in the neighborhood of the proposed outlet at Cherry Island Bar, and an estimate of the cost of disposing of the sewage both at this place and by discharging into the metropolitan system, either by gravity, or, if suitable grades for the sewers cannot be secured, by pumping the sewage after it has been collected by gravity at some suitable place.

It is advisable, also, that the sewerage of areas in the extreme north-easterly and north-westerly portions of the town be considered, and a definite method of disposal for these areas be selected, if practicable, so that a plan may be prepared which will provide for the sewerage of all portions of the town which are likely to require sewerage for a long time in the future. Portions of the plan can then be built as required.

When the results of further investigations are available, the Board will, upon application, give you further advice relative to the disposal of the sewage of the town.

SALEM. An application was received Sept. 11, 1901, from the sewer commissioners of Salem, for the advice of the State Board of Health relative to a system of sewage disposal for the city. The Board replied to this application as follows: —

SEPT. 20, 1901.

The State Board of Health received from you, on September 11, an application for advice with reference to a proposed system of sewerage and sewage disposal for the city of Salem, accompanied by an outline of a proposed plan for the disposal of the sewage, submitted by your engineer.

The plan provides for collecting the sewage of the city at a reservoir and pumping station on the north-westerly side of Cat Cove, from which the sewage will be pumped through a force main 30 inches in diameter, to be laid through Cat Cove and Juniper Cove, and thence passing near Abbott's Rock Beacon to the Middle Ground, so called, and along the Middle Ground to an outlet at the island of Great Haste. By this plan the sewage is to be pumped and discharged only during the first three hours of the outgoing tide. You ask to be informed whether the Board will approve a system of sewage disposal through a 30-inch pipe, with a temporary outlet, for ten years near Abbott's Rock Beacon, this pipe to be extended to Great Haste at such time thereafter as the volume of sewage discharged may make the suggested temporary outlet undesirable. You also request information as to whether the Board would approve a system of sewage disposal by septic tank treatment with contact filter beds filled with coke, as indicated upon a plan submitted, said tank and beds being located at any point which may be agreed upon, on the shores of Cat Cove, Winter Island or the north shore of Salem Neck, the effluent to be discharged into deep water.

The Board, in response to your application, has caused the locality to be examined by its engineer, and has carefully considered the proposed plans and the available information relative thereto.

The proposed location of the pumping station and of the line of force main from the pumping station to Great Haste appears to be a reasonable one, though the expense may be somewhat greater than would be the case should the pumping station be located nearer the city, and the force main laid to the south of Winter Island.

From a general study of the proposed plans, the Board can see no advantage to be gained by the city of Salem by the construction of a reservoir and the discharge of the sewage only on the outgoing tide. On the other hand, there will be certain definite advantages obtainable by pumping continuously at all times, since this plan will not only probably be less expensive, in any case in the long run, but by this plan the sewage will be discharged in a fresher condition and in much smaller quantities, greatly reducing the danger that the particles may reach any inhabited shore, or that odors may be noticeable in the harbor. For these reasons, and on account of the character of the harbor and the currents, the Board does not advise the discharge of sewage on the outgoing tide only, but advises that the sewage be discharged at all times as fast as it is received at the pumping station.

The Board is of the opinion that Great Haste is a satisfactory outlet for the sewage, but the proposed plan of discharging the sewage temporarily for a period of ten years at Abbott's Rock Beacon does not seem to the Board a desirable one. Only a very few observations on the currents in this immediate neighborhood have been made, but, so far as can be judged, these currents are very slow and weak, and the movement of the sewage would be influenced largely by the force and direction of the wind. Moreover, the nearness of this point to the northerly end of Winter Island and Salem Willows is such that there would be danger that odors from the outlet would be carried to these places by easterly or south-easterly winds. It is possible that a point of discharge might be found near the westerly end of the Middle Ground, so called, at which the sewage might be discharged for a time, before extending the outlet to Great Haste, without producing a nuisance.

Regarding the size of the proposed force main, the Board is of the opinion that for Salem alone a force main 30 inches in diameter, from the proposed pumping station to Great Haste, would probably be sufficient for the removal of the sewage for many years in the future, if the sewage is to be discharged continuously at all stages of the tide.

The Board has considered the plan and detail drawings of a system of sewage disposal by means of a so-called septic tank and contact filter beds submitted with your application. Considering the probable character of the sewage of Salem, there is a doubt as to whether the sewage of the city could be purified in a satisfactory manner by this plan; but it is probable that, with two sets of contact filter beds, by which the sewage would be filtered twice, an effluent could be obtained which might safely be discharged into the deep water of Salem harbor. The cost of works for disposal of the sewage in this way would without doubt be much greater than by the plan of discharging it into the sea at Great Haste; and, considering the circumstances, the Board does not recommend the disposal of the sewage of Salem by this plan.

SWAMPSCOTT. An application was received from the sewerage committee of Swampscott, Sept. 27, 1901, for advice relative to a proposed system of sewerage and sewage disposal. The Board replied to this application as follows: —

DEC. 5, 1901.

The State Board of Health received from you, on Sept. 27, 1901, an application for advice with reference to a proposed system of sewerage and sewage disposal for Swampscott, and subsequently plans and a report were received from your engineer, describing the proposed system and method of disposal of the sewage.

The plan for the disposal of the sewage of the central portion of the town is practically the same as that proposed in the previous application from the sewer commissioners of Swampscott in 1899. This plan provides in general for the collection of the sewage at a point near Humphrey Street, from which it will be pumped to an outlet into the sea in the neighborhood of Dread Ledge. The sewage of the westerly portion of the town in the valley of Stacy's Brook was, by the former plan, to be pumped into the central system; but a further investigation now shows that it is feasible to convey the sewage from the valley of Stacy's Brook into the central system by gravity, at a less expense than by pumping the sewage as proposed in the former plan. The plan for the disposal of the sewage at the easterly end of the town provides for an outlet into the sea 1,800 feet from the shore, close to the boundary line between Marblehead and Swampscott.

The Board has carefully considered your application and the plans and other information submitted therewith, and has caused the locality to be examined by its engineer. Regarding the plan for the disposal of the sewage of the central and westerly portions of the town, the Board sees no reason to modify the advice given in a previous reply, that the discharge of the sewage into the sea south of Dread Ledge is an appropriate method for the disposal of the sewage of the town; and, since it is now found that the sewage from the westerly portion can be conveyed in the central system by gravity, a considerable saving in the cost of pumping will be effected.

Studies relative to the disposal of the sewage from the valley of the brook draining the easterly section of the town, and discharging into the sea at the boundary line between Swampscott and Marblehead, indicate that a large portion of this territory can be diverted by gravity into the central section, and the sewage disposed of in connection with other sewage of the town at Dread Ledge; but there is an area in the lower portion of the valley, bordering the town of Marblehead and lying between Humphrey Street and the sea, which contains approximately 210 acres, from which it is not practicable to deliver sewage into the central system by gravity. A part of this area is quite low and sparsely populated, but other portions contain a considerable population, and sewerage is apparently urgently needed for a portion of this area at the present time. The plans provide for discharging the sewage from this area into the sea about 1,800 feet from the shore, opposite the boundary line between Marblehead and Swampscott. While, in the opinion of the Board, with the small quantity of sewage that would be discharged here for several years it is unlikely that matters from the sewage would be noticeable, at least upon the shores in the neighborhood of the outlet, provided it is placed 1,800 feet from the shore, as proposed in the plan submitted, it is not desirable to discharge sewage in this neighborhood if it is practicable to dispose of it in any other way.

It is practicable to collect the sewage from this area at some place in the neighborhood of the brook near its outlet, and to pump it into the main sewerage system of the town, through which it will be discharged at the main outlet near Dread Ledge; and, while the cost of disposing of the sewage of this area in this way would probably be somewhat greater than the cost of a sea outlet, the extra cost will be largely for the maintenance of pumping, and will not be a serious burden to the town of Swampscott.

Considering all the circumstances, the Board would advise that the sewage of this section be pumped into the general sewerage system of the town, and disposed of in connection with the other sewage at the outlet near Dread Ledge.

TAUNTON. The sewer commissioners of Taunton applied to the State Board of Health, Oct. 28, 1901, requesting an extension of the time for the completion of its sewerage system beyond July 1, 1902, the date which had been set for the completion of the system. The Board replied to this application as follows: —

DEC. 5, 1901.

The State Board of Health received from you, Oct. 30, 1901, a communication giving an outline of the work thus far done in the construction of a system of sewerage and sewage disposal for Taunton, and requesting this Board to grant an extension of time beyond the date set for the completion of the work, that is, beyond the first day of July, 1902.

The Board has carefully considered your application and information relative to the sewerage and sewage-disposal works of the city, and has caused the Taunton and Mill rivers in the city and below to be examined by its engineer. It appears that trunk sewers have been constructed in the valley of Mill River and Cobb Brook, with which several sewers are now connected, and others will soon be connected, which will provide sewerage throughout much of the thickly settled portion of the city west of the Taunton River, and that sewage from these trunk sewers is now discharged into Taunton River near Weir Bridge, about half a mile up the stream from the proposed site of the pumping station. There are also at the present time several other sewer outlets from which sewage from other portions of the city west of the Taunton River is discharged into the Mill and Taunton rivers.

Further consideration of the matter leads the Board to the conclusion that the discharge of crude sewage into the Taunton River or its tributaries from the portion of Taunton west of the river should be discontinued as soon as possible, both in the interests of the health of the people of Taunton, and those living in other towns in the valley of the stream below the city.

It is practicable, in the time that remains before July 1, 1902, if the work of construction shall be continued diligently, to advance materially toward completion the work which now remains to be done for the removal of all the sewage to the filtration area in Berkley, as provided by the plan of 1897; and the Board has concluded to take no action upon your application until July 1, 1902, when it will be practicable to determine much more definitely the length of time required to complete the work, if carried on with diligence. The Board will then consider the propriety of making an extension of the time to such a date as may then seem necessary.

WAKEFIELD. An application was received from the sewer commissioners of Wakefield, Oct. 29, 1900, for the approval of the State Board of Health of a system of sewage disposal to connect with the North Metropolitan sewerage system, under the provisions of chapter 377, Acts of 1900. In compliance with this request, a hearing was held at the office of the State Board of Health, Jan. 3, 1901, due notice having been sent to the city of Lynn, the Lynn water board and to the Wakefield Water Company; and the following reply was sent to the sewer commissioners of Wakefield: —

FEB. 7, 1901.

The State Board of Health received from you, on Oct. 29, 1900, an application, under the authority of chapter 377 of the Acts of 1900, requesting the approval by the Board of plans of a system of sewage disposal designed for the town of Wakefield, to connect with the North Metropolitan sewerage system. Subsequently a plan of the proposed system of sewerage was received, showing in solid red lines the sewers proposed for immediate construction, and in dotted red and yellow lines future extensions to, or partial systems for, other districts in the town.

Sub-drains are also shown upon this plan beneath the main sewer and the two main tributary sewers in the central portion of the town, leading to two sub-drain outlets, one discharging into a small stream which forms one of the head waters of the Malden River near the southern boundary of the town, and the other discharging into Wakefield Brook. The plan was accompanied by profiles of the main and tributary sewers and of the main underdrains, with general details of construction.

In accordance with the provisions of chapter 377 of the Acts of 1900, the State Board of Health, after the receipt of your application, gave notice of a hearing, as required by section 17 of said chapter 377, to be held at the rooms of the Board at the State House, on Jan. 3, 1901, at eleven o'clock. Notice of the hearing was sent to the city of Lynn, to its water board and to the Wakefield Water Company, as required by the said act. At this hearing the plans were presented by you, showing the work to be done in constructing a system of sewerage for the town of Wakefield, which is designed to have an outlet into the metropolitan sewerage system, as provided for by chapter 172 of the Acts of 1900.

It appearing to the Board that some modifications in the proposed underdrainage system were desirable, it was suggested that your board enlarge the underdrainage system beneath the sewers of the town as much as might seem desirable after further consideration, and that you avoid, if practicable, the discharge of underdrainage from the main portion of the town, within the water-shed of the Saugus River and Wakefield Brook, into the Malden River near the southerly portion of the town; and subsequently modifications were presented by you, providing for a much more complete system of underdrainage in the central portion of the town and larger main underdrains, with an outlet into Wakefield Brook, and for the omission of the underdrain outlet into the tributary of Malden River in the southerly portion of the town.

The State Board of Health, after consideration, hereby approves so much of the plan of Wakefield sewerage presented by you as is shown in solid red lines upon a plan entitled "Map of the sewerage system proposed for Wakefield, Mass., October, 1900. Scale, 1″ = 400′," signed by William H. Lee, William B. Daniel, George M. Tompson, Wakefield sewerage commissioners, and Orlando K. Morgan, engineer, and approves the modified system of underdrainage described in your communications of Jan. 9 and Jan. 24, 1901, which provides for underdrains beneath nearly all the sewers, indicated in solid red lines upon the plan above described, with a single outlet for the underdrainage into Wakefield Brook, as indicated.

The Board is of the opinion that there is no reasonable objection to the discharge into the tributary of Malden River, near the Melrose boundary line, of underdrainage from drains beneath the main or tributary sewers which may collect water within the water-shed of that stream only.

It does not seem to the Board, after consideration, that the sewers and partial systems of sewerage, indicated in broken lines upon the plan submitted, are presented in such detail as to show all of the work to be done in constructing a system of sewerage as required by the provisions of chapter 377 of the Acts of 1900; and the Board, therefore, does not at present approve these portions of the plan.

WELLESLEY (Dana Hall School). The principal of Dana Hall School in Wellesley applied to the State Board of Health for its advice relative to a proposed system of sewage disposal for the school. The Board replied to this application as follows: —

OCT. 3, 1901.

The State Board of Health received from you, on Aug. 21, 1901, an application for advice with reference to a proposed system of sewage disposal for the Dana Hall School at Wellesley, and subsequently plans were submitted by your engineer, showing the proposed method of disposing of the sewage. The plans provide for purifying the sewage by filtration through sand, after a preliminary treatment for the removal of sludge by passing the sewage through strainers of coke breeze, the effluent to flow into Fuller's Brook.

It appears that since the application was received the proposed works have been constructed, and the Board is informed that they are now in operation.

The Board has carefully considered the application and the plans submitted, and concludes that the proposed works are capable of purifying satisfactorily all the sewage likely to be discharged from the Dana Hall School at the present time. The system will require considerable care to maintain, and should be regarded as a temporary one, to be abandoned when a general system of sewerage for this neighborhood is available.

WESTBOROUGH (Insane Hospital). An application was received from the trustees of the Westborough Insane Hospital, for the advice of the Board relative to a proposed system of sewage disposal for new cottages. The Board replied to this application as follows: —

Oct. 3, 1901.

The State Board of Health received from you, on Aug. 1, 1901, an application for advice with reference to plans for the disposal of the sewage of a group of three cottages, intended to care for about 100 patients, to be located on the opposite side of the lake from the present hospital buildings. It appears that it is proposed to dispose of the sewage of these buildings ultimately upon the area now used for the purification of the sewage of the hospital, but it is desired to provide a temporary system of disposal for these cottages until the permanent system shall be built. Subsequently, a plan was submitted showing a system of disposal for temporary use, consisting of 6 filter beds, having an aggregate area of a little more than half an acre, to be located about 800 feet from the buildings, near the bottom of a small valley having an outlet into Chauncy Pond. Provision is made for conveying the sewage of the buildings into a tank, from which it will be distributed intermittently upon the filter beds, which are to be prepared artificially of suitable soil from the neighborhood.

The Board has caused the locality to be examined by one of its engineers, and, having carefully considered the plans submitted, concludes that they are well adapted for the purification and disposal of all of the sewage which would be discharged from the buildings which it is now proposed to construct and use. The effluent will, however, discharge into Chauncy Pond, from which it is understood that a portion of the water supply of the hospital is now taken. Early in the present year your attention was called to the danger involved in the use of this water for drinking, and to the indications that cases of very serious illness had been caused thereby. There will be much danger, if the filter beds are located as proposed, that through lack of care in their operation, or some other cause, unpurified sewage may at some time find its way into the lake; and, under the circumstances, the Board cannot advise the disposal of the sewage of the buildings in question by the plan now proposed until satisfactory evidence is presented to show that this method of disposing of the sewage of these buildings will not endanger the health of the inmates or employees of the hospital to whom water from the pond is available for drinking. If the use of Chauncy Pond as a source of water supply by the institution shall be abandoned, the Board is of the opinion that the proposed plan is a suitable temporary method of disposing of the sewage of these buildings.

West Springfield. An application was received from the selectmen of West Springfield, July 3, 1901, for advice relative to proposed systems of sewerage for two districts in the northerly part of that town. The Board replied to this application as follows: —

Aug. 1, 1901.

The State Board of Health received from you, on July 3, 1901, an application for advice with reference to a proposed system of sewerage for two districts in the northerly part of the town of West Springfield, — one being the small village of Riverdale, and the other the village of Ashleyville and other territory in the extreme northerly part of the town opposite Chicopee, — accompanied by plans showing the proposed sewers and outlets.

The plan for the Riverdale district provides for a main sewer in the valley of Darby Brook, which will receive the sewage from the territory in the valley of the brook and along the Riverdale road for a distance of a little over half a mile north of the brook, and convey it to an outlet in the Connecticut River just north of the mouth of the brook. The proposed sewer from the village of Ashleyville extends through the Riverdale road for a distance of one and one-half miles, and through Wayside Avenue to the Connecticut River at the Chicopee bridge. A branch sewer in Ashley Avenue will receive sewage from this street. Both systems are designed to receive a small quantity of storm water, but in general it is proposed to dispose of the storm water of these districts by discharging it into local water courses.

The Board has caused the locality to be examined by one of its engineers, and has carefully considered the plans submitted. The plan for the Riverdale district will provide for the present needs of this district, and the size of the sewer appears to be sufficient for the removal of the sewage from the territory which it is designed to serve, and for the removal of a small quantity of storm water.

By the proposed plan, the main sewer leading to this outlet will discharge into a manhole near the bank of the river, from the bottom of which a pipe will extend to a submerged outlet in the river about 50 feet from the edge of the stream at low water. It is expected that the dry-weather flow of sewage will discharge through this pipe. Another pipe will extend from the opposite side of the manhole from which the sewer enters, and at about the same level, to a point of discharge at the edge of the river bank, through which mingled sewage and storm water will be discharged at times of rain.

Experience with submerged outlets indicates that the submerged pipe in this case is likely to be stopped up by matters carried along in the sewer at times of flood in the river; and the Board would advise that the plan of this outlet be changed, so that sand and other matters brought down the main sewer at times of storm would be likely to be carried through the storm outlet, and that the entrance to the submerged outlet be placed at the side of the main sewer, so that it will be less likely to be obstructed.

The proposed outlet, which will be about 50 feet from the shore of the river at low water, is located at a place where the bank of the stream in the immediate neighborhood is unoccupied; but no float experiments appear to have been made, which would indicate whether solid matters from the sewage discharged at this point would be likely to return to the bank of the river, or not. Float experiments could be made here with very little expense, which would indicate the probable direction that sewage discharged at this outlet would take; and the Board would advise that, before the outlet is constructed, float experiments should be made, and the outlet located at a sufficient distance from the shore, so that there will be no danger that sewage will return upon it until thoroughly mingled with the river water.

The proposed sewer for Ashleyville and the territory opposite Chicopee appears to be adapted for the sewerage of this neighborhood at the present time. The plan of this outlet, while differing somewhat from the proposed outlet near Darby Brook, has the same general features, and the modifications suggested with reference to the plan of the Darby Brook outlet apply also to this one. The proposed submerged outlet in this case will be located at a point about 45 feet from the edge of the stream at low water, where, from examination, it appears that the river has practically no current. The bank of the river in the neighborhood of this outlet is already quite thickly populated, and if the sewage should be discharged as proposed, it would be likely to return upon the shore and create a serious nuisance in the neighborhood. The Board would advise that, before deciding upon a location for this outlet, float experiments be made in this case also, in order to determine how far out it is desirable to place the outlet, to prevent the danger of polluting the shore; and the outlet should be carried out a sufficient distance to prevent danger of such pollution.

The Board is not informed as to the area from which it is proposed to admit storm water to these sewers, and cannot advise as to their capacity for removing storm water. If, after you have made float experiments, you desire further advice of the Board in this matter, the Board will, upon receiving the results of the experiments, give the matter further consideration.

Pollution of Ponds, Streams and Other Bodies of Water.

The following is the substance of the action of the Board during the past year in reply to applications for advice relative to the pollution of ponds, streams and other bodies of water: —

Alewife Brook (Cambridge, Somerville, Arlington and Belmont). A petition was received by the Board Sept. 6, 1900, from a committee of citizens of the foregoing cities and towns, stating that "there is reason to believe that the conditions of Alewife Brook and the territory in its vicinity are a menace to the public health, and they therefore respectfully petition your Honorable Board to examine said locality and the conditions therein as pertaining to the public health, and to make such report and recommendations in the matter as seems fitting to your Board." The Board replied to this petition as follows: —

FEB. 7, 1901.

In response to your petition for an investigation by this Board of the condition of Alewife Brook and the territory in its vicinity, with reference to the effect of the conditions existing in the meadows and streams in this territory upon the public health, and for recommendations as to the improvement of these meadows and streams, the Board has caused the locality to be examined by its engineer, and has considered the plans and other information that have been presented.

Alewife Brook is bordered by meadows and marshy lands, having an approximate area, as measured from available maps, of 380 acres, in the cities of Cambridge and Somerville and the towns of Arlington and Belmont. These lands are at a low level, and portions of them are subject to flooding by high tides, and apparently also by freshets in the streams. The tide gates formerly located at the place where the stream is crossed by Broadway, not far from its mouth, which were intended to keep tide water off the meadows, have not been operative, so far as the Board is informed, for the last three or four years. Large portions of the meadows were wet during so dry a period as the latter part of last year, and were covered with decaying vegetation. There are several small ponds and pools of stagnant water in the meadows, and in many places the water in the ditches, owing to obstructions and the lack of a suitable outlet, has also become stagnant, and the odor from the stagnant ponds and ditches is very offensive.

The sewage from the territory about the meadows is discharged into the Alewife Brook branch of the metropolitan system. The sewers in the westerly portions of Cambridge and Somerville, which discharge into the metropolitan sewer at points near Alewife Brook, are built to take both sewage and storm water; and at the connections with the metropolitan sewer there are overflows from these sewers through which mingled sewage and storm water is discharged into Alewife Brook at times of storms, and there is evidence that large quantities of sewage enter the brook at such times, doubtless causing deposits of sewage matters along the stream, and probably having much to do with the offensive odors noticeable at places in its neighborhood.

The Board is of the opinion, judging from the information that has been submitted and the limited investigation it has been able to make, that the filthy and unsanitary condition of the streams and meadows in this neighborhood is injurious to the public health. It would apparently be possible to greatly improve the condition of the meadows, and prevent their being flooded, at least during the warmer portion of the year, by the construction of suitable tide gates near the mouth of Alewife Brook, and providing suitable channels for the removal of the water from the meadows, thus making it possible also to prevent the stagnation of the water in the ponds and ditches, and to provide suitable drainage for the land. In order, however, to ascertain definitely the extent to which the meadows can be improved by any drainage works that it may be practicable to construct, and to determine upon the best plan of providing for the permanent improvement of these lands, a careful survey and examination of the meadows will be necessary.

The Board would advise that the towns and cities in which these lands are located cause the surveys and other necessary investigations to be made and a plan to be prepared before any work upon the drainage or improvement of the meadows is undertaken.

COLRAIN (Griswoldville). In the course of an examination of the North River with reference to its use as a source of ice supply for the town of Shelburne, the Board was informed that water taken directly from this stream had been used for the supply of dwelling houses in the village of Griswoldville, and that the occurrence of several cases of typhoid fever at the village of Willis Place, where sewage is discharged directly into the stream, had been followed by cases of typhoid fever in the village of Griswoldville. In view of these circumstances, the Board sent the following communication to the Griswoldville Manufacturing Company: —

JAN. 29, 1901.

In the course of an examination of the North River, with reference to its use as a source of ice supply, the Board has been informed that water taken directly from this stream has been used during the past year for the supply of dwelling houses in the village of Griswoldville, and that, notwithstanding warnings as to the unsafe character of the water for drinking, it has been used for that purpose; and the occurrence of several cases of typhoid fever in the latter part of last year at the village of Willis Place, where sewage is discharged directly into the stream, has been followed by cases of typhoid fever in the village of Griswoldville.

Considering the circumstances, the Board would advise that a supply of good water, adequate for the needs of the inhabitants of this village at all times, be secured; and that, while the sources of pollution continue to exist, no water be supplied from the river or introduced at any time into any of the pipes used for conveying water which is intended for drinking or may be so used. The Board will, if you desire, assist you in an investigation for a source of water supply, by making such analyses of samples of water as may be necessary, and will advise you as to the suitability of any source which you may designate for the supply of the village.

HARWICH. An application was received, Oct. 26, 1899, from the selectmen of Harwich, for the advice of the Board relative to improving the sanitary condition of Wychmere harbor at Harwichport. The Board replied to this application as follows: —

FEB. 7, 1901.

The State Board of Health received from you, on Oct. 26, 1899, an application for advice as to improving the sanitary condition of Wychmere harbor at Harwichport, in which it was stated that a deposit of seaweed had gradually accumulated in a portion of the harbor, to such an extent that it was exposed at low tide, and at such times gave off a very offensive odor, creating a serious nuisance in the summer season.

In response to this application, the Board caused the locality to be examined by its engineer soon after the application was received, and further investigations have been made since that time.

About the time your application was made, jetties were being constructed at the mouth of the harbor, under the direction of the Harbor and Land Commissioners, the object being, as stated by the commissioners in their report, as follows: —

These structures are designed to maintain the existing width and depth of the channel, and to prevent obstruction by sand, which is annually driven into it from the beach to the westward by the winter storms, and also to prevent the seaweed from driving into the harbor, where it decays and settles, shoaling the water and emitting odors detrimental to health. The construction of the timber jetty has already substantially accomplished this last purpose, and it is anticipated that the portion of the stone jetty which has just been built will prevent the sand from driving in to any extent from the beach to the westward, and that both structures will have a tendency, by training the ebb and flow of the tides, to deepen the channel.

It appears, from the information furnished the Board, that since these structures were built further accumulation of seaweed in the harbor has largely ceased, and the deposit already there has settled to such an extent that odors from it were far less noticeable during the past year than in previous years; and it does not now appear to the Board that, under the conditions which exist, serious odors are caused by the deposit referred to, or that it is necessary, under present conditions, to take further action in the matter.

HAVERHILL. The board of health of Haverhill applied to the State Board of Health, July 15, 1901, for advice upon the question "whether it would be in any way harmful to the public health to use for topping, filling and grading the public streets of Haverhill, gravel taken from the bed of the Merrimack River opposite Hales' Island below Haverhill bridge." The Board replied to this application as follows: —

AUG. 1, 1901.

The Board has caused the gravel and the locality from which it is to be taken to be examined. This gravel appears to be clean, and free from material which might be deposited by sewage, and is, moreover, taken from a channel in the river where the velocity of the current is such that it is not likely that sewage deposits would collect. The Board sees no objection to the use of this gravel on the public streets, as proposed.

ICE SUPPLIES.

The following is the substance of the action of the Board during the past year in reply to applications for advice relative to sources of ice supply: —

BRIDGEWATER. An application was received, Dec. 20, 1900, from the board of health of Bridgewater, for the advice of the Board relative to the propriety of using ice from a pond near South Street in that town. The Board replied to this application as follows: —

FEB. 7, 1901.

The State Board of Health has considered your application for advice as to the suitability of a pond near South Street as a source of ice supply, and has caused the pond and its surroundings to be examined by one of its engineers, and a sample of the water to be analyzed.

The results of the analysis show that the water contains a large quantity of organic matter, and, on account of the shallowness of the pond, weeds and other organic matters are frozen into the ice. The pond is exposed to pollution from houses and barns along South Street, and, considering all the circumstances, the Board does not advise the use of ice cut from this pond in drinking water or in any place where it would come in contact with food.

CHICOPEE. An application was received Aug. 14, 1901, from the board of health of Chicopee, for the advice of the State Board of Health relative to the quality of the ice cut from a cove upon the Chicopee River above Chicopee Falls. The Board replied to this application as follows: —

SEPT. 20, 1901.

In response to your communication of Aug. 14, 1901, requesting an examination of ice cut from a cove on the Chicopee River, about a mile above Chicopee Falls, which has been used largely as a source of ice supply for the city of Chicopee, the Board has caused the locality to be examined, and samples of the water and of the ice from two large ice-houses at this place to be analyzed.

An examination of the river in the neighborhood of the place from which ice is taken shows that most of the water passes through the main channel of the river, but that there is a free communication with the main channel both at the upper and lower ends of the arm or cove of the stream from which ice is taken. The analysis of a sample of the water collected from this place gives evidence of sewage pollution, and analyses of the ice show that it contains a considerable quantity of organic matter. The circumstances are such that the Board does not regard the source from which this ice is taken as a safe one from which to take ice for domestic purposes, and advises that the ice collected from this source should not be used where it may come in contact with food or drinking water.

DANVERS. The board of health of Danvers applied to the State Board of Health, Feb. 26, 1901, for advice relative to the use of Putnam's mill pond as a source of ice supply. The Board replied to this application as follows: —

APRIL 20, 1901.

In response to your request for an examination of the water and ice of Putnam's mill pond, in Danvers, used as a source of ice supply, the Board has caused the pond and its surroundings to be examined, and samples of the water and ice to be analyzed.

As a result of its investigations, the Board is of the opinion that the ice of Putnam's mill pond, as formed, cannot be safely used for domestic purposes, although the bottom portion of the ice, when it is clear and contains no particles of foreign matter, might safely be so used. The only safety in using such ice lies in a proper inspection, under your direction and control, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond and all of the ice which forms above the first inch, whether by snow or rain or flooding, and to insure the rejection of all ice containing particles of foreign matter.

The Board would advise that no ice be cut in the immediate neighborhood of the feeders of the pond, the flow from which may cause matters to become entangled in the ice, or at any place in the pond where the water is shallow, and there would be danger that weeds or organic matters from the bottom of the pond might be taken up by the ice.

HOLYOKE. An application was received Dec. 18, 1900, from the board of health of Holyoke, for the advice of the State Board of Health relative to the quality of certain proposed sources of ice supply for that city. The Board replied to this application as follows: —

JAN. 21, 1901.

The State Board of Health has considered your application for advice with reference to the character of the water of two ponds which it is in-

Ell Pond is situated in the central portion of Melrose, and receives the drainage from a territory containing a dense population, and is evidently considerably polluted by sewage.

Numerous samples of ice collected from various parts of this pond, both during the winter just passed and the previous winter, have been analyzed by the Board; and, judging from the results of all its examinations, the Board is of the opinion that the ice of Ell Pond, as formed, cannot be safely used for domestic purposes, although the bottom portion of the ice, when it is clear and contains no particles of foreign matter, might safely be so used.

Under the existing conditions, the only safety in using such ice lies in a proper inspection, under your direction and control, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond and all of the ice which forms above the first inch, whether by snow or rain or flooding, and to insure the rejection of all ice containing particles of foreign matter.

On March 6, 1901, a letter was received from the city clerk of Melrose, enclosing a vote of the board of aldermen, requesting the State Board of Health to make an examination of the ice of Ell Pond or Crystal Lake, in that city. The Board replied to this communication as follows:—

APRIL 20, 1901.

In response to your request to this Board to make a careful examination of the ice in different parts of Ell Pond or Crystal Lake, so called, and advise you as to the use of the ice from this source for domestic purposes, the Board has caused Ell Pond and its water-shed to be examined, and samples of the water and ice to be analyzed, and has to-day sent the following communication to the board of health of the city of Melrose, relative to the use of Ell Pond as a source of ice supply:—

Ell Pond is situated in the central portion of Melrose, and receives the drainage from a territory containing a dense population, and is evidently considerably polluted by sewage.

Numerous samples of ice collected from various parts of this pond, both during the winter just passed and the previous winter, have been analyzed by the Board; and, judging from the results of all its examinations, the Board is of the opinion that the ice of Ell Pond, as formed, cannot be safely used for domestic purposes, although the bottom portion of the ice, when it is clear and contains no particles of foreign matter, might safely be so used.

Under the existing conditions, the only safety in using such ice lies in a proper inspection, under your direction and control, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond and all of the ice which forms above the first inch, whether by snow or rain or flooding, and to insure the rejection of all ice containing particles of foreign matter.

PITTSFIELD (Morewood Lake Ice Company). An application was received from the Morewood Lake Ice Company, Aug. 19, 1901, for the advice of the Board as to the quality of Morewood proper inspection, under your direction and control, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond and all of the ice which forms above the first inch, whether by snow or rain or flooding, and to insure the rejection of all ice containing particles of foreign matter.

The Board would advise that no ice be cut in the immediate neighborhood of the feeders of the pond, the flow from which may cause matters to become entangled in the ice, or at any place in the pond where the water is shallow, and there would be danger that weeds or organic matters from the bottom of the pond might be taken up by the ice.

All of the other sources examined show evidences of sewage pollution, and the Board is of the opinion that the only safety in using ice from these sources also, excepting Dorr's Pond, is to provide that the harvesting of the ice shall be done under your direction and control, and that the ice be inspected in the same manner as recommended in the case of Ell Pond, — that is, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond and all of the ice which forms above the first inch, and to insure the rejection of all ice containing particles of foreign matter.

Some of these ponds are quite shallow, or contain large areas where the depth of the water is small. The Board would call special attention to the liability, in shallow ponds and in all ponds if ice is cut near the shore, that weeds, grass or other foreign matter may be frozen into the ice, which would render it entirely unfit for domestic uses. This was the case with the ice examined from Dorr's Pond; and the Board would advise that the ice from this source be not used where it will come in contact with food or drinking water.

On Feb. 11, 1901, a petition was received from twenty-eight citizens of Melrose, consumers of the ice cut from Ell Pond, requesting a hearing, under the provisions of chapter 287 of the Acts of 1886. After notice had been given, a hearing was held at the office of the Board, on April 4, 1901. The following communication was sent to the petitioners: —

APRIL 20, 1901.

In response to a complaint to this Board, in your petition of Feb. 11, 1901, alleging that the ice cut from Ell Pond or Crystal Lake, in the city of Melrose, is impure and injurious to health, and should not be allowed to be cut, sold and held for sale, the State Board of Health gave a hearing upon your petition at its office in the State House on Thursday, April 4, 1901; and, after considering the information submitted at that hearing and the results of investigations which it has caused to be made as to the condition of Ell Pond and the quality of the ice cut from it during the past winter, has given the following advice to the board of health of Melrose: —

Ell Pond is situated in the central portion of Melrose, and receives the drainage from a territory containing a dense population, and is evidently considerably polluted by sewage.

Numerous samples of ice collected from various parts of this pond, both during the winter just passed and the previous winter, have been analyzed by the Board; and, judging from the results of all its examinations, the Board is of the opinion that the ice of Ell Pond, as formed, cannot be safely used for domestic purposes, although the bottom portion of the ice, when it is clear and contains no particles of foreign matter, might safely be so used.

Under the existing conditions, the only safety in using such ice lies in a proper inspection, under your direction and control, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond and all of the ice which forms above the first inch, whether by snow or rain or flooding, and to insure the rejection of all ice containing particles of foreign matter.

On March 6, 1901, a letter was received from the city clerk of Melrose, enclosing a vote of the board of aldermen, requesting the State Board of Health to make an examination of the ice of Ell Pond or Crystal Lake, in that city. The Board replied to this communication as follows: —

April 20, 1901.

In response to your request to this Board to make a careful examination of the ice in different parts of Ell Pond or Crystal Lake, so called, and advise you as to the use of the ice from this source for domestic purposes, the Board has caused Ell Pond and its water-shed to be examined, and samples of the water and ice to be analyzed, and has to-day sent the following communication to the board of health of the city of Melrose, relative to the use of Ell Pond as a source of ice supply: —

Ell Pond is situated in the central portion of Melrose, and receives the drainage from a territory containing a dense population, and is evidently considerably polluted by sewage.

Numerous samples of ice collected from various parts of this pond, both during the winter just passed and the previous winter, have been analyzed by the Board; and, judging from the results of all its examinations, the Board is of the opinion that the ice of Ell Pond, as formed, cannot be safely used for domestic purposes, although the bottom portion of the ice, when it is clear and contains no particles of foreign matter, might safely be so used.

Under the existing conditions, the only safety in using such ice lies in a proper inspection, under your direction and control, to insure the removal from the ice, when it is harvested, of the first inch that forms upon the pond and all of the ice which forms above the first inch, whether by snow or rain or flooding, and to insure the rejection of all ice containing particles of foreign matter.

Pittsfield (Morewood Lake Ice Company). An application was received from the Morewood Lake Ice Company, Aug. 19, 1901, for the advice of the Board as to the quality of Morewood

Lake as a source of ice supply. The Board replied to this application as follows: —

SEPT. 20, 1901.

In response to your request, received August 19, for advice with reference to the use of Morewood Lake as a source of ice supply, the Board has caused the lake and its surroundings to be examined, and samples of the water and of ice collected from the lake last winter to be analyzed. The results indicate that this ice is of satisfactory quality. The limits of the water-shed of the lake are somewhat uncertain, on account of the course of Wanpenum Brook, which flows near the shore of the lake, and is separated from it only by low, marshy ground. It seems possible that water from this brook, which is exposed somewhat to pollution, may find its way into the lake at times of high flow in the streams when the water in the lake is low, but it is not practicable to determine definitely, from an examination made at this season of the year, whether such is the case or not. If no water from this brook finds its way into the lake, or if danger of pollution of the waters of the lake from this stream shall be prevented, the Board is of the opinion that Morewood Lake will be a suitable source of ice supply.

SHELBURNE. An application was received Jan. 10, 1901, from the board of health of Shelburne, for the advice of the Board relative to the quality of the ice cut from a mill pond at Shattuckville on the North River in Colrain. The Board replied to this application as follows: —

JAN. 29, 1901.

It appears from this examination that sewage is discharged into the stream at Willis Place and Griswoldville, two villages located on the stream not far above Shattuckville, and that several cases of typhoid fever occurred in these villages in the latter part of last year.

While these circumstances continue, the Board is of the opinion that the mill pond at Shattuckville is an unsafe source from which to take ice for use in drinking water and for other domestic purposes.

The river above the village of Willis Place has a large water-shed, and the population upon it is very small. If precautions should be taken to prevent injury to the ice from anything discharged into the stream from the village of Colrain or from one or two places where sawmills are said to exist above Colrain, the Board is of the opinion that the river above Willis Place would be a good source of ice supply.

SOUTH HADLEY. An application was received from Charles Huot of South Hadley Falls, June 21, 1901, for advice as to the propriety of using Huot's Pond in South Hadley as a source of ice supply. The Board replied to this application as follows: —

AUG. 1, 1901.

The State Board of Health has considered your application for advice relative to the use of Huot's Pond, so called, as a source of ice supply, and as to the quality of ice stored in the ice-house near the pond, and has caused the pond and its surroundings to be examined by one of its engineers, and samples of the ice to be analyzed. The results of these analyses show that one sample of ice was of good quality; but the other was of very poor quality, and contained large numbers of bacteria.

The water of the brook upon which the pond is situated was also analyzed, and the results, as compared with the examination at a previous time, show no improvement in the quality of the water, but rather a deterioration; and it is evident that this brook, at the time this sample was collected, was being polluted by a considerable quantity of sewage.

Considering all the circumstances, the Board is of the opinion that this pond is not a suitable source from which to take ice for domestic purposes.

While some of the ice at present stored in the ice-house near the pond is of good quality, portions of it appear to be of poor quality; and, in the opinion of the Board, this ice should not be used where it may come in contact with food or drinking water.

On Oct. 3, 1901, Mr. Huot again applied to the Board, submitting certain plans for the improvement of Huot's Pond as a source of ice supply. The Board replied to this application as follows: —

NOV. 7, 1901.

The State Board of Health received from you, on Oct. 9, 1901, an application relative to improving your source of ice supply in South Hadley, in which you state that you have received suggestions from Mr. Percy M. Blake, C.E., for the improvement of your ice pond, and that you propose to carry out these suggestions in every detail; and you wish to know whether, if carried out strictly, the ice of this pond will be safe for domestic uses. The suggestions are as follows: —

1. That our dwelling house and those in its immediate vicinity be connected with a sewer, to be constructed in the highway in front of the houses, and all drainage from all the houses be discharged into such sewer. We understand this sewer is to be constructed at an early day, but in case it is not constructed, these houses are to be provided with absolutely tight cesspools and vaults, the accumulations in which shall never be allowed to overflow, but shall be removed and deposited on land outside the water-shed of the pond.

2. No fertilizing or manuring of the land forming the water-shed of the ice pond should be done before the first day of April nor after the first day of September in any year, and no fertilizing or manuring of any land located nearer than 300 feet from any water course or channel in which water is collected, or through which water runs into the ice pond, should be done at any time of the year.

3. The keeping of pigs and cattle in barns or buildings or elsewhere on the

water-shed should be discontinued, but cattle may be allowed to graze in the fields, provided they be not allowed to approach nearer any water course or channel through which water flows into the pond than 100 feet.

4. The pond should be entirely emptied and thoroughly cleaned by the removal of all muck and vegetable matter over the entire flowed area. The pond should be emptied every year by April first, and not refilled for the winter before the fifteenth day of November. In cleaning the bottom of the pond, care should be taken to so deepen the edges of the basin that when the pond is flooded the water shall be at least 2 feet deep around the entire shore line of the pond. After the pond is thoroughly cleaned it should be kept clean, and every year the growths on the bottom should be removed late in the fall, and just before the time of flooding (November 15) arrives.

5. No dumping of rubbish of any sort or kind should be permitted in or near any of the water courses or channels conveying water into the pond, and no wash from the highway, barn cellars or door yards should be allowed to get into the pond.

The Board has carefully considered your application and the suggestions for the improvement of your ice pond contained therein, and concludes that, if these suggestions are carried out as proposed, ice of suitable quality for all domestic purposes can be obtained from your ice pond; but the first inch of ice that forms and all above the first inch should be removed and not used, and all ice that forms within one foot of the bottom also should not be used.

The Board would call your attention to the necessity, in case the sewage shall be removed from the water-shed by a sewer or system of sewers, that the sewage be disposed of in some proper manner, so that it may not cause the pollution of another pond, stream or water course.

SOUTH HADLEY. An application was received Jan. 11, 1901, from H. E. Gaylord of South Hadley Falls, for the advice of the Board relative to the use of certain streams in that town as sources of ice supply. The Board replied to this application as follows: —

FEB. 7, 1901.

In response to your application of January 11, for advice with reference to a proposed source of ice supply, to be formed by the construction of a dam and the creation of a small pond a short distance west of Newton Street and about a quarter of a mile north of Granby road in South Hadley, the State Board of Health has caused the locality to be examined by one of its engineers, and several samples of the water of the main brook and its tributaries to be analyzed. The results of the analyses indicate that the water of the main brook is considerably polluted by sewage or animal wastes, and the water of the small tributary from the brickyard, which enters the brook near the proposed dam, is polluted to a considerably greater degree.

The examination of the water-shed of the main brook has shown that there are very few buildings upon it, all of which are located at a considerable distance from the stream or its tributaries, and there is no evidence that serious pollution was entering any of the streams from these buildings.

It is difficult, at the present season of the year, to make a sufficiently thorough examination to determine the source of the pollution of the water which is indicated by the analyses. So far as can be judged from the investigations that have been made, it is possible that it is due to manure put upon the lands within the water-shed recently in the course of the cultivation of the soil.

Under the existing conditions, the Board does not advise the construction of an ice pond for the taking of ice from this source at the present time. It is possible that the present pollution of the brook is due to conditions which will cease to affect its quality, and in that case the proposed pond on this stream would be a suitable source of ice supply.

The Board will, if you so request, make an examination at some future time, when it is practicable to make a more thorough examination of the water-shed, and will advise you again concerning your proposed plan of constructing a pond to be used as a source of ice supply.

Later in the year (June 18) another application was received from Mr. Gaylord, requesting further advice, and indicating the sources from which it was proposed to use water for an ice supply. The Board replied as follows: —

AUG. 1, 1901.

In response to your request of June 18 for further advice as to a proposed source of ice supply in South Hadley, the Board has again caused the locality to be examined, and samples of the water from the streams indicated to be analyzed. The results of the analyses of these waters do not show any material change in their condition from that found earlier in the year, and all of the streams examined show considerable pollution either by sewage or by animal wastes. An examination of the water-shed makes it evident that the chief causes of the pollution of the main stream and its tributary from the south are the cattle pastured there, and the manure put upon the cultivated land. With these conditions, it does not seem to the Board desirable to use these streams as sources of ice supply.

It would apparently be difficult to prevent the pollution of the main stream from the causes indicated; but the water-shed of the southerly tributary is smaller, is free from dwelling houses and contains but little cultivated land, and if a suitable pond can be constructed on this stream, and the deposit of manure upon the land during the fall and winter season can be prevented, this stream can, in the opinion of the Board, be made a suitable source of ice supply.

WALPOLE. An application was received from J. A. Turner, Feb. 20, 1901, for the advice of the Board relative to the use of Morey's Pond in Walpole as a source of ice supply. The Board replied to this application as follows: —

APRIL 4, 1901.

In response to your request for an examination of Morey's Pond in Walpole, and advice as to the use of this pond as a source of supply, the Board has caused the pond and its water-shed to be examined by one of its engineers, and samples of the water and ice to be analyzed.

An examination of the water-shed of the pond shows that it is very sparsely populated, and there do not appear to be any sources of direct sewage pollution at the present time. The results of the analyses show that the water of the pond contains a considerable quantity of organic matter; but this matter is doubtless taken up by contact with vegetable matter in swampy lands on the water-shed, while the ice was found to be nearly free from organic matter.

As the result of its investigations, the Board is of the opinion that Morey's Pond is a safe source of ice supply.

WARREN. An application was received from the board of health of Warren, Jan. 17, 1901, for the advice of the Board relative to the quality of the ice of certain sources in that town. To this report the Board replied as follows: —

FEB. 7, 1901.

In response to your communication of January 17, for advice as to the quality of the ice of two sources in West Warren, from which you state that ice which will be used for the supply of the town during the coming summer will be taken, the Board has caused the two ice ponds indicated by you to be examined, and samples of their waters to be analyzed.

One of the sources indicated by you is a mill pond on the Quaboag River, formed by a dam about a quarter of a mile west of the village of West Warren. This mill pond has an area of about two acres, and the flow of the Quaboag River passes through it. Near the shore of the pond is a factory from which much sewage is discharged directly into it, and there are several stables and privies located along the stream and its tributaries not far from the pond, some of which are directly over the streams. In the opinion of the Board, ice cut from this pond should not be used for domestic purposes where it is liable to come in contact with food or drinking water.

The second source indicated by you is the pond of George Bliss, located near South Street, a short distance south of the village of West Warren. An examination of the water-shed of this stream indicates that it is free from possible sources of pollution, and this pond would naturally be a good source of ice supply. The Board is informed, however, that a field just south of the pond, the natural drainage from which is in the direction of the pond, was used in the latter part of last year as a place of deposit for night soil. An examination of the water of the pond, on January 22, showed only very slight traces of sewage pollution; but, considering the circumstances, the Board is of the opinion that ice should not be cut or taken from this pond for domestic purposes during the present winter, nor at any future time while the deposit or disposal of night soil within its water-shed is continued.

Rules and Regulations for the Purpose of preventing the Pollution and securing the Sanitary Protection of Sources of Water Supply, in Compliance with Requests from the Authorities of Cities and Towns under the Provisions of Chapter 510 of the Acts of 1897.

Under the provisions of chapter 510 of the Acts of 1897, authorizing the State Board of Health to make rules and regulations for preventing the pollution and securing the sanitary protection of sources of water supply, requests were received during the year from the following authorities for such rules and regulations: from the water board of Danvers, March 6, 1901, and from the water board of Haverhill, Aug. 3, 1901, with reference to the protection of the water-shed of Kenoza Lake, one of the sources of water supply of that city; and copies of the rules and regulations made by the State Board of Health were forwarded to these authorities, as provided by the act.

Public Institutions (Chapter 101, Acts of 1886, Section 4).

Massachusetts State Board of Insanity. An application was received from the State Board of Insanity, Aug. 1, 1901, for the approval by the State Board of Health of a tract of land situated in the towns of Gardner and Westminster as a location for a State colony for the insane. The tract comprises over 1,400 acres of land, lying in the easterly part of Gardner and the westerly part of Westminster, and partly in the water-shed of the Whitman River, a tributary of the Nashua River, and partly in the water-shed of the Miller's River. The Board approved the location, Sept. 5, 1901.

EXAMINATION OF WATER SUPPLIES.

EXAMINATION OF WATER SUPPLIES.

EXPLANATORY NOTE.

The systematic examination of the water supplies of Massachusetts was begun by the State Board of Health, June 1, 1887, and has been continued up to the present time. The results of the investigations which were made during the first two years were published in the special report of the Board upon the Examination of Water Supplies (1890), and the results of the examinations made in succeeding years have been published in the annual reports of the Board, beginning with the twenty-second (1890).

The special report upon the Examination of Water Supplies (1890) contains descriptions of each of the public water supplies in the State existing at the time of that report, and the results of chemical and microscopical examinations of samples of water collected from the principal sources of supply. The annual reports beginning with the report for the year 1890 contain descriptions of all new works and the important changes in existing works, together with the results of the chemical and microscopical examinations which have been made of the various sources of supply. In the annual report for the year 1898 a brief description of the source of supply was given in cases where a knowledge of the conditions and surroundings of the source would assist materially in understanding and interpreting the analyses.

In previous reports the results of practically all of the analyses which have been made of the various sources of supply have been presented in full; in the present report the results of the individual analyses are omitted in most cases, and only the average of the analyses made during the year is given. In a few cases, however, in which the analyses made during the year are of special interest from some cause, or in which there has been a marked change in the character of the water during the year, the analyses of all of the samples collected during the year are given in full. Wherever analyses have been made regularly in previous years, the mean of the averages of previous years is given for comparison; but in some cases where there has been a change from year to year in the character of the water, the average analysis for each previous year is given in the tables.

Microscopical examinations have been made of nearly all of the samples from surface water sources which have been examined chemically; but the results of these examinations are omitted from this report, except in cases where certain organisms which are known to have given trouble in water supplies have been found in considerable numbers.

In this report, as in former reports, an alphabetical arrangement by towns has been adopted in presenting the analyses of all sources of water supply, the source being tabulated under the name of the town supplied, except that the analyses of the sources used for the supply of the metropolitan water district are placed at the beginning. The analyses of samples collected from rivers not used directly as sources of water supply are given in a subsequent chapter on the "Examination of Rivers," and the results are tabulated alphabetically by the name of the river.

The method of making chemical examinations has not been changed during the past year. All surface waters and such samples of ground water as contain suspended matter are filtered through filter paper before determining the color, residue on evaporation, albuminoid ammonia in solution and oxygen consumed. Some ground waters which are practically clear and colorless when drawn from the ground become turbid on standing, in consequence of the oxidation of the iron which they contain; in these waters the residue on evaporation is determined without filtration.

The color of the water is expressed by numbers, which increase with the amount of color. The standards used are natural waters, the color of which has been accurately determined by comparing them with the nesslerized ammonia standards which were described on page 531 of the special report on the Examination of Water Supplies (1890), and on page 329 of the annual report for 1892. By using natural waters as standards of comparison, an apparent rather than an actual color is obtained, as a natural water nearly always has a greater or less degree of turbidity, which gives the water an appearance of having a greater color than it would have if there were no turbidity.

The rainfall during the year 1901 was greatly in excess of the normal. During January, February, June, October and November it was considerably less than normal for those months, but during the remaining months of the year the rainfall was unusually high. The effect of this high rainfall and its distribution was to make the flow of the streams during the spring and summer months unusually high, and to keep the ground water from reaching as low a level as in an ordinary year.

Tables showing the rainfall at various places in the State, the average rainfall for a large number of years and the flow of some of the streams in the State, are given in a chapter entitled "Water Supply Statistics and Flow of Streams."

EXAMINATION OF WATER SUPPLIES.

WATER SUPPLY OF THE METROPOLITAN WATER DISTRICT.

During the year 1901 water was supplied from the Metropolitan Water Works to the following cities and towns: —

CITY OR TOWN.	Population in 1900.
Boston,	560,892
Somerville,	61,643
Chelsea,	34,072
Malden,	33,664
Arlington,	8,603
Quincy,	23,899
Everett,	24,336
Medford,*	18,244
Melrose,	12,962
Watertown,	9,706
Revere,	10,395
Winthrop,	6,058
Belmont,	3,929
Nahant,	1,152
Stoneham,*	6,197
Swampscott,	4,548
Total population of cities and towns supplied,	820,300

* Partially supplied from local sources.

The town of Stoneham was added to the Metropolitan Water District in the year 1901, by an act of the Legislature. This town was supplied with water by the Wakefield Water Company until October 21, after which date the entire supply was taken from the Metropolitan Water District.

The principal source of supply of the district during the year has been Framingham Reservoir No. 3, which obtains its supply mainly from the Sudbury Reservoir, which in turn receives through the Wachusett Aqueduct the water of the South Branch of the Nashua River. Water was drawn from Framingham Reservoir No. 2 from the middle of February to the middle of March, and from

METROPOLITAN WATER DISTRICT.

the middle of June to the first of August. Water from Framingham Reservoir No. 1 was used for a few days in March and a few days in July. Lake Cochituate was drawn on during the greater part of the year.

Chemical Examination of Water from the Sources of Supply of the Metropolitan Water District.

Quinepoxet River, Holden.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
Average of 6 samples collected in 1901, .	.47	3.69	1.68	.0015	.0229	.0192	.0037	.26	.0065	.0002	.65	0.5
Average of nine previous years, . .	.64	3.82	1.64	.0024	.0245	.0202	.0043	.22	.0053	.0001	.67	0.7

Odor in 1901, vegetable or unpleasant.

Stillwater River, Sterling.

Average of 6 samples collected in 1901, .	.42	3.23	1.48	.0015	.0184	.0164	.0020	.16	.0043	.0001	.57	0.7
Average of nine previous years, . .	.47	3.29	1.33	.0012	.0168	.0148	.0020	.17	.0037	.0000	.53	0.8

Odor in 1901, vegetable or unpleasant.

South Branch of Nashua River, above Clinton.

Average of 12 samples collected in 1901,	.35	3.75	1.44	.0017	.0183	.0152	.0031	.22	.0070	.0001	.46	1.1
Average of seven previous years, . .	.42	3.73	1.36	.0016	.0187	.0158	.0029	.22	.0054	.0000	.47	1.1

Odor in 1901, vegetable or none.

Sudbury Reservoir, Surface.

Average of 52 samples collected in 1901,	.25	4.03	1.51	.0025	.0169	.0143	.0026	.24	.0131	.0001	.40	1.4
Average of three previous years, . .	.27	3.78	1.29	.0027	.0170	.0141	.0029	.23	.0078	.0001	.38	1.2

Odor in 1901, generally faintly vegetable, becoming stronger on heating.

Sudbury Reservoir, Mid-depth.

Average of 52 samples collected in 1901,	.26	4.08	1.52	.0034	.0154	.0136	.0018	.24	.0145	.0001	.41	1.5
Average of three previous years, . .	.29	4.06	1.41	.0041	.0156	.0137	.0019	.25	.0097	.0001	.39	1.3

Odor in 1901, generally faintly vegetable, becoming stronger on heating.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from the Sources of Supply of the Metropolitan Water District — *Continued.*

Sudbury Reservoir, Bottom.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
					Total.	Dissolved.	Sus-pended.					
Average of 52 samples collected in 1901,	.25	4.14	1.54	.0038	.0152	.0136	.0016	.25	.0157	.0001	.41	1.5
Average of three previous years, . .	.29	4.18	1.42	.0048	.0153	.0135	.0018	.25	.0119	.0001	.39	1.4

Odor in 1901, generally faintly vegetable, becoming stronger on heating.

Framingham Reservoir No. 3.

Average of 12 samples collected in 1901,	.24	4.49	1.57	.0021	.0164	.0142	.0022	.25	.0156	.0001	.42	1.5
Average of three previous years, . .	.26	3.92	1.32	.0018	.0168	.0143	.0025	.25	.0078	.0001	.39	1.3

Odor in 1901, generally vegetable.

Indian Brook, at Head of Hopkinton Reservoir.

Average of 6 samples collected in 1901,	1.78	7.24	4.07	.0049	.0423	.0408	.0015	.42	.0080	.0001	1.65	1.7
Average of seven previous years, . .	1.46	5.95	3.00	.0017	.0327	.0303	.0024	.47	.0031	.0000	1.50	1.5

Odor in 1901, distinctly vegetable. The color ranged from .82 in March to 2.85 in July.

Hopkinton Reservoir, Surface.

Average of 6 samples collected in 1901,	.59	4.12	1.77	.0039	.0249	.0222	.0027	.29	.0055	.0001	.78	1.1
Average of seven previous years, . .	.61	3.79	1.68	.0017	.0207	.0181	.0026	.34	.0039	.0001	.68	1.0

Odor in 1901, vegetable, becoming frequently unpleasant and fishy on heating. Large numbers of the organism *Dinobryon* were found in the samples collected in March and April.

Hopkinton Reservoir, Bottom.

Average of 6 samples collected in 1901,	.55	4.42	1.82	.0046	.0224	.0195	.0029	.30	.0080	.0001	.76	1.1
Average of seven previous years, . .	.64	3.82	1.67	.0036	.0182	.0161	.0021	.34	.0051	.0001	.66	1.0

Odor in 1901, faintly vegetable, becoming stronger on heating.

Cold Spring Brook, at Head of Ashland Reservoir.

Average of 6 samples collected in 1901,	1.66	6.36	3.42	.0062	.0440	.0407	.0033	.27	.0055	.0001	1.78	1.4
Average of ten previous years, . .	1.20	4.85	2.39	.0009	.0281	.0255	.0026	.28	.0045	.0000	1.10	1.2

Odor in 1901, vegetable. The color ranged from .70 in March to 3.00 in September.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from the Sources of Supply of the Metropolitan Water District — *Continued.*

Ashland Reservoir, Surface.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Average of 6 samples collected in 1901,	.65	4.07	1.77	.0026	.0251	.0232	.0019	.24	.0087	.0001	.82	1.0
Average of ten previous years, . .	.65	3.60	1.69	.0013	.0214	.0190	.0024	.26	.0040	.0000	.75	0.9

Odor in 1901, faintly vegetable, becoming stronger on heating.

Ashland Reservoir, Bottom.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Average of 6 samples collected in 1901,	.59	4.21	1.90	.0029	.0227	.0206	.0021	.23	.0062	.0001	.76	1.0
Average of nine previous years, . .	.67	3.67	1.63	.0017	.0190	.0170	.0020	.26	.0067	.0000	.73	1.1

Odor in 1901, faintly vegetable, becoming stronger on heating.

Sudbury River, at Head of Framingham Reservoir No. 2.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Average of 6 samples collected in 1901,	1.01	5.56	2.46	.0042	.0320	.0292	.0028	.36	.0115	.0002	1.16	1.4
Average of ten previous years, . .	0.93	4.49	2.00	.0013	.0254	.0226	.0028	.31	.0071	.0001	0.89	1.1

Odor in 1901, faintly vegetable, becoming stronger on heating. The color ranged from .47 in March to 1.70 in September.

Framingham Reservoir No. 2.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Average of 6 samples collected in 1901,	.90	5.27	2.27	.0050	.0274	.0253	.0021	.33	.0105	.0001	1.02	1.8
Average of ten previous years, . .	.83	4.20	1.87	.0011	.0228	.0200	.0028	.29	.0065	.0001	0.83	1.0

Odor in 1901, vegetable, becoming stronger on heating.

Lake Cochituate, Wayland.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Average of 12 samples collected in 1901,	.26	5.17	1.86	.0042	.0239	.0200	.0039	.41	.0102	.0002	.48	2.1
Average of ten previous years, . .	.23	4.79	1.59	.0017	.0189	.0157	.0032	.47	.0104	.0001	.41	2.0

Odor in 1901, vegetable or none.

Chestnut Hill Reservoir.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
Average of 11 samples collected in 1901,	.27	4.02	1.47	.0020	.0165	.0147	.0018	.25	.0159	.0001	.42	1.5
Average of three previous years, . .	.29	3.94	1.44	.0023	.0159	.0138	.0021	.24	.0072	.0001	.40	1.2

Odor in 1901, faintly vegetable or none. A vegetable odor was developed in all of the samples on heating.

METROPOLITAN WATER DISTRICT.

Chemical Examination of Water from the Sources of Supply of the Metropolitan Water District — *Concluded.*

Spot Pond, Stoneham.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
Average of 12 samples collected in 1901,	.08	4.73	1.50	.0014	.0171	.0146	.0025	.28	.0042	.0001	.31	2.0
Average of two years, 1898-99, . .	.42	5.30	1.84	.0055	.0250	.0202	.0048	.42	.0031	.0000	.48	2.0

Odor in 1901, frequently unpleasant and fishy; at other times, vegetable or none. Large numbers of the organism *Dinobryon* were found in the samples collected during the winter months.

Faucet at State House, Boston.

Average of 12 samples collected in 1901,	.24	4.43	1.64	.0013	.0158	.0142	.0016	.30	.0173	.0001	.42	1.7
Average of three previous years, . .	.29	3.90	1.37	.0009	.0148	.0132	.0016	.26	.0103	.0001	.39	1.3

Odor in 1901, vegetable or none. The color ranged from .14 in October and November to .32 in January.

Faucets in Revere.

Average of 12 samples collected in 1901,	.11	4.67	1.47	.0012	.0154	.0135	.0019	.28	.0082	.0001	.30	2.0
Average for 1900, ...	.17	3.81	1.16	.0013	.0150	.0138	.0012	.26	.0053	.0001	.35	1.5

Odor in 1901, faintly vegetable or none. The color ranged from .00 in September to .22 in March.

Faucets in Quincy.

Average of 12 samples collected in 1901,	.24	4.45	1.68	.0010	.0152	.0134	.0018	.31	.0183	.0001	.41	1.8

Odor, generally vegetable. The color ranged from .13 in November to .32 in March.

WATER SUPPLY OF ABINGTON AND ROCKLAND.

Big Sandy Pond in Pembroke.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.			
Average of 4 samples collected in 1901.	.09	3.09	1.22	.0028	.0163	.0146	.0017	.63	.0030	.0000	.28	0.5	-
Average of six previous years, .	.10	3.18	1.11	.0008	.0167	.0146	.0021	.65	.0018	.0000	.22	0.5	-

Odor in 1901, occasionally vegetable.

ADAMS FIRE DISTRICT.

WATER SUPPLY OF ADAMS FIRE DISTRICT.

Bassett Brook.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 3 samples collected in 1901.	.01	3.38	0.95	.0003	.0040	.0036	.0004	.08	.0180	.0000	.10	2.4	-
Average of five previous years, .	.05	3.52	0.88	.0003	.0044	.0037	.0007	.08	.0158	.0000	.13	2.2	-

Dry Brook.

Average of 4 samples collected in 1901.	.22	6.72	2.06	.0015	.0104	.0087	.0017	.10	.0100	.0001	.36	4.8	-
Average of five previous years, .	.24	6.75	1.75	.0008	.0100	.0090	.0010	.10	.0097	.0000	.37	4.4	-

Odor in 1901, generally vegetable.

WATER SUPPLY OF AMESBURY. — POWOW HILL WATER COMPANY.

Wells near Main Street.

Average of 6 samples collected in 1901.	.10	10.73	-	.0009	.0013	-	-	.60	.0390	.0001	.04	4.7	.0408

Wells near Market Street.

Average of 5 samples collected in 1901.	.03	24.20	-	.0089	.0043	-	-	1.28	.0028	.0001	.07	8.8	.0134

WATER SUPPLY OF AMHERST. — AMHERST WATER COMPANY.

Amethyst Brook Reservoir.

Average of 4 samples collected in 1901.	.40	3.39	1.44	.0039	.0129	.0116	.0013	.15	.0047	.0000	.59	0.4	-

Odor, sometimes faintly vegetable.

WATER SUPPLY OF ANDOVER. (See also page 5.)

Haggett's Pond.

Average of 5 samples collected in 1901.	.18	3.23	1.52	.0018	[illegible]	.0134	.0027	.22	.0026	.0000	.34	1.2	-
Average of ten previous years, .	.12	3.62	1.80	.0009	.0154	.0133	.0021	.24	.0027	.0000	.31	1.3	-

Odor in 1901, occasionally faintly vegetable or unpleasant. The organism Anabaena was found in the sample collected in August.

Water Supply of Arlington.

(See *Metropolitan Water District*, pages 120-123.)

The Following Waters were examined in Connection with Advice to Town Authorities.
(See also page 7.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
36162	June 28	None.	None.	.00	43.30	.0000	.0102	1.60	3.2000	.0000	.03	13.7	.0060
36163	June 28	None.	V. slight.	-	35.30	.0024	.0150	1.44	2.2800	.0000	.06	10.2	.0050
37666	Oct. 22	None.	Slight.	.00	7.10	.0002	.0020	0.46	0.1280	.0000	.01	3.3	.0050

No. 36162 was collected from a spring located on Summer Street, and used for the supply of the town almshouse; No. 36163 was collected from a spring on Pine Street; No. 37666 was collected from a spring which it was proposed to use as a source of supply for the Stephen Symnes Hospital.

Water Supply of Athol. — Athol Water Company.

Large Reservoir in Phillipston.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 5 samples collected in 1901.	.66	3.81	1.97	.0060	.0315	.0259	.0056	.14	.0052	.0000	.82	0.7	-
Average of seven previous years, .	.67	3.78	1.74	.0033	.0365	.0212	.0153	.14	.0059	.0000	.78	0.7	-

Odor in 1901, generally unpleasant. The samples collected in June contained a large number of organisms, consisting chiefly of *Melosira*, *Tabellaria* and *Protococcus*. The organism *Uroglena* was found in the sample collected in December.

Buckman Brook Reservoir.

March, 1901, ...	.20	3.35	0.80	.0028	.0254	.0228	.0026	.19	.0030	.0000	.38	0.6	-
Average of three previous years, .	.46	3.35	1.54	.0014	.0196	.0171	.0025	.13	.0049	.0000	.69	0.6	-

Odor in 1901, vegetable. The organisms *Peridinium* and *Synura* were found in this sample.

Water Supply of Attleborough. (See also page 8.)

Well.

Average of 12 samples collected in 1901.	.00	3.79	-	.0001	.0028	-	-	.33	.0125	.0000	.02	1.7	.0068
Average of eight previous years, .	.02	4.02	-	.0002	.0021	-	-	.34	.0142	.0000	.04	1.8	.0037

ATTLEBOROUGH.

Waters examined in Connection with Advice to Corporations in the Town.
(See also page 10.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
35353	April 9	None.	None.	.00	21.40	.0010	.0006	2.80	.0040	.0000	.01	9.9	.0050
37119	Sept. 9	None.	V. slight.	.00	22.00	.0010	.0004	2.72	.0020	.0000	.04	8.9	.0110

No. 35353 was collected from tubular wells upon the estate of E. A. Robinson; No. 37119 was collected from a well used as a source of supply for the factory of J. M. Fisher & Co.

Water Supply of Avon.

Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Suspended.						
Average of 6 samples collected in 1901.	.00	3.90	-	.0004	.0015	-	-	.34	.0363	.0000	.01	1.0	.0058
Average of three previous years, .	.01	3.37	-	.0003	.0006	-	-	.36	.0188	.0000	.02	1.0	.0038

Water Supply of Ayer.

Well.

Average of 6 samples collected in 1901.	.00	5.58	-	.0006	.0027	-	-	.47	.0405	.0000	.02	2.3	.0083
Average of two previous years, .	.01	5.78	-	.0003	.0014	-	-	.49	.0440	.0000	.03	2.5	.0049

Odor in June, 1901, distinctly unpleasant.

Water Supply of Barre. — Barre Water Company.

Reservoir.

September, 1901, ...	.09	2.75	1.10	.0028	.0366	.0268	.0098	.07	.0020	.0000	.32	1.0	-
Average of four previous years, .	.13	3.32	1.09	.0030	.0203	.0160	.0043	.14	.0063	.0000	.25	1.1	-

Odor in 1901, vegetable.

Water Supply of Belmont.

(See *Metropolitan Water District*, pages 120–123.)

Water Supply of Beverly.

(See *Salem.*)

Water Supply of Billerica.

Tubular Wells.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 13 samples collected in 1901.	.06	6.23	-	.0007	.0026	-	-	.27	.0113	.0000	.06	2.2	.0280
Average of two previous years,	.03	5.92	-	.0005	.0016	-	-	.25	.0082	.0000	.04	2.1	.0176

Water Supply of Boston.

(See *Metropolitan Water District*, pages 120–123.)

Water Supply of Braintree. (See also pages 11, 12.)

Filter Gallery.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34313	Jan. 1	V. slight.	None.	.04	6.00	.0022	.0092	.89	.1160	.0000	.11	2.1	.0110
34659	Feb. 5	V. slight.	V. slight.	.06	5.10	.0018	.0082	.85	.0500	.0000	.18	1.7	.0070
34993	Mar. 5	None.	V. slight.	.02	5.80	.0018	.0100	.96	.0760	.0002	.15	2.2	.0050
35309	Apr. 2	V. slight.	V. slight.	.19	4.70	.0016	.0156	.68	.0600	.0002	.31	1.7	.0100
35565	Apr. 30	V. slight.	V. slight.	.11	5.10	.0028	.0116	.76	.0820	.0000	.25	2.0	.0090
35858	June 5	V. slight.	V. slight.	.22	4.40	.0008	.0138	.69	.0500	.0002	.40	1.4	.0110
36223	July 2	V. slight.	V. slight.	.20	5.20	.0010	.0182	.70	.0100	.0002	.26	1.6	.0260
36656	Aug. 6	None.	V. slight.	.03	4.90	.0002	.0042	.82	.0550	.0001	.09	1.4	.0130
37064	Sept. 3	Slight.	Slight.	.22	8.50	.0022	.0206	.64	.0060	.0002	.52	1.3	.0120
37441	Oct. 1	None.	None.	.00	4.20	.0004	.0066	.77	.0210	.0001	.03	1.7	.0050
37507	Oct. 8	None.	None.	.00	4.70	.0000	.0096	.77	.0300	.0000	.13	2.1	.0070
37618	Oct. 15	None.	None.	.01	5.40	.0000	.0064	.88	.0600	.0000	.01	2.0	.0050
37619	Oct. 15	None.	None.	.02	4.50	.0002	.0078	.75	.0200	.0000	.02	1.8	.0080
37856	Nov. 5	None.	None.	.02	4.90	.0022	.0056	.77	.0130	.0003	.15	1.8	.0100
38209	Dec. 3	None.	None.	.02	5.50	.0014	.0064	.86	.0500	.0001	.08	1.8	.0050

BRAINTREE.

Filter Gallery — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1892	-	-	.02	4.69	.0002	.0030	.75	.0192	.0001	-	1.8	.0343
-	1893	-	-	.03	4.72	.0002	.0049	.83	.0363	.0001	.10	1.8	.0037
-	1894	-	-	.04	5.19	.0004	.0048	.86	.0338	.0001	.10	1.7	.0135
-	1895	-	-	.12	5.32	.0004	.0060	.89	.0369	.0002	.13	2.0	.0417
-	1896	-	-	.08	5.55	.0006	.0051	.86	.0329	.0000	.12	1.7	.0095
-	1897	-	-	.04	5.20	.0010	.0058	.90	.0287	.0001	.10	2.0	.0059
-	1898	-	-	.07	5.22	.0013	.0049	.88	.0482	.0000	.12	2.0	.0059
-	1899	-	-	.04	5.20	.0020	.0044	.81	.0363	.0000	.09	1.9	.0051
-	1900	-	-	.10	4.89	.0014	.0120	.76	.0431	.0001	.23	1.4	.0112
-	1901	-	-	.09	5.40	.0015	.0109	.78	.0501	.0001	.21	1.7	.0104

Little Pond.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 7 samples collected in 1901.	.25	4.24	1.75	.0040	.0250	.0218	.0032	.67	.0087	.0001	.45	1.0	-
Average of five previous years, .	.22	4.04	1.47	.0016	.0247	.0214	.0033	.76	.0033	.0000	.43	1.0	-

Odor in 1901, generally faintly vegetable, becoming stronger and occasionally unpleasant on heating.

WATER SUPPLY OF BRIDGEWATER AND EAST BRIDGEWATER. — THE BRIDGEWATERS WATER COMPANY. (See also page 13.)

Tubular Wells.

Average of 7 samples collected in 1901.	.16	7.64	-	.0013	.0018	-	-	.41	.0036	.0000	.08	2.8	.0877

BRIDGEWATER AND EAST BRIDGEWATER.

Large Well East of Pumping Station.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as				
					Albuminoid.								
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 7 samples collected in 1901.	.01	3.67	-	.0005	.0018	-	-	.42	.0072	.0000	.01	0.7	.0089

Odor in June, distinctly unpleasant.

Large Well West of Pumping Station.

	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 7 samples collected in 1901.	.18	6.54	-	.0011	.0034	-	-	.43	.0110	.0000	.06	2.3	.0522

Water examined in Connection with Advice relative to a Source of Ice Supply.

(See also page 104.)

[Parts per 100,000.]

		Appearance.			Residue on Evaporation.		Ammonia.					Nitrogen as			
								Albuminoid.							
Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
34487	1901. Jan. 16	Decided.	Slight.	.31	3.10	1.20	.0020	.0388	.0256	.0132	.24	.0030	.0001	.69	0.5

Odor, distinctly unpleasant. —— The sample was collected from Chisholm's ice pond, near South Street.

Water Supply of Brockton.

Salisbury Brook Storage Reservoir.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as				
					Albuminoid.								
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 11 samples collected in 1901.	.62	4.28	2.01	.0025	.0267	.0235	.0032	.34	.0025	.0000	.77	0.8	-
Average of ten previous years,	.67	3.57	1.62	.0009	.0231	.0191	.0040	.37	.0023	.0000	.69	0.7	-

Odor in 1901, faintly vegetable or unpleasant, becoming stronger on heating. The organism *Uroglena* was found in the sample collected in April.

BROOKLINE.

WATER SUPPLY OF BROOKLINE.

Faucet at Low-service Pumping Station.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as				
					Albuminoid.								
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 7 samples collected in 1901.	.03	3.70	-	.0033	.0048	-	-	.55	.0359	.0002	.08	4.4	.0070
Average of seven previous years, .	.03	3.92	-	.0014	.0032	-	-	.58	.0338	.0001	.09	4.4	.0030

WATER SUPPLY OF CAMBRIDGE.

Fresh Pond.

Average of 12 samples collected in 1901.	.18	6.48	2.10	.0026	.0229	.0187	.0042	.54	.0322	.0003	.37	3.1	-
Average of ten previous years, .	.26	7.21	1.94	.0067	.0231	.0178	.0053	.64	.0269	.0005	.42	3.3	-

Odor in 1901, generally vegetable or unpleasant, becoming stronger on heating.

Stony Brook Storage Reservoir, Waltham.

Average of 12 samples collected in 1901.	.42	5.78	2.28	.0030	.0221	.0201	.0020	.45	.0255	.0003	.61	2.2	-
Average of ten previous years, .	.61	5.55	2.03	.0018	.0242	.0210	.0032	.43	.0183	.0001	.63	2.1	-

Odor in 1901, vegetable or unpleasant, becoming stronger on heating.

Upper Basin on Hobbs Brook.

Average of 12 samples collected in 1901.	.69	6.22	2.79	.0051	.0380	.0328	.0052	.34	.0134	.0001	.89	2.3	-
Average of two previous years, .	.37	5.24	2.08	.0028	.0349	.0277	.0072	.33	.0042	.0000	.68	1.8	-

Odor in 1901, vegetable or unpleasant, becoming stronger on heating. The color ranged from 0.41 in November to 1.40 in June.

Lower Basin on Hobbs Brook, at Surface.

Average of 12 samples collected in 1901.	.15	5.07	1.80	.0044	.0298	.0254	.0044	.35	.0037	.0001	.46	2.2	-
Average of two previous years, .	.11	4.69	1.55	.0016	.0264	.0224	.0040	.35	.0044	.0000	.40	1.8	-

Odor in 1901, vegetable or unpleasant, becoming stronger on heating. The color ranged from 0.03 in January to 0.31 in June.

Lower Basin on Hobbs Brook, at Bottom.

Average of 12 samples collected in 1901.	.15	5.17	1.92	.0035	.0268	.0230	.0038	.35	.0039	.0001	.44	2.3	-
Average of two previous years, .	.12	4.81	1.62	.0009	.0233	.0190	.0043	.35	.0051	.0000	.38	1.9	-

Odor in 1901, vegetable or unpleasant, becoming stronger on heating.

CAMBRIDGE.

Waters examined in Connection with Advice to Corporations in the City.

(See also pages 14, 15.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
34633	Jan. 30	Decided.	Cons.	-	54.50	.0080	.0076	1.81	.0000	.0001	.13	2.9	.4200
35397	Apr. 12	Decided.	Cons.	-	54.10	.0070	.0014	2.09	.0080	.0000	.12	1.3	.0900
35494	Apr. 22	Decided.	Cons.	.10	42.60	.0096	.0018	2.28	.0040	.0000	.06	1.1	.0550
35595	May 1	Decided.	Cons.	.02	34.60	.0110	.0018	2.68	.0010	.0000	.02	1.1	.0300
35660	May 9	Decided.	Cons.	.05	52.50	.0104	.0012	3.94	.0020	.0000	.06	1.1	.0360
35719	May 17	Decided.	Cons.	.02	44.80	.0112	.0020	3.26	.0020	.0000	.05	1.1	.0280
35758	May 22	Decided.	Cons.	.12	45.00	.0114	.0028	3.96	.0030	.0000	.05	1.1	.0550
35035	Mar. 9	None.	None.	.02	16.80	.0064	.0006	0.84	.0030	.0000	.08	8.1	.0050

The first seven samples were collected from a tubular well on the premises of the Reversible Collar Company; the last, from a tubular well on the premises of the Randall Hall Association. Several of the samples collected from the well of the Reversible Collar Company had an unpleasant odor, and a mineral analysis of the water of this well showed that it contained 27.7 parts per 100,000 of sodium carbonate.

Water Supply of Canton.

Springdale Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
					Albuminoid.								
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.			
Average of 6 samples collected in 1901.	.00	3.73	-	.0003	.0012	-	-	.32	.0043	.0000	.01	1.0	.0068
Average of two previous years,	.00	3.74	-	.0001	.0008	-	-	.33	.0052	.0000	.02	0.8	.0093

Well near Henry's Spring.

Average of 6 samples collected in 1901.	.04	3.80	-	.0004	.0030	-	-	.37	.0158	.0000	.07	1.3	.0052
Average of two previous years,	.14	5.06	-	.0003	.0045	-	-	.39	.0131	.0000	.17	1.5	.0094

Water Supply of Chelsea.

(See *Metropolitan Water District*, pages 120-123.)

CHESHIRE.

Water Supply of Cheshire. — Cheshire Water Company.

Old Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
November, 1901, ...	.00	4.55	0.90	.0006	.0066	.0062	.0004	.07	.0070	.0001	.08	3.5	-
Average of three previous years, .	.04	4.23	-	.0006	.0032	-	-	.07	.0111	.0000	.07	2.9	-

New Reservoir.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
July and November, 1901, . . .	.00	5.82	1.10	.0000	.0038	.0032	.0006	.07	.0045	.0002	.06	4.4	-

Water Supply of Chester.

Austin Brook Reservoir.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
August, 1901, ...	.04	2.85	0.65	.0004	.0048	.0038	.0010	.08	.0050	.0001	.12	1.4	-

Water Supply of Chicopee.

Morton Brook Reservoir.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.02	3.45	0.79	.0008	.0034	.0026	.0008	.12	.0062	.0000	.09	0.6	-
Average of seven previous years, .	.06	3.64	0.76	.0008	.0051	.0041	.0010	.13	.0072	.0000	.08	0.8	-

Cooley Brook Reservoir.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.53	4.04	1.47	.0023	.0156	.0115	.0041	.12	.0035	.0000	.55	0.9	-
Average of seven previous years, .	.70	4.21	1.41	.0013	.0147	.0114	.0033	.11	.0042	.0000	.61	1.1	-

Odor in 1901, generally faintly vegetable. The color in April was 1.46.

Water examined in Connection with Advice to the City Authorities. (See also page 15.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34459	Jan. 15	V. slight.	V. slight.	.20	4.25	.0000	.0102	.27	.0300	.0000	.35	1.4	.0150

Odor, distinctly unpleasant and musty. —— The sample was collected from a spring at the works of the Lamb Manufacturing Company.

CHICOPEE.

Water and Ice examined in Connection with Advice to the City Authorities.
(See also page 104.)

Water.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36916	Aug. 23	Slight.	Cons.	.68	4.80	2.25	.0064	.0316	.0240	.0076	.220	.0050	.0002	.66	1.8

Ice.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
36945	Aug. 26	None.	Slight.	.00	1.16	-	.0038	.0040	-	-	.003	.0010	.0002	.01	0.0
36946	Aug. 26	None.	V. slight.	.00	0.48	-	.0024	.0024	-	-	.000	.0030	.0005	.01	0.0
36947	Aug. 26	None.	V. slight.	.00	0.88	-	.0036	.0014	-	-	.007	.0020	.0005	.04	0.0
36948	Aug. 26	None.	V. slight.	.00	0.76	-	.0040	.0026	-	-	.005	.0010	.0003	.01	0.0

Odor of No. 36916, distinctly unpleasant. —— The sample of water was collected from an arm of the Chicopee River, above Chicopee Falls, from a point where ice is harvested. The first two samples of ice were taken from the ice-house of E. H. Munsell, the first being from the top of the cake and the second from the bottom of the cake; the last two samples, from the ice-house of Joseph Boudreau, the first being from the top of the cake and the second from the bottom of the cake. The ice in both ice-houses was harvested from the Chicopee River.

Bacteria per cubic centimeter in No. 36945, 34; in No. 36946, 45; in No. 36947, 43; in No. 36948, 27.

Water Supply of Clinton and Lancaster.

Faucet in Clinton.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
October, 1901, ...	.03	3.90	1.60	.0002	.0058	.0058	.0000	0.18	.0070	.0000	.13	1.8	-

Water Supply of Cohasset. — Cohasset Water Company.

Tubular Wells West of the Main Village (Old System).

	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 3 samples collected in 1901.	.05	14.73	-	.0003	.0027	-	-	1.74	.0298	.0000	.01	6.4	.0207
Average of eight previous years, .	.13	15.49	-	.0003	.0016	-	-	1.83	.0234	.0000	.04	7.2	.0432

COHASSET.

Tubular Wells in Ellms Meadow.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as				
					Albuminoid.								
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 8 samples collected in 1901.	.00	12.33	-	.0000	.0013	-	-	1.25	.0580	.0000	.01	4.7	.0043
Average of three previous years, .	.01	12.27	-	.0001	.0011	-	-	1.38	.0599	.0000	.02	4.8	.0039

Waters examined in Connection with Advice relative to Additional Water Supply. (See also page 16.)

[Parts per 100,000.]

		Appearance.			Residue on Evaporation.		Ammonia.					Nitrogen as		
								Albuminoid.						
Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
33290	Oct. 12	V. slight.	Slight.	0.95	5.85	2.85	.0036	.0360	.0340	.0020	0.97	.0070	.0001	1.26	0.8
33291	Oct. 12	None.	Slight.	0.83	11.55	4.30	.0056	.0404	.0384	.0020	1.45	.0030	.0001	1.28	2.5
33293	Oct. 12	V. slight.	Slight.	0.80	11.85	3.85	.0076	.0380	.0352	.0028	1.46	.0060	.0001	1.31	2.7
33292	Oct. 12	None.	V. slight.	1.26	13.05	5.35	.0088	.0440	.0420	.0020	1.46	.0030	.0000	1.90	2.7
33294	Oct. 12	None.	V. slight.	1.75	12.35	5.60	.0100	.0496	.0464	.0032	1.40	.0060	.0000	2.55	2.7
34092	Dec. 15	None.	V. slight.	0.40	4.75	1.40	.0014	.0098	.0094	.0004	1.02	.0000	.0000	0.64	0.8
34091	Dec. 15	None.	V. slight.	1.50	7.25	3.45	.0032	0234	.0226	.0008	1.22	.0020	.0000	1.89	1.6

Odor of most of the samples, distinctly vegetable.——No. 33290 was collected from Lily Pond, near the northerly shore; No. 33291, from Bound Brook at the old saw mill above North Scituate; No. 33293, from Bound Brook in North Scituate near the road from Cohasset to Scituate; No. 33292, from Bound Brook at Beechwood Street; No. 33294, from Bound Brook at Doane Street; No. 34092, from Turkey Hill Brook; No. 34091, from Scituate Hill Brook.

COLRAIN.

Waters examined in Connection with Advice to the Griswoldville Manufacturing Company. (See also page 18.)

	1901.														
35452	Apr. 18	None.	None.	0.04	4.50	0.90	.0000	.0044	.0044	.0000	.09	.0050	.0000	.10	3.5
35453	Apr. 18	None.	None.	0.04	4.60	1.25	.0000	.0044	.0044	.0000	.09	.0020	.0000	.18	2.9

Odor of both samples, very faintly vegetable when heated.——The first sample was collected from the east branch of McClellan Brook in Griswoldville; the last, from McClellan Brook above its junction with the east branch.

Water Supply of Concord and Lincoln.

Sandy Pond.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as				
					Albuminoid.								
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 7 samples collected in 1901.	.01	2.23	0.82	.0011	.0156	.0130	.0026	.25	.0014	.0000	.18	0.5	-
Average of four previous years, .	.05	2.59	0.91	.0008	.0127	.0114	.0013	.27	.0027	.0000	.18	0.8	-

Odor in February, 1901, distinctly unpleasant. The organism *Uroglena* was found in this sample.

Water Supply of Cottage City. — Cottage City Water Company.

Springs.

Average of 6 samples collected in 1901.	.02	4.00	-	.0002	.0010	-	-	.99	.0122	.0000	.02	0.7	.0122

Water Supply of Dalton Fire District.

Lower Reservoir.

April, 1901, ...	.29	1.90	0.85	.0012	.0130	.0126	.0004	.05	.0170	.0000	.65	0.8	-

Waters examined in Connection with Advice relative to Additional Water Supply.

(See also page 19.)

[Parts per 100,000.]

		Appearance.			Residue on Evaporation.		Ammonia.					Nitrogen as			
								Albuminoid.							
Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
35435	Apr. 17	None.	V. slight.	.26	2.50	0.90	.0006	.0094	.0086	.0008	.04	.0020	.0000	.41	1.1
35436	Apr. 17	V. slight.	V. slight.	.62	2.50	1.00	.0008	.0168	.0162	.0006	.05	.0070	.0000	.78	0.8
35437	Apr. 17	None.	V. slight.	.27	2.45	0.80	.0010	.0122	.0118	.0004	.06	.0050	.0000	.44	1.3

A vegetable odor was developed in all of the samples on heating. —— The first sample was collected from May Brook in Windsor, about 1,000 feet above Windsor Reservoir; the second, from Whitmarsh or Tyler Brook in Windsor, at the old road from Dalton to Windsor; the last, from Cady Brook, near its entrance to Windsor Reservoir.

DANVERS AND MIDDLETON.

Water Supply of Danvers and Middleton.

Middleton Pond.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.58	4.15	1.91	.0017	.0212	.0172	.0040	.31	.0007	.0000	.78	1.3	-
Average of five previous years,	.61	3.77	1.68	.0011	.0201	.0182	.0019	.35	.0028	.0000	.73	1.1	-

Odor in 1901, vegetable or unpleasant.

Water and Ice examined in Connection with Advice to the Town Authorities. (See also page 105.)

Water.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
L. 34934	**1901.** Mar. 1	Slight.	Slight.	.31	9.40	2.70	.0118	.0248	.0212	.0036	1.25	.1040	.0010	.38	3.5

Ice.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
29789	Mar. 1	None.	V. slight.	.03	-	-	.0008	.0008	-	-	0.00	.0000	.0002	.03	0.0

Odor of No. 34934, faintly unpleasant, becoming stronger on heating.—— The sample of water was collected from Putnam's ice pond, opposite the ice-house. The sample of ice was taken from the ice-house. Number of bacteria per cubic centimeter in top of cake, 39; in bottom of cake, 8.

Water Supply of Dedham. — Dedham Water Company.

Large Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 12 samples collected in 1901.	.01	9.01	-	.0010	.0057	-	-	.77	.1738	.0000	.04	3.7	.0057
Average of nine previous years,	.01	9.84	-	.0004	.0026	-	-	.86	.2025	.0000	.04	4.0	.0017

DEDHAM.

Tubular Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 7 samples collected in 1901.	.00	11.84	-	.0008	.0017	-	-	1.10	.3407	.0003	.01	4.3	.0086
Average of 12 samples collected in 1900.	.00	12.31	-	.0001	.0010	-	-	1.10	.3679	.0001	.02	4.6	.0036

Water Supply of Dracut. — American Woolen Company.

Well.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	4.17	-	.0007	.0018	-	-	.22	.0153	.0000	.02	1.4	.0057

Water Supply of East Bridgewater.

(See *Bridgewater*.)

Water Supply of Easthampton.

Bassett Brook.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.21	3.60	1.21	.0002	.0100	.0077	.0023	.10	.0040	.0001	.34	1.3	-
Average of seven previous years, .	.25	3.85	1.10	.0005	.0085	.0071	.0014	.11	.0064	.0000	.28	1.5	-

Odor in 1901, occasionally faintly vegetable.

Waters examined in Connection with Advice relative to Additional Water Supply.
(See also page 20.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
37567	Oct. 11	None.	V. slight.	.14	4.15	1.70	.0002	.0058	.0054	.0004	.07	.0050	.0000	.21	1.7
37568	Oct. 11	None.	V. slight.	.13	4.05	1.50	.0000	.0050	.0046	.0004	.10	.0030	.0001	.22	1.8
37569	Oct. 11	None.	V. slight.	.13	3.95	1.60	.0000	.0060	.0052	.0008	.12	.0020	.0001	.24	1.8

The first sample was collected from the north branch of the Manhan River, just above Kingsley Bridge; the second, from North Brook, above its junction with Sodden Brook; the last, from Sodden Brook, above a brook flowing from Westhampton.

EASTON.

WATER SUPPLY OF EASTON. — NORTH EASTON VILLAGE DISTRICT.

Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	4.52	-	.0002	.0018	-	-	.50	.0615	.0000	.00	1.6	.0047

WATER SUPPLY OF EVERETT.

(See *Metropolitan Water District*, pages 120–123.)

WATER SUPPLY OF FAIRHAVEN. — FAIRHAVEN WATER COMPANY.

Tubular Wells.

	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.20	6.57	-	.0002	.0072	-	-	.83	.0443	.0001	.28	2.1	.0088
Average of seven previous years, .	.16	5.69	-	.0003	.0047	-	-	.91	.0463	.0001	.23	1.7	.0113

WATER SUPPLY OF FALL RIVER.

North Watuppa Lake.

	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 12 samples collected in 1901.	.16	3.31	1.39	.0013	.0187	.0160	.0027	.50	.0023	.0001	.37	0.7	-
Average of six previous years, .	.19	3.30	1.19	.0011	.0174	.0153	.0021	.56	.0042	.0000	.38	0.6	-

Odor in 1901, occasionally faintly vegetable. A fishy or unpleasant odor was developed in many of the samples on heating. Large numbers of the organism *Dinobryon* were found in the samples collected in January and February, and the organism *Anabæna* was found in the samples collected in July and November.

South Watuppa Lake.

	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 12 samples collected in 1901.	.19	4.85	1.60	.0020	.0207	.0176	.0031	.70	.0026	.0001	.37	1.3	-
Average of three previous years, .	.25	4.28	1.43	.0014	.0214	.0190	.0024	.66	.0026	.0000	.43	1.0	-

Odor in 1901, occasionally faintly vegetable. A fishy or unpleasant odor was developed in many of the samples on heating. Large numbers of the organism *Dinobryon* were found in the samples collected in February and March, and the organism *Anabæna* was found in the sample collected in July. This lake is not used as a source of water supply.

WATER SUPPLY OF FALMOUTH. — FALMOUTH WATER COMPANY.

Tubular Wells.

	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 12 samples collected in 1901.	.00	2.88	-	.0006	.0086	-	-	.92	.0015	.0000	.03	0.2	.0046
Average of 12 samples collected in 1900.	.01	2.82	-	.0003	.0089	-	-	.92	.0014	.0000	.06	0.1	.0042

FALMOUTH.

Long Pond.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as				
					Albuminoid.								
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 12 samples collected in 1901.	.00	2.88	1.13	.0014	.0111	.0099	.0012	.92	.0014	.0000	.08	0.2	-

This pond is not used directly as a source of water supply.

Water Supply of Fitchburg.

Scott Reservoir.

Average of 4 samples collected in 1901.	.13	2.39	0.96	.0023	.0202	.0144	.0058	.12	.0030	.0000	.33	0.4	-
Average of ten previous years, .	.14	2.46	1.04	.0014	.0202	.0149	.0053	.16	.0036	.0000	.30	0.3	-

Odor in 1901, generally vegetable or unpleasant. The organism *Dinobryon* was found in large numbers in the sample collected in January.

Meetinghouse Pond in Westminster.

Average of 4 samples collected in 1901.	.05	2.37	0.84	.0020	.0137	.0115	.0022	.13	.0025	.0000	.26	0.6	-
Average of eight previous years, .	.09	2.51	0.99	.0012	.0154	.0130	.0024	.18	.0027	.0000	.26	0.6	-

Odor in 1901, generally vegetable. The organism *Dinobryon* was found in large numbers in the sample collected in January.

Water Supply of Foxborough Water Supply District.

Tubular Wells.

Average of 6 samples collected in 1901.	.00	3.62	-	.0000	.0009	-	-	.35	.0458	.0000	.01	0.6	.0052
Average of four previous years, .	.00	3.41	-	.0001	.0004	-	-	.35	.0421	.0000	.01	0.8	.0014

Water Supply of Framingham. — Framingham Water Company.

Filter Gallery.

Average of 6 samples collected in 1901.	.00	8.13	-	.0031	.0050	-	-	.85	.0322	.0004	.06	3.7	.0087
Average of nine previous years, .	.03	7.02	-	.0025	.0048	-	-	.83	.0382	.0001	.07	3.0	.0125

FRAMINGHAM.

Water examined in Connection with Advice to the Dennison Manufacturing Company. (See also page 21.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
37028	Aug. 30	Decided.	Cons.	.04	21.80	.0020	.0010	.38	.0020	.0000	.02	5.9	.2340

Odor, distinctly unpleasant. —— The sample was collected from a tubular well in the yard of the Dennison Manufacturing Company at South Framingham.

Water Supply of Franklin. — Franklin Water Company.

(See also page 22.)

Wells.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia Free.	Ammonia Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34664	Feb. 5	V. slight.	V. slight.	.30	6.60	.0018	.0142	.63	.1380	.0000	.45	2.1	.0180
35306	Apr. 2	V. slight.	V. slight.	.48	5.30	.0020	.0174	.40	.0800	.0001	.52	1.6	.0180
35833	June 4	None.	V. slight.	.62	4.50	.0014	.0142	.35	.0620	.0000	.70	1.4	.0100
36658	Aug. 6	V. slight.	V. slight.	.48	5.20	.0002	.0162	.44	.0850	.0002	.69	2.1	.0150
37470	Oct. 2	V. slight.	V. slight.	.45	6.50	.0008	.0182	.48	.0800	.0001	.60	2.2	.0140
38214	Dec. 3	V. slight.	V. slight.	.40	8.00	.0014	.0130	.76	.2000	.0000	.46	2.9	.0140
Av.	....	....	....	.45	6.02	.0013	.0155	.51	.1075	.0001	.57	2.0	.0148

Odor, generally vegetable or earthy. All of the samples probably contain surface water drawn from Beaver Pond.

Water examined in Connection with Advice to the Town Authorities. (See also page 22.)

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia Free.	Ammonia Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
35152	Mar. 18	None.	Slight.	.00	19.50	.0000	.0016	2.00	1.0400	.0002	.01	5.7	.0090

The sample was collected from a well on the premises of Waldo Daniels, Union Street, used as a source of drinking water for the pupils in the Thayer schoolhouse.

Water Supply of Gardner. — Gardner Water Company.

Crystal Lake.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.02	3.75	1.12	.0026	.0153	.0135	.0018	.29	.0127	.0000	.20	1.3	-
Average of eight previous years, .	.06	3.03	1.02	.0014	.0161	.0137	.0024	.33	.0055	.0000	.19	1.0	-

Odor in March, 1901, faintly unpleasant when heated.

GEORGETOWN.

Water examined in Connection with Advice to the Town Authorities. (See also page 23.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
37492	1901. Oct. 7	None.	V. slight.	.00	18.70	.0010	.0084	2.66	.3200	.0016	.05	6.1	.0070

The sample was collected from a well at the Perley Free School.

WATER SUPPLY OF GLOUCESTER.

Dike's Brook Storage Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
					Albuminoid.								
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.			
Average of 6 samples collected in 1901.	.31	3.61	1.63	.0022	.0196	.0163	.0033	.84	.0016	.0000	.45	0.3	-
Average of nine previous years, .	.42	4.04	1.48	.0027	.0192	.0161	.0031	.88	.0049	.0000	.43	0.4	-

Odor in 1901, generally unpleasant. Large numbers of the organisms *Dinobryon* and *Peridinium* were found in many of the samples examined.

Wallace Pond.

Average of 6 samples collected in 1901.	.43	4.50	1.99	.0045	.0243	.0174	.0069	1.07	.0016	.0001	.54	0.4	-
Average of eight previous years, .	.52	4.56	1.73	.0016	.0274	.0199	.0075	1.10	.0037	.0000	.55	0.5	-

Odor in 1901, unpleasant. Large numbers of the organisms *Dinobryon* and *Peridinium* were found in many of the samples examined.

GOSHEN.

GOSHEN.

Waters examined in Connection with Advice to the Proprietors of the Highland House. (See also page 24.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
35297	Apr. 1	None.	None.	.00	73.70	.0000	.0062	25.05	.8400	.0001	.05	20.3	.0050
35133	Mar. 14	None.	V. slight.	.00	17.50	.0002	.0018	5.70	.0050	.0000	.04	5.6	.0050
35261	Mar. 27	None.	None.	.02	17.00	.0002	.0024	4.65	.0070	.0000	.01	6.6	.0030

The first sample was collected from a well situated under the Highland House; the last two, from a well in the rear of the Highland House Annex.

WATER SUPPLY OF GRAFTON. — GRAFTON WATER COMPANY.

Filter Gallery.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Suspended.						
Average of 4 samples collected in 1901.	.01	10.45	-	.0004	.0032	-	-	1.37	.2487	.0000	.03	4.0	.0072

WATER SUPPLY OF GREAT BARRINGTON FIRE DISTRICT.

Green River.

Average of 6 samples collected in 1901.	.01	8.53	1.37	.0006	.0036	.0026	.0010	.11	.0408	.0000	.05	6.5	-
Average of 4 samples collected in 1900.	.00	7.41	1.11	.0005	.0028	.0024	.0004	.10	.0225	.0000	.07	5.6	-

Odor in March, 1901, unpleasant; in September, 1901, distinctly vegetable.

WATER SUPPLY OF GREENFIELD FIRE DISTRICT.

Glen Reservoir in Leyden.

Average of 4 samples collected in 1901.	.02	4.89	1.09	.0001	.0039	.0037	.0002	.13	.0132	.0000	.06	3.2	-
Average of two previous years,	.05	5.13	0.89	.0012	.0071	.0063	.0008	.11	.0086	.0000	.10	3.0	-

Odor in October, 1901, faintly vegetable, becoming stronger on heating.

WATER SUPPLY OF GROTON. — GROTON WATER COMPANY.

Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	4.00	-	.0002	.0010	-	-	.16	.0082	.0000	.01	2.0	.0050
Average of three previous years, .	.02	4.38	-	.0002	.0012	-	-	.17	.0072	.0000	.02	2.1	.0066

WATER SUPPLY OF HATFIELD.

Reservoir.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.19	3.82	1.29	.0046	.0069	.0060	.0009	.13	.0065	.0000	.40	1.5	-
Average of three previous years, .	.18	3.92	1.13	.0008	.0075	.0064	.0011	.12	.0050	.0000	.28	1.6	-

Odor in September, 1901, distinctly vegetable, becoming unpleasant on heating.

WATER SUPPLY OF HAVERHILL.

Crystal Lake.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.19	3.15	1.72	.0013	.0198	.0170	.0028	.22	.0020	.0000	.41	0.9	-
Average of eight previous years, .	.18	3.03	1.20	.0010	.0190	.0160	.0030	.27	.0022	.0000	.35	1.0	-

Odor in 1901, vegetable or unpleasant.

Kenoza Lake.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
January and October, 1901, . .	.04	3.92	1.60	.0012	.0167	.0152	.0015	.37	.0010	.0000	.24	2.0	-
Average of eight previous years, .	.09	3.69	1.11	.0010	.0167	.0150	.0017	.40	.0017	.0000	.25	1.7	-

Odor in 1901, vegetable or unpleasant.

Lake Saltonstall.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.04	6.54	2.06	.0019	.0184	.0148	.0036	.69	.0047	.0001	.31	3.3	-
Average of eight previous years, .	.08	5.55	1.36	.0022	.0170	.0151	.0019	.68	.0044	.0000	.22	2.4	-

Odor in 1901, generally unpleasant.

Lake Pentucket.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.03	3.60	1.34	.0010	.0165	.0146	.0019	.38	.0022	.0000	.22	1.7	-
Average of eight previous years, .	.07	3.84	1.21	.0007	.0192	.0172	.0020	.48	.0014	.0000	.25	1.6	-

Odor in 1901, occasionally faintly vegetable.

HAVERHILL.

Johnson's Pond in Boxford and Groveland.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as				
					Albuminoid.								
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.10	4.00	1.67	.0014	.0195	.0177	.0018	.32	.0030	.0000	.33	1.9	-
Average of five previous years, .	.15	4.15	1.30	.0008	.0186	.0166	.0020	.37	.0028	.0000	.32	2.0	-

In 1901, a vegetable odor was developed in all of the samples on heating.

Millvale Reservoir on East Meadow River.

Average of 4 samples collected in 1901.	.49	4.84	2.16	.0021	.0237	.0210	.0027	.30	.0040	.0000	.70	1.8	-
Average of five previous years, .	.62	4.73	1.94	.0009	.0217	.0194	.0023	.30	.0031	.0000	.70	1.6	-

Odor in 1901, vegetable or unpleasant.

Water Supply of Hingham. — Hingham Water Company.

Accord Pond.

Average of 13 samples collected in 1901.	.21	2.92	1.25	.0009	.0139	.0127	.0012	.58	.0027	.0000	.39	0.2	-
Average of eight previous years, .	.22	3.08	1.19	.0006	.0141	.0121	.0020	.64	.0034	.0000	.35	0.3	-

Odor in the first four and last two months of 1901, vegetable or unpleasant. The organism *Uroglena* was found in the samples collected in February and March, and the organism *Dinobryon* was found in large numbers in the sample collected in November.

Fulling Mill Pond.

Average of 5 samples collected in 1901.	.05	4.52	1.09	.0010	.0052	.0047	.0005	.76	.0134	.0000	.12	1.5	-
Average of eight previous years, .	.20	4.86	1.27	.0024	.0113	.0072	.0041	.72	.0143	.0000	.22	1.3	-

Odor in March and November, 1901, faintly vegetable.

Water Supply of Hinsdale Fire District.

Storage Reservoir.

February and April, 1901, . . .	.20	2.05	1.02	.0071	.0219	.0134	.0085	.06	.0065	.0000	.31	0.4	-
Average of eight previous years, .	.29	2.50	1.24	.0012	.0205	.0138	.0067	.06	.0016	.0000	.41	0.5	-

Odor in 1901, distinctly unpleasant, becoming stronger on heating. The organism *Peridinium* was found in both of the samples.

Water Supply of Holbrook.

(See *Randolph.*)

WATER SUPPLY OF HOLLISTON. — HOLLISTON WATER COMPANY.

Well and Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34574	Jan. 23	None.	None.	.23	4.50	.0006	.0110	.33	.0060	.0001	.25	1.6	.0100
35265	Mar. 27	V. slight.	V. slight.	.42	3.50	.0006	.0160	.23	.0080	.0000	.41	0.8	.0150
35801	May 29	V. slight.	Slight.	.52	3.50	.0004	.0160	.23	.0010	.0001	.58	0.8	.0110
36609	July 31	Slight.	V. slight.	.54	4.10	.0004	.0274	.23	.0010	.0000	.66	0.9	.0550
37399	Sept. 26	V. slight.	None.	.25	4.40	.0004	.0118	.24	.0040	.0001	.42	1.4	.0180
38157	Nov. 25	None.	None.	.22	3.20	.0002	.0082	.30	.0040	.0000	.20	1.3	.0150

Averages by Years.

Number.	Year.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1892	-	-	.05	4.16	.0001	.0043	.27	.0108	.0000	-	2.1	.0480
-	1894	-	-	.10	4.60	.0001	.0035	.32	.0155	.0001	.08	2.4	.0218
-	1895	-	-	.25	4.28	.0006	.0097	.31	.0117	.0000	.29	1.6	.0095
-	1896	-	-	.28	3.68	.0003	.0114	.28	.0052	.0000	.30	1.0	.0087
-	1897	-	-	.25	3.92	.0008	.0093	.33	.0103	.0000	.22	1.5	.0015
-	1898	-	-	.38	3.82	.0011	.0123	.28	.0045	.0000	.34	1.2	.0243
-	1899	-	-	.21	3.88	.0008	.0077	.26	.0043	.0000	.22	1.1	.0168
-	1900	-	-	.21	3.78	.0006	.0090	.28	.0042	.0001	.24	1.2	.0275
-	1901	-	-	.36	3.87	.0004	.0151	.26	.0040	.0000	.41	1.1	.0207

Odor in January, March and May, 1901, vegetable or unpleasant.

WATER SUPPLY OF HOLYOKE.

Whiting Street Storage Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.09	4.58	1.54	.0022	.0234	.0168	.0066	.11	.0020	.0001	.26	2.5	-
Average of ten previous years, .	.22	5.08	1.57	.0044	.0278	.0199	.0079	.18	.0072	.0001	.31	2.7	-

Odor in 1901, generally vegetable or unpleasant. Large numbers of organisms were found in all of the samples, consisting chiefly of *Synedra* and *Dinobryon*. In July a large number of the organism *Anabæna* was observed.

HOLYOKE.

Fomar Reservoir on Manhan River in Southampton.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.			
Average of 6 samples collected in 1901.	.21	3.66	1.29	.0020	.0115	.0087	.0028	.10	.0033	.0000	.34	1.4	-
Average of three previous years, .	.34	3.65	1.35	.0006	.0130	.0108	.0022	.10	.0023	.0000	.46	1.3	-

Odor in 1901, vegetable; in July, also unpleasant.

Wright and Ashley Ponds.

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.			
Average of 6 samples collected in 1901.	.11	4.34	1.53	.0025	.0185	.0148	.0037	.12	.0043	.0001	.29	2.1	-
Average of three previous years, .	.11	4.25	1.22	.0033	.0199	.0164	.0035	.12	.0038	.0001	.26	2.3	-

Odor in 1901, generally faintly vegetable, becoming stronger on heating; in July, faintly unpleasant. The organism *Aphanizomenon* was found in large numbers in the sample collected in July.

Water examined in Connection with Advice to the Chemical Paper Company. (See also page 24.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
36393	**1901.** July 17	Decided.	V. slight.	.15	13.00	.0138	.0034	.69	.1160	.0003	.11	7.6	.0780

The sample was collected from a tubular well on the premises of the Chemical Paper Company.

Water examined in Connection with Advice to the City Authorities. (See also page 25.)

34227	**1900.** Dec. 26	V. slight.	None.	.06	6.20	.0004	.0016	.16	.0700	.0000	.04	4.4	.0080

The sample was collected from a tap in Elmwood supplied from Crystal Spring.

HOLYOKE.

Waters examined in Connection with Advice to the City Authorities relative to Sources of Ice Supply. (See also page 105.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1900.														
34229	Dec. 26	V. slight.	None.	.09	4.10	1.25	.0014	.0090	.0072	.0018	.15	.0030	.0000	.25	2.1
34230	Dec. 26	Slight.	Slight.	.41	6.30	2.05	.0030	.0570	.0284	.0286	.16	.0030	.0001	.76	3.4

Odor of both samples, unpleasant.——The first sample was collected from Murray's ice pond, near Cherry Street; the last, from Haley's upper ice pond, near Cherry Street.

Water Supply of Hopedale.

(See *Milford*.)

Water Supply of Hopkinton.

Tubular Wells.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
					Albuminoid.								
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.			
Average of 6 samples collected in 1901.	.00	12.15	-	.0004	.0017	-	-	1.15	.3925	.0000	.01	4.8	.0065
Average of 5 samples collected in 1900.	.00	11.06	-	.0002	.0015	-	-	1.25	.3298	.0001	.02	4.6	.0182

Water Supply of Hudson.

Gates Pond in Berlin.

Average of 6 samples collected in 1901.	.03	2.42	1.00	.0039	.0157	.0141	.0016	.18	.0032	.0000	.19	0.6	-
Average of nine previous years, .	.05	2.40	0.94	.0025	.0158	.0134	.0024	.22	.0031	.0000	.18	0.7	-

Odor in 1901, occasionally faintly vegetable.

HUDSON.

Fosgate Brook in Berlin.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34453	Jan. 15	V. slight.	None.	0.60	4.65	1.65	.0010	.0182	.0174	.0008	.17	.0300	.0000	0.88	1.7
34871	Feb. 26	None.	V. slight.	0.80	5.40	2.50	.0040	.0226	.0216	.0010	.19	.0230	.0000	1.06	1.3
35195	Mar. 22	V. slight.	V. slight.	0.34	2.50	1.00	.0018	.0138	.0124	.0014	.15	.0150	.0000	0.33	1.0
35414	Apr. 16	V. slight.	V. slight.	0.22	3.05	1.00	.0010	.0076	.0068	.0008	.17	.0180	.0000	0.30	1.0
35693	May 15	V. slight.	V. slight.	0.30	2.95	1.15	.0010	.0126	.0112	.0014	.17	.0300	.0000	0.36	0.6
36152	June 27	V. slight.	Slight.	0.46	5.10	1.90	.0028	.0184	.0162	.0022	.28	.0740	.0002	0.52	1.7
37672	Oct. 22	V. slight.	V. slight.	0.34	5.35	1.95	.0006	.0160	.0138	.0022	.22	.0680	.0002	0.57	1.7
38004	Nov. 18	V. slight.	Slight.	1.70	6.00	2.60	.0042	.0426	.0412	.0014	.15	.0030	.0000	2.35	1.7
38356	Dec. 18	None.	V. slight.	0.76	3.85	1.60	.0008	.0184	.0152	.0032	.16	.0070	.0000	0.98	0.6

Averages by Years.

-	1899	-	-	0.31	3.66	1.26	.0030	.0125	.0106	.0019	.18	.0060	.0001	0.40	0.9
-	1900	-	-	0.36	4.03	1.51	.0011	.0145	.0133	.0012	.20	.0179	.0000	0.49	1.0
-	1901	-	-	0.61	4.32	1.71	.0019	.0189	.0173	.0016	.18	.0298	.0000	0.82	1.3

Odor in 1901, generally vegetable and occasionally unpleasant.

Water Supply of Hull.

(See *Hingham.*)

Water Supply of Huntington Fire District.

Cold Brook Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.21	3.24	1.22	.0009	.0081	.0077	.0004	.09	.0045	.0000	.37	0.9	-
Average of two previous years, .	.14	3.24	1.01	.0010	.0097	.0085	.0012	.12	.0028	.0000	.27	0.9	-

Odor in September, 1901, vegetable.

HYDE PARK AND MILTON.

Water Supply of Hyde Park and Milton. — Hyde Park Water Company.

Tubular Wells near the Neponset River.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
34518	Jan. 21	V. slight.	Slight.	.11	10.30	.0160	.0048	1.76	.0880	.0002	.08	5.1	.0120
34858	Feb. 25	V. slight.	V. slight.	.08	12.60	.0144	.0042	1.73	.1360	.0008	.09	4.6	.0220
35230	Mar. 25	V. slight.	Slight.	.02	10.70	.0098	.0046	1.28	.1350	.0002	.03	4.7	.0200
35468	Apr. 22	None.	None.	.01	8.10	.0070	.0042	0.94	.1250	.0002	.08	3.5	.0100
35727	May 20	None.	V. slight.	.02	8.90	.0096	.0046	0.97	.1060	.0001	.05	3.6	.0060
36099	June 24	Slight.	Cons.	.07	12.50	.0138	.0052	1.05	.0940	.0006	.11	5.0	.0980
36439	July 22	None.	None.	.00	11.30	.0208	.0044	1.15	.1400	.0001	.13	4.7	.0120
36943	Aug. 26	V. slight.	Slight.	.00	11.60	.0190	.0056	1.02	.1000	.0005	.09	4.3	.0150
37311	Sept. 23	None.	Slight.	.04	12.30	.0212	.0066	1.20	.0960	.0003	.06	4.7	.0420
37639	Oct. 21	Slight.	Cons.	.09	11.40	.0222	.0082	1.39	.0960	.0002	.07	4.7	.0800
38100	Nov. 25	Slight.	Slight.	.15	10.80	.0184	.0060	1.40	.0880	.0003	.09	4.3	.0280
38425	Dec. 23	V. slight.	Slight.	.11	11.00	.0162	.0078	1.21	.0880	.0004	.06	4.7	.0800

Averages by Years.

-	1893	-	-	.02	8.62	.0031	.0032	1.19	.0879	.0002	.10	3.7	.0112
-	1894	-	-	.03	9.68	.0040	.0039	1.37	.0843	.0001	.09	3.9	.0175
-	1895	-	-	.04	9.44	.0063	.0035	1.31	.0867	.0001	.09	4.0	.0149
-	1896	-	-	.03	9.68	.0084	.0046	1.21	.0882	.0008	.11	4.1	.0141
-	1897	-	-	.04	9.94	.0093	.0037	1.30	.1170	.0002	.08	4.2	.0089
-	1898	-	-	.08	10.28	.0120	.0046	1.17	.1271	.0003	.12	4.4	.0113
-	1899	-	-	.04	10.39	.0122	.0041	1.24	.1043	.0002	.10	4.2	.0107
-	1900	-	-	.05	11.04	.0153	.0043	1.54	.1085	.0002	.10	4.6	.0340
-	1901	-	-	.05	10.96	.0157	.0055	1.26	.1077	.0003	.08	4.5	.0312

For the results of examinations of water from the Neponset River opposite the wells of the Hyde Park Water Company, see "Neponset River" in the chapter on the Examination of Rivers.

HYDE PARK AND MILTON.

Tubular Wells near Mother Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34519	Jan. 21	None.	None.	.04	8.20	.0008	.0036	0.93	.2450	.0000	.08	2.6	.0070
34859	Feb. 25	None.	None.	.00	9.00	.0004	.0026	1.04	.2600	.0000	.04	2.7	.0070
35231	Mar. 25	None.	None.	.00	9.60	.0008	.0032	1.01	.3000	.0003	.05	4.0	.0060
35469	Apr. 22	None.	None.	.00	9.80	.0006	.0028	1.14	.4400	.0002	.06	3.9	.0060
35728	May 20	None.	None.	.00	11.50	.0026	.0022	1.18	.5000	.0002	.01	4.4	.0040
36100	June 24	None.	None.	.00	10.30	.0010	.0018	0.89	.2900	.0004	.08	4.2	.0050
36438	July 22	None.	None.	.00	8.40	.0012	.0048	0.77	.1700	.0002	.13	3.6	.0090
36944	Aug. 26	None.	None.	.04	8.00	.0008	.0060	0.69	.0960	.0005	.14	2.9	.0100
37312	Sept. 23	None.	None.	.01	8.00	.0006	.0092	0.72	.1340	.0002	.09	3.3	.0070
37640	Oct. 21	None.	None.	.03	7.50	.0000	.0068	0.81	.1500	.0000	.10	3.1	.0060
38101	Nov. 25	None.	V. slight.	.01	8.40	.0004	.0044	0.85	.2000	.0000	.08	3.4	.0050
38426	Dec. 23	None.	None.	.02	9.70	.0026	.0034	1.03	.2900	.0001	.06	3.8	.0090
Av.	....	....	....	.01	9.03	.0010	.0042	0.92	.2562	.0002	.08	3.5	.0067

Water Supply of Ipswich.

Dow's Brook at Entrance to Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34430	Jan. 10	None.	V. slight.	0.10	4.60	1.15	.0004	.0058	.0054	.0004	.45	.0050	.0001	0.22	1.8
35159	Mar. 19	V. slight.	Slight.	0.50	4.75	1.75	.0008	.0162	.0136	.0026	.44	.0050	.0000	0.68	1.4
35424	Apr. 16	V. slight.	Slight.	0.43	3.85	1.80	.0006	.0098	.0090	.0008	.42	.0050	.0000	0.52	1.0
35691	May 14	V. slight.	Slight.	0.84	4.15	1.90	.0010	.0188	.0170	.0018	.44	.0010	.0000	0.80	0.8
36047	June 18	V. slight.	Slight.	0.25	4.00	1.50	.0008	.0086	.0076	.0010	.49	.0020	.0001	0.25	1.6
36372	July 15	V. slight.	Slight.	0.21	4.55	1.40	.0060	.0208	.0176	.0032	.44	.0030	.0000	0.43	1.6
36846	Aug. 20	V. slight.	Slight.	0.11	4.30	1.30	.0000	.0076	.0062	.0014	.42	.0030	.0002	0.18	2.2
37321	Sept. 24	None.	Slight.	0.11	5.00	1.65	.0010	.0096	.0082	.0014	.39	.0030	.0001	0.23	2.5
37595*	Oct. 15	V. slight.	V. slight.	1.40	9.20	4.50	.0048	.0424	.0396	.0028	.82	.0040	.0000	2.48	3.1
38111	Nov. 23	None.	V. slight	0.18	4.40	1.60	.0000	.0058	.0052	.0006	.49	.0010	.0000	0.31	2.0
38352	Dec. 17	V. slight.	V. slight.	0.42	5.05	1.85	.0008	.0126	.0120	.0006	.53	.0070	.0001	0.58	1.6

Averages by Years.

-	1895	-	-	0.47	4.74	1.62	.0005	.0129	.0111	.0018	.61	.0042	.0001	0.45	1.6
-	1896	-	-	0.38	4.45	1.39	.0009	.0122	.0105	.0017	.57	.0045	.0000	0.46	1.7
-	1897	-	-	0.44	4.66	1.62	.0022	.0131	.0112	.0019	.55	.0065	.0000	0.40	1.7
-	1898	-	-	0.63	4.25	1.78	.0007	.0183	.0134	.0049	.47	.0029	.0000	0.59	1.3
-	1899	-	-	0.28	5.00	1.52	.0004	.0121	.0098	.0023	.49	.0056	.0000	0.37	1.6
-	1901	-	-	0.41	4.90	1.85	.0015	.0144	.0129	.0015	.48	.0035	.0001	0.61	1.8

Odor in 1901, generally vegetable, becoming stronger on heating.

* This sample was collected after a very heavy rainfall.

IPSWICH.

Dow's Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34431	Jan. 10	None.	V. slight.	.25	5.15	1.75	.0050	.0202	.0186	.0016	.62	.0100	.0001	.55	2.0
34432	Jan. 10	None.	V. slight.	.38	5.75	1.75	.0052	.0154	.0140	.0014	.65	.0130	.0001	.46	2.1
34809	Feb. 18	V. slight.	V. slight.	.25	5.20	1.40	.0036	.0188	.0172	.0016	.71	.0160	.0000	.33	2.0
35160	Mar. 19	Decided.	Cons.	.34	3.95	1.40	.0024	.0232	.0172	.0060	.40	.0080	.0001	.60	1.0
35425	Apr. 16	Slight.	Slight.	.43	4.35	1.75	.0024	.0122	.0104	.0018	.45	.0180	.0000	.52	1.0
35692	May 14	V. slight.	Cons.	.40	4.65	2.05	.0030	.0186	.0162	.0024	.50	.0070	.0001	.52	1.1
36048	June 18	Slight.	Slight.	.36	4.25	1.60	.0040	.0154	.0128	.0026	.53	.0030	.0001	.45	1.4
36373	July 15	V. slight.	V. slight.	.20	4.50	1.50	.0042	.0176	.0162	.0014	.45	.0010	.0000	.41	1.6
36847	Aug. 20	V. slight.	V. slight.	.18	4.80	1.75	.0004	.0252	.0236	.0016	.48	.0050	.0001	.39	1.8
37216	Sept. 13	V. slight.	Slight.	.11	5.40	2.45	.0002	.0170	.0136	.0034	.55	.0040	.0000	.39	1.8
37250	Sept. 18	V. slight.	Slight.	.12	5.10	2.35	.0012	.0224	.0180	.0044	.56	.0020	.0000	.41	2.0
37322	Sept. 24	V. slight.	Slight.	.10	5.30	2.10	.0010	.0224	.0168	.0056	.45	.0010	.0000	.36	2.2
37369	Sept. 25	V. slight.	Slight.	.11	4.60	1.95	.0006	.0230	.0206	.0024	.46	.0020	.0001	.36	1.8
37421	Sept. 30	Slight.	Slight.	.14	4.60	2.00	.0016	.0292	.0264	.0028	.47	.0010	.0000	.40	2.0
37495	Oct. 7	None.	V. slight.	.14	4.50	1.85	.0010	.0236	.0226	.0010	.47	.0020	.0000	.40	2.1
37582	Oct. 14	V. slight.	Slight.	.14	4.65	2.05	.0006	.0214	.0200	.0014	.56	.0020	.0000	.39	2.0
37648	Oct. 21	Slight.	Slight.	.17	4.45	2.10	.0010	.0248	.0218	.0030	.59	.0010	.0002	.37	2.0
37754	Oct. 28	Slight.	Cons.	.17	4.90	2.15	.0010	.0252	.0198	.0054	.57	.0020	.0001	.41	1.8
37831	Nov. 4	V. slight.	V. slight.	.15	4.35	1.55	.0020	.0248	.0232	.0016	.58	.0020	.0001	.45	1.8
37894	Nov. 9	V. slight.	V. slight.	.13	4.35	1.60	.0006	.0222	.0184	.0038	.59	.0020	.0001	.38	1.6
37991	Nov. 15	V. slight.	V. slight.	.12	4.60	1.75	.0014	.0210	.0184	.0026	.60	.0050	.0000	.39	2.0
38353	Dec. 17	V. slight.	Slight.	.28	5.40	2.30	.0020	.0198	.0182	.0016	.63	.0080	.0001	.46	1.7

Averages by Years.

-	1895	-	-	.45	5.25	1.89	.0022	.0194	.0169	.0025	.76	.0072	.0001	.50	1.9
-	1896	-	-	.32	4.60	1.54	.0017	.0178	.0147	.0031	.67	.0058	.0001	.41	1.7
-	1897	-	-	.33	4.64	1.64	.0023	.0196	.0169	.0027	.62	.0058	.0000	.39	1.6
-	1898	-	-	.46	4.74	1.79	.0020	.0191	.0160	.0031	.55	.0048	.0001	.49	1.5
-	1899	-	-	.17	4.23	1.44	.0011	.0204	.0180	.0024	.48	.0034	.0000	.36	1.4
-	1900	-	-	.29	4.68	1.34	.0024	.0230	.0204	.0026	.54	.0060	.0001	.47	1.5
-	1901	-	-	.26	4.72	1.78	.0025	.0198	.0173	.0025	.53	.0070	.0001	.45	1.6

Odor in 1901, generally faintly vegetable, becoming stronger on heating. The odor of No. 34431 was distinctly unpleasant; of No. 35160, faintly vegetable, becoming unpleasant on heating.

IPSWICH.

Bull Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
35158	Mar. 19	V. slight.	Slight.	1.02	6.50	3.00	.0022	.0266	.0242	.0024	.52	.0090	.0001	1.22	2.0
35423	Apr. 16	V. slight.	Slight.	1.20	5.25	2.55	.0020	.0232	.0214	.0018	.49	.0050	.0000	1.14	1.6
35690	May 14	V. slight.	Slight.	1.90	5.85	3.15	.0048	.0348	.0314	.0034	.52	.0030	.0000	1.52	1.4
36046	June 18	Slight.	Cons.	2.04	6.95	3.50	.0026	.0296	.0266	.0030	.62	.0060	.0001	1.56	2.1
36371	July 15	V. slight.	V. slight.	1.40	8.25	3.70	.0026	.0322	.0302	.0020	.55	.0070	.0000	1.46	2.3
36845	Aug. 20	V. slight.	V. slight.	0.35	7.10	2.00	.0002	.0126	.0110	.0016	.57	.0050	.0002	0.44	2.6
37320	Sept. 24	None.	V. slight.	0.73	7.70	3.00	.0014	.0202	.0170	.0032	.58	.0060	.0001	0.78	3.0
37594	Oct. 15	V. slight	Slight.	2.10	9.50	5.00	.0075	.0525	.0495	.0030	.87	.0160	.0000	2.72	3.1
38112	Nov. 23	V. slight.	V. slight.	0.78	7.65	3.50	.0044	.0224	.0200	.0024	.76	.0050	.0000	1.02	2.5
38351	Dec. 17	V. slight.	V. slight.	1.96	7.90	4.40	.0030	.0376	.0356	.0020	.67	.0160	.0000	2.02	1.7

Averages by Years.

-	1896	-	-	1.23	6.96	2.80	.0010	.0252	.0227	.0025	.74	.0075	.0001	1.28	2.4
-	1897	-	-	1.44	6.87	2.99	.0018	.0258	.0247	.0011	.72	.0068	.0001	1.11	2.3
-	1901	-	-	1.35	7.26	3.38	.0031	.0292	.0267	.0025	.61	.0078	.0000	1.39	2.2

Odor in 1901, generally vegetable, becoming stronger on heating. The odor of No. 36046 was distinctly vegetable, becoming unpleasant on heating; of No. 36845, distinctly unpleasant.

Water Supply of Kingston.

Tubular Wells.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.			
Average of 6 samples collected in 1901.	.00	4.55	-	.0003	.0010	-	-	.74	.0065	.0000	.02	0.9	.0050

Water Supply of Lancaster.

(See *Clinton.*)

Water Supply of Lawrence.

Merrimack River above Lawrence.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34552	Jan. 23	V. slight.	Slight.	.26	4.40	1.50	.0134	.0208	.0180	.0028	.28	.0150	.0002	0.49	1.4
34872	Feb. 26	Slight.	V. slight.	.21	4.25	1.40	.0216	.0234	.0192	.0042	.31	.0150	.0003	0.38	1.4
35236	Mar. 26	Decided.	Cons.	.42	3.35	1.25	.0048	.0238	.0182	.0056	.16	.0110	.0000	0.55	0.8
35485	Apr. 23	Decided.	Cons.	.34	2.75	1.35	.0014	.0210	.0182	.0028	.13	.0050	.0000	0.54	0.8
35738	May 21	Decided.	Cons.	.54	3.50	1.70	.0014	.0222	.0176	.0046	.12	.0050	.0001	0.64	0.8
36134	June 26	Slight.	Cons.	.30	4.10	1.40	.0058	.0214	.0142	.0072	.32	.0100	.0004	0.46	1.4
36453	July 23	Slight.	Cons.	.26	4.40	1.55	.0056	.0376	.0238	.0138	.24	.0090	.0003	0.54	1.8
36988	Aug. 28	Slight.	Cons.	.40	4.45	2.00	.0136	.0252	.0192	.0060	.29	.0060	.0013	0.79	1.6
37375	Sept. 25	Slight.	Cons.	.32	5.10	2.05	.0106	.0246	.0206	.0040	.29	.0050	.0011	0.43	1.7
37700	Oct. 28	Slight.	Cons.	.85	5.25	2.60	.0076	.0332	.0242	.0090	.25	.0030	.0003	1.01	1.1
38144	Nov. 27	Slight.	Cons.	.50	5.10	1.80	.0170	.0258	.0210	.0048	.32	.0090	.0004	0.67	1.4
38482	Dec. 26	Slight.	Slight.	.56	4.65	2.15	.0074	.0216	.0170	.0046	.19	.0050	.0001	0.75	1.1

Averages by Years.

-	1888	-	-	.30	3.68	1.08	.0026	.0180	-	-	.18	.0094	.0002	-	-
-	1889	-	-	.30	3.09	0.87	.0080	.0176	.0144	.0032	.17	.0072	.0003	-	-
-	1890	-	-	.33	4.19	1.48	.0046	.0166	.0132	.0034	.17	.0089	.0001	-	1.6
-	1891	-	-	.27	3.79	1.32	.0040	.0152	.0121	.0031	.18	.0110	.0001	-	1.3
-	1892	-	-	.43	4.12	1.47	.0042	.0181	.0152	.0029	.18	.0105	.0001	-	1.4
-	1893	-	-	.42	3.86	1.48	.0057	.0181	.0141	.0040	.20	.0081	.0002	.53	1.1
-	1894	-	-	.37	3.70	1.30	.0062	.0167	.0141	.0026	.23	.0063	.0001	.44	1.2
-	1895	-	-	.51	4.34	1.75	.0064	.0249	.0185	.0064	.28	.0071	.0002	.59	1.4
-	1896	-	-	.42	3.98	1.52	.0068	.0220	.0183	.0037	.24	.0087	.0003	.53	1.2
-	1897	-	-	.56	3.84	1.54	.0049	.0228	.0186	.0042	.20	.0067	.0001	.54	1.1
-	1898	-	-	.45	3.90	1.63	.0050	.0212	.0169	.0043	.22	.0058	.0003	.53	1.1
-	1899	-	-	.29	3.99	1.49	.0088	.0232	.0175	.0057	.24	.0056	.0003	.47	1.0
-	1900	-	-	.30	3.96	1.38	.0089	.0224	.0180	.0044	.25	.0060	.0002	.50	1.1
-	1901	-	-	.41	4.27	1.73	.0092	.0251	.0193	.0058	.24	.0082	.0004	.60	1.3

Odor in 1901, unpleasant, becoming stronger on heating.

Merrimack River after Filtration.

	1901.														
34553	Jan. 23	None.	V. slight.	.35	4.85	1.35	.0162	.0104	.0100	.0004	.31	.0490	.0000	.39	1.8
34873	Feb. 26	V. slight.	V. slight.	.34	4.90	1.75	.0176	.0106	.0106	.0000	.40	.0460	.0002	.30	1.8
35237	Mar. 26	Slight.	V. slight.	.49	4.25	1.40	.0136	.0122	.0118	.0004	.24	.0400	.0000	.42	1.4
35486	Apr. 23	V. slight.	None.	.36	3.40	1.50	.0084	.0106	.0098	.0008	.16	.0370	.0000	.40	1.0
35739	May 21	V. slight.	V. slight.	.51	3.90	1.85	.0110	.0100	.0090	.0010	.20	.0400	.0000	.42	1.4
36135	June 26	Slight.	Cons.	.28	4.15	1.55	.0052	.0102	.0074	.0028	.32	.0420	.0001	.28	1.7
36454	July 23	V. slight.	None.	.22	4.60	1.50	.0062	.0046	.0042	.0004	.29	.0270	.0000	.36	1.8
36989	Aug. 28	Decided.	Cons.	.30	4.65	1.55	.0248	.0120	.0076	.0044	.27	.0110	.0006	.55	2.0
37401	Sept. 28	V. slight.	V. slight.	.28	5.05	1.75	.0054	.0110	.0094	.0016	.31	.0140	.0001	.49	2.0
37701	Oct. 28	V. slight.	V. slight.	.70	5.15	2.20	.0092	.0172	.0168	.0004	.25	.0090	.0000	.62	1.6
38145	Nov. 27	V. slight.	None.	.35	5.35	1.85	.0152	.0100	.0090	.0010	.34	.0290	.0000	.36	1.8
38483	Dec. 26	V. slight.	V. slight.	.65	4.85	2.00	.0104	.0142	.0132	.0010	.22	.0310	.0001	.59	1.6

LAWRENCE.

Merrimack River after Filtration — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
-	1894	-	-	.39	6.10	1.41	.0103	.0094	.0081	.0013	.30	.0309	.0002	.29	2.8
-	1895	-	-	.50	5.95	1.70	.0146	.0108	.0094	.0014	.31	.0274	.0001	.36	2.7
-	1896	-	-	.40	5.43	1.64	.0121	.0099	.0079	.0020	.25	.0319	.0004	.32	2.4
-	1897	-	-	.56	5.17	1.68	.0123	.0108	.0095	.0013	.25	.0317	.0002	.38	2.0
-	1898	-	-	.43	4.66	1.69	.0107	.0090	.0084	.0006	.26	.0324	.0001	.35	1.9
-	1899	-	-	.27	4.44	1.42	.0087	.0089	.0083	.0006	.28	.0205	.0001	.30	1.6
-	1900	-	-	.28	4.30	1.28	.0123	.0108	.0099	.0009	.27	.0173	.0001	.35	1.5
-	1901	-	-	.40	4.59	1.69	.0119	.0111	.0099	.0012	.28	.0312	.0001	.43	1.7

Odor in 1901, occasionally faintly vegetable; in January and February, faintly unpleasant.

Distributing Reservoir.

	1901.														
34554	Jan. 23	V. slight.	V. slight.	.26	4.85	1.40	.0098	.0136	.0114	.0022	.32	.0310	.0000	.37	1.7
34874	Feb. 26	V. slight.	V. slight.	.28	4.60	1.60	.0118	.0120	.0114	.0006	.37	.0380	.0001	.29	1.4
35238	Mar. 26	Slight.	V. slight.	.33	4.35	1.40	.0088	.0122	.0120	.0002	.27	.0360	.0000	.40	1.4
35487	Apr. 23	Decided.	Slight.	.31	3.40	1.30	.0064	.0106	.0098	.0008	.18	.0200	.0001	.34	1.3
35740	May 21	V. slight.	Slight.	.31	4.00	1.90	.0036	.0124	.0114	.0010	.18	.0400	.0000	.38	1.1
36136	June 26	V. slight.	V. slight.	.22	4.10	1.90	.0018	.0090	.0086	.0004	.24	.0410	.0001	.28	1.4
36455	July 23	V. slight.	V. slight.	.20	4.75	1.50	.0036	.0134	.0108	.0026	.30	.0290	.0002	.35	2.1
36990	Aug. 28	V. slight	Slight.	.24	4.60	1.90	.0028	.0104	.0100	.0004	.27	.0120	.0006	.51	1.8
37376	Sept. 25	V. slight.	Slight.	.27	4.55	1.75	.0036	.0132	.0110	.0022	.29	.0110	.0007	.38	1.8
37702	Oct. 23	V. slight.	V. slight	.30	4.85	1.95	.0014	.0120	.0112	.0008	.28	.0080	.0000	.54	1.8
38146	Nov. 27	V. slight.	V. slight.	.33	5.25	1.80	.0052	.0114	.0104	.0010	.30	.0190	.0000	.42	1.7
38484	Dec. 26	Slight.	Slight.	.46	4.80	1.90	.0100	.0142	.0126	.0016	.24	.0280	.0001	.46	1.6

Averages by Years.

-	1894	-	-	.26	5.07	1.35	.0029	.0093	.0081	.0012	.28	.0246	.0001	.31	2.2
-	1895	-	-	.29	5.01	1.55	.0051	.0109	.0093	.0016	.30	.0220	.0001	.34	2.1
-	1896	-	-	.29	4.52	1.49	.0035	.0113	.0087	.0026	.24	.0259	.0001	.32	1.9
-	1897	-	-	.37	4.45	1.53	.0051	.0104	.0089	.0015	.22	.0274	.0001	.34	1.7
-	1898	-	-	.35	4.20	1.56	.0048	.0120	.0096	.0024	.24	.0225	.0001	.34	1.7
-	1899	-	-	.19	4.22	1.42	.0035	.0098	.0090	.0008	.27	.0199	.0001	.27	1.4
-	1900	-	-	.22	4.22	1.25	.0041	.0107	.0100	.0007	.28	.0189	.0001	.32	1.4
-	1901	-	-	.29	4.51	1.69	.0057	.0120	.0109	.0011	.27	.0261	.0002	.39	1.6

Odor in 1901, occasionally faintly vegetable; in February, faintly unpleasant, becoming stronger on heating.

LAWRENCE.

Waters examined in Connection with Advice to Corporations. (See also pages 25, 26.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
L. 29260	Dec. 10	V. slight.	Slight.	.12	9.20	.0002	.0010	0.25	.0320	.0000	.03	2.0	.0800
	1901.												
L. 30490	July 1	None.	V. slight.	.05	7.80	.0004	.0040	0.27	.0760	.0000	.04	2.5	.0145
L. 30682	Aug. 5	None.	None.	.04	14.70	.0000	.0016	3.36	.2110	.0002	.00	2.5	.0120
L. 30726	Aug. 12	None.	V. slight.	.04	14.70	.0000	.0018	3.36	.1670	.0002	.00	2.5	.0120
37364	Sept. 25	None.	None.	.00	6.50	.0000	.0012	0.48	.0110	.0000	.04	2.3	.0060
37313	Sept. 23	V. slight.	V. slight.	.00	14.00	.0036	.0016	0.33	.0000	.0000	.05	3.1	.0240

Odor of No. 37313, decidedly unpleasant.——The first five samples were collected from a well on the premises of the Atlantic Cotton Mill; the last, from a tubular well on the premises of the Hamblet Machine Company. Number of bacteria per cubic centimeter in No. 29260, 53; in No. 30490, 84; in No. 30682, 38; in No. 30726, 7.

Water Supply of Lee. — Berkshire Water Company.

Upper Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Suspended.						
Average of 3 samples collected in 1901.	.32	2.92	1.37	.0085	.0226	.0181	.0045	.12	.0037	.0001	.58	0.5	-
Average of three previous years, .	.41	2.68	1.53	.0030	.0354	.0264	.0090	.08	.0019	.0000	.69	0.4	-

Odor in 1901, faintly vegetable, becoming stronger and occasionally unpleasant on heating.

Lower Reservoir.

Average of 3 samples collected in 1901.	.21	3.72	1.47	.0008	.0095	.0088	.0007	.09	.0040	.0003	.40	1.8	-
Average of three previous years, .	.32	3.29	1.46	.0008	.0146	.0131	.0015	.06	.0054	.0000	.51	1.4	-

Odor in 1901, occasionally faintly vegetable.

Water Supply of Leicester Water Supply District.

Wells.

Average of 4 samples collected in 1901.	.01	4.90	-	.0006	.0024	-	-	.20	.0965	.0000	.03	2.1	.0052
Average of nine previous years, .	.15	5.43	-	.0006	.0036	-	-	.24	.0641	.0001	.14	2.1	.0127

LENOX.

WATER SUPPLY OF LENOX. — LENOX WATER COMPANY. (See also page 26.)

Storage Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 5 samples collected in 1901.	.06	8.11	1.54	.0017	.0141	.0116	.0025	.09	.0048	.0001	.18	6.4	-
Average of three previous years, .	.06	7.89	0.97	.0018	.0125	.0107	.0018	.09	.0036	.0000	.16	5.7	-

Odor in August, 1901, faintly unpleasant, becoming stronger on heating.

Water examined in Connection with Advice to the Town Authorities. (See also page 28.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
37707	Oct. 22	V. slight.	Slight.	.03	14.10	4.90	.0052	.0210	.0180	.0030	.19	.0000	.0002	.22	12.1

The sample was collected from Laurel Lake, near its outlet.

WATER SUPPLY OF LEOMINSTER.

Haynes Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.17	2.27	1.11	.0106	.0308	.0224	.0084	.12	.0027	.0000	.38	0.2	-
Average of nine previous years, .	.26	2.55	1.40	.0050	.0370	.0222	.0148	.14	.0035	.0000	.38	0.3	-

Odor in 1901, vegetable, becoming stronger and occasionally unpleasant on heating. Large numbers of organisms were found in all of the samples, consisting chiefly of *Asterionella, Tabellaria, Dinobryon* and *Peridinium*.

Morse Reservoir.

Average of 4 samples collected in 1901.	.17	2.27	1.17	.0059	.0177	.0149	.0028	.12	.0032	.0001	.36	0.0	-
Average of eight previous years, .	.30	2.39	1.16	.0027	.0209	.0161	.0048	.14	.0025	.0000	.41	0.7	-

Odor in 1901, generally faintly vegetable, becoming stronger and occasionally unpleasant on heating.

LEOMINSTER.

Fall Brook, above Fall Brook Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34577	Jan. 23	None.	V. slight.	.28	2.80	1.15	.0018	.0098	.0088	.0010	.17	.0060	.0000	0.45	0.5
34893	Feb. 27	None.	V. slight	.30	2.85	1.00	.0002	.0088	.0084	.0004	.15	.0040	.0000	0.41	0.2
35262	Mar. 27	V. slight.	Slight.	.36	2.35	0.95	.0040	.0154	.0136	.0018	.13	.0080	.0000	0.55	0.3
35506	Apr. 24	V. slight.	V. slight.	.41	2.25	1.00	.0010	.0134	.0124	.0010	.14	.0030	.0000	0.54	0.3
35778	May 27	V. slight.	V. slight	.57	2.20	1.05	.0010	.0150	.0140	.0010	.12	.0020	.0001	0.65	0.3
36082	June 21	Slight.	Slight.	.20	2.10	1.00	.0002	.0196	.0156	.0040	.12	.0010	.0000	0.44	0.5
36594	July 31	V. slight	V. slight.	.72	4.40	2.50	.0018	.0220	.0204	.0016	.08	.0020	.0000	1.19	0.3
36982	Aug. 28	V. slight.	Slight.	.09	2.15	0.95	.0012	.0308	.0284	.0024	.10	.0010	.0001	0.31	0.3
37360	Sept. 25	V. slight	Cons.	.18	2.65	1.00	.0004	.0220	.0194	.0026	.11	.0020	.0000	0.38	0.3
37776	Oct. 30	V. slight.	V. slight.	.32	2.95	1.30	.0000	.0108	.0104	.0004	.18	.0010	.0000	0.54	0.3
38163	Nov. 28	None.	V. slight.	.36	3.95	1.60	.0004	.0116	.0102	.0014	.25	.0040	.0000	0.60	0.5
38450	Dec. 25	Slight.	Slight.	.51	2.85	1.35	.0000	.0158	.0144	.0014	.18	.0050	.0000	0.49	0.3

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Free.	Alb. Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1897	-	-	.61	3.01	1.49	.0006	.0135	.0126	.0009	.16	.0041	.0000	0.60	0.5
-	1898	-	-	.46	2.54	1.30	.0005	.0129	.0114	.0015	.13	.0035	.0000	0.50	0.6
-	1899	-	-	.20	2.45	1.03	.0006	.0151	.0129	.0022	.14	.0017	.0000	0.38	0.2
-	1900	-	-	.26	2.47	1.08	.0006	.0157	.0138	.0019	.15	.0026	.0000	0.48	0.2
-	1901	-	-	.35	2.79	1.24	.0010	.0163	.0147	.0016	.14	.0032	.0000	0.55	0.3

Odor in 1901, frequently faintly vegetable, becoming stronger on heating.

Fall Brook Reservoir, at Surface.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Free.	Alb. Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34578	Jan. 23	None.	V. slight.	.15	2.25	1.20	.0024	.0146	.0140	.0006	.16	.0030	.0000	.40	0.5
34894	Feb. 27	V. slight.	V. slight.	.10	2.35	1.15	.0012	.0164	.0132	.0032	.16	.0010	.0000	.31	0.2
35263	Mar. 27	V. slight	Slight.	.14	2.15	0.85	.0010	.0162	.0124	.0038	.16	.0030	.0000	.34	0.5
35507	Apr. 24	Slight.	Cons.	.14	2.00	0.90	.0014	.0170	.0130	.0040	.12	.0040	.0000	.36	0.0
35754	May 22	V. slight.	Cons.	.14	2.05	1.05	.0004	.0134	.0100	.0034	.12	.0010	.0000	.31	0.0
36083	June 21	Slight.	Cons.	.17	2.00	1.00	.0002	.0170	.0118	.0052	.12	.0000	.0000	.42	0.2
36595	July 31	Slight.	Slight.	.07	2.50	0.95	.0004	.0154	.0124	.0030	.10	.0010	.0000	.36	0.2
36983	Aug. 28	V. slight.	Slight.	.09	2.15	1.10	.0002	.0144	.0102	.0042	.10	.0010	.0000	.37	0.3
37361	Sept. 25	V. slight.	Cons.	.11	2.00	1.00	.0000	.0178	.0140	.0038	.10	.0020	.0000	.28	0.5
37777	Oct. 30	V. slight.	Cons.	.09	1.80	0.80	.0002	.0170	.0136	.0034	.10	.0020	.0000	.24	0.5
38164	Nov. 28	V. slight.	Slight.	.10	2.15	1.00	.0002	.0160	.0154	.0006	.14	.0100	.0000	.25	0.2
38451	Dec. 25	V. slight.	V. slight.	.12	2.00	0.90	.0016	.0146	.0124	.0022	.14	.0020	.0001	.25	0.0

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Free.	Alb. Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1897	-	-	.36	2.96	1.39	.0026	.0200	.0160	.0040	.20	.0033	.0000	.45	0.6
-	1898	-	-	.26	2.35	1.16	.0011	.0169	.0139	.0030	.16	.0037	.0001	.35	0.5
-	1899	-	-	.11	1.95	0.92	.0007	.0161	.0133	.0028	.13	.0015	.0000	.26	0.2
-	1900	-	-	.09	1.99	0.87	.0009	.0163	.0136	.0027	.13	.0027	.0000	.30	0.1
-	1901	-	-	.12	2.12	0.99	.0008	.0158	.0127	.0031	.13	.0025	.0000	.32	0.3

Odor in 1901, frequently faintly vegetable or unpleasant, becoming stronger on heating. The organism *Uroglena* was found in the samples collected in March, April, May and June; *Peridinium* in the samples collected during the first seven months of the year; and *Dinobryon* in the samples collected during the latter part of the year.

LEOMINSTER.

Fall Brook Reservoir, at Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34579	Jan. 23	V. slight.	Cons.	.10	2.25	1.20	.0028	.0212	.0126	.0086	.16	.0030	.0000	.35	0.2
34895	Feb. 27	Slight.	Cons.	.10	2.25	1.00	.0014	.0172	.0124	.0048	.17	.0030	.0000	.29	0.2
35264	Mar. 27	Slight.	Cons.	.13	2.35	1.00	.0008	.0198	.0140	.0058	.17	.0080	.0000	.35	0.2
35508	Apr. 24	Slight.	Cons.	.13	2.00	0.95	.0014	.0170	.0128	.0042	.12	.0030	.0000	.35	0.2
35755	May 22	Decided.	Cons.	.15	2.00	1.00	.0010	.0198	.0114	.0084	.12	.0010	.0000	.33	0.2
36084	June 21	Slight.	Cons.	.19	2.10	1.10	.0030	.0254	.0176	.0078	.13	.0010	.0000	.42	0.2
36596	July 31	Decided.	Heavy.	.19	2.50	1.05	.0025	.0250	.0180	.0070	.11	.0020	.0000	.35	0.2
36984	Aug. 28	Slight.	Cons.	.10	2.30	1.10	.0064	.0172	.0128	.0044	.12	.0020	.0000	.34	0.2
37362	Sept. 25	V. slight.	Cons.	.12	1.90	0.90	.0020	.0150	.0110	.0040	.10	.0010	.0001	.40	0.2
37778	Oct. 30	V. slight.	Cons.	.09	2.05	1.00	.0004	.0176	.0152	.0024	.10	.0010	.0000	.29	0.5
38165	Nov. 28	Slight.	Slight.	.09	2.10	1.05	.0010	.0222	.0148	.0074	.13	.0020	.0000	.22	0.0
38452	Dec. 25	Decided.	Cons.	.37	2.20	1.10	.0052	.0436	.0148	.0288	.15	.0040	.0000	.58	0.2

Averages by Years.

-	1897	-	-	.45	3.48	1.47	.0078	.0216	.0170	.0046	.20	.0043	.0001	.45	1.0
-	1898	-	-	.26	2.35	1.20	.0015	.0168	.0139	.0029	.16	.0040	.0000	.34	0.5
-	1899	-	-	.11	2.01	0.97	.0013	.0168	.0140	.0028	.13	.0023	.0000	.28	0.2
-	1900	-	-	.10	1.97	0.84	.0009	.0167	.0130	.0037	.13	.0020	.0000	.32	0.1
-	1901	-	-	.15	2.17	1.04	.0023	.0217	.0139	.0078	.13	.0026	.0000	.36	0.2

Odor in 1901, generally faintly vegetable or unpleasant, becoming stronger on heating.

Water Supply of Lexington.

Waters examined in Connection with Advice relative to Additional Water Supply.
(See also pages 29, 30.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
36034	June 17	None.	None.	.00	17.80	.0044	.0032	1.89	.7600	.0001	.02	6.1	.0090
36035	June 17	None.	V. slight.	.00	17.70	.0044	.0024	1.87	.6000	.0001	.02	6.1	.0100
37106	Sept. 5	None.	V. slight.	.04	10.90	.0020	.0018	0.64	.0010	.0000	.14	5.0	.0200
37876	Nov. 6	None.	V. slight.	.02	9.50	.0078	.0024	0.48	.0010	.0004	.04	4.9	.0150
37886	Nov. 7	V. slight.	Slight.	.02	10.50	.0068	.0018	0.50	.0010	.0003	.02	4.9	.0200
37891	Nov. 8	None.	V. slight.	.01	9.10	.0070	.0010	0.51	.0010	.0001	.05	4.7	.0200
37904	Nov. 9	None.	V. slight.	.01	9.40	.0072	.0020	0.53	.0010	.0001	.02	4.9	.0170
37920	Nov. 11	None.	V. slight.	.01	9.40	.0072	.0008	0.55	.0020	.0001	.02	5.0	.0150
37941	Nov. 12	None.	V. slight.	.01	9.60	.0066	.0024	0.52	.0010	.0001	.01	5.0	.0180
37972	Nov. 14	None.	None.	.00	10.00	.0058	.0010	0.52	.0010	.0000	.01	5.0	.0130
37986	Nov. 15	None.	None.	.01	10.40	.0078	.0010	0.54	.0010	.0001	.02	5.1	.0080
37989	Nov. 16	Decided.	Cons.	-	22.50	.0062	.0030	0.79	.0010	.0000	.53	6.0	.1500

The first two samples were collected from tubular test wells near the upper end of Munroe Meadow; the third, from a tubular test well in the meadow of M. H. Roberts, near Beaver Brook; the remaining samples from a group of tubular test wells in Roberts Meadow, near Beaver Brook, during a pumping test.

Water Supply of Lincoln.

(See *Concord.*)

Water Supply of Longmeadow.

Cooley Brook.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Sus-pended.						
Average of 4 samples collected in 1901.	.05	4.72	1.21	.0018	.0051	.0041	.0010	.18	.0227	.0001	.09	2.4	-
Average of three previous years, .	.07	4.76	1.09	.0013	.0044	.0038	.0006	.17	.0350	.0001	.10	2.6	-

Odor in September and December, 1901, vegetable.

Water Supply of Lowell.

Merrimack River above Lowell.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
	1901.														
34570	Jan. 22	Slight.	Slight.	.24	4.30	1.50	.0114	.0194	.0150	.0044	.25	.0050	.0001	.44	1.3
34878	Feb. 26	Slight.	Slight.	.19	4.30	1.50	.0118	.0228	.0190	.0038	.27	.0110	.0002	.34	1.3
35248	Mar. 26	Decided.	Cons.	.36	3.40	1.40	.0036	.0232	.0200	.0032	.15	.0080	.0000	.64	0.6
35509	Apr. 23	Decided.	Cons.	.33	2.60	1.25	.0012	.0160	.0120	.0040	.10	.0070	.0001	.50	0.3
35745	May 21	Decided.	Cons.	.58	3.40	1.50	.0010	.0214	.0168	.0046	.10	.0050	.0001	.70	0.6
36117	June 25	Slight.	Cons.	.29	3.70	1.85	.0048	.0202	.0152	.0050	.20	.0050	.0002	.56	1.0
36449	July 22	Slight.	Cons.	.23	4.25	1.60	.0048	.0232	.0176	.0056	.19	.0050	.0001	.54	1.3
37001	Aug. 28	Decided.	Cons.	.42	4.25	2.15	.0036	.0208	.0178	.0030	.21	.0010	.0002	.86	1.3
37389	Sept. 25	V. slight.	Slight.	.27	4.65	2.10	.0072	.0174	.0164	.0010	.17	.0050	.0003	.71	1.3
37712	Oct. 23	Slight.	Slight.	.76	4.65	2.50	.0048	.0254	.0214	.0040	.18	.0020	.0003	.98	1.1
38141	Nov. 28	Slight.	Slight.	.31	4.40	1.70	.0106	.0180	.0150	.0030	.25	.0070	.0002	.52	1.1
38458	Dec. 24	Slight.	Slight.	.54	4.10	1.40	.0070	.0212	.0178	.0034	.20	.0140	.0000	.72	0.6

Averages by Years.

-	1888	-	-	.30	3.42	0.97	.0016	.0148	-	-	.16	.0099	.0002	-	-
-	1889	-	-	.28	2.95	0.84	.0018	.0149	.0126	.0023	.14	.0071	.0002	-	-
-	1890	-	-	.30	3.57	1.54	.0014	.0128	.0104	.0024	.13	.0111	.0001	-	1.4
-	1891	-	-	.29	3.43	1.23	.0017	.0129	.0100	.0029	.13	.0137	.0001	-	1.2
-	1892	-	-	.39	3.61	1.36	.0021	.0141	.0113	.0028	.14	.0092	.0001	-	1.3
-	1893	-	-	.33	3.39	1.18	.0026	.0149	.0120	.0029	.17	.0083	.0001	.44	1.1
-	1894	-	-	.35	3.55	1.26	.0034	.0135	.0109	.0026	.18	.0063	.0001	.40	1.1
-	1895	-	-	.41	3.84	1.46	.0039	.0187	.0140	.0047	.21	.0066	.0001	.54	1.2
-	1896	-	-	.40	3.47	1.28	.0034	.0167	.0136	.0031	.17	.0070	.0001	.52	1.0
-	1897	-	-	.50	3.54	1.46	.0030	.0177	.0153	.0024	.15	.0067	.0001	.52	1.0
-	1898	-	-	.42	3.53	1.56	.0026	.0173	.0150	.0023	.17	.0048	.0001	.49	1.0
-	1899	-	-	.27	3.60	1.42	.0050	.0187	.0152	.0035	.18	.0060	.0002	.42	0.9
-	1900	-	-	.27	3.55	1.27	.0052	.0197	.0154	.0043	.19	.0049	.0002	.47	1.1
-	1901	-	-	.38	4.00	1.70	.0060	.0207	.0170	.0037	.19	.0062	.0001	.63	1.0

Odor in 1901, generally vegetable or unpleasant, becoming stronger on heating.

LOWELL.

Tubular Wells in the Valley of River Meadow Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
34572	Jan. 22	Slight.	Cons.	.14	9.80	.0046	.0062	.50	.0380	.0000	.09	3.5	.0780
34880	Feb. 26	None.	V. slight.	.00	8.50	.0016	.0036	.57	.0760	.0000	.08	3.6	.0110
35250	Mar. 26	V. slight	Slight.	.07	9.20	.0054	.0048	.48	.0400	.0001	.09	4.0	.0250
35511	Apr. 23	V. slight.	V. slight.	.08	8.00	.0044	.0052	.48	.0410	.0001	.09	3.8	.0250

Averages by Years.

-	1894	-	-	.02	7.33	.0003	.0014	.55	.0549	.0002	.02	2.8	.0078
-	1895	-	-	.02	9.22	.0001	.0024	.56	.0323	.0002	.05	3.8	.0119
-	1896	-	-	.02	8.37	.0002	.0035	.53	.0507	.0000	.09	3.8	.0068
-	1897	-	-	.02	8.71	.0008	.0035	.55	.0378	.0001	.08	3.7	.0041
-	1898	-	-	.06	9.02	.0002	.0038	.56	.0392	.0000	.10	3.9	.0056
-	1899	-	-	.08	8.55	.0020	.0045	.47	.0248	.0000	.12	3.4	.0139
-	1900	-	-	.05	8.86	.0025	.0047	.49	.0340	.0000	.11	3.6	.0247
-	1901	-	-	.07	8.87	.0040	.0049	.51	.0487	.0000	.09	3.7	.0347

The samples represent a mixture of water from the "Cook" wells with water from the "Hydraulic" wells.

Tubular Wells in the Valley of the Merrimack River, near the Pawtucket Boulevard.

	1901.												
34571	Jan. 22	None.	Slight.	.06	4.80	.0064	.0040	.26	.0140	.0001	.07	2.0	.0230
34879	Feb. 26	None.	V. slight.	.00	4.40	.0034	.0020	.29	.0240	.0000	.05	2.1	.0160
35249	Mar. 26	None.	V. slight.	.00	4.70	.0040	.0032	.29	.0270	.0000	.05	2.3	.0250
35510	Apr. 23	None.	V. slight.	.02	3.90	.0052	.0028	.25	.0170	.0002	.07	2.0	.0380
35746	May 21	None.	V. slight	.00	4.30	.0034	.0022	.26	.0220	.0000	.02	1.8	.0210
36118	June 25	None.	V. slight.	.01	3.60	.0052	.0032	.20	.0190	.0000	.06	1.4	.0250
36451	July 22	None.	V. slight.	.00	4.00	.0034	.0030	.24	.0100	.0001	.08	1.7	.0300
37002	Aug. 28	V. slight.	V. slight.	.05	3.30	.0036	.0034	.20	.0070	.0001	.14	1.4	.0480
37390	Sept. 25	V. slight.	V. slight.	.02	4.70	.0020	.0034	.22	.0070	.0001	.10	1.6	.0180
37713	Oct. 23	V. slight.	V. slight	.04	4.00	.0036	.0042	.23	.0020	.0003	.08	1.7	.0210
38142	Nov. 28	V. slight.	Slight.	.02	4.60	.0036	.0026	.26	.0100	.0001	.08	1.6	.0160
38459	Dec. 24	V. slight.	Slight.	.06	4.50	.0058	.0038	.28	.0170	.0000	.07	1.8	.0310

Averages by Years.

-	1896	-	-	.01	4.36	.0044	.0019	.30	.0452	.0001	.04	1.8	.0098
-	1897	-	-	.09	4.55	.0096	.0032	.24	.0255	.0001	.05	1.8	.0222
-	1898	-	-	.13	4.43	.0105	.0030	.27	.0247	.0000	.08	1.9	.0310
-	1899	-	-	.13	4.56	.0103	.0034	.28	.0203	.0001	.08	1.7	.0388
-	1900	-	-	.10	4.29	.0089	.0043	.26	.0149	.0001	.10	1.6	.0591
-	1901	-	-	.02	4.23	.0041	.0031	.25	.0147	.0001	.07	1.8	.0260

LOWELL.

Pumping Station No 1.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34881	Feb. 26	V. slight.	V. slight.	.00	4.70	.0026	.0026	.31	.0320	.0000	.06	2.0	.0090
35747	May 21	V. slight.	Slight.	.01	4.20	.0018	.0022	.31	.0640	.0001	.02	2.3	.0220
36119	June 25	None.	None.	.00	4.90	.0028	.0016	.23	.0380	.0000	.07	1.6	.0140
36450	July 22	None.	V. slight.	.00	4.20	.0022	.0032	.26	.0130	.0002	.07	1.4	.0210
37003	Aug. 28	V. slight.	V. slight.	.02	3.60	.0014	.0028	.23	.0160	.0001	.08	1.7	.0180
37391	Sept. 25	None.	V. slight.	.01	4.40	.0048	.0046	.24	.0180	.0001	.06	1.6	.0070
37714	Oct. 23	None.	V. slight.	.01	4.20	.0018	.0036	.25	.0080	.0003	.09	1.8	.0110
38143	Nov. 28	V. slight.	V. slight.	.01	4.00	.0014	.0024	.28	.0200	.0000	.09	1.7	.0090
38460	Dec. 24	None.	V. slight.	.02	4.60	.0040	.0032	.29	.0230	.0000	.06	1.8	.0070

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1899	-	-	.12	4.81	.0077	.0036	.30	.0312	.0001	.08	1.8	.0272
-	1900	-	-	.08	4.37	.0063	.0042	.27	.0252	.0002	.09	1.8	.0373
-	1901	-	-	.01	4.31	.0025	.0029	.27	.0258	.0001	.07	1.8	.0181

The samples represent water from the "Boulevard" wells.

Water Supply of Ludlow.

(See *Springfield.*)

Water Supply of Lynn and Saugus.

Breed's Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34380	Jan. 8	V. slight.	Slight.	.30	3.90	1.40	.0062	.0232	.0188	.0044	.59	.0110	.0001	.55	1.1
34733	Feb. 12	V. slight.	V. slight.	.30	4.30	1.75	.0082	.0204	.0184	.0020	.62	.0130	.0000	.46	1.0
35067	Mar. 12	Slight.	Slight.	.27	4.25	1.15	.0096	.0204	.0170	.0034	.59	.0040	.0000	.47	1.6
35358	Apr. 9	Slight.	Cons.	.38	3.65	1.65	.0046	.0250	.0206	.0044	.46	.0050	.0001	.51	1.1
35623	May 7	Slight.	Cons.	.41	3.75	1.50	.0042	.0204	.0172	.0032	.44	.0010	.0000	.51	1.1
35991	June 11	Slight.	Cons.	.59	3.75	1.50	.0044	.0232	.0188	.0044	.44	.0020	.0000	.70	0.8
36330	July 9	V. slight.	V. slight.	.43	3.75	1.75	.0030	.0192	.0172	.0020	.45	.0010	.0001	.61	1.0
36794	Aug. 14	V. slight.	Slight.	.35	3.80	1.60	.0116	.0308	.0208	.0100	.40	.0010	.0000	.55	1.3
37206	Sept. 12	V. slight.	V. slight.	.33	3.70	1.75	.0008	.0212	.0196	.0016	.45	.0020	.0001	.46	1.4
37522	Oct. 8	V. slight.	Slight.	.44	3.35	1.40	.0028	.0258	.0230	.0028	.41	.0030	.0001	.45	0.8
37974	Nov. 13	Slight.	V. slight.	.46	3.45	1.35	.0044	.0256	.0216	.0040	.46	.0050	.0000	.51	0.8
38274	Dec. 10	V. slight.	V. slight.	.50	3.90	1.75	.0020	.0270	.0216	.0054	.47	.0020	.0000	.52	0.6
Av...	....	....	....	.40	3.80	1.55	.0051	.0235	.0195	.0040	.48	.0042	.0000	.52	1.0
Average of ten previous years,			.	.44	3.60	1.41	.0024	.0205	.0174	.0031	.51	.0037	.0001	.49	0.9

Odor in 1901, generally faintly vegetable, occasionally unpleasant, becoming stronger on heating. —— The samples collected during the spring and summer months contained a large number of organisms, consisting chiefly of *Asterionella*, *Tabellaria* and *Dinobryon*. The organism *Uroglena* was found in the sample collected in April.

LYNN AND SAUGUS.

Birch Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34732	Feb. 12	V. slight.	Slight.	.55	7.05	2.90	.0252	.0312	.0286	.0026	.69	.0190	.0000	.83	2.2
35066	Mar. 12	Slight.	Cons.	.34	6.10	1.75	.0218	.0276	.0234	.0042	.57	.0050	.0001	.58	2.2
35357	Apr. 9	Decided.	Cons.	.24	4.10	1.75	-	-	-	-	.45	.0080	.0001	.39	1.4
35622	May 7	Slight.	Cons.	.24	3.65	1.50	.0028	.0228	.0170	.0058	.45	.0070	.0001	.50	1.1
35990	June 11	Slight.	Cons.	.27	3.30	1.40	.0060	.0326	.0276	.0050	.47	.0040	.0001	.44	0.8
36329	July 9	V. slight.	Slight.	.22	3.80	1.70	.0026	.0208	.0168	.0040	.50	.0020	.0001	.44	1.3
36793	Aug. 14	V. slight.	Slight.	.46	4.35	2.10	.0072	.0332	.0236	.0096	.45	.0020	.0000	.60	1.6
37521	Oct. 8	Decided.	Slight.	.42	3.55	1.75	.0050	.0300	.0246	.0054	.35	.0040	.0001	.55	1.0
37978	Nov. 13	Slight.	Cons.	.36	3.55	1.50	.0026	.0482	.0370	.0112	.42	.0030	.0000	.57	0.6
38273	Dec. 10	Slight.	Slight.	.34	3.50	1.60	.0008	.0302	.0228	.0074	.37	.0010	.0001	.47	0.5
Av...	....	....	....	.34	4.29	1.79	.0082	.0307	.0246	.0061	.47	.0055	.0001	.53	1.3
Average of ten previous years, .				.48	4.15	1.65	.0080	.0262	.0212	.0050	.54	.0057	.0001	.41	1.1

Odor in 1901, generally faintly vegetable, frequently unpleasant, becoming stronger on heating. The samples contained a large number of organisms, consisting chiefly of *Asterionella*, *Cyclotella*, *Tabellaria* and *Dinobryon*. The organism *Synura* was found in the samples collected in March, April and May, and *Uroglena* in the samples collected during the latter part of the year.

Walden Pond.

	1901.														
34384	Jan. 8	Slight.	Slight.	.48	4.05	1.80	.0008	.0360	.0256	.0104	.51	.0040	.0000	.81	0.9
34737	Feb. 12	Slight.	Slight.	.40	3.90	1.85	.0012	.0330	.0232	.0098	.51	.0050	.0000	.72	0.8
35071	Mar. 12	Slight.	Cons.	.36	3.90	1.30	.0020	.0372	.0236	.0136	.44	.0020	.0000	.65	0.6
35362	Apr. 9	Slight.	Cons.	.36	3.40	1.75	.0006	.0280	.0208	.0072	.37	.0050	.0000	.61	0.5
35627	May 7	Decided.	Cons.	.32	3.05	1.40	.0010	.0272	.0216	.0056	.36	.0020	.0000	.52	0.3
35995	June 11	Decided.	Cons.	.31	3.30	1.35	.0016	.0262	.0196	.0066	.38	.0020	.0000	.53	0.8
36334	July 9	Decided.	Slight.	.35	3.30	1.65	.0032	.0280	.0240	.0040	.38	.0020	.0001	.58	0.3
36798	Aug. 14	V. slight.	Cons.	.39	3.15	1.55	.0116	.0340	.0192	.0148	.37	.0010	.0000	.50	0.6
37210	Sept. 12	Slight.	Cons.	.41	4.10	1.95	.0088	.0264	.0240	.0024	.38	.0020	.0001	.47	0.8
37526	Oct. 8	Slight.	Cons.	.21	2.95	1.90	.0036	.0360	.0296	.0064	.35	.0030	.0001	.51	0.6
37977	Nov. 13	V. slight.	Slight.	.25	2.75	1.25	.0006	.0342	.0236	.0106	.35	.0020	.0000	.52	0.6
38277	Dec. 10	Slight.	Cons.	.19	3.20	1.25	.0006	.0280	.0172	.0108	.28	.0000	.0000	.36	0.2

Averages by Years.

-	1890	-	-	1.06	4.98	2.53	.0292	.0432	.0351	.0081	.34	.0057	.0001	-	1.1
-	1891	-	-	1.21	4.32	2.20	.0058	.0615	.0403	.0212	.34	.0091	.0001	-	0.7
-	1892	-	-	0.90	4.81	2.50	.0094	.0626	.0383	.0243	.41	.0116	.0001	-	0.6
-	1893	-	-	0.92	4.33	2.40	.0066	.0470	.0309	.0161	.44	.0047	.0001	.80	0.7
-	1896	-	-	0.68	3.45	1.57	.0031	.0296	.0255	.0041	.40	.0017	.0000	.76	0.5
-	1897	-	-	0.77	4.03	1.88	.0040	.0355	.0282	.0073	.45	.0044	.0001	.67	0.8
-	1898	-	-	0.63	3.57	1.81	.0010	.0298	.0248	.0050	.39	.0031	.0000	.66	0.6
-	1899	-	-	0.50	3.20	1.58	.0038	.0337	.0266	.0071	.34	.0023	.0000	.62	0.5
-	1900	-	-	0.42	3.50	1.54	.0039	.0307	.0237	.0070	.40	.0032	.0001	.59	0.5
-	1901	-	-	0.34	3.42	1.58	.0030	.0312	.0227	.0085	.39	.0025	.0000	.56	0.6

Odor in 1901, generally distinctly disagreeable or unpleasant. All of the samples contained a large number of organisms, consisting chiefly of *Asterionella*, *Melosira*, *Synedra*, *Tabellaria*, *Dinobryon* *Peridinium* and *Chlamydomonas*.

LYNN AND SAUGUS.

Glen Lewis Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34381	Jan. 8	V. slight.	V. slight.	.24	3.55	1.85	.0052	.0368	.0296	.0072	.42	.0020	.0000	.65	0.8
34734	Feb. 12	Slight.	Slight.	.33	4.15	2.25	.0280	.0310	.0240	.0070	.48	.0050	.0000	.52	0.6
35068	Mar. 12	Decided.	Cons.	.53	3.95	1.50	.0440	.0400	.0272	.0128	.45	.0020	.0000	.63	0.6
35359	Apr. 9	Slight.	Cons.	.23	2.90	1.55	.0046	.0190	.0142	.0048	.33	.0050	.0000	.31	0.3
35624	May 7	Decided.	Cons.	.14	3.15	1.10	.0030	.0258	.0206	.0052	.36	.0030	.0000	.26	0.6
35994	June 11	Decided.	Cons.	.22	2.50	1.00	.0044	.0256	.0202	.0054	.36	.0010	.0000	.31	0.8
36331	July 9	Decided.	Cons.	.23	3.00	1.40	.0012	.0284	.0186	.0098	.35	.0020	.0001	.34	0.8
36795	Aug. 14	Slight.	Cons.	.32	3.30	1.80	.0140	.0464	.0376	.0088	.35	.0020	.0000	.45	0.6
37207	Sept 12	V. slight.	Slight.	.46	3.55	1.85	.0020	.0252	.0216	.0036	.40	.0020	.0001	.45	1.1
37523	Oct. 8	Slight.	Cons.	.30	2.95	1.80	.0012	.0340	.0176	.0164	.35	.0020	.0001	.34	0.5

Averages by Years.

-	1890	-	-	.76	4.84	2.21	.0412	.0445	.0327	.0118	.36	.0063	.0001	-	1.0
-	1891	-	-	.63	3.90	1.75	.0328	.0484	.0324	.0160	.34	.0124	.0002	-	0.6
-	1892	-	-	.62	3.95	1.95	.0127	.0475	.0332	.0143	.40	.0193	.0002	-	0.6
-	1893	-	-	.64	3.81	2.14	.0112	.0729	.0329	.0400	.42	.0040	.0002	.60	0.6
-	1894	-	-	.85	3.81	1.89	.0107	.0495	.0297	.0198	.44	.0023	.0001	.69	0.5
-	1895	-	-	.42	3.77	1.65	.0053	.0381	.0246	.0135	.50	.0035	.0001	.54	0.7
-	1896	-	-	.36	3.74	1.91	.0068	.0567	.0306	.0261	.43	.0039	.0001	.47	0.4
-	1897	-	-	.42	3.80	2.20	.0084	.0460	.0384	.0076	.49	.0125	.0003	.58	0.9
-	1898	-	-	.40	3.63	1.73	.0066	.0393	.0264	.0129	.40	.0030	.0000	.46	0.5
-	1899	-	-	.24	3.55	1.78	.0035	.0417	.0268	.0149	.33	.0019	.0000	.46	0.4
-	1900	-	-	.21	3.31	1.57	.0034	.0427	.0253	.0174	.38	.0016	.0000	.47	0.4
-	1901	-	-	.30	3.30	1.61	.0108	.0312	.0231	.0081	.38	.0026	.0000	.43	0.5

Odor in 1901, generally distinctly unpleasant. All of the samples contained a large number of organisms, consisting chiefly of *Asterionella*, *Melosira*, *Clathrocystis*, *Dinobryon* and *Peridinium*. The organism *Anabæna* was found in the samples collected in June, July, August and September, and *Uroglena* in the samples collected in January, February, March and April.

Hawkes Pond.

	1901.														
34382	Jan. 8	V. slight.	Slight.	.50	5.95	2.25	.0042	.0308	.0292	.0016	.62	.0090	.0000	.77	2.5
34735	Feb. 12	V. slight.	V. slight.	.51	7.00	2.95	.0052	.0328	.0296	.0032	.69	.0120	.0000	.81	3.1
35069	Mar. 12	Decided.	Cons.	.70	6.65	2.30	.0124	.0424	.0336	.0088	.56	.0060	.0002	.93	2.5
35360	Apr. 9	Slight.	Cons.	.55	5.30	2.50	.0038	.0304	.0230	.0074	.50	.0120	.0001	.71	2.0
35625	May 7	Slight.	Cons.	.54	4.55	2.10	.0024	.0226	.0204	.0022	.46	.0080	.0000	.52	2.1
35992	June 11	Slight.	Slight.	.58	4.20	2.05	.0040	.0270	.0244	.0026	.45	.0030	.0000	.75	1.3
36332	July 9	V. slight.	V. slight.	.43	4.50	2.15	.0026	.0302	.0232	.0070	.45	.0020	.0002	.69	1.3
36796	Aug. 14	V. slight.	Slight.	.34	4.20	2.05	.0140	.0288	.0232	.0056	.40	.0010	.0000	.68	1.7
37208	Sept. 12	V. slight.	Slight.	.30	4.15	1.90	.0006	.0258	.0232	.0026	.41	.0010	.0001	.55	1.3
37524	Oct. 8	V. slight.	V. slight.	.53	7.85	3.30	.0038	.0264	.0258	.0006	.78	.0050	.0001	.77	3.6
37975	Nov. 13	V. slight.	V. slight.	.24	3.90	1.90	.0012	.0232	.0216	.0016	.43	.0010	.0000	.51	1.4
38275	Dec. 10	V. slight.	V. slight.	.26	4.10	1.80	.0034	.0204	.0164	.0040	.42	.0020	.0000	.51	1.4

Averages by Years.

-	1897	-	-	.54	4.64	1.85	.0024	.0242	.0204	.0038	.53	.0098	.0001	.59	1.6
-	1898	-	-	.51	4.02	1.80	.0016	.0227	.0189	.0038	.43	.0044	.0001	.57	1.2
-	1899	-	-	.28	4.10	1.72	.0025	.0259	.0213	.0046	.39	.0043	.0000	.50	1.3
-	1900	-	-	.37	4.85	1.83	.0040	.0297	.0243	.0054	.51	.0040	.0001	.64	1.7
-	1901	-	-	.46	5.20	2.27	.0048	.0284	.0245	.0039	.51	.0052	.0001	.68	2.0

Odor in 1901, generally vegetable, occasionally unpleasant, becoming stronger on heating. The organism *Dinobryon* was found in considerable numbers in the samples collected in March and August; *Synura* was present in the samples collected in July and September.

LYNN AND SAUGUS.

Saugus River, at Montrose.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34385	Jan. 8	None.	V. slight.	1.40	12.15	4.80	.0060	.0530	.0520	.0010	0.97	.0080	.0000	1.88	4.4
34738	Feb. 12	V. slight.	V. slight.	1.00	11.35	4.75	.0088	.0448	.0408	.0040	1.14	.0100	.0001	1.53	4.6
35072	Mar. 12	Decided.	Cons.	0.61	5.00	1.60	.0086	.0432	.0300	.0132	0.44	.0050	.0001	0.88	1.8
35364	Apr. 9	Slight.	Cons.	0.98	5.55	2.65	.0048	.0344	.0284	.0060	0.45	.0050	.0000	0.89	2.3
35629	May 7	V. slight.	Cons.	1.18	6.40	3.25	.0032	.0376	.0336	.0040	0.71	.0050	.0000	1.19	2.5
35996	June 11	V. slight.	Slight.	1.45	7.50	3.50	.0044	.0394	.0374	.0020	0.72	.0090	.0000	1.45	3.0
36335	July 9	V. slight.	Slight.	0.72	7.80	3.55	.0046	.0330	.0312	.0018	0.71	.0070	.0005	1.02	3.0
36799	Aug. 14	None.	V. slight.	0.68	7.50	3.20	.0012	.0356	.0300	.0056	0.69	.0030	.0001	0.90	3.0
37212	Sept. 12	V. slight.	V. slight.	0.44	7.80	3.15	.0028	.0286	.0208	.0078	0.69	.0010	.0002	0.73	3.0
37527	Oct. 8	Slight.	Slight.	0.28	4.15	2.10	.0012	.0250	.0236	.0014	0.39	.0020	.0001	0.50	1.4
37978	Nov. 13	None.	V. slight.	1.15	8.00	4.00	.0040	.0436	.0408	.0028	0.71	.0020	.0000	1.26	3.3
38279	Dec. 10	V. slight.	V. slight.	1.20	10.35	5.10	.0028	.0522	.0480	.0042	0.80	.0100	.0009	1.64	3.8

Averages by Years.

-	1898	-	-	0.97	7.55	3.36	.0043	.0380	.0321	.0059	0.65	.0026	.0001	1.04	3.0
-	1899	-	-	0.51	7.30	2.67	.0045	.0264	.0234	.0030	0.61	.0091	.0002	0.67	3.2
-	1900	-	-	0.64	7.26	2.69	.0055	.0306	.0278	.0028	0.63	.0064	.0002	0.84	3.3
-	1901	-	-	0.92	7.80	3.47	.0044	.0392	.0347	.0045	0.70	.0056	.0002	1.16	3.0

Odor in 1901, generally vegetable, occasionally faintly unpleasant, becoming stronger on heating.

Saugus River, at Howlett's Dam, Saugus.

	1901.														
34383	Jan. 8	V. slight.	V. slight.	1.00	11.35	4.10	.0198	.0364	.0340	.0024	1.30	.0820	.0010	1.13	4.0
34736	Feb. 12	Slight.	V. slight.	0.61	10.50	3.80	.0308	.0280	.0268	.0012	1.28	.0780	.0008	0.88	4.4
35070	Mar. 12	Decided.	Heavy.	-	6.15	1.60	.0676	.0600	.0236	.0364	0.57	.0090	.0006	1.01	1.8
35361	Apr. 9	Slight.	Slight.	0.95	6.55	3.40	.0040	.0308	.0254	.0054	0.52	.0240	.0003	0.88	2.1
35626	May 7	V. slight.	Slight.	1.16	7.20	3.50	.0032	.0332	.0304	.0028	0.74	.0150	.0003	1.12	2.6
35993	June 11	V. slight.	Slight.	1.50	8.20	3.75	.0106	.0456	.0424	.0032	0.81	.0090	.0003	1.48	3.0
36333	July 9	Slight.	Slight.	0.75	8.90	3.35	.0098	.0358	.0336	.0022	0.91	.0060	.0006	0.89	3.8
36797	Aug. 14	V. slight.	Slight.	0.82	9.90	4.30	.0168	.0484	.0448	.0036	0.98	.0120	.0001	1.18	4.0
37209	Sept. 12	V. slight.	Slight.	0.51	9.60	3.75	.0060	.0368	.0288	.0080	1.44	.0010	.0001	0.75	4.2
37525	Oct. 8	V. slight.	V. slight.	0.48	10.85	4.35	.0070	.0322	.0296	.0026	1.82	.0160	.0004	0.71	4.3
37976	Nov. 13	None.	V. slight.	0.53	12.00	4.50	.0250	.0306	.0288	.0018	2.10	.0780	.0045	0.80	5.1
38276	Dec. 10	V. slight.	V. slight.	0.80	10.10	4.60	.0252	.0316	.0298	.0018	1.40	.0750	.0032	1.04	4.3

Averages by Years.

-	1894	-	-	1.16	8.68	3.36	.0056	.0310	.0272	.0038	1.03	.0112	.0014	0.95	3.5
-	1895	-	-	1.29	8.33	3.62	.0064	.0381	.0349	.0032	0.94	.0125	.0003	1.31	3.1
-	1896	-	-	0.94	7.50	2.92	.0058	.0343	.0304	.0039	0.86	.0163	.0004	0.93	2.7
-	1897	-	-	1.09	7.74	3.08	.0050	.0337	.0317	.0020	0.84	.0110	.0002	1.00	3.1
-	1898	-	-	0.90	7.41	3.11	.0043	.0321	.0295	.0026	0.84	.0164	.0002	0.88	2.8
-	1899	-	-	0.57	8.42	2.69	.0376	.0340	.0256	.0084	1.10	.0171	.0011	0.65	3.2
-	1900	-	-	0.63	8.51	2.82	.0192	.0336	.0290	.0046	1.07	.0232	.0008	0.78	3.6
-	1901	-	-	0.83	9.27	3.75	.0188	.0374	.0315	.0059	1.16	.0337	.0010	0.99	3.6

Odor in 1901, generally distinctly vegetable, occasionally unpleasant.

LYNN AND SAUGUS.

Faucet in Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34386	Jan. 8	V. slight.	V. slight.	.70	7.35	2.80	.0046	.0314	.0280	.0034	.67	.0140	.0000	1.95	3.3
34739	Feb. 12	V. slight.	V. slight.	.64	7.70	3.25	.0044	.0302	.0292	.0010	.75	.0110	.0000	1.01	3.3
35073	Mar. 12	Decided.	Cons.	.70	7.90	2.40	.0082	.0330	.0300	.0030	.75	.0110	.0001	0.94	3.3
35368	Apr. 9	Slight.	Slight.	.45	5.35	2.45	.0014	.0222	.0198	.0024	.51	.0100	.0001	0.63	2.1
35628	May 7	Decided.	Cons.	.31	3.10	1.10	.0010	.0186	.0142	.0044	.45	.0050	.0000	0.54	1.3
35997	June 11	Slight.	Slight.	.27	4.00	1.75	.0024	.0202	.0168	.0034	.44	.0050	.0000	0.43	1.1
36336	July 9	V. slight.	V. slight.	.24	4.25	1.65	.0006	.0182	.0162	.0020	.45	.0030	.0001	0.40	1.1
36800	Aug. 14	V. slight.	V. slight.	.35	4.30	1.80	.0100	.0216	.0188	.0028	.44	.0020	.0001	0.46	1.6
37211	Sept. 12	V. slight.	V. slight.	.57	4.30	1.75	.0010	.0226	.0198	.0028	.44	.0020	.0001	0.50	1.3
37528	Oct. 8	Slight.	V. slight.	.38	4.35	2.35	.0026	.0250	.0236	.0014	.35	.0040	.0003	0.42	1.1
37979	Nov. 13	V. slight.	V. slight.	.34	3.25	1.25	.0014	.0288	.0222	.0066	.35	.0040	.0000	0.50	0.6
38278	Dec. 10	V. slight.	V. slight.	.35	3.50	1.50	.0010	.0266	.0248	.0018	.41	.0010	.0000	0.54	0.5

Averages by Years.

Number.	Year.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1894	-	-	.76	4.60	1.95	.0023	.0216	.0194	.0022	.57	.0065	.0001	0.62	1.3
-	1895	-	-	.78	5.12	2.14	.0017	.0225	.0195	.0030	.65	.0102	.0001	0.84	1.7
-	1896	-	-	.54	4.41	1.79	.0015	.0217	.0179	.0038	.51	.0063	.0001	0.58	1.3
-	1897	-	-	.53	4.88	1.75	.0012	.0206	.0179	.0027	.59	.0079	.0001	0.51	1.8
-	1898	-	-	.45	3.75	1.55	.0007	.0173	.0159	.0014	.46	.0047	.0000	0.46	1.1
-	1899	-	-	.30	3.55	1.45	.0025	.0181	.0157	.0024	.42	.0069	.0001	0.42	0.9
-	1900	-	-	.33	3.97	1.52	.0029	.0210	.0186	.0024	.47	.0038	.0001	0.50	1.2
-	1901	-	-	.44	4.95	2.00	.0032	.0249	.0220	.0029	.50	.0060	.0001	0.69	1.7

Odor in 1901, generally faintly vegetable, occasionally unpleasant, becoming stronger on heating. The organism *Dinobryon* was found in the samples collected in January, February, March, April and May.

Waters examined in Connection with Advice relative to Additional Water Supply.

(See also page 32.)

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
35716	May 17	V. slight.	Slight.	1.50	4.40	2.65	.0016	.0304	.0276	.0028	.48	.0030	.0000	1.62	1.1
35718	May 17	None.	V. slight.	2.20	6.00	3.50	.0028	.0424	.0384	.0040	.33	.0020	.0000	2.06	1.1
35717	May 17	V. slight.	Cons.	0.63	3.15	1.65	.0010	.0272	.0238	.0034	.29	.0020	.0000	1.05	1.0

Odor of all the samples, distinctly vegetable.——The first sample was collected from Martin's Brook, at the Boston & Maine Railroad crossing in Wilmington; the second, from the Ipswich River, opposite the pumping station of the Reading water works; the last, from Foster's Pond, in Andover, near its outlet.

MALDEN.

Water Supply of Malden.

(See *Metropolitan Water District*, pages 120–123.)

Water Supply of Manchester.

Large Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	10.70	-	.0003	.0011	-	-	1.84	.1246	.0000	.01	3.6	.0064
Average of nine previous years,	.00	10.26	-	.0001	.0006	-	-	1.83	.1127	.0000	.02	3.4	.0036

Tubular Wells, near Coolidge Spring.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 2 samples collected in 1901.	.00	9.30	-	.0013	.0024	-	-	1.28	.1700	.0000	.00	2.3	.0045

Waters examined in Connection with Advice relative to Additional Water Supply.

(See also page 35.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
35327	Apr. 3	Decided.	Cons.	.01	13.20	.0180	.0036	1.56	.2150	.0060	.06	3.5	0.6800
35398	Apr. 12	Decided.	Cons.	-	10.80	.0022	.0006	1.55	.1660	.0012	.03	3.1	0.2500
35330	Apr. 3	Decided.	Cons.	.00	16.70	.0006	.0036	2.59	.0210	.0005	.06	4.4	0.2200
35402	Apr. 12	Slight.	Cons.	.05	16.70	.0000	.0006	2.55	.0190	.0000	.01	4.7	0.0700
35329	Apr. 3	Decided.	Heavy.	-	86.30	.0050	.0040	2.00	.0740	.0000	.14	3.6	1.2400
35401	Apr. 12	None.	Slight.	.00	13.20	.0000	.0006	2.48	.0200	.0000	.01	4.3	0.0160
35328	Apr. 3	Slight.	Cons.	.01	10.60	.0104	.0032	1.30	.0920	.0007	.02	2.9	0.4800
35399	Apr. 12	None.	None.	.00	8.50	.0000	.0006	1.30	.1080	.0000	.02	2.6	0.0050
35400	Apr. 12	Slight.	Cons.	.02	9.80	.0006	.0072	1.31	.1380	.0000	.11	2.7	0.0100

The samples were collected from tubular test wells in the vicinity of the large well from which the main supply is at present derived, as follows: the first two, from a well 66 feet south of the large well; the next two, from a well 64 feet south-east of the large well; the next two, from a well 35 feet east of the large well; the next two, from a well 174 feet north-east of the large well; the last, from a well about 300 feet north-west of the large well.

Water Supply of Mansfield Water Supply District.

Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Sus-pended.						
Average of 6 samples collected in 1901.	.00	2.75	-	.0000	.0007	-	-	.26	.0032	.0000	.01	0.5	.0037
Average of two previous years,	.00	2.82	-	.0001	.0008	-	-	.29	.0026	.0000	.01	0.7	.0011

Water Supply of Marblehead.

Collecting Well No. 1.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1901.												
34315	Jan. 2	Decided.	Cons.	.30	16.80	.0150	.0024	2.68	.0500	.0001	.02	6.3	.1000
34693	Feb. 8	Decided.	Cons.	.05	16.70	.0136	.0018	2.69	.0490	.0001	.06	6.9	.0850
34998	Mar. 6	Decided.	Cons.	.01	16.80	.0150	.0034	2.34	.0420	.0000	.03	5.9	.1500
35326	Apr. 4	Decided.	Cons.	.01	19.70	.0146	.0036	2.16	.0380	.0002	.09	7.3	.1750
35593	May 2	Decided.	Cons.	.16	20.80	.0178	.0042	1.72	·0160	.0002	.04	8.1	.1800
35963	June 11	Decided.	Cons.	.07	16.80	.0140	.0028	1.63	.0330	.0001	.05	6.3	.1240
36225	July 2	Decided.	Cons.	.01	18.60	.0172	.0024	1.72	.0290	.0002	.04	6.7	.3600
36694	Aug. 8	Decided.	Heavy.	.03	17.60	.0188	.0030	1.85	.0160	.0001	.04	5.7	.1440
37114	Sept. 6	Decided.	Cons.	.05	18.60	.0144	.0014	1.92	.0100	.0002	.04	5.4	.0960
37801	Nov. 1	Decided.	Cons.	.01	17.00	.0172	.0042	2.27	.0150	.0001	.07	8.6	.2300
38227	Dec. 4	Decided.	Cons.	.35	17.40	.0118	.0028	2.32	.0210	.0001	.04	7.1	.1600

Averages by Years.

-	1891	-	-	.00	20.42	.0008	.0023	4.73	.1121	.0005	-	8.7	-
-	1892	-	-	.01	32.39	.0001	.0005	9.56	.1808	.0002	-	11.3	-
-	1893	-	-	.10	15.77	.0016	.0009	2.78	.0793	.0004	.04	8.2	.0683
-	1894	-	-	.02	13.46	.0071	.0018	2.13	.0829	.0001	.03	6.4	.0603
-	1895	-	-	.06	15.05	.0011	.0016	2.27	.0350	.0000	.03	7.1	.0152
-	1896	-	-	.09	15.72	.0021	.0028	1.67	.0365	.0005	.05	7.5	.0295
-	1897	-	-	.09	15.42	.0024	.0025	1.62	.0356	.0000	.02	7.1	.0212
-	1898	-	-	.11	14.78	.0100	.0028	1.67	.0383	.0003	.04	6.6	.1095
-	1899	-	-	.05	14.19	.0145	.0023	1.54	.0242	.0001	.06	5.7	.2172
-	1900	-	-	.12	16.67	.0160	.0085	2.36	.0178	.0001	.06	6.6	.2175
-	1901	-	-	.10	17.89	.0154	.0029	2.12	.0290	.0001	.05	6.8	.1640

The samples represent a mixture of water from collecting well No. 1 with water from collecting well No. 2, which flows into it.

MARBLEHEAD.

Collecting Well No. 2.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34316	Jan. 2	Decided.	Cons.	.60	17.00	.0270	.0032	1.80	.0050	.0000	.06	5.9	.2200
34694	Feb. 8	Decided.	Cons.	.02	16.70	.0130	.0022	2.71	.0570	.0001	.05	6.9	.1700
34997	Mar. 6	Decided.	Cons.	.02	17.70	.0256	.0040	1.65	.0060	.0000	.06	5.7	.4500
35325	Apr. 4	Decided.	Cons.	.03	23.20	.0294	.0036	1.69	.0030	.0000	.06	8.1	.2700
35594	May 2	Decided.	Heavy.	.10	23.00	.0332	.0062	1.60	.0130	.0000	.06	8.0	.3400
35964	June 11	Decided.	Heavy.	.06	20.40	.0298	.0044	1.53	.0030	.0000	.10	7.6	.3400
36224	July 2	Decided.	Cons.	.02	19.40	.0356	.0040	1.64	.0030	.0002	.03	7.7	.6000
36695	Aug. 8	Decided.	Heavy.	.20	18.30	.0342	.0032	1.65	.0020	.0000	.11	6.1	.2340
37115	Sept. 6	Decided.	Cons.	.05	18.20	.0224	.0018	1.51	.0030	.0001	.06	5.4	.1300
37802	Nov. 1	Decided.	Heavy.	.01	17.80	.0328	.0052	1.64	.0030	.0001	.11	8.1	.5200

Averages by Years.

-	1894	-	-	-	12.87	.0143	.0033	1.39	.0033	.0000	.07	5.3	.2933
-	1899	-	-	.04	14.92	.0276	.0029	1.65	.0013	.0000	.08	6.0	.2972
-	1900	-	-	.16	16.83	.0253	.0040	1.85	.0070	.0001	.08	6.2	.3333
-	1901	-	-	.11	19.17	.0283	.0038	1.74	.0098	.0000	.07	6.9	.3274

Water Supply of Marlborough.

Lake Williams.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.08	4.29	1.45	.0026	.0243	.0197	.0046	.45	.0050	.0000	.31	1.6	-
Average of nine previous years, .	.09	4.20	1.28	.0011	.0214	.0182	.0032	.47	.0049	.0000	.25	1.8	-

Odor in 1901, generally faintly vegetable or unpleasant when heated.

MARLBOROUGH.

North Branch of Millham Brook, near its Entrance to the Millham Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34344	Jan. 7	V. slight.	Cons.	0.70	6.00	1.85	.0024	.0224	.0186	.0038	.48	.0150	.0000	0.84	1.6
34707	Feb. 11	V. slight.	V. slight.	0.70	6.15	2.25	.0082	.0164	.0154	.0010	.35	.0130	.0000	0.67	1.3
35129	Mar. 15	Slight.	Slight.	0.71	3.85	2.00	.0090	.0228	.0204	.0024	.25	.0300	.0001	0.81	1.1
35342	Apr. 8	Decided.	Cons.	0.60	3.75	2.00	.0040	.0218	.0192	.0026	.25	.0160	.0000	0.62	0.8
35608	May 6	V. slight.	V. slight.	1.20	4.15	2.40	.0006	.0218	.0210	.0008	.30	.0010	.0000	1.01	1.1
35933	June 10	None.	V. slight.	1.44	6.10	3.00	.0024	.0318	.0298	.0020	.26	.0020	.0000	1.32	1.3
36261	July 8	V. slight.	Slight.	1.04	4.85	2.25	.0038	.0318	.0270	.0048	.27	.0000	.0001	0.86	1.1
36704	Aug. 12	V. slight.	Slight.	1.50	6.30	3.30	.0036	.0408	.0378	.0030	.31	.0010	.0001	1.66	1.7
37113	Sept. 8	V. slight.	Slight.	1.50	7.65	3.30	.0068	.0372	.0336	.0036	.35	.0040	.0001	1.70	1.8
37514	Oct. 8	Decided.	Slight.	1.16	6.60	3.35	.0028	.0380	.0332	.0048	.46	.0020	.0000	1.34	1.7
37910	Nov. 11	V. slight.	V. slight.	1.10	7.50	2.40	.0016	.0226	.0220	.0006	.38	.0030	.0000	0.97	1.3
38265	Dec. 9	None.	Slight.	0.90	6.30	2.70	.0032	.0202	.0190	.0012	.42	.0110	.0000	1.00	1.1

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1896	-	-	1.22	5.45	2.11	.0023	.0262	.0226	.0036	.35	.0095	.0001	1.09	1.4
-	1897	-	-	1.46	5.65	2.51	.0022	.0291	.0265	.0026	.38	.0076	.0001	1.05	1.4
-	1898	-	-	1.35	5.44	2.53	.0018	.0265	.0236	.0029	.34	.0107	.0001	1.05	1.3
-	1899	-	-	0.84	4.82	1.93	.0038	.0287	.0234	.0053	.29	.0100	.0001	0.78	1.1
-	1900	-	-	0.99	5.60	2.18	.0031	.0251	.0228	.0023	.33	.0053	.0000	0.93	1.3
-	1901	-	-	1.05	5.77	2.57	.0040	.0273	.0247	.0026	.34	.0082	.0000	1.07	1.3

Odor in 1901, generally vegetable or unpleasant, becoming stronger on heating.

Millham Brook, near its Entrance to the Millham Brook Storage Reservoir.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34345	Jan. 7	V. slight.	Slight.	.32	5.75	1.60	.0022	.0174	.0140	.0034	.54	.0610	.0000	.54	2.1
34708	Feb. 11	V. slight.	V. slight	.30	5.70	2.10	.0040	.0158	.0148	.0010	.45	.0490	.0000	.54	2.1
35130	Mar. 15	V. slight.	V. slight.	.46	4.85	2.10	.0028	.0200	.0196	.0004	.32	.0550	.0001	.65	2.3
35348	Apr. 8	V. slight.	V. slight.	.36	3.95	1.90	.0058	.0190	.0182	.0008	.32	.0170	.0001	.51	1.1
35605	May 6	V. slight.	V. slight.	.52	4.10	1.95	.0010	.0156	.0136	.0020	.34	.0180	.0000	.56	1.6
35934	June 10	V. slight.	V. slight.	.75	5.00	2.10	.0014	.0232	.0218	.0014	.38	.0180	.0001	.71	2.1
36262	July 8	V. slight.	V. slight.	.32	5.45	2.15	.0026	.0234	.0206	.0028	.44	.0180	.0003	.52	2.1
36705	Aug. 12	V. slight.	V. slight.	.60	5.90	2.65	.0044	.0298	.0284	.0014	.36	.0020	.0002	.79	2.1
37110	Sept. 8	V. slight.	V. slight.	.37	6.00	2.70	.0032	.0178	.0168	.0010	.43	.0060	.0001	.65	2.3
37515	Oct. 8	V. slight.	V. slight.	.46	6.35	2.60	.0025	.0220	.0212	.0008	.44	.0060	.0001	.78	2.6
37911	Nov. 11	V. slight.	V. slight.	.44	6.35	1.85	.0010	.0198	.0180	.0018	.47	.0130	.0001	.70	2.2
38266	Dec. 9	None.	V. slight.	.38	6.20	2.35	.0020	.0162	.0146	.0016	.45	.0200	.0000	.51	2.0

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1896	-	-	.62	5.47	1.90	.0022	.0199	.0174	.0025	.37	.0209	.0001	.65	1.9
-	1897	-	-	.74	5.27	2.02	.0018	.0214	.0198	.0016	.38	.0162	.0001	.65	2.0
-	1898	-	-	.54	5.12	2.11	.0016	.0172	.0156	.0016	.39	.0165	.0001	.53	1.8
-	1899	-	-	.29	4.97	1.65	.0021	.0169	.0149	.0020	.39	.0128	.0001	.40	1.8
-	1900	-	-	.47	5.59	1.96	.0027	.0198	.0183	.0015	.39	.0136	.0001	.66	1.9
-	1901	-	-	.44	5.47	2.17	.0028	.0200	.0185	.0015	.41	.0236	.0001	.62	2.0

Odor in 1901, generally vegetable or unpleasant, becoming stronger on heating.

MARLBOROUGH.

Millham Brook Storage Reservoir, at Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34346	Jan. 7	Decided.	Slight.	.39	4.45	1.60	.0018	.0310	.0240	.0070	.34	.0180	.0000	.61	1.6
34709	Feb. 11	V. slight.	V. slight.	.34	4.70	1.85	.0034	.0270	.0242	.0028	.37	.0230	.0000	.56	1.7
35131	Mar. 15	Decided.	Slight.	.40	3.30	1.70	.0068	.0296	.0232	.0064	.18	.0190	.0001	.64	1.1
35344	Apr. 8	Slight.	Cons.	.39	3.65	1.80	.0074	.0242	.0214	.0028	.24	.0080	.0001	.53	1.0
35606	May 6	Slight.	Cons.	.40	3.40	1.50	.0010	.0208	.0140	.0068	.28	.0120	.0001	.52	1.1
35935	June 10	V. slight.	Cons.	.61	4.00	1.85	.0018	.0278	.0210	.0068	.29	.0050	.0001	.59	1.4
36263	July 8	V. slight.	Slight.	.49	3.80	1.65	.0020	.0268	.0224	.0044	.27	.0010	.0001	.61	1.3
36706	Aug. 12	Slight.	Cons.	.39	3.50	1.65	.0032	.0396	.0272	.0124	.25	.0010	.0001	.57	1.1
37111	Sept. 8	V. slight.	Cons.	.32	3.65	1.95	.0004	.0312	.0230	.0082	.26	.0030	.0001	.67	1.8
37516	Oct. 8	V. slight.	Cons.	.80	4.65	2.30	.0284	.0364	.0276	.0088	.26	.0020	.0001	.69	1.7
37912	Nov. 11	V. slight.	V. slight.	.84	4.60	1.85	.0258	.0310	.0272	.0038	.28	.0070	.0000	.69	1.1
38267	Dec. 9	None.	V. slight.	.62	5.40	2.25	.0118	.0242	.0226	.0016	.36	.0150	.0002	.59	1.6

Averages by Years.

-	1896	-	-	.80	4.44	1.68	.0058	.0306	.0248	.0058	.30	.0088	.0003	.69	1.3
-	1897	-	-	.83	4.24	1.77	.0031	.0293	.0243	.0050	.30	.0088	.0001	.64	1.5
-	1898	-	-	.67	4.30	1.95	.0050	.0239	.0191	.0048	.32	.0095	.0001	.59	1.3
-	1899	-	-	.37	3.67	1.58	.0065	.0323	.0223	.0100	.27	.0081	.0001	.43	1.1
-	1900	-	-	.41	3.78	1.40	.0029	.0332	.0240	.0092	.26	.0032	.0001	.54	1.1
-	1901	-	-	.50	4.09	1.83	.0078	.0291	.0231	.0060	.28	.0095	.0001	.61	1.4

Odor in 1901, generally faintly vegetable or unpleasant, becoming stronger on heating. All of the samples contained a very large number of organisms, consisting chiefly of *Asterionella*, *Tabellaria*, *Anabæna*, *Cœlosphærium* and *Dinobryon*. The organism *Uroglena* was found in the sample collected in January.

Millham Brook Storage Reservoir, at Bottom.

	1901.														
34347	Jan. 7	Decided.	Cons.	0.44	4.75	1.40	.0074	.0292	.0220	.0072	.35	.0200	.0000	0.60	1.4
34710	Feb. 11	V. slight.	Slight.	0.39	5.20	1.85	.0094	.0310	.0268	.0042	.38	.0180	.0000	0.58	1.6
35132	Mar. 15	Decided.	Cons.	0.45	4.55	2.05	.0190	.0382	.0228	.0154	.29	.0180	.0001	0.60	1.8
35345	Apr. 8	Decided.	Cons.	0.38	3.60	1.70	.0058	.0234	.0186	.0048	.24	.0170	.0002	0.53	1.3
35607	May 6	Slight.	Cons.	0.40	3.45	1.50	.0010	.0204	.0138	.0066	.29	.0120	.0001	0.50	1.1
35936	June 10	Decided.	Cons.	0.78	4.00	1.75	.0242	.0260	.0200	.0060	.28	.0080	.0002	0.67	1.4
36264	July 8	Decided.	Cons.	-	5.30	2.25	.0972	.0396	.0292	.0104	.25	.0010	.0002	0.89	1.3
36707	Aug. 12	Decided.	Heavy.	0.70	4.00	1.85	.0172	.0448	.0296	.0152	.26	.0030	.0001	0.65	1.0
37112	Sept. 8	Decided.	Cons.	2.70	7.10	2.95	.1800	.0496	.0280	.0216	.27	.0050	.0001	1.18	2.1
37517	Oct. 8	Slight.	Cons.	0.77	4.50	2.25	.0288	.0344	.0268	.0076	.26	.0010	.0000	0.68	1.4
37913	Nov. 11	None.	V. slight.	0.82	4.60	1.85	.0256	.0326	.0270	.0056	.29	.0080	.0000	0.75	1.1
38268	Dec. 9	None.	Slight.	0.80	5.00	2.10	.0180	.0264	.0228	.0036	.34	.0100	.0002	0.63	1.4

Averages by Years.

-	1896	-	-	1.04	5.07	1.94	.0186	.0331	.0271	.0060	.31	.0110	.0002	0.82	1.5
-	1897	-	-	1.47	5.33	2.24	.0233	.0343	.0288	.0055	.32	.0075	.0003	0.79	1.7
-	1898	-	-	1.29	5.21	2.35	.0472	.0285	.0224	.0061	.31	.0071	.0002	0.68	1.5
-	1899	-	-	0.80	4.25	1.62	.0310	.0370	.0238	.0132	.29	.0086	.0001	0.49	1.3
-	1900	-	-	0.92	4.43	1.61	.0402	.0395	.0252	.0143	.26	.0026	.0001	0.63	1.1
-	1901	-	-	0.78	4.67	1.96	.0361	.0330	.0240	.0090	.29	.0101	.0001	0.69	1.4

Odor in 1901, generally faintly vegetable or unpleasant, becoming stronger on heating.

Water Supply of Brant Rock, Marshfield. — Brant Rock Water Company.

Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.			
August, 1901, ...	.00	12.20	-	.0002	.0014	-	-	3.41	.0700	.0000	.02	2.0	.0040

Water Supply of Maynard.

White Pond.

Average of 4 samples collected in 1901.	.03	2.94	1.11	.0003	.0104	.0095	.0009	0.33	.0027	.0000	.17	0.9	-
Average of nine previous years, .	.04	2.35	0.86	.0005	.0146	.0122	.0024	0.29	.0018	.0000	.16	0.6	-

Water Supply of Medfield.

Spring.

September, 1901, ...	.00	3.90	-	.0006	.0034	-	-	0.20	.0000	.0000	.09	1.1	.0060

Water Supply of Medfield Insane Asylum.

Farm Pond in Sherborn.

Average of 4 samples collected in 1901.	.01	2.05	0.71	.0002	.0122	.0116	.0006	0.24	.0017	.0000	.18	0.4	-
Average of three previous years, .	.05	1.86	0.84	.0016	.0121	.0111	.0010	0.25	.0019	.0000	.13	0.1	-

Odor in March, 1901, fishy; in September, faintly vegetable.

Water Supply of Medford.

(See *Metropolitan Water District*, pages 120–123.)

Water Supply of Melrose.

(See *Metropolitan Water District*, pages 120–123.)

METHUEN.

WATER SUPPLY OF METHUEN.

Tubular Wells.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34892	Feb. 27	None.	None.	.00	7.80	.0000	.0042	.36	.0200	.0000	.01	3.3	.0050
35514	Apr. 24	None.	None.	.01	7.50	.0006	.0044	.36	.0280	.0000	.02	3.9	.0050
36153	June 26	V. slight.	None.	.11	8.50	.0004	.0044	.33	.0200	.0000	.01	4.0	.0090
37022	Aug. 28	V. slight.	V. slight.	.10	7.50	.0000	.0080	.30	.0150	.0001	.20	3.3	.0120
37781	Oct. 30	V. slight.	None.	.09	6.80	.0000	.0076	.34	.0170	.0001	.20	3.5	.0070
38463	Dec. 24	None.	V. slight.	.04	7.90	.0002	.0066	.34	.0300	.0000	.02	3.0	.0080

Averages by Years.

-	1894	-	-	.02	7.77	.0002	.0033	.26	.0057	.0000	.05	3.1	.0050
-	1895	-	-	.06	7.44	.0001	.0030	.26	.0062	.0000	.09	3.2	.0133
-	1896	-	-	.06	7.58	.0005	.0015	.25	.0065	.0001	.06	3.2	.0123
-	1897	-	-	.06	7.04	.0002	.0038	.27	.0032	.0003	.10	3.3	.0052
-	1898	-	-	.07	6.72	.0002	.0028	.32	.0158	.0001	.11	2.8	.0038
-	1899	-	-	.07	6.97	.0003	.0049	.33	.0238	.0000	.11	2.6	.0092
-	1900	-	-	.08	7.48	.0003	.0046	.34	.0220	.0000	.09	3.3	.0223
-	1901	-	-	.06	7.67	.0002	.0059	.34	.0217	.0000	.08	3.5	.0077

Odor of Nos. 34892 and 35514, earthy.

WATER SUPPLY OF MIDDLEBOROUGH FIRE DISTRICT.

Well.

	1901.												
34325	Jan. 2	Slight.	Cons.	.08	6.40	.0022	.0028	.77	.1300	.0000	.07	2.2	.0860
34683	Feb. 6	None.	V. slight.	.00	6.20	.0010	.0024	.73	.1200	.0000	.05	2.1	.0300
35010	Mar. 6	V. slight.	Cons.	.03	6.60	.0010	.0026	.74	.0800	.0000	.05	2.3	.0240
35324	Apr. 3	None.	V. slight.	.05	5.80	.0014	.0026	.76	.1000	.0000	.05	2.3	.0300
35579	May 1	V. slight.	Slight.	.05	6.40	.0014	.0032	.79	.1750	.0000	.08	2.9	.0480
35861	June 5	V. slight.	Cons.	.06	7.70	.0012	.0054	.78	.1000	.0000	.03	2.9	.0350
36217	July 2	Decided.	Cons.	.40	8.00	.0006	.0112	.61	.0480	.0002	.18	2.7	.0560
36663	Aug. 7	Decided.	Slight.	.37	6.10	.0006	.0088	.58	.0300	.0000	.22	2.0	.0580
37102	Sept. 5	Decided.	V. slight.	.30	7.00	.0010	.0086	.52	.0190	.0001	.24	2.2	.0380
37456	Oct. 2	Decided.	Slight.	.37	5.90	.0000	.0076	.52	.0280	.0002	.24	2.0	.0700
37861	Nov. 6	Decided.	Slight.	.32	5.50	.0038	.0052	.61	.0460	.0000	.20	2.3	.0700
38231	Dec. 4	Slight.	Cons.	.22	6.00	.0026	.0036	.62	.0390	.0001	.06	2.2	.0400

Averages by Years.

-	1888	-	-	.00	8.67	.0001	.0025	.96	.1494	.0001	-	-	-
-	1895	-	-	.06	6.74	.0001	.0028	.74	.0687	.0000	.08	2.6	.0187
-	1896	-	-	.18	6.54	.0008	.0038	.72	.0565	.0000	.09	2.4	.0288
-	1897	-	-	.09	6.28	.0006	.0039	.71	.0580	.0000	.11	2.5	.0227
-	1898	-	-	.16	6.78	.0008	.0044	.75	.0687	.0001	.14	2.7	.0408
-	1899	-	-	.15	6.54	.0010	.0037	.69	.0684	.0000	.12	2.3	.0329
-	1900	-	-	.15	5.99	.0012	.0037	.69	.0592	.0000	.10	2.2	.0489
-	1901	-	-	.19	6.47	.0014	.0058	.67	.0762	.0000	.12	2.3	.0487

Odor in October, 1901, distinctly unpleasant.

WATER SUPPLY OF MIDDLETON.

(See *Danvers*.)

WATER SUPPLY OF MILFORD AND HOPEDALE. — MILFORD WATER COMPANY.

Wells.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.07	3.83	-	.0011	.0061	-	-	.28	.0255	.0000	.13	1.1	.0105
Average of three previous years, .	.09	3.41	-	.0006	.0062	-	-	.26	.0125	.0000	.19	1.0	.0211

The samples represent water from the wells mingled with water from the river which has passed through the sand filters.

Charles River, above Milford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34810	Feb. 18	Slight.	Slight.	.34	4.20	1.30	.0084	.0340	.0288	.0052	.35	.0200	.0000	.55	0.6
35482	Apr. 22	V. slight.	V. slight.	.42	2.60	1.35	.0010	.0150	.0136	.0014	.22	.0040	.0000	.52	0.3
36109	June 24	V. slight.	Slight.	.50	3.85	1.85	.0018	.0250	.0220	.0030	.28	.0100	.0003	.57	0.5
36962	Aug. 27	Slight.	Slight.	.45	4.95	3.00	.0136	.0320	.0292	.0028	.23	.0040	.0001	.77	0.6
37811	Nov. 1	Slight.	Cons.	.44	4.10	2.60	.0044	.0288	.0228	.0060	.25	.0040	.0001	.60	0.6
38438	Dec. 23	V. slight.	V. slight.	.47	3.60	1.85	.0020	.0134	.0110	.0024	.27	.0140	.0001	.53	0.5
Av...	1901	....	....	.44	3.88	1.99	.0052	.0247	.0212	.0035	.27	.0093	.0001	.59	0.5
Av...	1900	....	....	.43	3.60	1.57	.0015	.0209	.0192	.0017	.24	.0040	.0000	.61	0.5

Odor in 1901, generally unpleasant.

WATER SUPPLY OF MILLBURY. — MILLBURY WATER COMPANY.

Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	6.85	-	.0605	.0017	-	-	.23	.0365	.0000	.02	3.1	.0073
Average of four previous years, .	.02	4.65	-	.0007	.0025	-	-	.23	.0182	.0001	.04	2.2	.0070

MILLIS.

Water Supply of Millis.

Aqua Rex Spring.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	7.07	-	.0001	.0022	-	-	.60	.1823	.0000	.01	2.7	.0045

Water Supply of Milton. — Milton Water Company.

(See *Hyde Park*.)

Water Supply of Monson.

Well.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	3.28	-	.0001	.0009	-	-	.13	.0102	.0000	.01	1.0	.0060
Average of five previous years, .	.00	3.86	-	.0002	.0013	-	-	.12	.0081	.0000	.02	1.1	.0080

Water Supply of Montague. — Turner's Falls Fire District.

Lake Pleasant.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.02	2.35	0.87	.0016	.0096	.0080	.0016	.11	.0082	.0001	.10	0.4	-
Average of eight previous years, .	.04	2.26	0.70	.0019	.0090	.0073	.0017	.13	.0029	.0000	.11	0.4	-

Odor in May, 1901, unpleasant, becoming also fishy on heating; in November, distinctly vegetable.

Water Supply of Nahant.

(See *Metropolitan Water District*, pages 120–123.)

Water Supply of Nantucket. — Wannacomet Water Company.

Wannacomet Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
35189	Mar. 19	None.	Cons.	.00	7.40	1.80	.0036	.0186	.0126	.0060	2.15	.0050	.0001	.16	2.0
36127	June 25	Slight.	Cons.	.06	5.25	0.85	.0040	.0188	.0154	.0034	2.45	.0020	.0000	.15	1.4
36521	July 23	None.	Slight.	.00	6.90	2.10	.0044	.0170	.0138	.0032	2.39	.0010	.0000	.24	1.6
36970	Aug. 27	V. slight.	Cons.	.04	7.30	3.25	.0008	.0144	.0124	.0020	2.50	.0010	.0001	.15	1.8
37412	Sept. 24	V. slight.	V. slight.	.04	7.15	2.20	.0022	.0154	.0120	.0034	2.28	.0030	.0000	.18	2.0
37779	Oct 29	V. slight.	Slight.	.01	6.70	3.40	.0006	.0154	.0128	.0026	2.48	.0010	.0000	.12	1.7
38133	Nov. 26	V. slight.	Slight.	.00	7.15	2.35	.0006	.0126	.0110	.0016	2.55	.0010	.0000	.12	1.7
38442	Dec. 24	V. slight.	V. slight.	.02	6.50	1.90	.0000	.0136	.0110	.0026	2.48	.0030	.0000	.08	1.4

NANTUCKET.

Wannacomet Pond — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
-	1891	-	-	.22	7.54	2.33	.0112	.0588	.0317	.0271	1.86	.0076	.0001	-	1.4
-	1892	-	-	.03	6.84	1.68	.0004	.0136	.0111	.0025	2.22	.0033	.0000	-	1.6
-	1893	-	-	.22	7.00	2.02	.0013	.0469	.0208	.0261	2.08	.0025	.0000	.22	1.6
-	1894	-	-	.05	6.74	1.65	.0015	.0131	.0108	.0023	2.30	.0000	.0000	.12	1.6
-	1895	-	-	.06	6.41	1.57	.0008	.0146	.0119	.0027	2.14	.0024	.0000	.14	1.6
-	1896	-	-	.06	6.24	1.57	.0008	.0137	.0114	.0023	2.20	.0027	.0000	.13	1.5
-	1897	-	-	.08	6.66	1.58	.0014	.0186	.0137	.0049	2.42	.0016	.0000	.13	1.6
-	1898	-	-	.14	6.87	1.88	.0075	.0268	.0168	.0100	2.28	.0004	.0000	.15	1.4
-	1899	-	-	.07	6.71	1.52	.0009	.0152	.0128	.0024	2.49	.0017	.0000	.14	1.5
-	1900	-	-	.16	7.59	1.68	.0059	.0402	.0213	.0189	2.44	.0021	.0000	.17	1.6
-	1901	-	-	.02	6.79	2.23	.0020	.0157	.0126	.0031	2.41	.0021	.0000	.15	1.7

Odor in March and November, 1901, faintly unpleasant, becoming stronger on heating. A faintly unpleasant odor was developed in some of the other samples on heating. The organism *Dinobryon* was found in large numbers in the samples collected in June, October and November.

Wells near Wannacomet Pond.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
					Albuminoid.								
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.			
Average of 6 samples collected in 1901.	.00	6.47	-	.0049	.0032	-	-	2.25	.0158	.0001	.04	1.4	.0093

Water Supply of Natick. (See also page 37.)

Dug Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1900.														
34284	Dec. 31	V. slight.	Slight.	.07	4.65	1.40	.0180	.0204	.0166	.0038	.59	.0120	.0001	.24	2.1
	1901.														
34653	Feb. 4	V. slight.	Slight.	.06	4.90	1.50	.0174	.0198	.0160	.0038	.59	.0180	.0001	.19	1.8
34984	Mar. 5	V. slight.	Cons.	.08	4.65	1.30	.0150	.0192	.0162	.0030	.65	.0160	.0003	.22	2.2
35302	Apr. 2	Slight.	Slight.	.22	4.70	1.70	.0022	.0164	.0158	.0006	.46	.0190	.0001	.18	2.2
35567	Apr. 30	Decided.	Cons.	.16	4.90	1.70	.0028	.0218	.0188	.0030	.58	.0420	.0002	.25	2.0
35824	June 3	Slight.	Cons.	.20	5.25	1.65	.0040	.0222	.0202	.0020	.57	.0420	.0004	.45	2.2
36194	July 1	Slight.	Cons.	.13	5.60	1.85	.0018	.0214	.0198	.0016	.58	.0280	.0002	.26	2.2
36648	Aug. 5	V. slight	V. slight.	.12	5.90	1.20	.0018	.0242	.0216	.0026	.45	.0150	.0000	.30	2.5
37045	Sept. 3	Slight.	V. slight.	.10	7.25	2.00	.0014	.0216	.0176	.0040	.47	.0040	.0001	.33	2.5
37407	Sept. 30	None.	V. slight.	.06	5.30	1.95	.0014	.0196	.0186	.0010	.45	.0040	.0001	.25	2.6
37821	Nov. 4	Slight.	Slight.	.05	4.80	1.85	.0076	.0226	.0188	.0038	.52	.0010	.0000	.37	2.2
38197	Dec. 2	V. slight.	V. slight.	.08	5.15	2.00	.0026	.0176	.0154	.0022	.53	.0050	.0001	.24	2.2

NATICK.

Dug Pond — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1888	-	-	.13	-	-	.0070	.0228	-	-	.66	.0197	.0003	-	-
-	1889	-	-	.16	-	-	.0046	.0242	.0197	.0045	.71	.0292	.0004	-	-
-	1890	-	-	.14	-	-	.0027	.0199	.0166	.0033	.72	.0227	.0002	-	2.7
-	1891	-	-	.09	5.71	1.45	.0085	.0207	.0167	.0040	.69	.0326	.0003	-	2.4
-	1892	-	-	.06	5.38	1.24	.0068	.0173	.0135	.0038	.72	.0323	.0001	-	2.4
-	1893	-	-	.08	5.28	1.39	.0062	.0192	.0158	.0034	.71	.0193	.0003	.23	2.1
-	1894	-	-	.10	5.64	1.65	.0060	.0155	.0132	.0023	.80	.0218	.0001	.21	2.3
-	1895	-	-	.13	6.27	1.86	.0044	.0191	.0164	.0027	.87	.0312	.0001	.24	2.6
-	1896	-	-	.15	6.19	1.77	.0045	.0176	.0147	.0029	.86	.0290	.0002	.25	2.3
-	1897	-	-	.12	5.41	1.47	.0063	.0192	.0166	.0026	.84	.0130	.0002	.25	2.4
-	1898	-	-	.16	5.21	1.57	.0039	.0168	.0152	.0016	.70	.0127	.0002	.25	2.1
-	1899	-	-	.12	5.09	1.54	.0032	.0195	.0169	.0026	.60	.0158	.0001	.25	2.0
-	1900	-	-	.15	4.85	1.24	.0053	.0198	.0173	.0025	.55	.0067	.0001	.26	1.9
-	1901	-	-	.11	5.25	1.67	.0063	.0206	.0180	.0026	.54	.0172	.0001	.27	2.2

Odor in 1901, generally vegetable or unpleasant, becoming fishy on heating. Many of the samples contained a large number of organisms, consisting chiefly of *Asterionella*, *Melosira*, *Tabellaria* and *Dinobryon*.

Water Supply of Needham.

Well No. 1.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	5.73	-	.0001	.0015	-	-	.65	.2070	.0000	.01	2.1	.0045
Average of seven previous years, .	.00	6.15	-	.0003	.0008	-	-	.74	.1619	.0000	.02	1.9	.0014

Well No. 2.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	6.70	-	.0003	.0023	-	-	.68	.2515	.0000	.02	2.7	.0043
Average of 16 samples collected in 1900.	.00	7.23	-	.0005	.0017	-	-	.68	.1846	.0002	.01	2.4	.0039

Water Supply of New Bedford.

Old Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34886	Feb. 26	Decided.	Cons.	1.02	6.10	2.80	.0032	.0580	.0284	.0296	.66	.0030	.0002	1.20	1.4
35767	May 22	V. slight.	Cons.	1.36	4.40	2.50	.0022	.0206	.0168	.0038	.44	.0030	.0000	1.21	1.0
36969	Aug. 27	Slight.	Cons.	1.05	4.70	2.55	.0080	.0272	.0252	.0020	.45	.0010	.0002	1.00	1.1
38131	Nov. 26	V. slight.	V. slight.	0.50	3.75	1.75	.0012	.0252	.0240	.0012	.50	.0020	.0000	0.61	0.5
Av...	....	....	....	0.98	4.74	2.40	.0036	.0327	.0236	.0091	.51	.0022	.0001	1.00	1.0
Average of nine previous years, .				1.12	4.74	2.26	.0015	.0222	.0199	.0023	.53	.0067	.0000	1.03	1.0

Odor in February, 1901, distinctly unpleasant and fishy; at other times, distinctly vegetable. The organism *Dinobryon* was found in large numbers in the sample collected in February; *Synura* was also found in this sample.

Little Quittacas Pond, in Lakeville.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue: Total.	Loss on Ignition.	Ammonia: Free.	Albuminoid: Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34549	Jan. 22	None.	V. slight.	.16	3.65	1.80	.0028	.0186	.0150	.0036	.57	.0030	.0000	.35	0.6
34884	Feb. 26	V. slight.	Slight.	.20	3.70	1.70	.0010	.0192	.0166	.0026	.60	.0030	.0000	.41	0.8
35257	Mar. 26	V. slight.	Slight.	.22	3.25	1.30	.0010	.0178	.0164	.0014	.50	.0030	.0000	.41	0.5
35500	Apr. 23	V. slight.	Slight.	.27	3.10	1.45	.0010	.0178	.0160	.0018	.50	.0020	.0000	.45	0.6
35753	May 22	V. slight.	V. slight.	.32	3.15	1.55	.0010	.0140	.0130	.0010	.47	.0020	.0000	.47	0.5
36121	June 25	V. slight.	V. slight.	.42	3.60	1.60	.0014	.0222	.0194	.0028	.48	.0010	.0000	.65	0.6
36447	July 22	V. slight.	Slight.	.35	3.90	1.50	.0028	.0244	.0220	.0024	.40	.0020	.0000	.58	1.0
37025	Aug. 29	V. slight.	Cons.	.32	4.00	1.80	.0032	.0204	.0164	.0040	.46	.0020	.0000	.57	0.8
37411	Sept. 24	V. slight.	V. slight.	.28	3.95	1.90	.0032	.0194	.0172	.0022	.44	.0000	.0001	.53	0.8
37657	Oct. 21	V. slight.	V. slight.	.22	3.40	1.60	.0004	.0216	.0180	.0036	.45	.0020	.0000	.41	1.0
38130	Nov. 26	V. slight.	Slight.	.23	3.40	1.65	.0014	.0162	.0126	.0036	.47	.0010	.0000	.30	0.5
38444	Dec. 23	V. slight.	Slight.	.25	3.20	1.25	.0006	.0176	.0162	.0014	.51	.0060	.0000	.35	0.5
Av...	....	....	....	.27	3.52	1.55	.0016	.0191	.0166	.0025	.49	.0022	.0000	.46	0.7
Average of eight previous years, .				.18	3.16	1.22	.0007	.0175	.0147	.0028	.51	.0020	.0000	.34	0.7

Odor in 1901, generally faintly vegetable, becoming stronger on heating; occasionally unpleasant. The organism *Uroglena* was found in the samples collected in March and April.

Great Quittacas Pond, in Lakeville.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue: Total.	Loss on Ignition.	Ammonia: Free.	Albuminoid: Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34883	Feb. 26	Slight.	Cons.	.39	4.10	1.85	.0016	.0268	.0180	.0088	.61	.0020	.0000	.58	0.8
35752	May 22	V. slight.	Cons.	.59	3.80	2.25	.0010	.0182	.0154	.0028	.46	.0010	.0000	.75	0.3
37024	Aug. 29	V. slight.	Slight.	.37	3.75	2.00	.0028	.0188	.0164	.0024	.44	.0010	.0001	.68	0.5
38129	Nov. 26	V. slight.	Slight.	.31	3.25	1.50	.0008	.0164	.0132	.0032	.46	.0000	.0000	.44	0.5
Av...	....	....	....	.41	3.72	1.90	.0015	.0200	.0157	.0043	.49	.0010	.0000	.61	0.5
Average of eight previous years, .				.49	3.52	1.52	.0004	.0171	.0153	.0018	.53	.0013	.0000	.60	0.6

Odor in February and May, 1901, decidedly unpleasant; at other times, faintly vegetable, becoming stronger on heating. The organism *Uroglena* was found in large numbers in the samples collected in February and May.

NEW BEDFORD.

Faucet at City Hall.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34528	Jan. 22	None.	V. slight.	.17	3.85	1.45	.0036	.0184	.0164	.0020	.57	.0010	.0000	.37	0.8
34887	Feb. 26	V. slight.	V. slight.	.16	3.50	1.40	.0016	.0166	.0152	.0014	.59	.0010	.0000	.39	0.8
35242	Mar. 26	V. slight.	V. slight	.20	3.70	1.50	.0040	.0174	.0162	.0012	.52	.0020	.0000	.42	0.6
35488	Apr. 23	V. slight.	V. slight.	.20	3.00	1.40	.0012	.0170	.0152	.0018	.46	.0020	.0000	.43	0.8
35768	May 22	V. slight.	Slight.	.23	3.00	1.35	.0018	.0154	.0140	.0014	.46	.0020	.0000	.42	0.8
36116	June 25	V. slight.	Slight.	.34	3.50	1.65	.0022	.0170	.0152	.0018	.49	.0030	.0001	.60	1.0
36520	July 24	V. slight.	V. slight.	.31	3.10	1.35	.0020	.0192	.0174	.0018	.43	.0010	.0001	.63	0.6
36968	Aug. 27	Slight.	Slight.	.32	3.55	1.90	.0072	.0228	.0184	.0044	.45	.0020	.0001	.52	1.1
37332	Sept. 24	V. slight.	Slight.	.24	4.75	2.35	.0002	.0194	.0168	.0026	.50	.0010	.0000	.69	1.3
37647	Oct. 21	V. slight.	Slight.	.20	3.10	1.50	.0000	.0202	.0178	.0024	.47	.0000	.0000	.38	1.1
38132	Nov. 26	V. slight.	V. slight.	.19	3.25	1.65	.0010	.0156	.0138	.0018	.46	.0000	.0000	.33	0.6
38432	Dec. 23	V. slight.	V. slight.	.26	3.45	1.40	.0020	.0190	.0162	.0028	.54	.0010	.0000	.40	1.0
Av.	....	....	....	.23	3.48	1.57	.0022	.0182	.0161	.0021	.49	.0018	.0000	.46	0.9
Average of two previous years,				.18	3.25	1.31	.0008	.0177	.0163	.0014	.49	.0014	.0000	.36	0.6

Odor in 1901, faintly vegetable, becoming stronger on heating.

Water Supply of Newburyport.

Wells.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.05	6.30	-	.0003	.0040	-	-	.47	.0240	.0000	.07	2.5	.0217
Average of eight previous years,	.13	6.47	-	.0005	.0041	-	-	.68	.0195	.0000	.09	2.5	.0278

Water Supply of Newton.

Wells and Filter Gallery.

Average of 6 samples collected in 1901.	.03	6.18	-	.0002	.0045	-	-	.43	.0435	.0000	.07	2.7	.0053
Average of nine previous years,	.03	5.70	-	.0004	.0025	-	-	.42	.0253	.0000	.07	2.5	.0087

Water Supply of North Adams.

Notch Brook Storage Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.			
Average of 4 samples collected in 1901.	.03	6.72	1.47	.0024	.0138	.0100	.0038	.08	.0042	.0000	.15	4.5	-
Average of five previous years, .	.06	7.68	1.25	.0027	.0074	.0056	.0018	.07	.0039	.0000	.13	5.8	-

Odor in July, 1901, unpleasant.

Broad Brook, in Pownal, Vt.

Average of 4 samples collected in 1901.	.16	3.71	1.51	.0006	.0083	.0077	.0006	.06	.0215	.0000	.38	1.8	-
Average of five previous years, .	.15	4.46	1.22	.0008	.0076	.0057	.0019	.07	.0128	.0000	.27	2.8	-

Odor in 1901, occasionally faintly vegetable.

Water Supply of Northampton. (See also page 38.)

Middle Storage Reservoir on Roberts' Meadow Brook.

Average of 12 samples collected in 1901.	.28	3.95	1.54	.0014	.0145	.0118	.0027	.11	.0043	.0000	.43	1.4	-
Average of five previous years, .	.26	3.90	1.32	.0010	.0133	.0107	.0026	.10	.0031	.0000	.38	1.5	-

Odor in 1901, generally vegetable or unpleasant.

Water Supply of North Andover.

Great Pond.

Average of 4 samples collected in 1901.	.10	3.42	1.15	.0031	.0222	.0191	.0031	.32	.0012	.0001	.32	1.3	-
Average of two previous years, .	.12	3.37	1.24	.0010	.0179	.0162	.0017	.32	.0024	.0000	.33	1.1	-

Odor in July, 1901, distinctly unpleasant; at other times, faintly vegetable.

Water examined in Connection with Advice to the Town Authorities. (See also page 40.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
-	Nov. 7	V. slight.	Slight.	-	9.20	.0012	.0130	0.28	.2020	.0000	.16	1.0	.3120
-	Nov. 27	None.	None.	-	12.30	.0006	.0020	1.56	.9020	.0002	.02	0.8	.0065

Bacteria per cubic centimeter in the first sample, 83; in the second sample, 11. —— The samples were collected from a well at the Town Farm used as a source of drinking water.

NEW BEDFORD.

Faucet at City Hall.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34528	Jan. 22	None.	V. slight.	.17	3.85	1.45	.0036	.0184	.0164	.0020	.57	.0010	.0000	.37	0.8
34887	Feb. 26	V. slight.	V. slight.	.16	3.50	1.40	.0016	.0166	.0152	.0014	.59	.0010	.0000	.39	0.8
35242	Mar. 26	V. slight.	V. slight	.20	3.70	1.50	.0040	.0174	.0162	.0012	.52	.0020	.0000	.42	0.6
35488	Apr. 23	V. slight.	V. slight.	.20	3.00	1.40	.0012	.0170	.0152	.0018	.46	.0020	.0000	.43	0.8
35768	May 22	V. slight.	Slight.	.23	3.00	1.35	.0018	.0154	.0140	.0014	.46	.0020	.0000	.42	0.8
36116	June 25	V. slight.	Slight.	.34	3.50	1.65	.0022	.0170	.0152	.0018	.49	.0030	.0001	.60	1.0
36520	July 24	V. slight.	V. slight.	.31	3.10	1.35	.0020	.0192	.0174	.0018	.43	.0010	.0001	.63	0.6
36968	Aug. 27	Slight.	Slight.	.32	3.55	1.90	.0072	.0228	.0184	.0044	.45	.0020	.0001	.52	1.1
37332	Sept. 24	V. slight.	Slight.	.24	4.75	2.35	.0002	.0194	.0168	.0026	.50	.0010	.0000	.69	1.3
37647	Oct. 21	V. slight.	Slight.	.20	3.10	1.50	.0000	.0202	.0178	.0024	.47	.0000	.0000	.38	1.1
38132	Nov. 26	V. slight.	V. slight.	.19	3.25	1.65	.0010	.0156	.0138	.0018	.46	.0000	.0000	.33	0.6
38432	Dec. 23	V. slight.	V. slight.	.26	3.45	1.40	.0020	.0190	.0162	.0028	.54	.0010	.0000	.40	1.0
Av. . .	. . . .	. . . .	. . . .	.23	3.48	1.57	.0022	.0182	.0161	.0021	.49	.0013	.0000	.46	0.9
Average of two previous years, .				.18	3.25	1.31	.0008	.0177	.0163	.0014	.49	.0014	.0000	.36	0.6

Odor in 1901, faintly vegetable, becoming stronger on heating.

Water Supply of Newburyport.

Wells.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.05	6.30	-	.0008	.0040	-	-	.47	.0240	.0000	.07	2.5	.0217
Average of eight previous years, .	.13	6.47	-	.0005	.0041	-	-	.68	.0195	.0000	.09	2.5	.0278

Water Supply of Newton.

Wells and Filter Gallery.

Average of 6 samples collected in 1901.	.03	6.18	-	.0002	.0045	-	-	.48	.0435	.0000	.07	2.7	.0053
Average of nine previous years, .	.03	5.70	-	.0004	.0025	-	-	.42	.0253	.0000	.07	2.5	.0057

Water Supply of North Adams.

Notch Brook Storage Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Suspended.						
Average of 4 samples collected in 1901.	.03	6.72	1.47	.0024	.0138	.0100	.0038	.08	.0042	.0000	.15	4.5	-
Average of five previous years,	.06	7.68	1.25	.0027	.0074	.0056	.0018	.07	.0039	.0000	.18	5.8	-

Odor in July, 1901, unpleasant.

Broad Brook, in Pownal, Vt.

Average of 4 samples collected in 1901.	.16	3.71	1.51	.0006	.0083	.0077	.0006	.06	.0215	.0000	.38	1.8	-
Average of five previous years,	.15	4.46	1.22	.0008	.0076	.0057	.0019	.07	.0128	.0000	.27	2.8	-

Odor in 1901, occasionally faintly vegetable.

Water Supply of Northampton. (See also page 38.)

Middle Storage Reservoir on Roberts' Meadow Brook.

Average of 12 samples collected in 1901.	.28	3.95	1.54	.0014	.0145	.0118	.0027	.11	.0043	.0000	.43	1.4	-
Average of five previous years,	.26	3.90	1.32	.0010	.0133	.0107	.0026	.10	.0031	.0000	.38	1.5	-

Odor in 1901, generally vegetable or unpleasant.

Water Supply of North Andover.

Great Pond.

Average of 4 samples collected in 1901.	.10	3.42	1.15	.0031	.0222	.0191	.0031	.32	.0012	.0001	.32	1.3	-
Average of two previous years,	.12	3.37	1.24	.0010	.0179	.0162	.0017	.32	.0024	.0000	.33	1.1	-

Odor in July, 1901, distinctly unpleasant; at other times, faintly vegetable.

Water examined in Connection with Advice to the Town Authorities. (See also page 40.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
-	Nov. 7	V. slight.	Slight.	-	9.20	.0012	.0130	0.28	.2020	.0000	.16	1.0	.3120
-	Nov. 27	None.	None.	-	12.30	.0006	.0020	1.56	.9020	.0002	.02	0.8	.0065

Bacteria per cubic centimeter in the first sample, 83; in the second sample, 11. —— The samples were collected from a well at the Town Farm used as a source of drinking water.

NORTH BROOKFIELD.

WATER SUPPLY OF NORTH BROOKFIELD.

Doane Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34530	Jan. 21	Slight.	Slight.	0.36	3.60	1.20	.0040	.0252	.0182	.0070	.17	.0110	.0001	.48	0.6
35465	Apr. 22	Decided.	V. slight.	0.32	2.75	1.35	.0022	.0200	.0190	.0010	.13	.0050	.0001	.42	0.6
36565	July 29	Decided.	Cons.	1.05	3.80	2.00	.0012	.0352	.0292	.0060	.13	.0010	.0000	.70	0.8
37742	Oct. 28	V. slight.	V. slight.	0.52	3.55	1.40	.0032	.0192	.0166	.0026	.16	.0060	.0001	.48	0.6
Av...	....	....	....	0.56	3.42	1.49	.0026	.0249	.0207	.0042	.15	.0067	.0001	.52	0.6
Average of seven previous years, .				0.56	3.70	1.54	.0075	.0304	.0250	.0054	.16	.0055	.0001	.52	0.9

Odor in 1901, generally distinctly unpleasant. The sample collected in July contained a large number of organisms, consisting chiefly of *Staurastrum*.

North Pond.

	1901.														
34531	Jan. 21	V. slight.	Slight.	.51	4.00	1.55	.0068	.0254	.0228	.0026	.17	.0200	.0000	.69	0.8
35466	Apr. 22	Decided.	Cons.	.38	2.60	1.45	.0028	.0250	.0192	.0058	.14	.0100	.0001	.49	0.6
36566	July 29	Decided.	Cons.	.95	4.50	2.05	.0012	.0380	.0300	.0080	.12	.0010	.0000	.74	0.9
37743	Oct. 28	Slight.	Slight.	.72	4.10	1.65	.0020	.0300	.0270	.0030	.14	.0050	.0000	.73	0.6
Av...	....	....	....	.64	3.80	1.67	.0032	.0296	.0247	.0049	.14	.0090	.0000	.66	0.7
Average of four previous years, .				.48	3.39	1.56	.0059	.0314	.0245	.0069	.15	.0056	.0001	.59	0.7

Odor in 1901, vegetable or unpleasant. The organism *Dinobryon* was found in large numbers in the sample collected in July.

WATER SUPPLY OF NORTHFIELD. — NORTHFIELD WATER COMPANY.

Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.17	2.94	.99	.0004	.0080	.0072	.0008	.10	.0030	.0000	.33	0.6	-
Average of 6 samples collected in 1900.	.16	2.98	.93	.0002	.0056	.0053	.0003	.10	.0022	.0000	.27	0.8	-

Odor in 1901, occasionally vegetable.

NORTHBOROUGH.

Lower Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34795	Feb. 18	V. slight.	V. slight.	.43	3.95	1.25	.0030	.0188	.0158	.0030	.26	.0200	.0000	.54	1.3
35735	May 20	Slight.	Cons.	.73	3.35	1.75	.0020	.0240	.0222	.0018	.12	.0040	.0000	.75	1.0
36826	Aug. 19	Slight.	Cons.	.71	4.30	2.25	.0096	.0352	.0296	.0056	.23	.0020	.0001	.84	1.3
38011	Nov. 18	V. slight.	Slight.	.59	4.75	2.25	.0012	.0228	.0192	.0036	.23	.0050	.0000	.76	0.8
Av...	....	....	....	.61	4.09	1.87	.0039	.0252	.0217	.0035	.21	.0077	.0000	.72	1.1
Average of five previous years,			.	.67	3.62	1.56	.0016	.0222	.0192	.0030	.21	.0030	.0000	.68	0.8

Odor in February, 1901, unpleasant; at other times, distinctly vegetable. The organism *Uroglena* was found in the sample collected in November.

WATER SUPPLY OF NORTHBRIDGE. — WHITIN MACHINE WORKS.

Spring No. 2.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 9 samples collected in 1901.	.09	2.97	-	.0002	.0058	-	-	.25	.0169	.0000	.19	0.6	.0052

Spring No. 3.

Average of 4 samples collected in 1901.	.12	3.45	-	.0000	.0060	-	-	.19	.0075	.0000	.25	0.9	.0072

Water examined in Connection with Advice to the Whitin Machine Works.

(See also page 41.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
35986	June 10	None.	V. slight.	.30	2.60	0.90	.0010	.0106	.0086	.0020	.14	.0020	.0001	.40	0.0
36107	June 24	V. slight.	V. slight.	.32	2.80	1.15	.0004	[illegible]	.0082	.0006	.17	.0020	.0000	.46	0.2

Odor of the first sample, distinctly unpleasant. —— The samples were collected from Cook Allen Brook, at site of proposed reservoir.

ORANGE.

Water Supply of Orange.

Distributing Reservoir.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as				
					Albuminoid.								
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 3 samples collected in 1901.	.03	2.82	0.82	.0013	.0089	.0072	.0017	.12	.0020	.0001	.25	0.4	-
Average of seven previous years, .	.18	3.16	0.99	.0007	.0086	.0071	.0015	.13	.0028	.0000	.24	0.7	-

Water Supply of Palmer Fire District. — Palmer Water Company.

Lower Reservoir.

[Parts per 100,000.]

		Appearance.			Residue on Evaporation.		Ammonia.					Nitrogen as			
								Albuminoid.							
Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
35149	Mar. 18	Decided.	Cons.	.13	3.40	0.90	.0004	.0100	.0082	.0018	.13	.0030	.0001	.28	0.6
36015	June 17	Slight.	Slight.	.21	3.20	0.85	.0000	.0166	.0128	.0038	.14	.0030	.0000	.36	0.6
37272	Sept. 20	Slight.	Slight.	.43	3.90	1.65	.0002	.0136	.0130	.0006	.13	.0000	.0000	.49	1.1
38338	Dec. 16	Slight.	Slight.	.39	3.30	1.30	.0018	.0146	.0134	.0012	.15	.0030	.0000	.39	0.5

Averages by Years.

-	1897	-	-	.32	3.27	1.00	.0012	.0105	.0092	.0013	.12	.0038	.0000	.28	0.9
-	1898	-	-	.33	3.45	1.35	.0009	.0126	.0097	.0029	.13	.0022	.0001	.30	0.8
-	1899	-	-	.25	3.30	0.95	.0006	.0142	.0118	.0024	.13	.0025	.0000	.32	0.5
-	1900	-	-	.22	3.46	1.09	.0008	.0212	.0169	.0043	.14	.0047	.0001	.34	0.5
-	1901	-	-	.29	3.45	1.17	.0006	.0137	.0118	.0019	.14	.0022	.0000	.38	0.7

Odor in 1901, generally vegetable.

Water examined in Connection with Advice relative to a Proposed Source of Spring Water Supply. (See also page 42.)

[Parts per 100,000.]

		Appearance.				Ammonia.			Nitrogen as				
Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
36222	July 2	None.	None.	.00	2.90	.0000	.0020	.09	.0060	.0000	.01	0.6	.0050

The sample was collected from a spring at the village of Three Rivers.

Water Supply of Peabody.

Brown's Pond.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.17	3.01	1.47	.0013	.0183	.0153	.0030	.53	.0055	.0001	.32	0.7	-
Average of six previous years, .	.15	2.96	1.12	.0009	.0167	.0142	.0025	.55	.0036	.0000	.28	0.6	-

Odor in August, 1901, distinctly unpleasant; at other times, vegetable.

Spring Pond.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.04	4.21	1.27	.0124	.0146	.0119	.0027	.64	.0015	.0000	.15	1.7	-
Average of seven previous years, .	.03	3.82	1.15	.0022	.0145	.0114	.0031	.67	.0023	.0000	.17	1.4	-

Odor in 1901, sometimes vegetable.

Water examined in Connection with Advice to the Town Authorities. (See also page 42.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
36633	Aug. 3	Decided.	Heavy.	1.40	17.60	.0860	.0040	.28	.0010	.0000	.28	3.8	.7120
37136	Sept. 10	Decided.	Slight.	2.00	10.30	.0760	.0026	.30	.0040	.0001	.27	3.5	.6920

The samples were collected from a well in the basement of a schoolhouse in West Peabody.

Pembroke.

Silver Lake.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34671	Feb. 5	None.	V. slight.	.05	3.05	1.05	.0000	.0126	.0110	.0016	.62	.0050	.0000	.24	0.3
35844	June 4	V. slight.	V. slight.	.15	2.75	0.85	.0000	.0112	.0102	.0010	.60	.0010	.0000	.32	0.5
36661	Aug. 6	None.	None.	.12	2.80	1.10	.0010	.0128	.0116	.0012	.59	.0020	.0001	.34	0.3
37452	Oct. 1	V. slight.	V. slight.	.00	3.75	2.05	.0014	.0162	.0154	.0008	.57	.0020	.0001	.45	0.8
38212	Dec. 3	V. slight.	Slight.	.07	3.25	1.50	.0010	.0188	.0120	.0068	.60	.0000	.0000	.21	0.3

PEMBROKE.

Silver Lake — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
-	1898	-	-	.16	2.98	1.18	.0005	.0136	.0115	.0021	.64	.0007	.0000	.27	0.7
-	1899	-	-	.13	3.02	1.15	.0007	.0128	.0119	.0009	.63	.0020	.0000	.28	0.4
-	1900	-	-	.09	2.80	0.89	.0007	.0123	.0112	.0011	.64	.0020	.0000	.25	0.3
-	1901	-	-	.08	3.12	1.31	.0007	.0143	.0120	.0023	.60	.0020	.0000	.31	0.4

Odor in 1901, occasionally faintly vegetable when heated. —— This lake is not used as a source of water supply.

Oldham Pond.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34789	Feb. 17	V. slight.	Slight.	.30	3.80	1.25	.0010	.0276	.0220	.0056	.72	.0040	.0000	.40	0.6
35665	May 12	V. slight.	Cons.	.36	3.50	1.50	.0026	.0226	.0184	.0042	.56	.0020	.0000	.41	0.3
36930	Aug. 25	Slight.	Cons.	.24	3.50	1.55	.0004	.0214	.0192	.0022	.55	.0010	.0000	.42	0.5
37939	Nov. 12	V. slight.	V. slight.	.22	3.65	1.90	.0006	.0202	.0174	.0028	.59	.0010	.0000	.40	0.5

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1898	-	-	.41	3.78	1.70	.0011	.0205	.0174	.0031	.61	.0011	.0000	.47	0.6
-	1899	-	-	.27	3.55	1.24	.0017	.0208	.0183	.0025	.61	.0027	.0000	.43	0.5
-	1900	-	-	.21	3.59	1.05	.0013	.0217	.0180	.0037	.62	.0017	.0000	.37	0.4
-	1901	-	-	.28	3.61	1.55	.0011	.0229	.0192	.0037	.60	.0020	.0000	.41	0.5

Odor in February, 1901, faintly vegetable, becoming unpleasant and fishy on heating; in May, faintly unpleasant; at other times, faintly vegetable, becoming stronger on heating. —— This pond is not used as a source of water supply.

Water Supply of Pittsfield.

Sacket Brook Reservoir.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
35183	Mar 20	V. slight.	Slight.	.08	6.50	2.10	.0028	.0152	.0142	.0010	.15	.0240	.0000	.22	5.4
36055	June 19	V. slight.	V. slight.	.02	6.80	1.65	.0022	.0086	.0076	.0010	.11	.0060	.0000	.24	5.7
37344	Sept. 23	V. slight.	V. slight.	.05	8.60	2.90	.0042	.0154	.0126	.0028	.09	.0080	.0001	.27	6.9
38381	Dec. 17	V. slight.	V. slight.	.12	4.45	1.45	.0006	.0096	.0082	.0014	.08	.0140	.0000	.23	3.5

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1896	-	-	.10	6.80	1.20	.0005	.0077	.0064	.0013	.09	.0127	.0000	.16	5.7
-	1897	-	-	.11	6.27	1.19	.0011	.0093	.0083	.0010	.11	.0112	.0000	.14	4.8
-	1898	-	-	.17	5.79	1.34	.0004	.0081	.0070	.0011	.08	.0087	.0000	.22	4.2
-	1899	-	-	.21	6.74	1.71	.0010	.0152	.0138	.0014	.08	.0087	.0001	.34	4.7
-	1900	-	-	.03	7.19	1.21	.0028	.0155	.0134	.0021	.10	.0137	.0000	.11	5.8
-	1901	-	-	.07	6.59	2.02	.0024	.0122	.0106	.0016	.11	.0130	.0000	.24	5.4

PITTSFIELD.

Sacket Brook, near Pumping Station.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
35182	Mar. 20	Slight.	Cons.	.08	9.60	2.50	.0008	.0174	.0126	.0048	.10	.0110	.0001	.26	8.0
36054	June 19	V. slight.	V. slight.	.03	9.10	2.20	.0010	.0132	.0120	.0012	.12	.0170	.0000	.20	7.9
37345	Sept. 23	None.	V. slight.	.04	12.35	3.60	.0058	.0100	.0082	.0018	.09	.0130	.0001	.18	10.5
38380	Dec. 17	V. slight.	Slight.	.08	6.50	2.00	.0010	.0122	.0086	.0036	.10	.0180	.0000	.21	4.9

Averages by Years.

-	1896	-	-	.13	9.80	1.57	.0005	.0062	.0051	.0011	.10	.0145	.0000	.10	9.0
-	1897	-	-	.05	9.09	1.65	.0014	.0062	.0048	.0014	.08	.0127	.0000	.09	7.1
-	1898	-	-	.11	8.52	1.80	.0003	.0056	.0045	.0011	.07	.0155	.0000	.16	7.0
-	1899	-	-	.12	9.02	1.67	.0018	.0092	.0078	.0014	.12	.0155	.0001	.20	7.7
-	1900	-	-	.03	10.46	1.79	.0021	.0190	.0114	.0076	.10	.0175	.0000	.09	9.4
-	1901	-	-	.06	9.39	2.57	.0021	.0132	.0103	.0029	.10	.0147	.0000	.21	7.8

Odor in March, 1901, distinctly unpleasant.

Ashley Brook Reservoir.

	1901.														
35179	Mar. 20	Decided.	Cons.	.09	6.00	1.90	.0168	.0256	.0148	.0108	.11	.0200	.0000	.12	4.9
36051	June 19	None.	V. slight.	.02	7.60	1.90	.0016	.0100	.0080	.0020	.10	.0040	.0001	.24	6.6
37341	Sept. 23	None.	V. slight.	.13	8.85	3.35	.0020	.0202	.0190	.0012	.06	.0080	.0000	.36	6.9
38378	Dec. 17	V. slight.	V. slight.	.20	5.30	2.10	.0012	.0106	.0092	.0014	.08	.0100	.0000	.30	3.9

Averages by Years.

-	1896	-	-	.17	6.67	1.71	.0006	.0139	.0115	.0024	.09	.0133	.0000	.28	5.3
-	1897	-	-	.21	5.70	1.37	.0008	.0103	.0094	.0009	.09	.0070	.0000	.27	4.1
-	1898	-	-	.17	6.72	1.70	.0002	.0068	.0062	.0006	.07	.0122	.0000	.23	5.1
-	1899	-	-	.19	6.30	1.56	.0015	.0109	.0098	.0011	.08	.0095	.0000	.33	4.6
-	1900	-	-	.08	5.96	1.52	.0029	.0165	.0157	.0008	.10	.0095	.0000	.22	4.4
-	1901	-	-	.11	6.94	2.31	.0054	.0166	.0127	.0039	.09	.0105	.0000	.25	5.6

Odor in March, 1901, faintly unpleasant; in September, vegetable. The organism *Uroglena* was found in the sample collected in June.

PITTSFIELD.

Hathaway Brook Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.09	7.77	2.34	.0020	.0111	.0101	.0010	.12	.0132	.0000	.20	6.4	-
Average of five previous years,	.06	8.47	1.70	.0004	.0072	.0061	.0011	.10	.0152	.0000	.12	7.2	-

Mill Brook Reservoir.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.03	5.29	1.44	.0030	.0079	.0055	.0024	.09	.0085	.0000	.18	3.8	-
Average of five previous years,	.05	5.13	0.92	.0006	.0060	.0051	.0009	.08	.0090	.0000	.10	3.6	-

Water and Ice examined in Connection with Advice to the Morewood Lake Ice Company. (See also page 108.)

Water.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36914	Aug. 23	V. slight.	Slight.	.12	13.20	3.80	.0016	.0180	.0156	.0024	.12	.0020	.0001	.42	7.1
36915	Aug. 23	V. slight.	Slight.	.10	13.50	3.65	.0028	.0158	.0144	.0014	.11	.0010	.0001	.39	11.1

Ice.

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
36909	Aug. 23	None.	V. slight.	.00	0.72	-	.0064	.0036	-	-	.005	.0040	.0002	.02	0.0
36910	Aug. 23	None.	V. slight.	.00	0.32	-	.0048	.0032	-	-	.000	.0020	.0002	.02	0.0

Odor of Nos. 36914 and 36915, faintly vegetable, becoming stronger on heating. —— The first sample of water was collected from the inlet of Morewood Lake; the second from the lake near its outlet. The samples of ice were taken from the ice house, the first being from the top of the cake and the second from the bottom of the cake. Bacteria per cubic centimeter in No. 36909, 39; in No. 36910, 9.

PLYMOUTH.

WATER SUPPLY OF PLYMOUTH.

Little South Pond.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.01	2.41	0.96	.0006	.0146	.0132	.0014	.70	.0022	.0000	.10	0.1	-
Average of seven previous years, .	.03	2.51	0.82	.0009	.0151	.0129	.0022	.68	.0016	.0000	.12	0.2	-

Odor in 1901, generally faintly vegetable when heated.

WATER SUPPLY OF PROVINCETOWN.

Open Basin.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34326	Jan. 2	Decided.	Cons.	-	11.00	.0288	.0150	2.68	.0030	.0001	.70	2.9	.9000
34684	Feb. 6	Decided.	Heavy.	-	12.00	.0156	.0200	2.74	.0050	.0001	.86	3.0	.5200
35011	Mar. 6	Decided.	Cons.	-	11.50	.0252	.0162	2.57	.0040	.0002	.63	3.4	.4800
35323	Apr. 3	Decided.	Cons.	-	11.50	.0218	.0192	2.56	.0020	.0001	.80	3.4	.5600
35589	May 1	Decided.	Cons.	-	10.00	.0090	.0190	2.71	.0080	.0003	.61	2.6	.2000
35868	June 5	Slight.	Cons.	0.70	9.40	.0072	.0384	2.45	.0040	.0001	.84	1.8	.0550
36205	July 1	Decided.	Cons.	0.70	9.00	.0112	.0500	2.16	.0120	.0002	.65	1.4	.0640
36688	Aug. 7	Slight.	Cons.	0.90	9.40	.0014	.0164	2.45	.0080	.0002	.63	1.6	.1160
37080	Sept. 3	Decided.	Cons.	0.85	9.00	.0012	.0134	2.20	.0040	.0002	.64	1.6	.1360
37442	Oct. 1	Decided.	Cons.	-	10.50	.0002	.0214	2.60	.0040	.0002	.79	2.6	.4200
37885	Nov. 7	Decided.	Cons.	-	13.10	.0250	.0178	2.63	.0040	.0000	.98	3.5	.4800
38243	Dec. 4	Decided.	Heavy.	-	11.60	.0256	.0186	2.69	.0020	.0000	.90	3.3	.6400

Averages by Years.

-	1898	-	-	0.66	9.42	.0054	.0151	2.50	.0047	.0001	.62	2.1	.2289
-	1899	-	-	1.18	10.97	.0159	.0194	2.58	.0048	.0001	.77	2.8	.4433
-	1900	-	-	0.91	10.89	.0139	.0168	2.71	.0077	.0001	.70	2.6	.3774
-	1901	-	-	-	10.67	.0143	.0221	2.54	.0050	.0001	.75	2.6	.3809

QUINCY.

Water Supply of Quincy.

(See *Metropolitan Water District*, pages 120-123.)

Water Supply of Randolph and Holbrook.

Great Pond in Randolph and Braintree.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Suspended.						
Average of 12 samples collected in 1901.	.45	4.02	1.72	.0012	.0193	.0182	.0011	.49	.0046	.0000	.61	1.1	-
Average of seven previous years, .	.46	4.06	1.64	.0009	.0194	.0171	.0023	.54	.0041	.0000	.52	1.0	-

Odor in 1901, generally vegetable and occasionally unpleasant. The organism *Dinobryon* was found in the samples collected in March and April.

Water Supply of Reading.

Filter Gallery.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
34372	Jan. 8	Decided.	Cons.	0.70	10.30	.0112	.0104	.51	.0070	.0000	.47	3.9	.2000
34721	Feb. 12	Decided.	Cons.	0.35	12.20	.0106	.0088	.46	.0100	.0000	.41	4.9	.3000
35059	Mar. 12	Decided.	Cons.	0.50	9.90	.0122	.0082	.45	.0090	.0000	.40	5.3	.1500
35389	April 10	Decided.	Heavy.	0.33	11.00	.0060	.0090	.46	.0060	.0001	.52	3.4	.4500
35599	May 6	Decided.	V. slight.	0.70	7.80	.0082	.0096	.38	.0100	.0000	.44	3.0	.1200
35891	June 10	Decided.	Cons.	-	8.20	.0108	.0208	.37	.0070	.0000	.77	2.7	.1900
36266	July 8	Decided.	Cons.	-	8.00	.0090	.0172	.40	.0040	.0000	.76	2.3	.1300
36696	Aug. 12	Decided.	Heavy.	-	8.60	.0020	.0110	.42	.0030	.0001	.82	2.6	.1640
37125	Sept. 9	Decided.	Cons.	1.20	8.60	.0024	.0180	.41	.0030	.0001	.81	2.5	.1280
37493	Oct. 6	Decided.	Cons.	0.70	8.00	.0106	.0108	.42*	.0040	.0000	.57	2.7	.2000
37905	Nov. 11	Decided.	Cons.	0.70	9.60	.0110	.0120	.45	.0020	.0000	.57	3.3	.2300
38253	Dec. 9	Decided.	Cons.	0.70	9.80	.0106	.0098	.45	.0050	.0002	.43	2.9	.2200

Averages by Years.

-	1891	-	-	0.13	12.96	.0016	.0063	.48	.0094	.0001	-	5.1	-
-	1892	-	-	0.44	9.25	.0042	.0073	.54	.0071	.0001	-	3.4	-
-	1893	-	-	0.64	10.08	.0034	.0087	.56	.0032	.0001	.35	3.9	.1251
-	1894	-	-	0.45	12.76	.0043	.0107	.68	.0029	.0000	.35	5.0	.2642
-	1895	-	-	0.61	13.88	.0088	.0114	.72	.0048	.0000	.44	5.5	.2277
-	1896	-	-	0.52	11.50	.0080	.0089	.51	.0059	.0001	.40	4.1	.2696
-	1897	-	-	0.76	11.12	.0090	.0110	.53	.0058	.0001	.44	4.0	.2644
-	1898	-	-	0.82	9.61	.0095	.0141	.44	.0003	.0000	.64	3.0	.2254
-	1899	-	-	0.67	7.80	.0099	.0109	.44	.0025	.0000	.50	2.4	.1721
-	1900	-	-	0.59	9.27	.0105	.0098	.45	.0041	.0000	.43	2.9	.2497
-	1901	-	-	0.65	9.33	.0087	.0121	.43	.0058	.0000	.58	3.3	.2068

READING.

Water of Filter Gallery after passing through the Mechanical Filter.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
34373	Jan. 8	None.	None.	.12	16.10	.0056	.0090	.51	.0060	.0007	.20	8.6	.0050
34722	Feb. 12	V. slight.	None.	.09	15.90	.0066	.0062	.51	.0070	.0011	.20	7.7	.0080
35060	Mar. 12	None.	None.	.04	16.40	.0068	.0060	.47	.0050	.0011	.21	8.9	.0550
35390	Apr. 10	None.	V. slight.	.11	16.20	.0060	.0098	.48	.0080	.0016	.20	9.0	.0060
35600	May 6	None.	None.	.19	13.50	.0062	.0072	.42	.0060	.0012	.29	8.4	.0080
35892	June 10	V. slight.	None.	.40	15.50	.0090	.0178	.38	.0050	.0010	.48	9.9	.0180
36267	July 8	V. slight.	None.	.39	17.20	.0076	.0130	.42	.0030	.0013	.51	10.5	.0150
36697	Aug. 12	V. slight.	V. slight.	.26	15.90	.0112	.0172	.46	.0020	.0032	.41	8.9	.0140
37126	Sept. 9	V. slight.	None.	.22	16.90	.0024	.0062	.46	.0050	.0016	.44	9.3	.0050
37494	Oct. 6	None.	None.	.25	16.20	.0070	.0086	.44	.0030	.0009	.37	9.7	.0130
37906	Nov. 11	V. slight.	None.	.26	16.40	.0104	.0090	.50	.0040	.0001	.40	9.3	.0150
38254	Dec. 9	None.	None.	.22	16.40	.0086	.0076	.46	.0050	.0005	.31	9.3	.0180

Averages by Years.

Number.	Year.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1896	-	-	.15	19.42	.0035	.0067	.56	.0043	.0016	.24	11.3	.0091
-	1897	-	-	.23	18.54	.0034	.0084	.52	.0082	.0010	.29	12.7	.0037
-	1898	-	-	.27	16.82	.0028	.0103	.45	.0060	.0006	.34	10.0	.0132
-	1899	-	-	.23	14.60	.0040	.0080	.45	.0042	.0016	.32	8.4	.0084
-	1900	-	-	.14	14.59	.0053	.0073	.47	.0046	.0015	.25	7.9	.0082
-	1901	-	-	.21	16.05	.0073	.0098	.46	.0049	.0012	.33	9.1	.0150

Water Supply of Revere.

(See *Metropolitan Water District*, pages 120–123.)

Water Supply of Rockland.

(See *Abington*.)

Water Supply of Rockport.

Cape Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1901.														
35036	Mar. 8	Slight.	Slight.	.13	10.65	1.85	.0022	.0298	.0248	.0050	4.23	.0050	.0000	.38	1.6
35412	Apr. 15	Decided.	Cons.	.24	9.85	2.35	.0012	.0278	.0200	.0078	3.94	.0030	.0000	.33	1.4
36164	June 29	Decided.	Cons.	.36	11.00	2.50	.0570	.0460	.0340	.0120	4.18	.0030	.0003	.47	1.1
36953	Aug. 26	Decided.	Cons.	.20	10.20	2.15	.0090	.0276	.0206	.0070	3.69	.0020	.0005	.31	1.1
37766	Oct. 28	Decided.	Cons.	.34	10.55	3.15	.0340	.0356	.0240	.0116	3.81	.0050	.0002	.61	1.3
38511	Dec. 30	Decided.	Slight.	.50	9.95	2.10	.0046	.0262	.0220	.0042	3.82	.0050	.0001	.51	1.4
Av...	....	....	....	.29	10.37	2.35	.0180	.0322	.0242	.0080	3.94	.0038	.0002	.43	1.3
Average of seven previous years, . .				.29	11.21	2.05	.0026	.0280	.0196	.0084	4.75	.0033	.0000	.32	1.1

Odor in 1901, vegetable or unpleasant, becoming stronger on heating. Large numbers of organisms were found in many of the samples, consisting chiefly of *Melosira*.

RUTLAND.

Water Supply of Rutland.

Mushcopauge Lake.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1901.														
34836	Feb. 20	V. slight.	V. slight.	.01	2.55	0.90	.0022	.0250	.0228	.0022	.22	.0050	.0001	.19	0.6
36158	June 27	Slight.	Slight.	.05	2.25	0.75	.0028	.0210	.0176	.0034	.17	.0020	.0000	.24	0.3
38195	Nov. 30	V. slight.	None.	.10	2.25	0.65	.0006	.0120	.0110	.0010	.15	.0000	.0000	.05	0.3
Av...	....	....	....	.05	2.35	0.77	.0019	.0193	.0171	.0022	.18	.0023	.0000	.16	0.4
Average of four previous years,				.05	2.22	0.85	.0032	.0146	.0121	.0025	.17	.0029	.0000	.16	0.6

Odor in February and June, 1901, unpleasant. The organism *Dinobryon* was found in large numbers in the sample collected in February.

Water Supply of Salem and Beverly. (See also pages 43, 45.)

Wenham Lake in Beverly and Wenham.

	1901.														
34378	Jan. 8	V. slight.	Slight.	.09	5.50	1.35	.0076	.0166	.0146	.0020	.82	.0060	.0000	.22	2.7
34728	Feb. 12	V. slight.	Cons.	.08	5.85	1.50	.0074	.0174	.0128	.0046	.84	.0130	.0002	.33	2.8
35075	Mar. 12	V. slight.	Slight.	.08	6.10	1.50	.0068	.0160	.0144	.0016	.82	.0100	.0001	.25	2.7
35355	Apr. 9	Slight.	Slight.	.12	5.35	1.70	.0038	.0186	.0154	.0032	.65	.0100	.0001	.30	2.8
35613	May 7	Slight.	Cons.	.20	4.95	1.40	.0036	.0186	.0180	.0006	.75	.0100	.0001	.35	2.1
35949	June 11	V. slight.	Cons.	.22	5.25	1.90	.0014	.0264	.0210	.0054	.70	.0080	.0002	.38	2.1
36303	July 9	V. slight.	Slight.	.22	5.40	2.00	.0036	.0224	.0210	.0014	.66	.0030	.0001	.41	2.1
36733	Aug. 13	Slight.	Cons.	.12	5.65	2.35	.0014	.0186	.0158	.0028	.63	.0020	.0001	.35	2.0
37138	Sept. 10	V. slight.	Cons.	.09	5.10	2.10	.0006	.0198	.0164	.0034	.60	.0020	.0000	.34	2.3
37513	Oct. 8	V. slight.	Slight.	.05	5.10	1.85	.0010	.0178	.0150	.0028	.69	.0020	.0001	.36	2.5
37923	Nov. 12	Slight.	Cons.	.13	5.75	2.25	.0104	.0228	.0176	.0052	.68	.0030	.0001	.35	2.3
38281	Dec. 10	V. slight.	Cons.	.08	5.50	2.15	.0012	.0160	.0122	.0038	.71	.0030	.0001	.27	2.2

Averages by Years.

-	1888	-	-	.05	-	-	.0020	.0146	-	-	.73	.0058	.0001	-	-
-	1889	-	-	.06	-	-	.0014	.0173	.0138	.0035	.72	.0052	.0002	-	-
-	1890	-	-	.05	-	-	.0016	.0154	.0125	.0029	.74	.0104	.0001	-	2.5
-	1891	-	-	.07	4.70	1.12	.0006	.0147	.0113	.0034	.72	.0125	.0000	-	1.9
-	1892	-	-	.08	4.85	1.10	.0016	.0137	.0103	.0034	.75	.0077	.0000	-	2.2
-	1893	-	-	.04	5.49	1.26	.0033	.0130	.0100	.0030	.77	.0055	.0001	.16	2.6
-	1894	-	-	.07	6.69	1.53	.0030	.0148	.0114	.0034	.82	.0023	.0001	.14	3.0
-	1895	-	-	.21	6.75	1.97	.0026	.0177	.0146	.0031	.81	.0059	.0001	.30	3.1
-	1896	-	-	.15	6.30	1.82	.0020	.0213	.0152	.0061	.80	.0053	.0001	.28	2.7
-	1897	-	-	.13	6.09	1.60	.0027	.0206	.0170	.0036	.82	.0048	.0001	.29	2.7
-	1898	-	-	.15	5.61	1.73	.0025	.0181	.0151	.0030	.80	.0040	.0001	.29	2.3
-	1899	-	-	.13	5.37	1.70	.0043	.0184	.0155	.0029	.73	.0069	.0002	.27	2.1
-	1900	-	-	.10	5.31	1.32	.0059	.0187	.0145	.0042	.74	.0055	.0001	.26	2.2
-	1901	-	-	.12	5.46	1.84	.0041	.0193	.0162	.0031	.71	.0060	.0001	.33	2.3

Odor in 1901, generally faintly vegetable, becoming stronger, and frequently distinctly unpleasant, on heating. The organism *Anabæna* was found in the samples collected in the months from June to October, inclusive. Large numbers of organisms were found in many of the other samples.

SALEM AND BEVERLY.

Longham Brook, in Beverly and Wenham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34377	Jan. 8	Slight.	Cons.	0.59	8.50	2.60	.0084	.0280	.0190	.0090	1.29	.0960	.0001	0.77	2.7
34727	Feb. 12	Slight.	Slight.	1.20	8.25	3.00	.0116	.0376	.0316	.0060	1.14	.0390	.0002	1.31	2.9
35074	Mar. 12	Decided.	Cons.	1.10	5.25	2.35	.0252	.0560	.0488	.0072	0.66	.0040	.0001	1.13	1.0
35354	Apr. 9	V. slight.	Slight.	0.72	4.20	1.70	.0026	.0212	.0190	.0022	0.61	.0060	.0000	0.78	1.1
35612	May 7	V. slight.	Slight.	1.06	4.60	2.00	.0014	.0234	.0228	.0006	0.78	.0010	.0000	1.02	1.1
35948	June 11	V. slight.	Cons.	1.70	6.45	3.45	.0038	.0468	.0412	.0056	0.91	.0060	.0002	1.60	1.7
36302	July 9	Slight.	Cons.	1.05	8.30	2.95	.0200	.0380	.0324	.0056	1.23	.0050	.0010	0.90	2.0
36732	Aug. 13	Slight.	Cons.	1.10	8.25	3.70	.0044	.0412	.0380	.0032	1.09	.0040	.0008	1.29	2.5
37137	Sept. 10	Slight.	Cons.	0.68	7.90	2.75	.0036	.0296	.0280	.0016	1.29	.0070	.0004	0.75	2.5
37512	Oct. 8	V. slight.	Slight.	0.76	8.20	3.95	.0032	.0308	.0296	.0012	1.14	.0000	.0001	1.14	2.2
37922	Nov. 12	V. slight.	Slight.	0.72	8.55	3.30	.0060	.0268	.0252	.0016	1.13	.0400	.0001	0.89	2.5
38280	Dec. 10	Decided.	Cons.	0.84	6.90	3.25	.0024	.0288	.0262	.0026	0.98	.0050	.0000	1.13	1.4

Averages by Years.

-	1897	-	-	1.83	6.99	3.05	.0127	.0504	.0415	.0089	0.94	.0098	.0002	1.17	1.7
-	1898	-	-	1.39	6.29	2.89	.0094	.0472	.0394	.0078	0.86	.0085	.0002	1.03	1.5
-	1899	-	-	0.76	5.53	2.26	.0079	.0361	.0293	.0068	0.75	.0073	.0001	0.73	1.2
-	1900	-	-	0.63	6.13	1.76	.0052	.0239	.0208	.0031	0.87	.0153	.0001	0.72	2.0
-	1901	-	-	0.96	7.11	2.92	.0077	.0340	.0301	.0039	1.02	.0177	.0002	1.06	2.0

Odor in 1901, distinctly vegetable or unpleasant, becoming stronger on heating.

Water examined in Connection with Advice to the City Authorities. (See also page 45.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
37741	Oct. 28	Decided.	Heavy.	-	54.70	.0032	.0104	4.47	2.5000	.0005	.83	15.4	.0800
37887	Nov. 8	Decided.	Cons.	.06	56.00	.0036	.0068	4.55	2.8800	.0006	.12	12.8	.1250

Odor of No. 37741, unpleasant.——The samples were collected from a well in the yard of the St. James School.

SALISBURY.

Water examined in Connection with Advice to E. P. Shaw. (See also page 45.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
34268	1900. Dec. 31	Slight.	Cons.	.02	64.80	.0256	.0014	26.15	.0020	.0000	.10	18.8	.0600

The sample was collected from a tubular well near Salisbury Beach.

WATER SUPPLY OF SAUGUS.

(See *Lynn.*)

WATER SUPPLY OF SHARON.

Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	9.50	-	.0002	.0011	-	-	1.15	.2733	.0000	.01	3.5	.0045
Average of three previous years, .	.01	9.18	-	.0002	.0009	-	-	1.10	.2450	.0000	.02	3.2	.0058

WATER SUPPLY OF SHEFFIELD. — SHEFFIELD WATER COMPANY.

Spring.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	3.48	-	.0002	.0007	-	-	.07	.0075	.0000	.02	1.7	.0098

WATER SUPPLY OF SOMERVILLE.

(See *Metropolitan Water District*, pages 120–123.)

SOMERVILLE.

Water examined in Connection with Advice to the Somerville Iron Foundry. (See also page 46.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
34940	1901. Mar. 4	V. slight.	V. slight.	.08	29.50	.0122	.0114	2.80	.6400	.0015	.19	8.9	.0250

Odor, earthy. —— The sample was collected from a faucet supplied from a driven well on the factory grounds.

SOUTHBOROUGH.

Waters examined in Connection with Advice to the School Committee. (See also page 47.)

37750	1901. Oct. 28	V. slight.	V. slight.	.02	29.00	.0042	.0018	1.48	.8000	.0032	.06	11.1	.0200
37751	Oct. 28	None.	V. slight.	.00	22.60	.0002	.0078	2.01	.8400	.0004	.04	8.9	.0040

The first sample was collected from a tubular well supplying the high school building; the last from a dug well on the premises of C. P. Jones, M.D.

WATER SUPPLY OF SOUTHBRIDGE. — SOUTHBRIDGE WATER SUPPLY COMPANY.

Hatchet Brook Storage Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.37	3.15	1.35	.0023	.0169	.0152	.0017	.18	.0025	.0000	.50	0.8	-
Average of four previous years, .	.48	3.41	1.60	.0027	.0227	.0180	.0047	.15	.0023	.0000	.59	0.6	-

Odor in March, 1901, decidedly unpleasant and fishy when heated; in September and December, faintly vegetable, becoming stronger on heating. The organism *Uroglena* was found in the sample collected in March.

SOUTHBRIDGE.

Waters examined in Connection with Advice to the Southbridge Water Supply Company. (See also page 48.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
36201	July 1	None.	V. slight.	.00	2.40	.0000	.0062	0.16	.0030	.0000	.02	1.4	.0060
36202	July 1	None.	V. slight.	.00	17.80	.0000	.0030	1.88	.7400	.0000	.02	6.6	.0050

The first sample was collected from a spring just below reservoir No. 1 of the Southbridge Water Supply Company; the last, from Glover Spring, on High Street.

Water examined in Connection with Advice to the Town Authorities. (See also page 47.)

	1901.												
38173	Nov. 29	None.	V. slight.	.02	5.60	.0000	.0078	.49	.0600	.0000	.01	2.2	.0050

The sample was collected from the spring of the Southbridge Village Aqueduct Company.

Water Supply of South Hadley Falls Fire District.

Leaping Well Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.02	2.60	0.87	.0029	.0155	.0095	.0060	.12	.0010	.0000	.11	0.6	-
Average of four previous years, .	.09	2.79	0.94	.0014	.0136	.0102	.0034	.13	.0036	.0000	.10	0.6	-

Odor in May, 1901, faintly unpleasant. The organism *Anabæna* was found in this sample.

Buttery Brook Reservoir.

Average of 4 samples collected in 1901.	.13	3.76	1.29	.0037	.0133	.0093	.0040	.21	.0240	.0002	.17	0.9	-

Odor in January and November, unpleasant; at other times, vegetable.

SOUTH HADLEY.

Water and Ice examined in Connection with Advice to Charles Huot. (See also page 109.)

Water.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36128	June 26	Decided.	Cons.	.24	10.10	3.35	.0396	.0244	.0096	.0148	1.25	.1950	.0028	.22	3.0

Ice.

	1901.														
36537	July 24	None.	Slight.	.00	1.38	-	.0014	.0018	-	-	.005	.0000	.0004	.03	0.0
36538	July 24	None.	V. slight.	.00	0.42	-	.0014	.0010	-	-	.000	.0000	.0008	.03	0.0

The sample of water was collected from the main feeder of Huot's ice pond. The samples of ice were taken from the ice-house, the first being from the top of the cake, and the second from the bottom of the cake. A sample of ice examined on June 26, 1901, contained 322 bacteria per cubic centimeter in the top of the cake and 30 in the bottom of the cake.

Waters examined in Connection with Advice to H. E. Gaylord relative to Ice Supply. (See also page 111.)

	1901.														
34461	Jan. 15	V. slight.	V. slight.	0.07	7.00	0.70	.0160	.0064	.0062	.0002	.64	.1850	.0005	.12	5.1
34581	Jan. 24	Slight.	V. slight.	0.06	8.80	2.65	.0172	.0084	.0074	.0010	.67	.1220	.0005	.10	3.8
36130	June 26	Decided.	Cons.	0.26	8.50	2.50	.0090	.0280	.0240	.0040	.62	.0300	.0024	.33	4.3
34460	Jan. 15	Decided.	Cons.	1.30	8.00	1.75	.0448	.0176	.0132	.0044	.43	.1020	.0006	.25	4.0
36131	June 26	V. slight.	Cons.	0.07	4.75	1.45	.0038	.0220	.0164	.0056	.32	.0030	.0004	.20	2.0
34462	Jan. 15	Slight.	Cons.	0.08	6.95	1.10	.0244	.0080	.0056	.0024	.87	.4200	.0030	.13	4.6
36129	June 26	Decided.	Cons.	0.28	6.75	2.00	.0126	.0150	.0120	.0030	.64	.0440	.0008	.32	2.0

The first three samples were collected from a brook a short distance west of Newton Street, and about a quarter of a mile north of Granby Road; the next two, from the outlet of Smith's ice pond, which is tributary to this brook; the next, from a small tributary which enters the main stream from Flander's brick yard; the last, from a small tributary entering the main stream from the south.

Water Supply of Spencer.

Shaw Pond.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.03	2.36	0.84	.0006	.0189	.0128	.0011	.16	.0052	.0000	.10	0.6	-
Average of four previous years,	.05	2.29	0.78	.0020	.0148	.0129	.0019	.16	.0057	.0000	.14	0.6	-

SPRINGFIELD AND LUDLOW.

Water Supply of Springfield and Ludlow. (See also page 49.)

Ludlow Reservoir.

[Parts per 100,000.]

Date of Collection.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
1901.												
January,	.37	3.22	1.43	.0067	.0235	.0202	.0033	.16	.0069	.0001	.51	1.0
February,	.35	3.36	1.35	.0061	.0302	.0221	.0081	.15	.0092	.0001	.47	0.9
March,	.32	3.27	1.41	.0036	.0272	.0210	.0062	.15	.0077	.0001	.46	1.0
April,	.31	2.68	1.15	.0025	.0223	.0174	.0049	.13	.0040	.0001	.41	0.6
May,	.28	2.71	1.04	.0026	.0205	.0155	.0050	.12	.0022	.0001	.41	0.7
June,	.27	2.75	1.20	.0032	.0224	.0181	.0043	.14	.0033	.0000	.38	0.6
July,	.27	2.75	1.32	.0059	.0215	.0179	.0036	.12	.0024	.0000	.40	0.7
August,	.34	3.17	1.64	.0133	.0722	.0341	.0381	.12	.0022	.0001	.42	0.9
September,	.28	3.33	1.80	.0144	.0662	.0312	.0350	.11	.0040	.0002	.34	0.8
October,	.18	2.68	1.23	.0037	.0210	.0166	.0044	.12	.0142	.0002	.27	0.9
November,	.12	2.37	1.09	.0016	.0180	.0156	.0024	.13	.0156	.0000	.27	0.6
December,	.12	2.40	1.24	.0012	.0190	.0148	.0042	.17	.0152	.0001	.25	0.5

Averages by Years.

1888,	.13	-	-	.0019	.0332	-	-	.12	.0047	.0001	-	-
1889,	.12	-	-	.0028	.0461	.0237	.0224	.10	.0033	.0002	-	-
1890,	.15	-	-	.0029	.0387	.0210	.0177	.10	.0065	.0001	-	0.9
1891,	.20	3.00	1.42	.0050	.0425	.0228	.0197	.09	.0050	.0001	-	0.8
1894,	.37	3.39	1.47	.0009	.0221	.0165	.0056	.16	.0018	.0000	.42	1.1
1895,	.29	3.35	1.55	.0028	.0315	.0201	.0114	.18	.0030	.0000	.41	1.1
1896,	.26	3.25	1.41	.0042	.0404	.0220	.0184	.15	.0031	.0000	.37	1.0
1897,	.33	3.28	1.67	.0039	.0453	.0267	.0186	.15	.0028	.0000	.43	0.8
1898,	.29	2.90	1.44	.0020	.0373	.0218	.0155	.15	.0016	.0000	.38	0.7
1901,	.27	2.89	1.32	.0054	.0304	.0204	.0100	.13	.0072	.0001	.38	0.8

Odor in January, February, July, October, November and December, 1901, faintly vegetable, becoming stronger on heating; in August and September, decidedly disagreeable; in March and April, unpleasant when heated; in May and June, vegetable when heated. —— Each analysis is the average of analyses of samples collected weekly from the reservoir. For the results of microscopical examinations of the water of Ludlow Reservoir, see paper on "Results of Filtration Experiments at Ludlow," in a subsequent portion of this report.

SPRINGFIELD AND LUDLOW.

Receiving Basin at Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1900.														
34292	Dec. 31	V. slight.	V. slight.	.28	3.75	1.00	.0008	.0110	.0102	.0008	.17	.0100	.0000	.38	1.3
	1901.														
34458	Jan. 15	V. slight.	Slight.	.22	3.30	1.15	.0020	.0132	.0090	.0042	.15	.0120	.0000	.39	1.1
34669	Feb. 5	V. slight.	V. slight.	.20	3.70	1.25	.0016	.0092	.0082	.0010	.14	.0200	.0000	.25	1.3
34977	Mar. 4	Slight.	Slight.	.25	4.25	1.15	.0080	.0196	.0166	.0030	.19	.0150	.0003	.35	1.3
36256	July 8	Slight.	Slight.	.36	3.25	1.65	.0038	.0214	.0194	.0020	.12	.0020	.0001	.44	1.0
36791	Aug. 15	Slight.	Cons.	.37	4.25	1.75	.0068	.0396	.0268	.0128	.14	.0010	.0000	.56	1.8
37075	Sept. 3	Slight.	Cons.	.34	3.65	1.50	.0070	.0278	.0184	.0094	.11	.0030	.0002	.58	1.1
37487	Oct. 7	V. slight.	Slight.	.42	3.80	2.20	.0024	.0216	.0200	.0016	.15	.0030	.0001	.53	0.8
37851	Nov. 5	V. slight.	V. slight.	.30	3.65	1.30	.0008	.0142	.0126	.0016	.16	.0050	.0000	.41	1.0
38219	Dec. 3	V. slight.	V. slight.	.19	3.80	1.50	.0010	.0088	.0076	.0012	.20	.0090	.0000	.20	1.1

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1891	-	-	.31	3.27	1.20	.0011	.0225	.0147	.0078	.09	.0049	.0001	-	1.0
-	1892	-	-	.44	3.79	1.39	.0004	.0164	.0127	.0037	.14	.0089	.0001	-	1.3
-	1893	-	-	.49	3.76	1.39	.0009	.0204	.0146	.0058	.15	.0026	.0001	.51	1.2
-	1894	-	-	.49	3.68	1.42	.0010	.0196	.0151	.0045	.16	.0027	.0000	.46	1.6
-	1895	-	-	.47	3.86	1.61	.0019	.0212	.0162	.0050	.18	.0050	.0000	.50	1.3
-	1896	-	-	.43	3.71	1.37	.0012	.0182	.0150	.0032	.15	.0051	.0000	.50	1.1
-	1897	-	-	.51	3.49	1.40	.0013	.0185	.0154	.0031	.16	.0051	.0000	.51	1.0
-	1898	-	-	.45	3.54	1.54	.0011	.0162	.0131	.0031	.15	.0048	.0000	.45	0.9
-	1899	-	-	.38	3.43	1.36	.0014	.0177	.0155	.0022	.13	.0044	.0000	.49	0.8
-	1900	-	-	.40	3.34	1.29	.0014	.0215	.0168	.0047	.14	.0027	.0000	.51	0.8
-	1901	-	-	.30	3.76	1.49	.0036	.0194	.0155	.0039	.15	.0077	.0001	.41	1.2

Odor in August, 1901, faintly unpleasant, becoming stronger on heating; at other times, faintly vegetable, becoming stronger on heating. The organism *Anabæna* was found in considerable numbers in the samples collected in August and September.

Jabish Brook Canal, Ludlow.

[Parts per 100,000.]

Date of Collection.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
1901.													
January,	.25	3.60	1.08	.0013	.0108	.0095	.0013	.17	.0073	.0000	.35	1.4	.0170
February,	.20	3.70	1.07	.0014	.0101	.0086	.0015	.18	.0157	.0001	.27	1.3	.0113
March,	.35	3.48	1.48	.0103	.0287	.0231	.0056	.16	.0093	.0001	.62	0.9	.0157
April,	.33	2.85	1.18	.0013	.0161	.0133	.0028	.14	.0050	.0001	.45	0.7	.0130
May,	.50	3.17	1.32	.0010	.0167	.0142	.0025	.12	.0040	.0000	.52	0.9	.0275
June,	.42	3.18	1.22	.0015	.0192	.0142	.0050	.12	.0023	.0000	.46	0.9	.0218
July,	.38	4.05	1.49	.0081	.0238	.0172	.0066	.13	.0015	.0001	.49	1.1	.0472
August,	.41	3.99	1.71	.0030	.0234	.0196	.0038	.16	.0014	.0001	.56	1.5	.0330
September,	.36	4.21	1.62	.0037	.0208	.0169	.0039	.16	.0027	.0001	.54	1.5	.0590
October,	.49	4.10	2.04	.0013	.0223	.0174	.0049	.18	.0036	.0001	.59	1.3	.0346
November,	.31	3.59	1.36	.0007	.0161	.0111	.0050	.17	.0060	.0000	.44	1.0	.0250
December,	.35	3.77	1.56	.0013	.0137	.0114	.0023	.17	.0092	.0000	.47	0.9	.0212
Average,	.36	3.64	1.43	.0029	.0185	.0147	.0038	.15	.0057	.0001	.48	1.1	.0271

Odor during the first six months, generally faintly vegetable, becoming stronger on heating; during the remainder of the year, distinctly vegetable, becoming stronger on heating. Unpleasant odors were observed in the samples collected during the latter part of July and the first of August. Each analysis is the average of analyses of samples collected weekly from the canal. For the results of microscopical examinations of the water of Jabish Brook Canal, see paper on "Results of Filtration Experiments at Ludlow," in a subsequent portion of this report.

SPRINGFIELD AND LUDLOW.

Chapin Pond, in Ludlow.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.			
Average of 9 samples collected in 1901.	.02	2.29	1.03	.0011	.0219	.0184	.0035	.11	.0020	.0001	.26	0.4	-
Average of five previous years, .	.07	2.39	0.98	.0016	.0195	.0158	.0037	.11	.0022	.0000	.24	0.5	-

Odor in January, February, March, October and November, 1901, unpleasant, becoming stronger on heating. The organism *Uroglena* was found in considerable numbers in the first three samples.

Five Mile Pond.

Average of 9 samples collected in 1901.	.04	2.66	1.14	.0052	.0229	.0203	.0026	.15	.0026	.0000	.27	0.6	-
Average of five previous years, .	.10	2.26	1.05	.0055	.0229	.0201	.0028	.14	.0020	.0000	.28	0.4	-

Odor in 1901, generally faintly vegetable or unpleasant. The organisms *Anabæna*, *Dinobryon*, *Synura* and *Uroglena* were found in many of the samples.

Loon Pond.

Average of 8 samples collected in 1901.	.02	2.52	1.02	.0010	.0185	.0168	.0017	.21	.0032	.0000	.19	0.8	-
Average of five previous years, .	.04	2.49	1.01	.0011	.0192	.0168	.0024	.22	.0026	.0000	.18	0.8	-

Odor in January and December, 1901, vegetable. The organism *Uroglena* was found in the sample collected in March.

Waters examined in Connection with Advice to the City Authorities. (See also page 48.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
36966	Aug. 27	None.	None.	.00	19.00	.0004	.0008	1.01	.0750	.0002	.01	7.9	.0040
36967	Aug. 27	None.	None.	.00	10.60	.0004	.0026	0.86	.3800	.0001	.00	3.9	.0030
36964	Aug. 27	None.	None.	.00	9.90	.0000	.0020	0.41	.1400	.0001	.00	5.1	.0020
36965	Aug. 27	Slight.	Slight.	.13	6.00	.0032	.0076	0.10	.0050	.0003	.07	3.0	.0430

The first sample was collected from Hygeia Spring, in Springfield; the second, from Ingersoll Grove Spring, in Springfield; the third, from Wilbraham Mountain Spring, in Wilbraham; the last, from Iroquois Spring, in West Springfield.

WATER SUPPLY OF STOCKBRIDGE. — STOCKBRIDGE WATER COMPANY.

Lake Averic.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Sus-pended.						
Average of 6 samples collected in 1901.	.09	6.22	1.93	.0014	.0178	.0156	.0022	.08	.0042	.0000	.27	4.0	-
Average of five previous years, .	.12	6.30	1.35	.0015	.0176	.0149	.0027	.08	.0032	.0000	.28	4.3	-

Odor in 1901, generally distinctly vegetable or unpleasant when heated. The organism *Dinobryon* was found in considerable numbers in the samples collected in October and December.

WATER SUPPLY OF STONEHAM.

(See *Metropolitan Water District*, pages 120–123, and also *Wakefield.*)

WATER SUPPLY OF STOUGHTON.

Well.

Average of 6 samples collected in 1901.	.30	4.02	-	.0008	.0104	-	-	.32	.0043	.0000	.35	0.7	.0072
Average of three previous years, .	.22	3.89	-	.0006	.0084	-	-	.35	.0043	.0000	.31	0.7	.0071

In 1901, a faintly vegetable odor was developed in some of the samples on heating.

WATER SUPPLY OF SWAMPSCOTT.

(See *Metropolitan Water District*, pages 120–123.)

WATER SUPPLY OF TAUNTON.

Assawompsett Pond, in Lakeville.

Average of 7 samples collected in 1901.	.26	3.21	1.51	.0020	.0204	.0176	.0028	.44	.0035	.0000	.50	0.5	-
Average of seven previous years, .	.35	3.34	1.45	.0008	.0189	.0163	.0026	.52	.0018	.0000	.52	0.7	-

Odor in 1901, frequently faintly vegetable. An unpleasant or vegetable odor was developed in most of the samples on heating.

Elder's Pond, in Lakeville.

Average of 7 samples collected in 1901.	.07	2.68	1.17	.0010	.0171	.0151	.0020	.46	.0036	.0000	.25	0.4	-
Average of seven previous years, .	.05	2.59	1.00	.0007	.0159	.0141	.0018	.49	.0017	.0000	.23	0.5	-

Odor in 1901, occasionally vegetable; in July, faintly unpleasant. The organism *Anabæna* was found in the sample collected in May, and *Dinobryon* in the samples collected in January and July.

TAUNTON.

Long Pond, in Lakeville.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.72	3.95	2.21	.0017	.0189	.0173	.0016	.47	.0017	.0000	.88	0.4	-
Average of eight previous years, .	.89	3.88	2.05	.0004	.0195	.0178	.0017	.49	.0012	.0000	.94	0.4	-

Odor in 1901, faintly vegetable, becoming stronger on heating.

Tewksbury State Hospital.

Waters examined in Connection with Advice relative to a Proposed Water Supply.
(See also pages 50, 51.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
36361	July 12	V. slight.	V. slight.	1.96	6.75	.0072	.0380	.23	.0030	.0000	2.26	1.4	-
36362	July 12	None.	V. slight.	0.00	3.70	.0010	.0004	.32	.0300	.0000	0.00	1.6	.0080
36474	July 24	V. slight.	V. slight.	0.00	3.30	.0000	.0004	.34	.0460	.0000	0.00	0.6	.0100
36363	July 12	None.	V. slight.	0.00	3.60	.0000	.0006	.20	.0040	.0000	0.00	1.0	.0090
36475	July 24	V. slight.	V. slight.	0.00	4.00	.0000	.0002	.19	.0030	.0000	0.00	0.8	.0180
36364	July 12	Decided.	Cons.	0.60	7.80	.0040	.0006	.20	.0040	.0000	0.04	2.0	.2800
36476	July 24	Decided.	Cons.	-	9.50	.0044	.0002	.25	.0030	.0000	0.03	2.0	.4000
37395	Sept. 26	None.	None.	0.00	3.90	.0000	.0054	.29	.0390	.0000	0.01	1.6	.0060
37400	Sept. 28	None.	None.	0.00	3.10	.0000	.0008	.29	.0180	.0000	0.01	1.3	.0050
37404	Sept. 29	None.	None.	0.00	3.00	.0000	.0008	.30	.0210	.0000	0.01	1.0	.0060
37405	Sept. 30	None.	None.	0.00	3.10	.0002	.0010	.32	.0270	.0000	0.01	1.4	.0180
37430	Oct. 1	None.	None.	0.00	3.40	.0000	.0006	.32	.0300	.0001	0.01	0.8	.0060
37473	Oct. 2	None.	None.	0.00	3.30	.0004	.0022	.34	.0360	.0000	0.00	1.0	.0040
37474	Oct. 3	None.	None.	0.00	3.70	.0000	.0012	.35	.0260	.0000	0.00	1.1	.0050

Odor of No. 36361, faintly vegetable, becoming stronger on heating.——The first sample was collected from Strongwater Brook, from which the present supply of the hospital is taken; the next two, from test well No. 1, near Strongwater Brook, a short distance above the pumping station; the next two, from test well No. 2, a short distance above well No. 1; the next two, from test well No. 3, a short distance above well No. 2; the last seven, during a pumping test, from a group of test wells about 400 feet west of Strongwater Brook.

WATER SUPPLY OF TISBURY. — VINEYARD HAVEN WATER COMPANY.

Spring.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	4.30	-	.0003	.0016	-	-	1.02	.0060	.0000	.02	0.6	.0045

TYNGSBOROUGH.

Water examined in Connection with Advice to the Town Authorities. (See also page 52.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
35411	Apr. 15	V. slight.	Slight.	.07	3.40	.0006	.0062	.17	.0840	.0000	.18	2.0	.0050

The sample was collected from a well on the road from Tyngsborough to Dunstable.

WATER SUPPLY OF UXBRIDGE.

Spring.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.00	2.44	0.76	.0002	.0022	.0019	.0003	.15	.0055	.0000	.04	0.4	-

WAKEFIELD AND STONEHAM.

WATER SUPPLY OF WAKEFIELD AND STONEHAM. — WAKEFIELD WATER COMPANY.

Crystal Lake.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.15	4.77	1.87	.0042	.0217	.0175	.0042	.58	.0123	.0002	.30	2.0	-
Average of eight previous years, .	.16	4.44	1.37	.0023	.0174	.0149	.0025	.64	.0109	.0001	.28	1.8	-

Odor in 1901, vegetable, and occasionally unpleasant. Large numbers of organisms were found in many of the samples, consisting chiefly of *Asterionella*, *Synedra*, *Tabellaria* and *Dinobryon*. This source was used for the supply of Stoneham until October 21, after which date this town was supplied with water from the metropolitan water district.

WATER SUPPLY OF WALPOLE. (See also page 53.)

Tubular Wells.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 11 samples collected in 1901.	.00	3.52	-	.0001	.0007	-	-	.33	.0131	.0000	.01	1.1	.0051
Average of five previous years, .	.01	3.71	-	.0001	.0007	-	-	.29	.0069	.0000	.01	1.0	.0047

Water and Ice examined in Connection with Advice to J. A. Turner. (See also page 113.)

Water.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34933	Mar. 1	V. slight.	V. slight.	.25	3.75	1.25	.0010	.0234	.0204	.0030	.49	.0070	.0002	.41	1.3

Ice.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
L. 29787	Mar. 1	None.	V. slight.	.08	-	-	.0010	.0018	-	-	.00	.0000	.0002	.02	0.0
L. 29788	Mar. 1	None.	V. slight.	.05	-	-	.0016	.0028	-	-	.00	.0000	.0002	.03	0.0

Odor of No. 34933, faintly unpleasant, becoming stronger on heating. —— The sample of water was collected from Morey's Pond. The first sample of ice was collected from the pond; the second was taken from the ice-house of Pope & Turner.

Water Supply of Waltham.

Well and Filter Gallery.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34505	Jan. 21	None.	V. slight.	.00	6.60	.0012	.0046	.60	.0570	.0000	.02	2.7	.0090
34792	Feb. 18	V. slight.	Slight.	.00	6.70	.0010	.0042	.64	.0590	.0000	.10	3.0	.0350
35216	Mar. 25	None.	None.	.02	6.40	.0032	.0048	.56	.0280	.0000	.05	3.4	.0110
35462	Apr. 22	V. slight.	None.	.06	7.10	.0036	.0046	.55	.0280	.0000	.10	3.4	.0200
35725	May 20	V. slight.	Cons.	.08	6.80	.0030	.0070	.54	.0300	.0000	.12	3.6	.0450
36093	June 24	None.	None.	.12	6.60	.0016	.0044	.53	.0280	.0000	.18	3.1	.0150
36437	July 22	None.	None.	.00	6.80	.0004	.0020	.55	.0350	.0000	.09	3.2	.0100
36933	Aug. 26	None.	None.	.00	7.10	.0016	.0044	.56	.0150	.0000	.04	3.4	.0040
37324	Sept. 24	None.	None.	.00	8.00	.0018	.0052	.52	.0190	.0001	.06	3.6	.0110
37659	Oct. 22	None.	None.	.03	7.00	.0040	.0046	.55	.0200	.0000	.06	3.6	.0100
38092	Nov. 25	None.	None.	.06	7.00	.0052	.0038	.57	.0160	.0000	.06	3.8	.0140
38345	Dec. 17	V. slight.	Slight.	.12	7.20	.0036	.0044	.51	.0200	.0000	.06	3.6	.0350

Averages by Years.

-	1888	-	-	.00	6.70	.0009	.0054	.46	.0273	.0003	-	-	-
-	1892	-	-	.00	6.81	.0033	.0027	.45	.0162	.0000	-	3.4	.0034
-	1893	-	-	.01	6.86	.0036	.0022	.47	.0179	.0000	.06	3.4	.0020
-	1894	-	-	.02	6.75	.0028	.0019	.51	.0192	.0000	.06	3.1	.0044
-	1895	-	-	.03	7.15	.0036	.0024	.53	.0198	.0000	.05	3.4	.0082
-	1896	-	-	.03	7.36	.0034	.0018	.55	.0194	.0000	.06	3.6	.0157
-	1897	-	-	.04	7.15	.0031	.0035	.57	.0222	.0001	.06	3.6	.0108
-	1898	-	-	.07	7.31	.0034	.0028	.59	.0280	.0000	.07	3.4	.0162
-	1899	-	-	.03	7.22	.0024	.0027	.58	.0371	.0000	.05	3.1	.0082
-	1900	-	-	.02	6.69	.0015	.0053	.55	.0259	.0000	.08	3.0	.0086
-	1901	-	-	.04	6.94	.0025	.0045	.56	.0296	.0000	.08	3.4	.0182

For the results of examinations of water from the Charles River opposite the well and filter gallery of the Waltham water works, see "Charles River" in the chapter on the Examination of Rivers.

Distributing Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.07	7.37	-	.0024	.0115	-	-	.54	.0200	.0001	.11	3.5	.0193
Average of nine previous years, .	.05	7.05	-	.0012	.0102	-	-	.53	.0136	.0001	.09	3.2	.0068

Odor in December, 1901, distinctly vegetable. A vegetable odor was developed in some of the other samples on heating. Large numbers of the organism *Asterionella* were found in most of the samples.

WALTHAM.

Water examined in Connection with Advice to the City Authorities. (See also page 55.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
36627	Aug. 2	Decided.	Heavy.	-	7.20	.0000	.0034	.22	.0010	.0000	.09	1.8	.0280
36861	Aug. 20	V. slight.	Slight.	.10	5.00	.0000	.0042	.24	.0020	.0000	.04	2.0	.0150

Odor of the first sample, decidedly disagreeable; of the last, faintly unpleasant when heated. —— The samples were collected from a well in Prospect Hill Park.

Water Supply of Ware.

Well.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Suspended.						
Average of 7 samples collected in 1901.	.00	7.61	-	.0000	.0009	-	-	.56	.2686	.0000	.01	2.6	.0067
Water Supply of Onset Bay Fire District, Wareham. — Onset Water Company. *Jonathan's Pond.*													
Average of 4 samples collected in 1901.	.00	2.49	0.99	.0020	.0187	.0120	.0017	.74	.0022	.0000	.15	0.1	-

Odor in July, faintly unpleasant, becoming stronger on heating; at other times, occasionally faintly vegetable.

Warren.

Waters examined in Connection with Advice to the Town Authorities relative to Ice Supply. (See also page 113.)

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1901.														
34542	Jan. 22	None.	None.	.04	3.05	0.80	.0018	.0116	.0100	.0016	.15	.0220	.0000	.13	0.6
34543	Jan. 22	V. slight.	V. slight.	.33	4.50	1.50	.0046	.0210	.0192	.0018	.28	.0160	.0002	.45	1.3

Odor of No. 34542, faintly unpleasant and musty; of No. 34543, faintly vegetable, becoming stronger on heating. —— The first sample was collected from Bliss's Pond; the last, from the Quaboag River.

WATER SUPPLY OF WATERTOWN.

(See *Metropolitan Water District*, pages 120–123.)

WATER SUPPLY OF WAYLAND.

Filter Gallery.

[Parts per 100,000.]

		RESIDUE ON EVAPORATION.		AMMONIA.					NITROGEN AS				
					ALBUMINOID.								
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.92	5.25	-	.0136	.0258	-	-	.30	.0162	.0001	.96	1.7	.0372
Average of eight previous years, .	.57	4.59	-	.0061	.0194	-	-	.33	.0228	.0001	.62	1.6	.0683

Odor in 1901, occasionally faintly vegetable or unpleasant.

Storage Reservoir.

Average of 4 samples collected in 1901.	.92	4.84	2.26	.0069	.0334	.0296	.0038	.27	.0077	.0000	.98	1.4	-
Average of five previous years, .	.71	4.15	1.91	.0024	.0289	.0241	.0048	.27	.0085	.0000	.77	1.4	-

Odor in 1901, vegetable, becoming stronger on heating.

WATER SUPPLY OF WEBSTER.

Well.

Average of 8 samples collected in 1901.	.00	3.80	-	.0001	.0015	-	-	.22	.0116	.0000	.01	1.3	.0067
Average of seven previous years, .	.00	3.87	-	.0002	.0011	-	-	.23	.0190	.0000	.01	1.4	.0028

WATER SUPPLY OF WELLESLEY.

Filter Gallery.

September, 1901, ...	.00	6.80	-	.0000	.0012	-	-	.41	.0880	.0001	.01	3.1	.0060

Well at Williams Spring.

Average of 6 samples collected in 1901.	.00	9.63	-	.0003	.0013	-	-	.79	.4167	.0000	.01	3.6	.0047
Average of two previous years, .	.01	9.56	-	.0013	.0014	-	-	.78	.4342	.0009	.02	3.4	.0037

Tubular Wells.

Average of 6 samples collected in 1901.	.00	7.27	-	.0002	.0013	-	-	.63	.1090	.0001	.01	3.3	.0045
Average of three previous years, .	.02	7.07	-	.0023	.0012	-	-	.57	.0730	.0022	.02	2.8	.0053

WESTBOROUGH.

Water Supply of Westborough.

Lower Sandra Pond.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.03	2.54	1.01	.0004	.0096	.0083	.0013	.19	.0022	.0001	.17	1.1	-
Average of five previous years, .	.09	3.20	1.18	.0009	.0127	.0095	.0032	.21	.0028	.0000	.21	1.0	-

Odor in November, 1901, faintly unpleasant, becoming stronger on heating.

Water Supply of Westfield.

Montgomery Storage Reservoir.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.59	2.74	1.35	.0046	.0239	.0202	.0037	.11	.0047	.0000	.73	0.3	-
Average of five previous years, .	.53	2.67	1.36	.0023	.0228	.0183	.0045	.11	.0034	.0000	.63	0.5	-

Odor in 1901, generally vegetable. An unpleasant odor was developed in the June sample on heating. The organisms *Anabæna* and *Peridinium* were found in the sample collected in November. Two of the other samples contained a very large number of organisms.

Tillottson Brook Reservoir, in Granville.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.04	2.57	0.66	.0002	.0049	.0039	.0010	.11	.0050	.0000	.15	0.5	-
Average of three previous years, .	.13	2.70	0.80	.0008	.0058	.0051	.0007	.12	.0035	.0000	.20	0.5	-

Odor in March, 1901, faintly vegetable, becoming stronger on heating. A faintly vegetable odor was developed in some of the other samples on heating.

Water Supply of Weston. — Weston Aqueduct Company.

Well.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34685	Feb. 6	V. slight.	None.	.03	6.30	.0000	.0062	.40	.0560	.0000	0.08	2.2	.0040
35332	Apr. 4	V. slight.	None.	.15	5.80	.0010	.0078	.39	.0510	.0000	0.03	2.7	.0050
35847	June 5	V. slight.	V. slight.	.96	7.60	.0014	.0252	.37	.0110	.0001	1.04	3.4	.0090
36353	July 11	None.	None.	.00	6.20	.0000	.0024	.43	.0490	.0000	0.06	3.0	.0030
36665	Aug. 7	None.	V. slight.	.03	6.80	.0004	.0060	.45	.0400	.0002	0.14	3.1	.0030
37480	Oct. 3	None.	V. slight.	.00	6.80	.0002	.0032	.44	.0380	.0000	0.08	3.1	.0150
38245	Dec. 5	V. slight.	V. slight.	.40	8.00	.0002	.0154	.61	.0240	.0000	0.62	3.0	.0060

Well — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1896	-	-	.01	6.99	.0001	.0019	.41	.0433	.0001	.03	3.2	.0019
-	1897	-	-	.01	6.07	.0006	.0023	.44	.0452	.0000	.03	2.8	.0009
-	1898	-	-	.05	6.80	.0002	.0031	.48	.0338	.0000	.07	3.2	.0028
-	1899	-	-	.03	5.88	.0001	.0026	.42	.0390	.0000	.03	2.4	.0078
-	1900	-	-	.02	6.62	.0002	.0039	.47	.0422	.0000	.07	2.7	.0063
-	1901	-	-	.22	6.79	.0005	.0095	.44	.0384	.0000	.29	2.9	.0064

Odor in June, 1901, faintly vegetable, becoming stronger on heating.

Water Supply of West Springfield. (See also page 57.)

Darby Brook Storage Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Loss on Ignition.	Ammonia. Free.	Albuminoid. Total.	Dissolved.	Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.11	5.25	1.69	.0036	.0141	.0101	.0040	.16	.0067	.0000	.23	2.8	-
Average of four previous years, .	.21	5.27	1.46	.0015	.0178	.0113	.0065	.15	.0044	.0000	.29	2.6	-

Odor in January and July, 1901, distinctly unpleasant. The organisms *Anabæna* and *Uroglena* were found in the sample collected in November.

Receiving Well.

Average of 4 samples collected in 1901.	.00	7.05	-	.0000	.0014	-	-	.55	.2612	.0000	.01	2.6	.0047
Average of three previous years, .	.00	7.16	-	.0002	.0016	-	-	.49	.2058	.0000	.03	2.9	.0050

Water Supply of Weymouth.

Great Pond.

Average of 4 samples collected in 1901.	.72	4.07	1.91	.0021	.0220	.0192	.0028	.46	.0027	.0000	.87	0.7	-
Average of nine previous years, .	.82	3.95	1.87	.0006	.0187	.0169	.0018	.56	.0034	.0000	.77	0.6	-

Odor in January, 1901, faintly unpleasant, becoming stronger on heating; at other times, vegetable. The organisms *Synedra* and *Dinobryon* were found in large numbers in the sample collected in January.

WHITMAN.

Water Supply of Whitman.

Filter Gallery.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1901.												
34996	Mar. 6	Slight.	Slight.	0.60	8.70	.0086	.0222	1.26	.0300	.0003	0.60	2.9	.0580
35836	June 4	None.	V. slight.	1.02	5.10	.0042	.0268	0.56	.0110	.0000	1.05	1.3	.0220
37109	Sept. 7	V. slight.	Cons.	0.70	7.80	.0120	.0300	0.98	.0040	.0000	0.77	2.2	.0350
38251	Dec. 9	Slight.	Slight.	0.60	8.90	.0086	.0170	1.08	.0400	.0001	0.54	2.6	.1400

Averages by Years.

-	1891	-	-	0.45	5.64	.0067	.0184	0.68	.0137	.0001	-	1.9	-
-	1893	-	-	0.51	5.70	.0027	.0209	0.81	.0067	.0000	0.55	1.8	.0402
-	1896	-	-	0.34	5.65	.0023	.0230	0.79	.0125	.0000	0.51	1.8	-
-	1897	-	-	0.60	5.69	.0045	.0253	0.76	.0127	.0000	0.55	1.5	.0430
-	1898	-	-	0.65	6.80	.0109	.0239	0.92	.0190	.0001	0.63	2.4	.0925
-	1900	-	-	0.66	6.56	.0047	.0264	0.96	.0175	.0001	0.72	1.6	.0632
-	1901	-	-	0.73	7.62	.0083	.0240	0.97	.0212	.0001	0.74	2.2	.0637

Odor in March and June, 1901, faintly vegetable, becoming stronger on heating.

Hobart's Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34995	Mar. 6	Slight.	Cons.	0.55	5.45	1.90	.0096	.0256	.0236	.0020	0.87	.0100	.0002	0.73	2.0
35835	June 4	None.	None.	1.00	5.15	2.15	.0048	.0276	.0258	.0018	0.55	.0080	.0002	1.19	1.1
37108	Sept. 7	V. slight.	Slight.	0.49	7.10	3.40	.0052	.0344	.0292	.0052	1.00	.0040	.0000	0.77	2.1
38250	Dec. 9	Slight.	Slight.	0.80	7.75	3.00	.0020	.0366	.0302	.0064	1.24	.0120	.0001	1.13	2.0

Averages by Years.

-	1891	-	-	0.64	5.34	2.02	.0012	.0334	.0273	.0061	0.68	.0112	.0001	-	1.6
-	1893	-	-	0.67	5.62	2.15	.0009	.0309	.0272	.0037	0.80	.0060	.0000	0.64	1.6
-	1896	-	-	0.41	5.50	1.90	.0008	.0329	.0295	.0034	0.78	.0085	.0000	0.61	1.7
-	1897	-	-	0.75	6.55	2.47	.0024	.0314	.0287	.0027	0.86	.0152	.0001	0.79	1.8
-	1898	-	-	0.69	6.67	2.63	.0025	.0361	.0318	.0043	0.88	.0065	.0001	0.79	2.0
-	1900	-	-	0.66	6.06	2.17	.0040	.0320	.0271	.0049	0.90	.0102	.0001	0.83	1.6
-	1901	-	-	0.71	6.36	2.61	.0054	.0310	.0272	.0038	0.91	.0085	.0001	0.95	1.8

Odor in June, 1901, faintly vegetable, becoming stronger on heating; at other times, unpleasant. The organisms *Dinobryon* and *Synura* were found in many of the samples.

Water Supply of Williamstown. — Williamstown Water Company.

Cold Spring.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.			
					Total.	Dissolved.	Sus-pended.						
Average of 4 samples collected in 1901.	.00	12.02	-	.0002	.0020	-	-	.06	.0402	.0000	.03	9.7	.0045
Average of three previous years, .	.01	12.42	-	.0004	.0015	-	-	.06	.0348	.0000	.02	11.0	.0022

Sherman Spring.

	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.04	9.22	-	.0001	.0134	-	-	.07	.0170	.0000	.03	6.3	.0060
Average of three previous years, .	.02	8.15	-	.0016	.0037	-	-	.06	.0099	.0000	.04	6.0	.0013

Flora Glen Reservoir.

	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.05	5.16	1.26	.0005	.0174	.0116	.0058	.08	.0030	.0000	.12	3.4	-
Average of three previous years, .	.07	4.94	0.67	.0007	.0062	.0047	.0015	.08	.0051	.0000	.09	3.1	-

Odor in May, 1901, distinctly unpleasant when heated.

Paul Brook Reservoir.

	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 4 samples collected in 1901.	.07	5.60	1.14	.0007	.0267	.0196	.0071	.09	.0172	.0000	.11	3.9	-
Average of three previous years, .	.02	4.10	0.74	.0005	.0033	.0023	.0010	.07	.0081	.0000	.05	2.9	-

Odor in May, 1901, faintly unpleasant, becoming stronger on heating.

Water Supply of Winchendon.

Well.

	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 6 samples collected in 1901.	.00	3.17	-	.0009	.0015	-	-	.12	.0038	.0000	.02	0.9	.0058
Average of four previous years, .	.03	3.21	-	.0004	.0014	-	-	.11	.0042	.0000	.03	1.2	.0097

WINCHESTER.

WATER SUPPLY OF WINCHESTER.

North Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
	1901.														
34950	Mar. 4	Slight.	Slight.	.10	4.50	1.30	.0286	.0200	.0168	.0032	.42	.0110	.0002	.40	1.8
35312	Apr. 3	Slight.	Cons.	.13	5.65	2.00	.0012	.0262	.0216	.0046	.49	.0120	.0001	.25	2.3
35869	June 6	Slight.	Slight.	.15	4.40	0.90	.0074	.0256	.0214	.0042	.50	.0090	.0003	.37	2.5
36681	Aug. 7	V. slight.	Slight.	.07	5.35	1.90	.0016	.0296	.0236	.0060	.40	.0010	.0001	.28	2.3
37444	Oct. 2	V. slight.	Slight.	.05	5.55	2.10	.0014	.0232	.0210	.0022	.46	.0060	.0001	.29	2.6
38228	Dec. 4	V. slight.	Slight.	.08	5.20	1.90	.0006	.0270	.0216	.0054	.51	.0000	.0000	.34	2.3
Av...	....	....	....	.10	5.11	1.68	.0068	.0253	.0210	.0043	.46	.0065	.0001	.32	2.3
Average of ten previous years, .				.09	5.64	1.71	.0034	.0227	.0183	.0044	.67	.0111	.0001	.28	2.4

Odor of Nos. 34950 and 38228, unpleasant; of Nos. 36681 and 37444, distinctly vegetable. The organism *Anabæna* was found in the sample collected in August, and the organism *Uroglena* in the sample collected in December.

South Reservoir.

	1901.														
34951	Mar. 4	V. slight.	V. slight.	.07	3.65	1.10	.0068	.0218	.0204	.0014	.36	.0100	.0000	.28	1.6
35313	Apr. 3	Slight	Cons.	.10	3.50	1.55	.0088	.0228	.0204	.0024	.27	.0030	.0001	.25	1.3
35870	June 6	V. slight.	Slight.	.06	3.10	1.25	.0058	.0220	.0200	.0020	.29	.0050	.0000	.32	1.1
36682	Aug. 7	None.	Slight.	.08	3.10	1.70	.0004	.0214	.0192	.0022	.28	.0010	.0001	.26	1.0
37445	Oct. 2	V. slight.	V. slight.	.03	3.00	1.50	.0008	.0204	.0194	.0010	.28	.0050	.0000	.25	1.4
38230	Dec. 4	V. slight.	Slight.	.11	3.75	1.70	.0138	.0208	.0184	.0024	.29	.0010	.0001	.23	1.0
Av...	....	....	....	.07	3.35	1.47	.0061	.0215	.0196	.0019	.29	.0042	.0000	.26	1.2
Average of ten previous years, .				.25	4.31	1.72	.0056	.0307	.0248	.0059	.37	.0059	.0001	.39	1.7

Odor in 1901, generally faintly vegetable.

Middle Reservoir.

	1901.														
34952	Mar. 4	Slight.	Slight.	.30	3.95	1.40	.0054	.0330	.0302	.0028	.36	.0070	.0008	.41	1.1
35314	Apr. 3	Slight.	Cons.	.28	3.25	1.75	.0048	.0330	.0298	.0032	.27	.0030	.0001	.43	0.8
35871	June 6	Slight.	Cons.	.22	3.15	1.30	.0000	.0278	.0242	.0036	.30	.0020	.0000	.39	1.3
36683	Aug. 7	Slight.	Cons.	.27	3.50	1.90	.0034	.0358	.0266	.0092	.28	.0010	.0001	.43	1.3
37446	Oct. 2	Slight.	Cons.	.15	3.60	1.90	.0010	.0434	.0290	.0144	.27	.0050	.0001	.43	1.4
38229	Dec. 4	V. slight.	Slight.	.21	3.70	1.65	.0042	.0330	.0270	.0060	.31	.0010	.0000	.38	1.0
Av...	....	....	....	.24	3.52	1.65	.0031	.0343	.0278	.0065	.30	.0032	.0002	.41	1.1
Average of seven previous years, .				.40	4.30	2.23	.0030	.0558	.0377	.0181	.36	.0043	.0001	.61	1.3

Odor in October and December, 1901, decidedly unpleasant; at other times, generally vegetable. The organisms *Anabæna*, *Dinobryon* and *Trachelomonas* were found in large numbers in the sample collected in October, and in smaller numbers in several of the other samples.

WATER SUPPLY OF WINTHROP.

(See *Metropolitan Water District*, pages 120-123.)

Water Supply of Woburn.

Filter Gallery.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1901.												
34551	Jan. 23	None.	None.	.00	9.50	.0068	.0042	1.24	.0220	.0000	.07	4.3	.0040
34891	Feb. 27	None.	None.	.00	9.50	.0056	.0028	1.31	.0180	.0000	.03	4.4	.0040
35273	Mar. 29	None.	V. slight.	.00	9.80	.0066	.0030	1.23	.0220	.0000	.10	5.0	.0040
35505	Apr. 24	None.	None.	.00	9.60	.0062	.0030	1.16	.0260	.0000	.12	5.0	.0040
35760	May 22	None.	None.	.00	8.50	.0030	.0018	1.12	.0360	.0000	.02	4.7	.0040
36183	June 26	None.	None.	.00	9.80	.0050	.0024	1.11	.0280	.0000	.04	4.2	.0050
36574	July 30	None.	None.	.00	10.60	.0052	.0030	1.10	.0200	.0000	.11	4.4	.0030
37005	Aug. 28	None.	None.	.00	9.30	.0048	.0032	1.14	.0180	.0000	.10	4.4	.0040
37357	Sept. 25	None.	None.	.00	9.10	.0050	.0036	1.11	.0170	.0000	.05	4.4	.0040
37797	Oct. 30	None.	None.	.00	9.20	.0052	.0040	1.11	.0130	.0000	.06	4.9	.0080
38139	Nov. 27	None.	None.	.00	9.70	.0042	.0026	1.18	.0110	.0000	.13	4.7	.0060
38477	Dec. 24	None.	V. slight.	.00	9.70	.0064	.0060	1.22	.0200	.0000	.18	5.3	.0040

Averages by Years.

-	1888	-	-	.00	12.00	.0012	.0032	2.50	.0346	.0000	-	-	-
-	1889	-	-	.00	10.84	.0010	.0022	2.07	.0372	.0000	-	-	-
-	1890	-	-	.01	11.06	.0012	.0023	1.91	.0481	.0000	-	5.0	-
-	1891	-	-	.00	10.85	.0008	.0015	1.79	.0668	.0000	-	4.9	-
-	1892	-	-	.00	11.27	.0012	.0024	1.95	.0542	.0000	-	5.1	-
-	1893	-	-	.00	11.50	.0022	.0018	2.04	.0447	.0000	.05	5.3	.0004
-	1894	-	-	.01	11.02	.0026	.0018	1.94	.0262	.0000	.05	5.0	.0021
-	1895	-	-	.01	10.82	.0031	.0022	1.74	.0204	.0000	.06	4.9	.0023
-	1896	-	-	.01	10.49	.0033	.0031	1.56	.0242	.0000	.04	5.0	.0011
-	1897	-	-	.01	10.06	.0041	.0032	1.36	.0202	.0000	.04	5.0	.0012
-	1898	-	-	.02	10.15	.0041	.0026	1.27	.0252	.0000	.06	4.5	.0015
-	1899	-	-	.01	9.51	.0044	.0025	1.19	.0258	.0000	.05	4.4	.0015
-	1900	-	-	.00	9.32	.0055	.0029	1.20	.0169	.0000	.05	4.6	.0032
-	1901	-	-	.00	9.52	.0053	.0033	1.17	.0209	.0000	.08	4.6	.0045

Horn Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1901.														
34550	Jan. 23	None.	Slight.	.20	8.55	2.30	.0054	.0282	.0178	.0104	0.99	.0820	.0005	.44	3.0
34890	Feb. 27	Slight.	Slight.	.19	8.75	2.50	.0024	.0258	.0186	.0072	1.10	.0900	.0007	.45	3.3
35272	Mar. 29	Decided.	Cons.	.37	8.15	2.65	.0100	.0286	.0236	.0050	0.84	.1140	.0012	.55	3.1
35504	Apr. 24	Slight.	Cons.	.35	7.35	2.50	.0026	.0284	.0198	.0086	0.79	.1050	.0006	.50	2.1
35759	May 22	Slight.	Cons.	.43	7.30	2.50	.0018	.0222	.0170	.0052	0.77	.1080	.0012	.51	2.9
36182	June 26	Slight.	Slight.	.33	8.25	2.90	.0048	.0222	.0202	.0020	0.89	.0860	.0014	.50	3.3
36573	July 30	V. slight	V. slight.	.20	7.85	2.30	.0020	.0260	.0210	.0050	0.94	.0840	.0010	.50	3.6
37004	Aug. 28	Slight.	Slight.	.22	8.05	3.10	.0010	.0226	.0200	.0026	0.96	.0150	.0012	.49	3.0
37356	Sept. 25	V. slight.	V. slight.	.19	8.00	2.80	.0030	.0224	.0206	.0018	0.84	.0080	.0010	.47	3.4
37796	Oct. 30	Slight.	Slight.	.23	7.70	2.70	.0048	.0256	.0218	.0038	0.96	.0150	.0005	.39	3.6
38138	Nov. 27	Slight.	Cons.	.21	7.65	2.00	.0026	.0288	.0204	.0084	1.04	.0220	.0008	.41	3.3
38476	Dec. 24	Slight.	Cons.	.28	7.40	2.50	.0074	.0232	.0204	.0028	0.95	.0490	.0007	.49	3.6

WOBURN.

Horn Pond — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
-	1888	-	-	.82	11.28	1.71	.0186	.0383	-	-	2.98	.0398	.0015	-	-
-	1889	-	-	.30	8.37	2.03	.0092	.0376	.0216	.0160	1.98	.0498	.0015	-	-
-	1890	-	-	.27	10.76	2.07	.0080	.0380	.0211	.0169	1.93	.0542	.0008	-	3.4
-	1891	-	-	.22	8.90	2.06	.0129	.0453	.0237	.0216	1.76	.0502	.0009	-	2.9
-	1892	-	-	.25	10.57	2.13	.0110	.0358	.0216	.0142	2.42	.0821	.0008	-	3.3
-	1893	-	-	.30	9.83	2.51	.0061	.0455	.0247	.0208	2.10	.0472	.0009	.45	3.2
-	1894	-	-	.33	9.03	1.98	.0065	.0292	.0184	.0108	1.84	.0404	.0009	.40	3.3
-	1895	-	-	.36	9.43	2.84	.0087	.0297	.0205	.0092	1.53	.0523	.0014	.48	3.4
-	1896	-	-	.27	8.27	2.43	.0043	.0321	.0199	.0122	1.18	.0476	.0010	.39	3.1
-	1897	-	-	.41	7.95	2.30	.0052	.0355	.0224	.0131	1.02	.0389	.0008	.48	3.2
-	1898	-	-	.40	7.80	2.32	.0037	.0286	.0206	.0080	0.96	.0616	.0015	.48	3.0
-	1899	-	-	.18	7.55	2.14	.0046	.0344	.0203	.0141	0.87	.0527	.0011	.37	2.9
-	1900	-	-	.22	7.17	1.94	.0065	.0320	.0216	.0104	0.85	.0207	.0005	.46	2.7
-	1901	-	-	.27	7.92	2.56	.0040	.0253	.0201	.0052	0.92	.0607	.0009	.47	3.2

Odor in November, 1901, unpleasant; at other times, faintly vegetable, becoming stronger, and occasionally unpleasant, on heating. The organisms *Peridinium* and *Synura* were found in small numbers in several of the samples.

Water Supply of Worcester.

Bottomly Pond, on Kettle Brook, in Paxton.

[Parts per 100,000.]

	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.			
Average of 12 samples collected in 1901.	.44	3.45	1.50	.0069	.0249	.0191	.0058	.14	.0113	.0001	.63	0.9	-
Average of six previous years, .	.42	3.29	1.48	.0049	.0243	.0190	.0053	.15	.0066	.0001	.55	0.8	-

Odor in 1901, generally vegetable and occasionally unpleasant.

Kent Reservoir, on Kettle Brook, in Leicester.

Average of 12 samples collected in 1901.	.31	3.33	1.41	.0024	.0192	.0157	.0035	.16	.0083	.0000	.47	1.0	-
Average of three previous years, .	.32	3.22	1.32	.0032	.0209	.0175	.0034	.15	.0048	.0001	.47	0.8	-

Odor in 1901, frequently vegetable or unpleasant. The organism *Dinobryon* was found in large numbers in the samples collected in January, August and September, and the organism *Uroglena* in the samples collected in October and November.

WORCESTER.

Lynde Brook Storage Reservoir.

[Parts per 100,000.]

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 12 samples collected in 1901.	.24	3.15	1.29	.0039	.0171	.0148	.0023	.16	.0088	.0000	.46	0.9	-
Average of ten previous years,	.29	3.04	1.17	.0041	.0155	.0131	.0024	.16	.0073	.0000	.38	0.8	-

Odor in 1901, generally faintly vegetable. The organisms *Anabæna* and *Uroglena* were found in small numbers in several of the samples.

Tatnuck Brook Storage Reservoir.

	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
Average of 12 samples collected in 1901.	.12	2.22	0.90	.0019	.0155	.0116	.0039	.13	.0032	.0000	.31	0.3	-
Average of ten previous years,	.20	2.25	0.91	.0014	.0155	.0118	.0037	.14	.0044	.0000	.31	0.4	-

Odor in 1901, occasionally faintly vegetable or unpleasant. A vegetable or unpleasant odor was developed in most of the samples on heating. The organism *Uroglena* was found in the samples collected in April and May.

WRENTHAM.

Waters examined in Connection with Advice to the Town Authorities. (See also page 58.)

Well in School Yard.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1900.												
33437	Oct. 24	V. slight.	Cons.	.12	12.40	.0014	.0028	.42	.1900	.0008	.01	4.2	.1800
33522	Oct. 30	V. slight.	Slight.	.10	12.00	.0028	.0022	.43	.4200	.0012	.04	4.0	.0850
33536	Nov. 2	V. slight.	V. slight.	.01	13.00	.0006	.0030	.38	.4700	.0000	.02	4.7	.0630
33537	Nov. 2	V. slight.	Cons.	.11	14.60	.0010	.0034	.39	.4150	.0000	.02	4.4	.1850
34285	Dec. 31	V. slight.	V. slight.	.00	13.40	.0058	.0060	.61	.5400	.0001	.08	4.3	.0050
34286	Dec. 31	V. slight.	Cons.	.03	15.50	.0016	.0040	.57	.6000	.0005	.01	5.0	.4600
	1901.												
34435	Jan. 11	None.	V. slight.	.02	12.10	.0012	.0032	.62	.4200	.0004	.01	4.2	.0180
34436	Jan. 11	V. slight.	V. slight.	.02	12.00	.0010	.0036	.63	.4200	.0003	.02	4.2	.0180
34437	Jan. 11	None.	V. slight.	.02	11.90	.0006	.0028	.63	.4200	.0004	.02	4.3	.0200
35134	Mar. 15	V. slight.	Cons.	.00	11.20	.0024	.0026	.75	.3900	.0028	.04	4.2	.1080
35135	Mar. 15	None.	V. slight.	.00	10.90	.0000	.0028	.75	.3600	.0002	.04	4.0	.0170
35136	Mar. 15	V. slight.	Slight.	.00	11.00	.0014	.0030	.76	.3800	.0000	.04	4.0	.0120

Nos. 34285 and 35136 were collected directly from the well; Nos. 33437, 33522, 33536, 33537 and 34286, from the pump after pumping a few minutes; Nos. 34435 and 35134, from the pump before any considerable quantity of water had been pumped; No. 34436, from the pump after pumping fifteen minutes; No. 35135, from the pump after pumping twenty minutes; No. 34437, from the pump after pumping twenty-five minutes.

WRENTHAM.

Tubular Wells at Straw Factory.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1900.												
33521	Oct. 30	None.	None.	.01	19.80	.0000	.0014	1.09	.1100	.0000	.02	3.4	.0120
33534	Nov. 2	None.	None.	.02	22.20	.0000	.0018	1.28	.1000	.0000	.01	4.0	.0150
33632	Nov. 12	None.	None.	.00	22.20	.0006	.0018	1.24	.1060	.0000	.02	3.3	.0050
33860	Nov. 30	None.	V. slight.	.02	20.40	.0002	.0018	1.28	.0860	.0000	.02	3.4	.0080
33975	Dec. 7	None.	None.	.00	26.40	.0006	.0030	1.49	.1600	.0000	.03	5.7	.0050

Faucet in Straw Factory supplied from Tubular Wells.

	1900.												
33859	Nov. 30	None.	V. slight.	.02	20.50	.0002	.0040	1.30	.0800	.0000	.03	3.5	.0100
33976	Dec. 7	None.	None.	.01	25.00	.0000	.0020	1.46	.1650	.0000	.02	5.1	.0080

Fountain in Common supplied from Tubular Wells.

	1900.												
33633	Nov. 12	None.	None.	.03	21.30	.0002	.0024	1.24	.1100	.0000	.03	3.4	.0060
33863	Nov. 30	None.	V. slight.	.01	19.60	.0000	.0020	1.28	.0920	.0000	.02	3.4	.0060
33978	Dec. 7	None.	None.	.00	-	-	-	1.42	.1340	.0000	.02	5.0	-

Faucet in School Building supplied from Tubular Wells.

	1900.												
33436	Oct. 24	None.	None.	.00	24.80	.0050	.0022	1.15	.0370	.0180	.03	7.7	.0160
33535	Nov. 2	None.	None.	.01	18.80	.0176	.0022	1.20	.0180	.0005	.06	7.4	.0040
33634	Nov. 12	None.	None.	.01	22.80	.0102	.0020	1.10	.0380	.0340	.06	6.3	.0050
33861	Nov. 30	None.	None.	.01	21.10	.0106	.0020	1.16	.0280	.0320	.03	7.1	.0080
33862	Nov. 30	None.	None.	.02	23.30	.0114	.0020	1.32	.0290	.0440	.04	8.0	.0070
33977	Dec. 7	V. slight.	None.	.01	26.60	.0076	.0020	1.39	.0700	.0300	.02	8.6	.0080

No. 33861 was collected after the water had been running from the faucet for twenty-five minutes.

EXAMINATION OF RIVERS.

EXAMINATION OF RIVERS.

During the year 1901 examinations have been made monthly of the waters of the Blackstone, Charles, Concord, Hoosick, Housatonic, Merrimack, Nashua, Neponset, Saugus, Taunton and Westfield rivers and some of their principal tributaries, and during the summer months of the waters of the Chicopee, Connecticut, Deerfield, French, Millers, Nemasket, Quinebaug, Salisbury Plain, Shawsheen and Ten Mile rivers and their principal tributaries. Occasional examinations have also been made of other streams in the State. The results of the examinations will generally be found arranged alphabetically by rivers in the pages which follow, but some of them are given on the preceding pages in the examinations of water supplies, as follows: —

	Page
Charles at Milford,	173
Green at Great Barrington,	142
Merrimack at Lowell,	159
Merrimack at Lawrence,	153
Nashua at Clinton,	120
Quinepoxet at Holden,	120
Saugus at Montrose,	164
Saugus at Howlett's Dam,	164
Stillwater at Sterling,	120
Sudbury at Framingham,	122

The flow of streams for the year as a whole was somewhat above the normal, the excess being particularly marked in the late spring and summer months. Tables showing the flow of several streams in the State and the normal flow are given in a subsequent chapter entitled "Water Supply Statistics and Flow of Streams."

ASSABET RIVER.

(See *Concord River.*)

BLACKSTONE RIVER.

BLACKSTONE

Chemical Examination of Water from Blackstone River, between

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Residue on Evaporation.					
						Total Residue.			Loss on Ignition.		
			Turbidity.	Sediment.	Color.	Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
		1901.									
1	34474	Jan. 15	Decided.	Heavy.	0.05	28.90	24.10	4.80	9.60	7.70	1.90
2	34840	Feb. 19	Decided.	Heavy.	0.04	53.00	42.20	10.80	18.80	18.40	0.40
3	35173	Mar. 19	Decided.	Heavy.	0.04	10.80	7.00	3.80	3.30	2.00	1.30
4	35456	Apr. 18	Decided.	Heavy.	0.10	29.70	25.90	3.80	12.70	10.90	1.80
5	35683	May 14	Decided.	Heavy.	0.00	25.80	22.00	3.80	10.20	8.35	1.85
6	36079	June 20	Decided.	Heavy.	0.12	26.50	17.20	9.30	7.50	3.40	4.10
7	36472	July 22	Decided.	Heavy.	0.03	26.00	22.00	4.00	7.70	5.60	2.10
8	36957	Aug. 26	Decided.	Heavy.	0.70	12.40	9.90	2.50	2.20	2.20	0.00
9	37289	Sept. 20	Decided.	Cons.	0.26	39.30	36.60	2.70	14.30	12.80	1.50
10	37704	Oct. 23	Decided.	Cons.	0.10	36.30	33.70	2.60	12.90	12.40	0.50
11	38060	Nov. 20	Decided.	Cons.	0.17	45.70	44.30	1.40	19.50	18.30	1.20
12	38422	Dec. 23	Decided.	Cons.	1.36	13.00	10.00	3.00	4.80	3.80	1.00
13	Av....	....	....	....	0.25	28.95	24.57	4.38	10.29	8.82	1.47

Odor, distinctly disagreeable.——The samples were collected from the river about 200 feet below Nos. 35456 and 36079 on Thursday, No. 37289 on Friday, and the other samples on Tuesday. The samples

Chemical Examination of Water from Blackstone River,

		1901.									
1	34475	Jan. 15	Decided.	Heavy.	0.07	30.50	21.50	9.00	8.80	4.00	4.80
2	34841	Feb. 19	Decided.	Heavy.	0.05	67.20	59.60	7.60	27.00	19.60	7.40
3	35174	Mar. 19	Decided.	Heavy.	0.05	15.60	10.40	5.20	4.50	2.50	2.00
4	35457	Apr. 18	Decided.	Heavy.	0.09	37.20	33.80	3.40	15.50	13.80	1.70
5	35684	May 14	Decided.	Heavy.	0.00	15.40	6.00	9.40	3.50	1.65	1.85
6	36080	June 20	Decided.	Heavy.	0.11	24.00	19.30	4.70	7.80	4.70	3.10
7	36473	July 22	Decided.	Heavy.	-	36.00	28.40	7.60	7.60	4.70	2.90
8	36958	Aug. 26	Decided.	Heavy.	-	38.20	34.50	3.70	9.80	7.10	2.70
9	37290	Sept. 20	Decided.	Heavy.	0.13	30.40	25.10	5.30	5.20	3.40	1.80
10	37705	Oct. 23	Decided.	Cons.	0.04	25.90	22.70	3.20	5.50	5.00	0.50
11	38061	Nov. 20	Decided.	Heavy.	-	32.20	28.30	3.90	5.50	4.80	0.70
12	38423	Dec. 23	Decided.	Cons.	1.10	17.00	14.10	2.90	5.90	5.50	0.40
13	Av....	....	....	....	0.18	30.80	25.31	5.49	8.88	6.39	2.49

Odor of No. 36473, offensive; of the others, distinctly disagreeable.——The samples were collected precipitation works enters the river. Nos. 36958 and 38423 were collected on Monday, Nos. 37705 and Tuesday. The samples were collected between 9.45 and 11.30 A.M.

BLACKSTONE RIVER.

RIVER.

Millbrook Channel and the Worcester Sewage Precipitation Works.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		Hardness.	Iron.		
Free.	Albuminoid. Total.	Albuminoid. Dis-solved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.	Un-filtered.	Filtered.		Unfiltered.	Filtered.	
.2960	.1260	.1080	.0180	-	-	.0017	1.91	1.11	13.0	2.5600	2.0000	1
.4200	.1740	.1020	.0720	-	-	.0019	2.58	2.14	18.9	2.7000	1.5200	2
.0580	.0480	.0130	.0350	0.85	.0400	.0007	1.04	0.34	3.6	0.4800	0.4000	3
.1080	.0590	.0530	.0060	-	-	.0012	1.60	1.20	16.2	2.2400	1.4000	4
.1400	.0520	.0170	.0350	-	-	.0012	1.24	0.81	14.0	3.4400	3.2000	5
.1400	.0970	.0300	.0670	-	-	.0080	2.24	0.82	7.7	1.4400	0.6800	6
.2130	.0680	.0360	.0320	-	-	.0012	1.36	0.96	9.6	1.7600	1.3200	7
.1260	.0470	.0270	.0200	1.11	.0100	.0018	0.78	0.52	2.6	0.4800	0.0640	8
.1590	.0330	.0285	.0045	-	-	.0005	1.46	1.40	20.6	3.2000	2.2000	9
.1000	.0430	.0285	.0145	-	-	.0017	1.90	1.60	17.8	2.5600	2.5600	10
.1080	.0410	.0355	.0055	-	-	.0005	2.64	2.40	24.5	5.9200	3.6000	11
.0680	.0370	.0230	.0140	0.60	.0580	.0008	0.93	0.62	3.1	0.5000	0.3000	12
.1613	.0687	.0418	.0269	0.85	.0360	.0018	1.64	1.16	12.6	2.2733	1.6037	13

the iron bridge. Nos. 36957 and 38422 were collected on Monday, Nos. 37704 and 38060 on Wednesday, were collected between 8.45 and 11.45 A.M.

below the Worcester Sewage Precipitation Works.

.4400	.1780	.1300	.0480	1.89	.0380	.0060	2.94	1.18	9.6	0.5600	0.3000	1
.7400	.2080	.1300	.0780	-	-	.0032	2.82	1.05	28.1	2.8000	2.6000	2
.1600	.0940	.0320	.0620	0.98	.0360	.0018	1.08	0.42	4.7	0.8000	0.1120	3
.0720	.0480	.0430	.0050	-	-	.0013	1.76	1.56	21.2	5.6000	1.7200	4
.2000	.0520	.0160	.0360	1.14	.0250	.0048	0.90	0.42	5.7	1.7200	0.7000	5
.1600	.2080	.0900	.1180	-	-	.0034	2.12	1.12	8.9	1.6800	1.0400	6
.7680	.1600	.0770	.0830	3.68	.0030	.0000	1.68	1.04	8.1	0.8000	0.1300	7
.1700	.2140	.1650	.0490	4.27	.0090	.0112	2.40	2.16	13.6	0.4600	0.0820	8
.3900	.0280	.0255	.0025	-	-	.0015	0.86	0.82	11.1	2.3000	0.6000	9
.5800	.0730	.0405	.0325	2.23	.0150	.0130	0.60	0.48	11.2	0.8800	0.0100	10
.6800	.0930	.0650	.0280	3.52	-	.0056	1.56	1.44	12.0	1.6800	0.2400	11
.2350	.0495	.0360	.0135	1.14	.1120	.0024	1.04	0.70	5.0	0.3600	0.1600	12
.3829	.1171	.0708	.0463	2.36	.0340	.0045	1.62	1.03	11.6	1.6367	0.6370	13

from the river above Millbury and below the point where the effluent from the Worcester sewage 38061 on Wednesday, Nos. 35457 and 36080 on Thursday, No. 37290 on Friday, and the other samples on

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River, at Uxbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34438	Jan. 12	Decided.	Cons.	0.10	11.00	2.20	.2800	.0390	.0290	.0100	1.18	.0390	.0026	.34	3.8
34852	Feb. 21	Decided.	Cons.	0.03	14.00	2.60	.3700	.0415	.0370	.0045	1.62	.0200	.0026	.49	4.3
35190	Mar. 20	Decided.	Cons.	0.16	8.25	1.85	.1800	.0540	.0270	.0270	0.83	.0170	.0012	.40	3.0
35455	Apr. 18	Decided.	Cons.	0.70	6.75	1.90	.0970	.0290	.0220	.0070	0.65	.0190	.0014	.29	2.5
35701	May 15	Decided.	Cons.	0.73	8.00	2.00	.1800	.0340	.0250	.0090	0.80	.0180	.0017	.45	2.7
36081	June 20	Decided.	Cons.	0.10	10.60	2.00	.2480	.0224	.0160	.0064	1.24	.0170	.0013	.32	3.5
36430	July 19	Slight.	Slight.	0.11	13.20	2.70	.2240	.0212	.0192	.0020	1.53	.0290	.0052	.33	4.9
36889	Aug. 22	Slight.	Slight.	0.21	14.60	2.80	.1232	.0226	.0188	.0038	1.33	.0280	.0120	.36	5.9
37308	Sept. 23	V. slight.	Cons.	0.10	15.00	2.40	.2800	.0240	.0200	.0040	1.73	.0150	.0004	.27	5.3
37628	Oct. 17	Decided.	Cons.	0.80	13.15	2.85	.6000	.0430	.0390	.0040	1.30	.0130	.0002	.44	4.3
38090	Nov. 23	Decided.	Cons.	0.02	16.90	3.25	.4200	.0380	.0310	.0070	1.90	.0150	.0017	.43	6.1
38411	Dec. 20	Decided.	Cons.	1.20	9.20	3.20	.0720	.0360	.0300	.0060	0.72	.0320	.0012	.63	2.3
Av...	....	....	....	0.35	11.72	2.48	.2562	.0338	.0262	.0076	1.24	.0218	.0026	.40	4.0

Odor, vegetable or unpleasant, occasionally becoming disagreeable on heating.—The samples were collected from the canal leading from the upper dam of the Calumet Woolen Company to the mill, just before the water passed the screens.

Chemical Examination of Water from Blackstone River at Millville, Blackstone.

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34495	Jan. 17	Decided.	Slight.	0.32	7.90	2.25	.1600	.0290	.0265	.0025	0.84	.0200	.0013	.44	2.6
34846	Feb. 21	Decided.	Cons.	0.34	9.00	2.05	.2400	.0350	.0235	.0115	1.06	.0130	.0008	.46	2.3
35192	Mar. 21	Decided.	Cons.	0.51	6.20	2.10	.0720	.0320	.0265	.0055	0.56	.0230	.0006	.50	2.0
35454	Apr. 18	Decided.	Cons.	0.60	4.90	1.75	.0550	.0210	.0180	.0030	0.47	.0300	.0010	.38	1.8
35696	May 15	Decided.	Cons.	0.60	6.10	1.95	.0760	.0230	.0205	.0025	0.65	.0180	.0008	.43	2.0
36076	June 20	Slight.	Cons.	0.25	6.85	1.75	.1000	.0208	.0148	.0060	0.73	.0200	.0008	.39	2.3
36416	July 18	Slight.	Cons.	0.34	7.95	1.85	.0900	.0305	.0270	.0035	0.76	.0200	.0012	.44	2.5
36884	Aug. 22	Slight.	Slight.	0.30	8.80	2.15	.0460	.0280	.0240	.0040	0.85	.0090	.0008	.44	3.8
37269	Sept. 19	Slight.	Cons.	0.34	7.65	2.15	.0880	.0206	.0190	.0016	0.81	.0140	.0003	.46	3.1
37627	Oct. 17	Decided.	Cons.	0.35	10.50	2.25	.3000	.0450	.0300	.0150	1.10	.0170	.0001	.40	3.9
38068	Nov. 21	Decided.	Slight.	0.28	10.00	2.65	.2280	.0280	.0215	.0065	0.98	.0130	.0006	.51	2.9
38403	Dec. 19	Decided.	Cons.	1.05	8.55	2.45	.0368	.0296	.0240	.0056	0.50	.0320	.0005	.67	1.6
Av...	....	....	....	0.44	7.87	2.11	.1243	.0285	.0229	.0056	0.78	.0191	.0007	.46	2.6

Odor, vegetable or unpleasant, occasionally disagreeable, becoming stronger on heating.—The samples were collected from the river just above the dam in the village of Millville.

BLACKSTONE RIVER.

Averages of Chemical Analyses of Water from the Blackstone River for the Years 1888 to 1901, inclusive.

Blackstone River between Mill Brook Channel and the Sewage Precipitation Works.

[Parts per 100,000.]

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1888,	0.64	-	-	.2112	.1040	-	-	1.21	.0370	.0029	-
1889,	0.76	-	-	.2841	.1198	.0629	.0569	1.06	.0235	.0024	-
1890,	0.82	-	-	.1800	.1024	.0549	.0475	1.03	.0367	.0014	-
1891,	0.80	13.54	4.00	.3340	.1563	.0840	.0723	1.73	.0338	.0032	4.6
1892,	0.71	16.23	4.85	.2530	.1262	.0627	.0635	1.84	.0312	.0061	4.9
1893,	0.68	17.95	4.88	.1429	.0603	.0325	.0277	1.04	.0180	.0012	4.5
1894,	0.86	17.17	5.58	.0739	.0570	.0304	.0266	0.88	.0195	.0006	3.7
1895,	0.84	13.40	4.02	.0507	.0374	.0229	.0145	0.86	.0175	.0007	2.9
1896,	0.75	12.69	3.37	.0759	.0486	.0309	.0177	1.01	.0187	.0010	2.9
1897,	0.94	17.62	5.31	.0715	.0533	.0306	.0227	0.77	.0151	.0015	2.9
1898,	0.50	13.52	4.34	.0762	.0557	.0259	.0298	0.83	.0167	.0011	3.5
1899,	0.26	25.33	8.08	.1921	.0751	.0360	.0391	1.20	.0109	.0010	9.7
1900,	0.18	19.49	5.44	.1141	.0602	.0253	.0349	0.83	.0102	.0011	6.2
1901,	0.25	28.95	10.29	.1613	.0687	.0418	.0269	-	-	.0018	12.6

Blackstone River below Sewage Precipitation Works.

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1888,	0.64	-	-	.2112	.1040	-	-	1.21	.0370	.0029	-
1889,	0.76	-	-	.2841	.1198	.0629	.0569	1.06	.0235	.0024	-
1890,	0.74	-	-	.2253	.1177	.0581	.0596	1.26	.0381	.0016	-
1891,	0.80	15.62	4.52	.4080	.1303	.0695	.0608	1.91	.0358	.0031	4.6
1892,	0.53	19.85	5.29	.3633	.1442	.0737	.0705	2.21	.0278	.0033	7.2
1893,	0.74	25.65	6.54	.3757	.1447	.0864	.0583	1.98	.0369	.0070	7.4
1894,	0.60	25.75	6.61	.4228	.1309	.0946	.0363	2.13	.0316	.0047	7.9
1895,	0.79	19.14	4.78	.2298	.0840	.0573	.0267	1.52	.0347	.0040	5.8
1896,	0.40	24.28	6.36	.2645	.0930	.0615	.0315	1.91	.0356	.0071	8.3
1897,	0.75	19.94	4.59	.2447	.0843	.0630	.0213	1.33	.0300	.0047	5.4
1898,	0.49	19.41	5.20	.2260	.0725	.0473	.0252	1.30	.0264	.0072	6.6
1899,	0.30	32.48	7.90	.3908	.1337	.0749	.0588	2.37	.0176	.0053	12.0
1900,	0.25	22.47	5.02	.3120	.1120	.0499	.0621	1.57	.0210	.0081	7.2
1901,	0.18	30.80	8.88	.3829	.1171	.0708	.0463	2.36	.0340	.0045	11.6

Blackstone River at Uxbridge.

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1888,	0.45	-	-	.0979	.0284	-	-	0.61	.0322	.0008	-
1889,	0.28	-	-	.0992	.0300	.0191	.0109	0.60	.0253	.0009	-
1890,	0.25	-	-	.1168	.0214	.0152	.0062	0.66	.0272	.0006	-
1891,	0.27	8.32	1.94	.1647	.0272	.0197	.0075	0.77	.0396	.0008	2.8
1892,	0.21	8.59	1.90	.2113	.0222	.0153	.0069	0.82	.0326	.0007	2.8
1893,	0.40	9.45	1.91	.1603	.0256	.0167	.0089	1.00	.0424	.0029	3.2
1894,	0.51	10.80	1.97	.1372	.0242	.0187	.0055	1.22	.0460	.0032	4.0
1895,	0.64	10.56	2.44	.1081	.0315	.0243	.0072	1.05	.0439	.0037	3.9
1896,	0.42	10.77	2.50	.1209	.0308	.0249	.0059	1.09	.0405	.0054	4.2
1897,	0.59	10.31	2.50	.1126	.0298	.0248	.0050	1.04	.0481	.0035	3.8
1898,	0.58	8.72	2.30	.0818	.0305	.0232	.0073	0.84	.0360	.0046	3.2
1899,	0.26	14.06	2.51	.2298	.0374	.0297	.0077	1.59	.0331	.0078	5.6
1900,	0.27	11.43	1.97	.2122	.0351	.0262	.0089	1.38	.0359	.0039	4.2
1901,	0.35	11.72	2.48	.2562	.0338	.0262	.0076	1.24	.0218	.0026	4.0

Blackstone River at Millville.

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1888,	0.47	-	-	.0444	.0253	-	-	0.44	.0242	.0005	-
1889,	0.38	-	-	.0450	.0277	.0206	.0071	0.43	.0160	.0004	-
1890,	0.34	-	-	.0587	.0211	.0162	.0049	0.46	.0240	.0004	-
1891,	0.32	6.05	1.83	.0807	.0293	.0194	.0099	0.55	.0275	.0005	1.9
1892,	0.35	6.03	1.62	.0896	.0249	.0180	.0069	0.54	.0218	.0004	1.8
1893,	0.40	6.23	1.53	.0899	.0288	.0225	.0063	0.66	.0289	.0008	2.0
1894,	0.49	6.37	1.90	.0528	.0219	.0173	.0046	0.73	.0232	.0008	2.5
1895,	0.58	7.47	2.27	.0501	.0253	.0189	.0064	0.74	.0278	.0016	2.7
1896,	0.40	7.34	1.64	.0549	.0248	.0185	.0063	0.76	.0347	.0018	2.8
1897,	0.53	7.07	2.14	.0528	.0262	.0219	.0043	0.78	.0332	.0014	2.6
1898,	0.55	6.43	1.95	.0456	.0256	.0201	.0055	0.61	.0222	.0016	2.3
1899,	0.28	8.95	2.04	.0985	.0267	.0221	.0046	0.88	.0220	.0029	3.2
1900,	0.36	8.32	1.81	.1194	.0288	.0232	.0056	0.93	.0272	.0023	2.9
1901,	0.44	7.87	2.11	.1243	.0285	.0229	.0056	0.78	.0191	.0007	2.6

BLACKSTONE RIVER.

AVERAGES OF CHEMICAL ANALYSES OF WATER FROM THE BLACKSTONE RIVER FOR SIX MONTHS, FROM JUNE TO NOVEMBER, 1887 TO 1901, INCLUSIVE.

Blackstone River between Mill Brook Channel and the Sewage Precipitation Works.

[Parts per 100,000.]

MONTHS.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.91	-	-	.2686	.1741	-	-	1.35	.0160	-	-
" " 1888,	0.76	-	-	.2658	.1112	.0557	.0555	1.50	.0382	.0041	-
" " 1889,	0.86	-	-	.3980	.1430	.0772	.0658	1.32	.0177	.0026	-
" " 1890,	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
" " 1891,	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0037	5.0
" " 1892,	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
" " 1893,	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
" " 1894,	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0005	4.4
" " 1895,	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.92	.0163	.0006	3.4
" " 1896,	0.51	12.90	2.93	.0780	.0415	.0282	.0133	0.97	.0147	.0015	3.4
" " 1897,	0.85	26.45	7.68	.1130	.0674	.0362	.0312	0.89	.0090	.0024	4.2*
" " 1898,	0.33	17.42	5.62	.0857	.0619	.0260	.0359	0.96	.0053	.0010	4.6
" " 1899,	0.14*	34.38	10.60	.2583	.0788	.0390	.0398	1.55†	.0050†	.0004	14.3
" " 1900,	0.05	16.48	3.38	.1068	.0518	.0210	.0308	1.03	.0107	.0012	3.6
" " 1901,	0.23	31.03	11.68	.1410	.0548	.0309	.0239	-	-	.0023	13.8

Blackstone River below Sewage Precipitation Works.

MONTHS.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Dissolved.	Albuminoid Ammonia. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.91	-	-	.2686	.1741	-	-	1.35	.0160	-	-
" " 1888,	0.76	-	-	.2658	.1112	.0557	.0555	1.50	.0382	.0041	-
" " 1889,	0.86	-	-	.3980	.1430	.0772	.0658	1.32	.0177	.0026	-
" " 1890,	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0270	.0018	3.9
" " 1891,	1.05	22.25	6.60	.6367	.1508	.0883	.0625	2.61	.0233	.0040	6.2
" " 1892,	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
" " 1893,	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
" " 1894,	0.40	29.30	5.86	.6189	.1390	.1113	.0277	2.63	.0212	.0071	10.6
" " 1895,	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.3
" " 1896,	0.30	26.03	6.53	.2831	.0898	.0600	.0298	2.10	.0217	.0118	9.7
" " 1897,	0.73	25.98	4.97	.3650	.1122	.0782	.0340	1.61	.0207	.0063	6.9
" " 1898,	0.23	25.63	6.73	.3064	.0868	.0560	.0308	1.55	.0182	.0119	9.2
" " 1899,	0.14*	44.02	9.67	.5251	.1707	.0912	.0795	3.26	.0108*	.0068	16.1
" " 1900,	0.22	24.57	4.48	.4430	.1249	.0621	.0628	2.13	.0110	.0145	7.3
" " 1901,	0.09	31.12	6.90	.4580	.1293	.0772	.0521	3.42	.0090	.0058	10.8

* Average of five months. † Average of two months.

BLACKSTONE RIVER.

AVERAGES OF CHEMICAL ANALYSES OF WATER FROM THE BLACKSTONE RIVER FOR SIX MONTHS, ETC. — *Concluded.*

Blackstone River at Uxbridge.

[Parts per 100,000.]

MONTHS.	Color.	Residue on Evaporation.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.		Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
June-Nov., 1887,	0.39	-	-	.1129	.0271	-	-	0.79	.0360	-	-
" " 1888,	0.38	6.42	1.52	.1155	.0288	.0222	.0066	0.68	.0310	.0007	-
" " 1889,	0.32	-	-	.1133	.0296	.0192	.0104	0.66	.0333	.0009	-
" " 1890,	0.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0005	2.9
" " 1891,	0.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
" " 1892,	0.13	9.36	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
" " 1893,	0.24	11.74	2.37	.1985	.0207	.0140	.0067	1.20	.0623	.0050	4.2
" " 1894,	0.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0673	.0050	4.9
" " 1895,*	0.56	12.95	2.69	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
" " 1896,	0.33	12.68	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0
" " 1897,	0.48	11.60	2.47	.1029	.0280	.0215	.0065	1.32	.0652	.0051	4.3
" " 1898,	0.49	10.59	2.78	.0801	.0264	.0219	.0045	1.00	.0470	.0076	3.8
" " 1899,	0.18	18.34	3.11	.2490	.0359	.0310	.0049	2.17	.0510	.0141	7.4
" " 1900,	0.19	13.42	2.04	.2260	.0347	.0257	.0090	1.76	.0558	.0060	5.0
" " 1901,	0.22	13.91	2.67	.3159	.0285	.0240	.0045	1.50	.0195	.0035	5.0

Blackstone River at Millville.

MONTHS.	Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia: Total.	Albuminoid Ammonia: Dissolved.	Albuminoid Ammonia: Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
June-Nov., 1887,	0.31	-	-	.0468	.0220	-	-	0.51	.0210	-	-
" " 1888,	0.41	5.22	1.40	.0467	.0296	.0233	.0063	0.50	.0278	.0004	-
" " 1889,	0.38	-	-	.0499	.0273	.0213	.0060	0.45	.0167	.0003	-
" " 1890,	0.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0003	2.3
" " 1891,	0.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
" " 1892,	0.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
" " 1893,	0.23	7.43	1.73	.0677	.0119	.0087	.0031	0.77	.0385	.0011	2.6
" " 1894,	0.47	8.42	2.16	.0510	.0172	.0139	.0033	0.89	.0273	.0012	2.8
" " 1895,	0.51	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
" " 1896,	0.35	8.53	1.69	.0484	.0237	.0180	.0057	0.97	.0418	.0027	3.3
" " 1897,	0.45	7.66	1.98	.0509	.0258	.0210	.0048	0.92	.0445	.0019	3.1
" " 1898,	0.51	7.12	2.17	.0325	.0240	.0193	.0047	0.63	.0240	.0023	2.5
" " 1899,	0.20	12.50	2.44	.1310	.0301	.0247	.0054	1.31	.0310	.0049	4.6
" " 1900,	0.29	9.33	1.82	.1168	.0254	.0219	.0035	1.15	.0417	.0039	3.4
" " 1901,	0.31	8.62	2.13	.1420	.0288	.0227	.0061	0.87	.0155	.0006	3.1

* Average of five months.

CHARLES RIVER.

Charles River.

Chemical Examination of Water from Charles River, below Milford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36108	June 24	Decided.	Cons.	0.57	5.25	2.50	.0628	.0544	.0192	.0352	0.69	.0140	.0024	0.65	1.6
36536	July 24	Decided.	Cons.	0.56	11.45	3.20	.2120	.0640	.0472	.0168	2.73	.0190	.0040	0.87	2.7
36961	Aug. 27	Decided.	Cons.	1.10	11.45	4.25	.1140	.0416	.0324	.0092	1.28	.0600	.0072	1.57	3.3
37398	Sept. 23	Slight.	Cons.	0.44	9.60	3.00	.1600	.0355	.0285	.0070	1.40	.0270	.0090	0.62	2.7
37810	Nov. 1	Slight.	Cons.	0.32	10.30	3.40	.2432	.0328	.0276	.0052	1.48	.1050	.0044	0.53	3.3
38106	Nov. 25	Decided.	Cons.	0.80	9.10	3.85	.0596	.0420	.0352	.0068	0.83	.0280	.0017	0.91	2.0

Averages by Years.

-	1898	-	-	0.63	10.47	3.08	.1195	.0597	.0422	.0175	2.47	.0473	.0064	0.69	2.4
-	1899	-	-	0.50	12.52	3.12	.3487	.1345	.0803	.0542	3.00	.0053	.0008	1.12	2.6
-	1900	-	-	0.63	10.82	2.36	.2845	.0617	.0457	.0160	2.16	.0270	.0041	0.84	2.6
-	1901	-	-	0.63	9.52	3.37	.1419	.0451	.0317	.0134	1.40	.0422	.0048	0.86	2.6

Odor in 1901, generally distinctly unpleasant; in August, distinctly disagreeable; in September, faintly vegetable. —— The samples were collected from the river, below the point where the sewage from the town enters the river.

Chemical Examination of Water from Charles River, at Needham.

	1901.														
34340	Jan. 7	V. slight.	Slight.	0.60	5.50	1.85	.0042	.0212	.0202	.0010	0.50	.0180	.0000	0.82	1.4
34717	Feb. 11	Slight.	Slight.	0.50	5.75	2.00	.0034	.0202	.0174	.0028	0.51	.0220	.0002	0.59	1.7
35040	Mar. 11	Decided.	Heavy.	0.64	5.35	2.40	.0252	.0716	.0360	.0356	0.41	.0170	.0003	0.82	1.6
35348	Apr. 8	V. slight.	Slight.	0.68	3.50	1.70	.0022	.0222	.0208	.0014	0.28	.0090	.0001	0.70	1.1
35604	May 6	V. slight.	Slight.	0.82	3.75	2.15	.0012	.0222	.0200	.0022	0.31	.0030	.0000	0.86	1.1
35937	June 10	V. slight.	Slight.	1.04	4.25	2.00	.0032	.0308	.0266	.0042	0.30	.0050	.0001	0.68	1.7
36257	July 8	V. slight.	V. slight.	0.98	5.20	2.55	.0006	.0294	.0258	.0036	0.36	.0070	.0002	0.87	1.4
36698	Aug. 12	V. slight.	V. slight.	0.84	5.05	2.40	.0026	.0300	.0286	.0014	0.38	.0010	.0001	0.97	1.3
37121	Sept. 9	V. slight.	Slight.	1.40	6.50	3.65	.0045	.0330	.0310	.0020	0.37	.0070	.0002	1.54	1.6
37502	Oct. 7	Slight.	Slight.	0.80	5.60	2.80	.0028	.0308	.0300	.0008	0.46	.0030	.0001	0.93	1.6
37919	Nov. 11	V. slight.	Slight.	0.73	4.95	2.25	.0010	.0222	.0212	.0010	0.46	.0120	.0000	0.82	1.4
38258	Dec. 9	V. slight.	V. slight.	0.78	5.90	2.50	.0016	.0196	.0184	.0012	0.54	.0120	.0001	0.83	1.4

Averages by Years.

-	1899	-	-	0.46	4.70	1.82	.0008	.0219	.0202	.0017	0.38	.0077	.0001	0.60	1.3
-	1900	-	-	0.63	4.82	1.74	.0010	.0246	.0226	.0020	0.40	.0041	.0001	0.77	1.2
-	1901	-	-	0.82	5.11	2.35	.0044	.0294	.0247	.0047	0.41	.0097	.0001	0.87	1.4

Odor in 1901, generally vegetable, sometimes unpleasant or musty, becoming stronger on heating. —— The samples were collected from the river, at Dedham Avenue bridge.

CHARLES RIVER.

Chemical Examination of Water from Charles River, opposite the Filter Gallery of the Brookline Water Works, at West Roxbury.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1901.														
34982	Mar. 4	Decided.	Slight.	0.20	3.70	1.50	.0196	.0200	.0176	.0024	.34	.0120	.0003	0.34	0.6
35244	Mar. 25	Slight.	Slight.	0.65	4.45	2.30	.0024	.0294	.0252	.0042	.27	.0120	.0000	0.79	1.1
35558	Apr. 29	V. slight.	Slight.	0.68	3.90	2.00	.0016	.0254	.0238	.0016	.29	.0050	.0001	0.78	1.1
35737	May 20	Decided.	Slight.	1.14	4.60	2.50	.0052	.0326	.0256	.0070	.31	.0050	.0000	0.92	1.4
36111	June 24	Slight.	Slight.	0.95	5.10	2.60	.0028	.0304	.0272	.0032	.38	.0080	.0003	0.86	1.3
36446	July 22	V. slight.	Slight.	1.05	5.50	2.55	.0024	.0412	.0364	.0048	.36	.0030	.0001	1.16	1.6
37661	Oct. 21	V. slight.	V. slight.	1.10	6.00	3.00	.0022	.0304	.0284	.0020	.40	.0030	.0001	1.11	1.4
38110	Nov. 25	Slight.	V. slight.	0.58	5.20	2.25	.0006	.0236	.0182	.0054	.51	.0050	.0000	0.68	1.4
38435	Dec. 23	Slight.	Slight.	1.05	4.75	2.40	.0014	.0272	.0258	.0014	.39	.0090	.0000	1.02	1.1

Averages by Years.

-	1898	-	-	0.81	4.75	2.12	.0011	.0257	.0237	.0020	.39	.0055	.0000	0.80	1.4
-	1899	-	-	0.44	4.83	1.86	.0014	.0237	.0213	.0024	.38	.0055	.0001	0.58	1.2
-	1900	-	-	0.55	4.77	1.69	.0019	.0245	.0224	.0021	.41	.0053	.0001	0.72	1.3
-	1901	-	-	0.82	4.80	2.34	.0042	.0289	.0254	.0035	.36	.0069	.0001	0.85	1.2

Odor in 1901, vegetable or unpleasant, becoming stronger on heating.

Chemical Examination of Water from Charles River, opposite the Well of the Waltham Water Works.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue: Total.	Residue: Loss on Ignition.	Ammonia: Free.	Albuminoid: Total.	Albuminoid: Dissolved.	Albuminoid: Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34504	Jan. 21	Slight.	Slight.	0.70	8.10	2.85	.0092	.0316	.0292	.0024	.76	.0400	.0000	0.76	2.5
34791	Feb. 18	Slight.	V. slight.	0.54	6.75	1.85	.0080	.0266	.0248	.0018	.63	.0460	.0005	0.66	2.2
35215	Mar. 25	Slight.	Cons.	0.58	4.40	1.75	.0056	.0300	.0276	.0024	.34	.0150	.0001	0.73	1.3
35461	Apr. 22	V. slight.	Slight.	0.70	3.90	2.05	.0028	.0250	.0230	.0020	.35	.0070	.0001	0.90	1.6
35724	May 20	Slight.	Slight.	1.02	4.90	2.40	.0070	.0342	.0304	.0038	.39	.0100	.0001	0.98	1.7
36092	June 24	Slight.	Slight.	1.02	5.50	2.40	.0050	.0338	.0314	.0024	.40	.0080	.0002	0.92	2.0
36277	July 8	Slight.	Cons.	1.06	6.50	3.00	.0196	.0356	.0344	.0012	.44	.0060	.0004	0.85	1.7
36436	July 22	Slight.	Slight.	0.90	5.65	2.15	.0038	.0352	.0322	.0030	.41	.0040	.0001	0.87	1.7
36708	Aug. 12	V. slight.	Cons.	0.70	4.20	1.90	.0040	.0368	.0332	.0036	.40	.0020	.0002	0.97	1.6
36932	Aug. 26	Decided.	Cons.	0.70	5.45	2.35	.0112	.0348	.0248	.0100	.43	.0050	.0001	0.75	2.3
37323	Sept. 24	None.	Slight.	0.78	6.80	2.90	.0068	.0332	.0290	.0042	.49	.0080	.0002	0.90	2.3
37658	Oct. 22	V. slight	V. slight.	0.88	6.90	3.65	.0038	.0304	.0282	.0022	.46	.0050	.0002	0.89	1.6
38091	Nov. 25	Decided.	Slight.	0.56	5.50	2.70	.0040	.0250	.0226	.0024	.50	.0110	.0003	0.70	1.6
38344	Dec. 17	Slight.	Cons.	0.70	5.40	2.20	.0020	.0232	.0196	.0036	.44	.0100	.0000	0.73	1.3

Averages by Years.

-	1898	-	-	0.79	5.43	2.26	.0036	.0306	.0274	.0032	.45	.0083	.0002	0.76	1.7
-	1899	-	-	0.45	5.14	1.80	.0036	.0248	.0233	.0015	.44	.0087	.0001	0.55	1.7
-	1900	-	-	0.59	5.54	1.88	.0049	.0291	.0263	.0028	.45	.0068	.0001	0.70	1.6
-	1901*	-	-	0.76	5.75	2.45	.0061	.0303	.0273	.0030	.47	.0140	.0002	0.82	1.8

Odor in 1901, generally vegetable, occasionally unpleasant, becoming stronger on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

CHICOPEE RIVER.

CHICOPEE RIVER.

Chemical Examination of Water from Seven Mile River above the Sewage Filtration Area at Spencer.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
36577	July 20	Decided	Cons.	.75	5.55	2.35	.0550	.0590	.0395	.0195	0.34	.0110	.0010	.77	1.6
36864	Aug. 21	Decided.	Cons.	.70	5.20	2.05	.0100	.0436	.0380	.0056	0.32	.0050	.0005	.61	1.7
37355	Sept. 24	Decided.	Cons.	.30	4.60	1.90	.0090	.0215	.0160	.0055	0.30	.0050	.0002	.39	1.3
Av...	....	....	....	.58	5.12	2.10	.0247	.0414	.0312	.0102	0.32	.0070	.0006	.59	1.5

Odor of No. 36577, faintly musty; of the others, decidedly unpleasant.

Chemical Examination of Water from Seven Mile River below the Sewage Filtration Area at Spencer.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36578	July 20	V. slight.	Cons.	.32	12.60	4.15	.1900	.0310	.0270	.0040	2.66	.2050	.0034	.41	2.5
36865	Aug. 21	Slight.	Cons.	.52	7.40	2.65	.0272	.0308	.0268	.0040	1.07	.0100	.0010	.55	2.0
37354	Sept. 24	Decided.	Cons.	.70	6.00	2.60	.0620	.0490	.0340	.0150	0.42	.0050	.0010	.67	1.7
Av...	....	....	....	.51	8.67	3.13	.0931	.0369	.0293	.0076	1.38	.0733	.0018	.54	2.1

Odor of No. 36578, distinctly musty; of the others, distinctly unpleasant.

Chemical Examination of Water from Quaboag River below Palmer.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36040	June 18	Slight.	Cons.	.49	3.60	1.25	.0014	.0234	.0146	.0088	0.20	.0040	.0002	.43	0.8
36386	July 17	Decided.	Cons.	.34	4.30	1.70	.0068	.0332	.0236	.0096	0.28	.0040	.0004	.48	1.0
36856	Aug. 20	Slight.	Cons.	.34	4.30	1.85	.0096	.0248	.0212	.0036	0.24	.0100	.0003	.48	1.3
37337	Sept. 24	V. slight.	Cons.	.33	4.70	1.95	.0042	.0242	.0208	.0034	0.24	.0020	.0001	.51	1.3
37626	Oct. 17	Slight.	Cons.	.66	4.80	2.10	.0006	.0284	.0248	.0036	0.22	.0030	.0000	.81	1.3
38014	Nov. 19	Decided.	Cons.	.34	4.25	1.60	.0030	.0188	.0160	.0028	0.22	.0080	.0000	.49	1.1

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1899	-	-	.35	4.54	1.68	.0048	.0252	.0208	.0044	0.26	.0060	.0002	.44	1.1
-	1900	-	-	.40	4.52	1.57	.0033	.0213	.0172	.0041	0.26	.0072	.0001	.49	1.2
-	1901	-	-	.42	4.32	1.74	.0043	.0255	.0202	.0053	0.23	.0052	.0002	.53	1.1

Odor in 1901, generally unpleasant, sometimes vegetable, becoming stronger on heating. —— The samples were collected from the river about half a mile below the Boston & Albany Railroad bridge.

CHICOPEE RIVER.

Chemical Examination of Water from Ware River at Gilbertville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1901.														
36072	June 20	Slight.	Cons.	0.56	3.50	1.85	.0006	.0214	.0168	.0046	.17	.0020	.0001	0.76	1.0
36380	July 16	Slight.	Cons.	0.52	4.05	1.70	.0016	.0284	.0224	.0060	.17	.0020	.0000	0.60	1.3
36822	Aug. 17	Slight.	Cons.	0.84	4.90	2.50	.0104	.0292	.0236	.0056	.15	.0020	.0001	1.13	1.4
37258	Sept. 18	Slight.	Cons.	0.54	4.75	2.15	.0112	.0260	.0228	.0032	.13	.0020	.0001	0.74	1.1
37573	Oct. 12	Slight.	Cons.	0.66	4.15	1.90	.0048	.0236	.0180	.0056	.21	.0020	.0001	0.58	1.7
37997	Nov. 16	Decided.	Slight.	0.51	3.80	1.60	.0004	.0180	.0160	.0020	.19	.0050	.0000	0.65	0.6
38326	Dec. 13	V. slight.	Cons.	0.63	3.95	2.10	.0008	.0184	.0160	.0024	.18	.0010	.0000	0.70	0.5
Av...	....	....	....	0.61	4.16	1.97	.0043	.0236	.0194	.0042	.17	.0023	.0001	0.74	1.1

Odor, vegetable or unpleasant, becoming stronger on heating.—— The samples were collected from the river at the dam of the George H. Gilbert Manufacturing Company.

Chemical Examination of Water from Ware River, below Ware.

	1901.														
35959	June 11	Decided.	Cons.	0.75	3.80	1.55	.0038	.0284	.0236	.0048	.16	.0050	.0001	0.75	0.8
36384	July 16	Slight.	Cons.	0.44	4.40	1.80	.0030	.0170	.0136	.0034	.22	.0040	.0004	0.58	1.0
36883	Aug. 21	Decided.	Cons.	0.83	5.25	2.35	.0112	.0376	.0296	.0080	.21	.0040	.0003	0.95	1.3
37235	Sept. 17	Slight.	Cons.	0.54	5.50	2.45	.0144	.0312	.0248	.0064	.17	.0060	.0001	0.81	1.7
37620	Oct. 16	Decided.	Cons.	1.08	5.00	2.60	.0088	.0360	.0296	.0064	.13	.0030	.0000	1.12	1.7

Averages by Years.

-	1899	-	-	0.46	4.82	1.77	.0052	.0371	.0268	.0103	.25	.0015	.0004	0.66	0.9
-	1900	-	-	0.51	4.96	1.71	.0077	.0315	.0234	.0081	.25	.0045	.0003	0.73	1.1
-	1901	-	-	0.73	4.79	2.15	.0082	.0300	.0242	.0058	.18	.0044	.0002	0.84	1.3

Odor in 1901, distinctly vegetable.—— The samples were collected from the river at the first railroad bridge below Ware.

Chemical Examination of Water from Chicopee River, below Ludlow.

	1901.														
35940	June 10	Decided.	Cons.	0.47	3.60	1.30	.0046	.0314	.0234	.0080	.18	.0070	.0001	0.55	1.1
36375	July 15	Slight.	Cons.	0.38	4.60	2.10	.0080	.0294	.0220	.0074	.20	.0060	.0001	0.50	1.0
36862	Aug. 21	Slight.	Cons.	0.50	4.65	2.15	.0156	.0344	.0248	.0096	.21	.0020	.0004	0.65	1.6
37782	Oct. 30	Slight.	Cons.	0.61	4.95	2.15	.0036	.0256	.0204	.0052	.21	.0050	.0002	0.73	1.3
38015	Nov. 19	Decided.	Cons.	0.49	4.50	1.75	.0026	.0230	.0178	.0052	.28	.0100	.0000	0.60	1.0

Averages by Years.

-	1899	-	-	0.39	4.62	1.65	.0047	.0255	.0221	.0034	.24	.0095	.0002	0.49	1.2
-	1900	-	-	0.38	4.60	1.48	.0042	.0240	.0193	.0047	.28	.0098	.0002	0.52	1.2
-	1901	-	-	0.49	4.46	1.89	.0069	.0288	.0217	.0071	.21	.0060	.0002	0.61	1.2

Odor in 1901, vegetable or unpleasant, becoming stronger on heating.—— The samples were collected from the river a short distance below the village of Ludlow.

CHICOPEE RIVER.

Chemical Examination of Water from Chicopee River at Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1901.														
35954	June 11	Slight.	Cons.	0.48	3.50	1.50	.0032	.0214	.0152	.0062	0.15	.0070	.0001	0.51	0.8
36374	July 15	Decided.	Cons.	0.36	4.70	2.05	.0022	.0308	.0238	.0070	0.23	.0060	.0003	0.48	1.4
36832	Aug. 19	Decided.	Cons.	0.57	4.80	2.15	.0040	.0340	.0268	.0072	0.23	.0010	.0003	0.70	1.8
37224	Sept. 16	Slight.	Cons.	0.46	5.30	1.80	.0124	.0256	.0176	.0080	0.20	.0070	.0002	0.61	1.8
37592	Oct. 15	Decided.	Cons.	0.50	4.50	2.00	.0014	.0248	.0184	.0064	0.25	.0050	.0001	0.60	2.0
38001	Nov. 18	Decided	Slight.	0.52	4.65	1.65	.0020	.0214	.0182	.0032	0.23	.0100	.0002	0.62	1.0
Av...	....	....	....	0.48	4.57	1.86	.0042	.0263	.0200	.0063	0.21	.0060	.0002	0.59	1.5

Odor, generally distinctly vegetable or unpleasant. —— The samples were collected from the river just below the Boston & Maine Railroad bridge below the city.

CONCORD RIVER.

Chemical Examination of Water from Sudbury River at Saxonville, Framingham.

	1901.														
34394	Jan. 11	Slight.	Slight.	-	7.60	2.95	.0115	.0350	.0335	.0015	0.46	.0210	.0002	1.45	1.7
34779	Feb. 14	Decided.	Cons.	0.55	8.15	4.50	.0348	.0344	.0280	.0064	0.52	.0340	.0003	1.63	1.6
34929	Feb. 27	Decided.	Cons.	-	16.25	5.15	.5040	.2720	.2120	.0600	1.11	.0200	.0013	2.57	2.7
35023	Mar. 7	Decided.	Cons.	-	6.65	2.00	.0164	.0372	.0244	.0128	0.45	.0380	.0006	0.62	2.1
35373	Apr. 10	Decided.	Cons.	0.58	3.55	1.85	.0016	.0252	.0212	.0040	0.21	.0090	.0001	0.68	0.8
35638	May 8	Decided.	Cons.	0.66	4.00	1.60	.0020	.0412	.0236	.0176	0.27	.0070	.0001	0.74	1.3
36004	June 13	Decided.	Cons.	0.75	4.90	2.25	.0028	.0356	.0252	.0104	0.35	.0040	.0005	0.86	1.6
36324	July 10	Decided.	Cons.	1.00	7.90	3.30	.0130	.0765	.0490	.0275	0.48	.0090	.0008	1.04	1.8
36874	Aug. 21	Decided.	Cons.	0.85	8.20	3.65	.0070	.0830	.0520	.0310	0.43	.0020	.0013	1.27	2.1
37177	Sept. 11	Decided.	Heavy.	1.00	10.40	5.15	.0005	.1080	.0730	.0350	0.53	.0020	.0000	1.23	2.2
37535	Oct. 8	Decided.	Cons.	0.64	5.90	2.75	.0004	.0308	.0252	.0056	0.34	.0050	.0008	0.77	2.2
38032	Nov. 20	Decided.	Slight.	0.80	6.00	3.10	.0200	.0404	.0340	.0064	0.17	.0080	.0001	1.14	1.4
38294	Dec. 11	Decided.	Cons.	0.78	5.50	2.75	.0012	.0302	.0246	.0056	0.38	.0120	.0002	0.92	1.1
Av.* .	....	....	....	0.76	6.90	3.01	.0288	.0580	.0421	.0159	0.41	.0120	.0004	1.06	1.7

Odor, generally distinctly unpleasant. —— The samples were collected from the river at the bridge on Danforth Street, below the village of Saxonville.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

CONCORD RIVER.

Chemical Examination of Water from Sudbury River at Concord.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1901.														
34877	Feb. 26	Slight.	Slight.	0.32	6.45	2.10	.0122	.0274	.0244	.0030	.60	.0290	.0005	0.47	2.1
34911	Feb. 27	Slight.	Cons.	0.37	6.50	2.10	.0144	.0284	.0214	.0070	.59	.0380	.0005	0.46	2.1
35247	Mar. 26	Decided.	Cons.	0.55	5.00	2.20	.0046	.0308	.0280	.0028	.30	.0120	.0002	0.78	1.4
35521	Apr. 24	Decided.	Cons.	0.59	4.15	2.10	.0038	.0310	.0228	.0082	.35	.0070	.0001	0.69	1.3
35744	May 21	Slight.	Cons.	0.71	4.80	1.90	.0036	.0448	.0374	.0074	.38	.0050	.0001	0.83	1.6
36150	June 26	V. slight	Slight.	0.85	5.65	2.25	.0054	.0342	.0312	.0030	.39	.0050	.0002	0.81	1.8
36444	July 22	V. slight.	Slight.	0.50	5.20	1.70	.0032	.0302	.0270	.0032	.43	.0020	.0000	0.62	1.8
36860	Aug. 20	V. slight.	V. slight.	0.60	5.70	2.55	.0076	.0300	.0288	.0012	.43	.0040	.0003	0.69	2.1
37229	Sept. 16	V. slight.	Slight.	0.44	5.85	2.50	.0072	.0280	.0232	.0048	.40	.0040	.0001	0.65	2.1
37722	Oct. 24	V. slight	V. slight.	0.70	6.30	3.15	.0046	.0392	.0362	.0030	.56	.0030	.0001	1.09	1.8
38050	Nov. 20	Slight.	Slight.	0.51	5.95	2.65	.0046	.0248	.0232	.0016	.45	.0100	.0002	0.64	1.8
38377	Dec. 19	Decided.	Cons.	0.85	4.50	1.50	.0032	.0268	.0260	.0008	.27	.0110	.0000	0.91	0.6
Av.*.	....	....	....	0.60	5.42	2.24	.0056	.0316	.0279	.0037	.41	.0088	.0002	0.74	1.7

Odor, vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river near its junction with the Assabet River.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Chemical Examination of Water from Assabet River below the Sewage Filtration Area at Westborough.

	1901.														
36075	June 19	V. slight.	Slight.	1.00	4.50	2.60	.0006	.0296	.0282	.0014	.25	.0000	.0000	0.90	1.3
36608	July 27	V. slight.	Cons.	0.57	5.20	2.75	.0060	.0360	.0322	.0038	.34	.0010	.0000	0.94	1.9
36894	Aug. 21	Slight.	Cons.	0.83	6.35	3.25	.0032	.0420	.0384	.0036	.40	.0020	.0001	1.21	2.1
37394	Sept. 26	V. slight	V. slight.	0.90	5.10	2.60	.0044	.0332	.0292	.0040	.36	.0030	.0001	1.15	1.4
37725	Oct. 23	V. slight.	V. slight.	1.40	6.20	3.15	.0032	.0368	.0348	.0020	.35	.0040	.0000	1.75	1.7
38074	Nov. 20	V. slight.	Slight.	0.52	4.65	2.00	.0018	.0246	.0218	.0028	.39	.0050	.0000	0.71	1.4

Averages by Years.

-	1898	-	-	0.93	4.88	2.37	.0026	.0284	.0265	.0019	.30	.0020	.0001	0.93	1.5
-	1899	-	-	0.66	5.65	2.20	.0075	.0325	.0294	.0031	.38	.0036	.0001	0.89	1.6
-	1900	-	-	0.86	5.74	2.42	.0112	.0345	.0319	.0026	.46	.0066	.0002	1.05	1.6
-	1901	-	-	0.87	5.33	2.72	.0032	.0337	.0308	.0029	.35	.0025	.0000	1.11	1.6

Odor in 1901, generally vegetable, becoming stronger on heating. —— The samples were collected from the river, at the bridge on Belmont Street, about 1,000 feet below the filter beds of the town of Westborough.

CONCORD RIVER.

Chemical Examination of Water from Assabet River, below Hudson.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
37222	Sept. 16	Slight.	Cons.	0.54	5.85	3.25	.0472	.0352	.0288	.0064	0.52	.0040	.0007	0.82	2.1
37671	Oct. 22	Slight.	Cons.	1.00	7.15	2.90	.0054	.0416	.0364	.0052	0.93	.0070	.0003	1.22	1.7
38003	Nov. 18	Decided.	Cons.	0.45	3.40	1.00	.0054	.0358	.0234	.0124	0.91	.0210	.0004	0.70	1.6

Averages by Years.

-	1898	-	-	0.70	5.05	2.14	.0053	.0290	.0254	.0036	0.42	.0091	.0021	0.74	1.5
-	1899	-	-	0.50	8.30	3.01	.0205	.0457	.0383	.0074	0.80	.0020	.0004	0.73	2.1
-	1900	-	-	0.52	7.77	2.09	.0331	.0474	.0350	.0124	1.18	.0030	.0006	0.77	2.0
-	1901	-	-	0.66	5.47	2.38	.0193	.0375	.0295	.0080	0.79	.0107	.0005	0.91	1.8

Odor in 1901, vegetable or unpleasant, generally becoming stronger on heating.—— The samples were collected from the river, at O'Neil bridge, so called, about a mile below the village of Hudson.

Chemical Examination of Water from Assabet River, below Maynard.

	1901.														
36023	June 17	Decided.	Cons.	0.95	5.15	2.15	.0126	.0388	.0326	.0062	0.43	.0060	.0001	0.82	1.3
36448	July 23	Slight.	Slight.	0.60	5.10	1.75	.0068	.0328	.0288	.0040	0.40	.0020	.0000	0.68	1.3
36824	Aug. 19	Slight.	Slight.	0.80	6.15	2.85	.0120	.0380	.0312	.0068	0.45	.0020	.0002	0.87	1.8
37232	Sept 16	Decided.	Cons.	0.70	10.10	4.10	.0425	.0600	.0520	.0080	0.52	.0040	.0003	1.21	2.6
37673	Oct. 21	Decided.	Cons.	0.85	6.25	2.50	.0224	.0444	.0356	.0088	0.44	.0070	.0003	1.03	1.7
38023	Nov. 20	Decided.	Cons.	0.50	6.65	2.65	.0304	.0426	.0306	.0120	0.45	.0100	.0002	0.78	1.1

Averages by Years.

-	1898	-	-	0.73	5.25	2.28	.0021	.0333	.0265	.0068	0.40	.0050	.0002	0.78	1.4
-	1899	-	-	0.51	6.70	2.21	.0185	.0414	.0327	.0087	0.73	.0043	.0003	0.62	1.7
-	1900	-	-	0.52	5.69	1.86	.0189	.0365	.0292	.0073	0.66	.0081	.0002	0.64	1.4
-	1901	-	-	0.73	6.57	2.67	.0211	.0428	.0351	.0077	0.45	.0052	.0002	0.90	1.6

Odor in 1901, generally unpleasant, becoming stronger on heating.—— The samples were collected from the river near the works of the American Powder Company.

Chemical Examination of Water from Assabet River at Concord.

	1901.														
34876	Feb. 26	Slight.	Cons.	0.35	5.70	1.90	.0164	.0308	.0242	.0066	0.66	.0260	.0004	0.51	1.8
34907	Feb. 27	Slight.	Cons.	0.35	6.30	2.10	.0230	.0296	.0248	.0048	0.59	.0280	.0005	0.55	1.6
35246	Mar. 26	Decided.	Cons.	0.65	4.55	2.10	.0036	.0342	.0278	.0064	0.24	.0070	.0001	0.85	1.1
35520	Apr. 24	Slight.	Slight.	0.73	4.25	2.00	.0044	.0258	.0232	.0026	0.28	.0050	.0001	0.79	1.1
35743	May 21	Slight.	Cons.	1.12	4.20	2.55	.0032	.0336	.0306	.0030	0.20	.0060	.0001	1.03	1.3
36149	June 26	V. slight.	Cons.	1.00	5.75	2.25	.0138	.0340	.0306	.0034	0.47	.0100	.0003	0.85	1.6
36443	July 22	V. slight.	Cons.	0.56	5.60	2.10	.0116	.0418	.0398	.0020	0.54	.0030	.0007	0.67	1.6
36859	Aug. 20	Slight.	Slight.	0.80	6.40	3.10	.0144	.0424	.0368	.0056	0.47	.0030	.0004	0.85	1.4
37228	Sept. 16	Decided.	Cons.	0.70	8.60	3.45	.0292	.0528	.0460	.0068	0.49	.0050	.0010	0.91	2.2
37721	Oct. 24	Decided.	Cons.	1.00	6.85	3.50	.0092	.0460	.0416	.0044	0.45	.0100	.0002	1.33	1.7
38049	Nov. 20	Decided.	Cons.	0.63	6.40	2.55	.0280	.0328	.0268	.0060	0.50	.0100	.0003	0.78	1.7
38376	Dec. 19	Decided.	Cons.	1.10	4.85	2.35	.0028	.0600	.0428	.0172	0.30	.0150	.0001	1.10	0.8
Av.*.	....	....	....	0.79	5.77	2.54	.0127	.0394	.0337	.0057	0.41	.0092	.0003	0.88	1.5

Odor, generally distinctly vegetable or unpleasant.—— The samples were collected from the river near its junction with the Sudbury River.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

CONCORD RIVER.

Chemical Examination of Water from Concord River at Billerica.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended		Nitrates.	Nitrites.		
	1901.														
35501	Apr. 23	Decided.	Cons.	0.74	4.35	2.10	.0048	.0604	.0308	.0296	.30	.0050	.0002	0.79	1.1
35770	May 21	Slight.	Cons.	1.16	4.50	2.20	.0076	.0348	.0270	.0078	.29	.0060	.0001	1.04	1.4
36122	June 25	Slight.	Cons.	0.98	5.70	2.65	.0144	.0628	.0340	.0288	.44	.0090	.0004	0.86	2.0
36541	July 22	V. slight.	Cons.	0.54	5.10	2.10	.0188	.0456	.0312	.0144	.37	.0030	.0002	0.71	2.1
36837	Aug. 20	Decided.	Cons.	0.95	6.10	2.55	.0100	.0664	.0368	.0296	.45	.0040	.0001	0.92	1.8
37236	Sept. 16	Decided.	Cons.	0.55	6.90	3.00	.0190	.0720	.0430	.0290	.45	.0070	.0010	0.91	2.0
37663	Oct. 21	Decided.	Heavy.	0.90	6.25	2.75	.0470	.2560	.0380	.2180	.50	.0070	.0002	1.02	1.8
38062	Nov. 19	Decided.	Cons.	0.60	6.25	2.25	.0190	.0360	.0210	.0150	.51	.0100	.0002	0.65	2.0
38354	Dec. 16	Decided.	Cons.	0.75	4.90	2.00	.0016	.0272	.0282	.0040	.31	.0100	.0002	0.78	0.8
Av...	....	....	....	0.80	5.56	2.40	.0158	.0735	.0317	.0418	.40	.0068	.0003	0.85	1.7

Odor, vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river near the pumping station of the Billerica water works.

CONNECTICUT RIVER.

Chemical Examination of Water from the Connecticut River, at Northfield Farms.

	1901.														
35947	June 10	V. slight.	Cons.	0.23	5.15	1.80	.0006	.0138	.0126	.0012	.08	.0070	.0001	0.42	3.0
36268	July 8	V. slight.	Cons.	0.53	5.70	2.65	.0060	.0240	.0168	.0072	.09	.0040	.0002	0.90	2.3
36690	Aug. 13	V. slight.	Cons.	0.31	5.90	2.35	.0026	.0130	.0120	.0010	.08	.0020	.0002	0.75	3.1
37331	Sept. 24	None.	V. slight.	0.21	7.00	2.20	.0000	.0108	.0098	.0010	.08	.0010	.0001	0.78	4.2
37643	Oct. 21	V. slight.	Slight.	0.34	6.45	2.70	.0000	.0146	.0134	.0012	.11	.0040	.0001	0.75	-
38087	Nov. 23	V. slight.	Slight.	0.22	6.50	2.65	.0004	.0114	.0086	.0028	.14	.0040	.0003	0.74	3.5

Averages by Years.

-	1899	-	-	0.30	7.32	2.17	.0016	.0189	.0158	.0031	.11	.0023	.0001	0.85	3.6
-	1900	-	-	0.43	6.21	2.07	.0023	.0183	.0151	.0032	.09	.0057	.0002	0.91	2.9
-	1901	-	-	0.31	6.12	2.39	.0016	.0146	.0122	.0024	.10	.0037	.0002	0.72	3.2

Odor in 1901, generally vegetable, becoming stronger on heating.

CONNECTICUT RIVER.

Chemical Examination of Water from the Connecticut River below Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1901.														
36036	June 18	Slight.	Cons.	.31	5.30	1.55	.0016	.0192	.0150	.0042	.18	.0050	.0003	0.41	2.9
36351	July 11	Slight.	Cons.	.38	6.00	2.40	.0086	.0208	.0172	.0036	.18	.0050	.0002	0.86	2.6
36823	Aug. 15	V. slight.	Cons.	.34	5.65	2.40	.0144	.0188	.0144	.0044	.14	.0030	.0003	0.71	3.1
37127	Sept. 9	V. slight.	Cons.	.34	6.75	2.75	.0086	.0138	.0128	.0010	.16	.0060	.0006	0.59	3.6
37483	Oct. 4	V. slight.	Cons.	.29	6.50	2.55	.0032	.0214	.0180	.0034	.21	.0050	.0004	0.71	3.3
38103	Nov. 22	Slight.	Cons.	.28	6.00	2.40	.0004	.0200	.0144	.0056	.20	.0050	.0002	0.65	2.7

Averages by Years.

-	1899	-	-	.33	6.61	1.99	.0093	.0238	.0195	.0043	.23	.0042	.0003	0.67	3.1
-	1900	-	-	.41	6.35	1.82	.0083	.0233	.0168	.0065	.19	.0043	.0002	0.84	3.0
-	1901	-	-	.32	6.03	2.34	.0061	.0190	.0153	.0037	.18	.0048	.0003	0.65	3.0

Odor in 1901, generally faintly vegetable or unpleasant, becoming stronger on heating.—— The samples were collected from the river at the South End bridge, and were made up of portions taken at each pier of the bridge.

Deerfield River.

Chemical Examination of Water from Deerfield River at Shelburne Falls.

	1901.														
35941	June 10	Slight.	Cons.	.27	3.60	1.25	.0010	.0326	.0282	.0044	.10	.0030	.0001	0.51	2.1
36376	July 15	V. slight.	Slight.	.40	3.90	2.00	.0062	.0198	.0166	.0032	.07	.0050	.0000	0.78	1.3
36857	Aug. 19	V. slight.	Slight.	.40	4.10	1.95	.0076	.0152	.0136	.0016	.07	.0070	.0002	0.74	1.7
37234	Sept. 16	Slight.	Cons.	.38	4.55	2.15	.0184	.0220	.0176	.0044	.10	.0180	.0001	0.75	1.7
37570	Oct. 10	None.	V. slight.	.27	4.15	2.05	.0006	.0122	.0112	.0010	.09	.0020	.0001	0.42	2.0
38002	Nov. 16	V. slight.	Slight.	.34	3.80	1.50	.0004	.0180	.0152	.0028	.10	.0120	.0002	0.58	1.3
38339	Dec. 15	Decided.	Heavy.	-	4.25	2.25	.0052	.0704	.0232	.0472	.06	.0220	.0001	1.08	1.1
Av...	....	....	....	.34	4.05	1.88	.0056	.0272	.0180	.0092	.08	.0099	.0001	0.69	1.6

Odor of No. 37570, none; of No. 36857, distinctly unpleasant; of the others, vegetable.—— The samples were collected from the river just above the village of Shelburne Falls.

DEERFIELD RIVER.

Chemical Examination of Water from Deerfield River at Deerfield.

[Parts per 100,000]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1901.														
35985	June 11	V. slight	Cons.	.26	3.55	1.25	.0002	.0132	.0112	.0020	.10	.0090	.0002	.32	2.2
37393	Sept. 26	V. slight.	V slight.	.23	4.75	1.90	.0004	.0120	.0112	.0008	.08	.0050	.0001	.42	2.2
38057	Nov. 20	V. slight.	Slight.	.20	4.75	1.60	.0028	.0112	.0104	.0008	.12	.0100	.0000	.40	1.8
Av...	....	....	....	.23	4.35	1.58	.0011	.0121	.0109	.0012	.10	.0080	.0001	.38	2.1

Odor of the first two samples, none, becoming faintly vegetable on heating; of the last, faintly vegetable, becoming stronger on heating. —— The samples were collected from the river about one and one-half miles from its mouth.

French River.

Chemical Examination of Water from French River, below Webster.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
35956	June 11	Decided.	Cons.	.52	4.55	1.55	.0006	.0366	.0240	.0126	.27	.0040	.0003	.61	0.8
36349	July 11	Decided	Cons.	.53	5.15	1.95	.0240	.0364	.0264	.0100	.34	.0030	.0003	.68	1.1
37230	Sept. 16	Decided.	Cons.	.43	5.75	2.40	.0072	.0380	.0272	.0108	.29	.0040	.0003	.77	1.3
37578	Oct. 12	Decided.	Cons.	.40	5.55	2.85	.0016	.0444	.0268	.0176	.41	.0020	.0002	.82	1.6
38009	Nov. 18	Decided.	Cons.	.62	5.45	2.50	.0116	.0398	.0284	.0114	.33	.0090	.0001	.85	1.0

Averages by Years.

-	1899	-	-	.44	5.67	2.07	.0238	.0612	.0384	.0228	.42	.0024	.0007	.66	1.6
-	1900	-	-	.52	5.79	2.10	.0202	.0475	.0357	.0118	.46	.0062	.0007	.78	1.5
-	1901	-	-	.50	5.29	2.25	.0090	.0390	.0265	.0125	.33	.0044	.0002	.75	1.2

Odor in 1901, distinctly unpleasant. —— The samples were collected from the river, below the village of Webster, near the boundary line between the States of Massachusetts and Connecticut.

Hoosick River.

Chemical Examination of Water from the South Branch of the Hoosick River, above Adams.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36523	July 16	None.	Cons.	.04	10.40	1.70	.0010	.0152	.0120	.0032	.09	.0070	.0032	.35	8.1
36752	Aug. 13	V. slight.	Slight.	.10	10.35	2.00	.0020	.0140	.0128	.0012	.11	.0070	.0002	.34	8.0
37270	Sept. 12	Slight.	Cons.	.15	10.10	3.00	.0076	.0152	.0108	.0044	.11	.0080	.0004	.38	8.3
37635	Oct. 18	V. slight.	Slight.	.16	9.40	3.05	.0016	.0120	.0104	.0016	.10	.0050	.0001	.31	8.6
Av...	....	....	....	.11	10.06	2.44	.0030	.0141	.0115	.0026	.10	.0067	.0010	.34	8.2

Odor in August and September, none; in July and October, faintly unpleasant, becoming stronger on heating.

HOOSICK RIVER.

Chemical Examination of Water from the South Branch of the Hoosick River, below Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1901.														
36524	July 17	V. slight.	Cons.	.05	11.80	2.20	.0010	.0170	.0124	.0046	0.20	.0160	.0120	0.30	9.6
36753	Aug. 13	V. slight.	Cons.	.16	11.00	3.25	.0036	.0140	.0120	.0020	0.26	.0400	.0014	0.35	7.7
37271	Sept. 16	Slight.	Cons.	.18	11.75	3.25	.0080	.0220	.0140	.0080	0.32	.0120	.0008	0.41	6.4
37636	Oct. 18	Slight.	Cons.	.22	10.50	4.25	.0014	.0224	.0134	.0090	0.20	.0200	.0005	0.39	8.7
Av...	....	....	....	.15	11.26	3.24	.0035	.0188	.0129	.0059	0.24	.0220	.0037	0.36	8.1

Odor, generally distinctly unpleasant.

Chemical Examination of Water from the South Branch of the Hoosick River, near its Confluence with the North Branch at North Adams.

	1901.														
35952	June 10	Slight.	Cons.	.12	9.90	2.25	.0060	.0340	.0104	.0236	0.18	.0300	.0017	0.20	7.6
36461	July 23	Decided.	Cons.	-	22.20	5.20	.0220	.1320	.0630	.0690	1.47	.0100	.0000	0.57	10.3
36835	Aug. 19	Decided.	Cons.	.12	11.80	2.70	.0132	.0292	.0112	.0180	0.18	.0280	.0020	0.26	9.6
37130	Sept. 9	Slight.	Cons.	.13	13.55	4.15	.0180	.0264	.0168	.0096	0.17	.0270	.0020	0.31	10.3
37614	Oct. 16	Decided.	Cons.	.35	9.50	3.60	.0068	.0216	.0158	.0058	0.16	.0190	.0004	0.73	7.1
37917	Nov. 11	Slight.	Slight.	.09	13.85	4.75	.0148	.0156	.0132	.0024	0.25	.0490	.0010	0.21	10.5

Averages by Years.

-	1898	-	-	.22	9.43	2.14	.0047	.0202	.0137	.0065	0.19	.0251	.0005	0.30	6.9
-	1899	-	-	.18	12.95	2.65	.0078	.0332	.0212	.0120	0.33	.0182	.0012	0.31	9.8
-	1900	-	-	.16	12.95	2.44	.0148	.0377	.0174	.0203	0.33	.0221	.0019	0.30	8.6
-	1901	-	-	.16	13.47	3.77	.0135	.0431	.0217	.0214	0.40	.0272	.0012	0.38	9.2

Odor in 1901, generally distinctly unpleasant.—The samples were collected from the river about a quarter of a mile above its confluence with the north branch.

Chemical Examination of Water from the North Branch of the Hoosick River, near its Confluence with the South Branch at North Adams.

	1901.														
35951	June 10	Slight.	Cons.	.23	5.75	1.85	.0008	.0288	.0150	.0138	0.24	.0050	.0001	0.49	3.0
36460	July 23	Decided.	Cons.	-	44.00	12.35	.0160	.1160	.0650	.0510	3.55	.0000	-	3.72	14.1
36834	Aug. 19	Decided.	Heavy.	-	17.80	4.65	.0340	.0540	.0160	.0380	1.28	.0040	.0080	1.59	6.1
37129	Sept. 9	Decided.	Heavy.	-	25.15	6.75	.0012	.0988	.0240	.0748	1.74	.0020	.0001	2.79	6.6
37613	Oct. 16	Decided.	Cons.	.40	6.00	2.90	.0004	.0272	.0168	.0104	0.23	.0090	.0017	0.81	2.7
37916	Nov. 11	Decided.	Heavy.	-	20.15	6.40	.0150	.0390	.0335	.0055	1.72	.0140	.0090	2.26	5.3

Averages by Years.

-	1898	-	-	.50	8.15	2.50	.0084	.0299	.0185	.0114	0.49	.0207	.0008	0.80	3.4
-	1899	-	-	-	17.37	4.12	.0107	.0627	.0292	.0335	1.10	.0092	.0038	1.48	5.8
-	1900	-	-	.57	14.64	3.76	.0075	.0506	.0249	.0257	1.09	.0060	.0030	1.30	5.4
-	1901	-	-	.31	19.81	5.82	.0112	.0606	.0284	.0322	1.46	.0057	.0038	1.94	6.3

Odor in 1901, distinctly unpleasant or disagreeable.—The samples were collected from the river, about a quarter of a mile above its confluence with the south branch.

HOOSICK RIVER.

Chemical Examination of Water from the Hoosick River at North Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1901.														
35953	June 10	Slight.	Cons.	.20	8.85	2.50	.0048	.0498	.0196	.0302	0.33	.0130	.0012	0.39	5.4
36462	July 23	Decided.	Cons.	.16	12.95	2.70	.0320	.0820	.0240	.0580	0.28	.0200	.0015	0.33	8.1
36833	Aug. 19	Slight.	Cons.	.23	12.25	2.65	.0064	.0408	.0208	.0200	0.45	.0220	.0002	0.47	5.9
37131	Sept. 9	Decided.	Cons.	-	13.50	4.50	.0004	.0448	.0196	.0252	0.51	.0180	.0060	0.64	8.0
37615	Oct. 16	Decided.	Cons.	.38	10.00	3.85	.0008	.0588	.0246	.0342	0.35	.0150	.0017	0.79	5.9
37918	Nov. 11	Decided.	Cons.	-	18.15	6.15	.0976	.0488	.0376	.0112	0.76	.0370	.0036	1.12	11.1

Averages by Years.

-	1898	-	-	.29	9.65	2.67	.0067	.0319	.0195	.0124	0.33	.0172	.0009	0.46	5.9
-	1899	-	-	-	20.37	5.62	.8711	.3767	.1490	.2277	2.05	.0028	.0005	1.29	7.7
-	1900	-	-	-	22.89	7.41	.5947	.2637	.1042	.1595	2.50	.0066	.0017	1.72	7.0
-	1901	-	-	.24	12.62	3.72	.0237	.0542	.0244	.0298	0.45	.0208	.0024	0.62	7.4

Odor in 1901, distinctly unpleasant.——The samples were collected from the river about a mile below the junction of the north and south branches.

Chemical Examination of Water from the Hoosick River at Williamstown.

	1901.														
34463	Jan. 14	Decided.	Cons.	-	13.15	3.10	.0600	.0350	.0245	.0105	0.48	.0250	.0013	0.85	8.1
34799	Feb. 18	Decided.	Cons.	.28	14.65	3.00	.0740	.0395	.0320	.0075	0.60	.0250	.0014	0.62	8.1
35150	Mar. 18	Decided.	Cons.	-	9.65	2.25	.0465	.0390	.0255	.0135	0.33	.0340	.0006	0.49	6.4
35415	Apr. 15	Decided.	Cons.	.18	5.60	1.85	.0008	.0276	.0116	.0160	0.18	.0200	.0017	0.51	2.9
35670	May 13	Decided.	Cons.	.30	6.95	2.35	.0126	.0670	.0490	.0180	0.17	.0210	.0004	0.31	4.3
36020	June 17	V. slight.	Cons.	.10	11.10	2.35	.0480	.0266	.0192	.0074	0.34	.0150	.0012	0.17	8.0
36377	July 15	Decided.	Cons.	.26	14.80	3.50	.0812	.0516	.0272	.0244	0.54	.0180	.0044	0.57	8.0
36739	Aug. 13	Slight.	Heavy.	.33	12.15	3.45	.0056	.0440	.0224	.0216	0.36	.0150	.0050	0.62	6.3
37196	Sept. 10	Decided.	Cons.	-	16.70	4.95	.0115	.0700	.0270	.0430	0.56	.0080	.0003	0.58	7.1
37593	Oct. 15	Decided.	Cons.	.40	8.90	3.40	.0040	.0475	.0240	.0235	0.27	.0150	.0012	0.64	5.4
37966	Nov. 12	Decided.	Heavy.	-	14.45	4.55	.0900	.0720	.0300	.0420	0.53	.0200	.0026	0.61	9.1
38347	Dec. 17	Decided.	Cons.	.28	7.75	2.65	.0204	.0464	.0114	.0350	0.14	.0440	.0002	0.41	4.6

Averages by Years.

-	1888	-	-	.10	10.21	1.65	.0040	.0187	.0143	.0044	0.24	.0306	.0010	-	-
-	1894	-	-	.23	10.77	2.13	.0111	.0265	.0169	.0096	0.35	.0157	.0009	0.34	7.3
-	1895	-	-	.28	12.41	2.95	.0146	.0334	.0207	.0127	0.39	.0162	.0013	0.46	8.1
-	1896	-	-	.21	11.83	2.91	.0261	.0326	.0217	.0109	0.44	.0323	.0015	0.44	8.1
-	1897	-	-	.23	9.92	2.16	.0125	.0273	.0169	.0104	0.27	.0252	.0008	0.31	6.4
-	1898	-	-	.24	9.13	2.20	.0152	.0286	.0180	.0106	0.26	.0187	.0005	0.32	5.8
-	1899	-	-	.28	12.37	2.95	.0223	.0505	.0308	.0197	0.50	.0141	.0018	0.53	6.9
-	1900	-	-	.24	11.85	2.58	.0328	.0436	.0253	.0183	0.47	.0146	.0026	0.55	6.5
-	1901	-	-	.27	11.32	3.12	.0379	.0472	.0253	.0219	0.37	.0217	.0017	0.53	6.5

Odor in 1901, generally distinctly unpleasant. —— The samples were collected from the river, at the bridge near the Williamstown station on the Fitchburg Railroad.

Housatonic River.

Chemical Examination of Water from the East Branch of the Housatonic River, at Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36059	June 19	V. slight.	Cons.	.21	9.15	2.65	.0050	.0224	.0162	.0062	.18	.0080	.0004	.56	7.0
36389	July 16	Slight.	Cons.	.19	10.10	2.70	.0304	.0332	.0202	.0130	.24	.0130	.0006	.40	6.7
36906	Aug. 21	Slight.	Cons.	.24	11.50	3.80	.0200	.0248	.0212	.0036	.20	.0090	.0005	.56	8.7
37296	Sept. 18	V. slight.	Cons.	.41	9.50	3.50	.0156	.0248	.0184	.0064	.14	.0040	.0003	.75	7.1
37631	Oct. 15	Decided.	Cons.	.58	7.85	3.50	.0260	.0540	.0230	.0310	.15	.0070	.0002	.78	5.0
38052	Nov. 19	Decided.	Cons.	.25	9.65	3.30	.0056	.0276	.0208	.0068	.18	.0150	.0002	.46	7.4

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1898	-	-	.36	7.99	2.33	.0056	.0187	.0150	.0037	.14	.0142	.0003	.47	5.3
-	1899	-	-	.32	10.37	2.40	.0081	.0328	.0269	.0059	.21	.0122	.0003	.60	6.5
-	1900	-	-	.27	10.98	2.40	.0136	.0369	.0273	.0096	.26	.0145	.0006	.49	7.6
-	1901	-	-	.31	9.62	3.24	.0171	.0311	.0200	.0111	.18	.0093	.0004	.58	7.0

Odor in 1901, faintly unpleasant, becoming stronger on heating. —— The samples were collected from the river, at Hathaway bridge, above the thickly settled portion of the city.

Chemical Examination of Water from the West Branch of the Housatonic River, at Pittsfield.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36058	June 19	V. slight.	Cons.	.05	7.35	2.05	.0026	.0172	.0114	.0058	.14	.0010	.0001	.32	5.9
36387	July 16	Slight.	Slight.	.05	7.20	1.75	.0160	.0316	.0200	.0116	.14	.0040	.0002	.28	5.8
36905	Aug. 21	Decided.	Cons.	.23	8.95	2.60	.0320	.0312	.0208	.0104	.17	.0030	.0003	.22	6.0
37295	Sept. 18	Slight.	Cons.	.02	8.50	2.40	.0080	.0296	.0124	.0172	.21	.0010	.0001	.31	6.7
37609	Oct. 15	Slight.	Cons.	.20	9.70	4.05	.0064	.0242	.0168	.0074	.28	.0040	.0001	.42	8.1
38051	Nov. 19	Decided.	Cons.	.09	9.70	3.35	.0002	.0232	.0152	.0080	.21	.0030	.0002	.26	6.7

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1898	-	-	.13	8.95	1.68	.0037	.0183	.0116	.0067	.13	.0079	.0003	.26	6.6
-	1899	-	-	.16	10.62	2.35	.0054	.0394	.0284	.0110	.29	.0024	.0002	.41	6.7
-	1900	-	-	.14	15.53	3.74	.0209	.0821	.0545	.0276	.44	.0031	.0004	.69	6.5
-	1901	-	-	.11	8.57	2.70	.0109	.0262	.0161	.0101	.19	.0027	.0002	.30	6.4

Odor in July, 1901, none; at other times, faintly unpleasant, becoming stronger on heating. —— The samples were collected from the river, a short distance below the junction of the brooks from Onota and Pontoosuc lakes.

HOUSATONIC RIVER.

Chemical Examination of Water from the South-west Branch of the Housatonic River, at Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
36060	June 19	Decided.	Cons.	.13	11.75	3.00	.0004	.0232	.0122	.0110	.16	.0100	.0004	.38	8.9
36388	July 16	Decided.	Cons.	.10	12.30	2.75	.0100	.0408	.0272	.0136	.18	.0070	.0008	.43	8.0
37297	Sept. 18	Slight.	Cons.	.15	14.05	3.60	.0028	.0244	.0168	.0076	.13	.0070	.0003	.40	11.5
37608	Oct. 15	Decided.	Cons.	.21	14.05	5.15	.0056	.0380	.0240	.0140	.18	.0090	.0003	.51	11.4
38053	Nov. 19	Decided.	Cons.	.12	13.85	4.85	.0068	.0248	.0184	.0064	.17	.0150	.0002	.32	7.4

Averages by Years.

-	1898	-	-	.11	10.70	1.89	.0042	.0133	.0085	.0048	.13	.0170	.0001	.22	8.2
-	1899	-	-	.17	14.92	2.58	.0040	.0353	.0211	.0142	.16	.0108	.0004	.37	9.2
-	1900	-	-	.13	14.33	2.13	.0166	.0291	.0203	.0088	.20	.0159	.0007	.31	10.1
-	1901	-	-	.14	13.20	3.87	.0051	.0302	.0197	.0105	.16	.0096	.0004	.41	9.4

Odor in 1901, faintly unpleasant, becoming stronger on heating.——The samples were collected from the river, at the first (Barkerville) road crossing above its confluence with the north branch.

Chemical Examination of Water from the Housatonic River, at New Lenox.

	1901.														
34480	Jan. 15	Decided.	Cons.	.19	11.50	3.20	.0540	.0620	.0365	.0255	.33	.0300	.0011	.48	6.7
34851	Feb. 20	Slight.	Cons.	.13	12.25	3.20	.0272	.0324	.0212	.0112	.31	.0280	.0009	.34	7.3
35184	Mar. 20	Decided.	Cons.	.29	9.70	2.70	.0220	.0440	.0240	.0200	.20	.0240	.0008	.53	6.0
35434	Apr. 17	Slight.	Cons.	.14	7.10	1.85	.0028	.0220	.0154	.0066	.12	.0180	.0004	.32	5.6
35707	May 15	Slight.	Cons.	.23	8.70	2.75	.0092	.0200	.0166	.0034	.18	.0100	.0005	.42	5.3
36061	June 19	Slight.	Cons.	.17	10.15	3.00	.0336	.0380	.0156	.0224	.24	.0130	.0018	.39	7.6
36390	July 16	Slight.	Cons.	.10	12.15	2.65	.0460	.0352	.0254	.0098	.39	.0020	.0056	.30	7.4
36908	Aug. 21	Slight.	Cons.	.15	11.05	3.50	.0510	.0295	.0205	.0090	.23	.0080	.0048	.38	8.3
37298	Sept. 18	Slight.	Cons	.24	12.25	4.10	.0124	.0324	.0152	.0172	.18	.0100	.0012	.51	8.7
37632	Oct. 15	Decided.	Cons.	.33	10.00	3.50	.0340	.0330	.0185	.0145	.19	.0050	.0007	.51	7.6
38054	Nov. 19	Decided.	Cons.	.25	10.60	4.00	.0118	.0304	.0232	.0072	.28	.0130	.0007	.47	6.0
38385	Dec. 17	Decided.	Cons.	.43	8.15	3.00	.0044	.0432	.0182	.0250	.18	.0250	.0006	.81	5.0

Averages by Years.

-	1894	-	-	.27	11.37	2.13	.0131	.0183	.0144	.0039	.25	.0204	.0024	.35	8.5
-	1895	-	-	.26	11.73	2.50	.0183	.0238	.0183	.0055	.25	.0173	.0038	.43	8.4
-	1896	-	-	.26	11.18	1.97	.0169	.0192	.0152	.0040	.22	.0208	.0036	.36	8.6
-	1897	-	-	.32	10.79	2.47	.0159	.0240	.0170	.0070	.19	.0203	.0008	.40	7.5
-	1898	-	-	.27	9.40	2.17	.0106	.0223	.0141	.0082	.15	.0178	.0008	.37	6.4
-	1899	-	-	.20	10.76	2.43	.0197	.0233	.0179	.0054	.23	.0132	.0017	.35	7.4
-	1900	-	-	.22	11.17	2.34	.0378	.0278	.0207	.0071	.28	.0118	.0018	.41	7.2
-	1901	-	-	.22	10.30	3.12	.0257	.0352	.0209	.0143	.24	.0155	.0016	.45	6.8

Odor in 1901, generally distinctly unpleasant.

HOUSATONIC RIVER.

Chemical Examination of Water from the Housatonic River, at Stockbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1901.														
36086	June 19	Slight.	Cons.	.13	12.50	2.80	.0188	.0162	.0148	.0014	.28	.0200	.0028	.36	10.2
36434	July 17	V. slight.	Cons.	.06	12.10	3.25	.0208	.0276	.0220	.0056	.32	.0170	.0018	.31	7.3
36924	Aug. 21	Slight.	Cons.	.15	12.30	3.25	.0188	.0228	.0184	.0044	.27	.0100	.0040	.36	6.3
37281	Sept. 18	Slight.	Cons.	.30	12.65	4.65	.0140	.0216	.0196	.0020	.26	.0170	.0018	.61	10.0
37711	Oct. 21	Slight.	Cons.	.33	10.85	4.50	.0060	.0204	.0150	.0054	.19	.0040	.0005	.45	8.9
38086	Nov. 20	Slight.	Cons.	.24	11.80	5.00	.0112	.0244	.0216	.0028	.26	.0270	.0008	.48	6.4

Averages by Years.

-	1899	-	-	.19	12.61	2.50	.0119	.0246	.0180	.0066	.29	.0102	.0010	.36	8.3
-	1900	-	-	.16	13.31	2.67	.0195	.0260	.0205	.0055	.35	.0152	.0015	.39	9.6
-	1901	-	-	.20	12.03	3.91	.0149	.0222	.0186	.0036	.26	.0158	.0019	.43	8.2

Odor in June, 1901, none; at other times, vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river, opposite the sewage filtration area of the town of Stockbridge.

Chemical Examination of Water from the Housatonic River, at Sheffield.

	1901.														
35944	June 10	Slight.	Cons.	.21	10.55	2.20	.0070	.0182	.0144	.0038	.15	.0130	.0005	.25	6.7
36383	July 16	V. slight.	Cons.	.08	13.15	2.60	.0096	.0252	.0232	.0020	.26	.0160	.0009	.26	6.8
36855	Aug. 20	V. slight.	Slight.	.13	13.30	3.15	.0038	.0192	.0178	.0014	.30	.0180	.0007	.29	7.3
37266	Sept. 17	V. slight.	Slight.	.14	12.00	4.25	.0088	.0180	.0172	.0008	.24	.0120	.0007	.42	10.2
37637	Oct. 18	V. slight.	Cons.	.42	11.00	4.50	.0024	.0206	.0180	.0026	.23	.0090	.0002	.63	9.1
38021	Nov. 19	Decided.	Cons.	.22	11.75	4.35	.0044	.0162	.0130	.0032	.21	.0150	.0000	.46	6.4

Averages by Years.

-	1899	-	-	.16	12.96	2.81	.0094	.0249	.0219	.0030	.33	.0136	.0004	.35	8.7
-	1900	-	-	.16	12.82	2.26	.0079	.0214	.0175	.0039	.28	.0193	.0004	.34	9.0
-	1901	-	-	.20	11.96	3.51	.0060	.0196	.0173	.0023	.23	.0138	.0005	.38	7.7

Odor in 1901, faintly vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river, near the lower covered bridge.

Merrimack River.

The usual monthly examinations of the water of this river above Lowell and above Lawrence have been continued during the year 1901, the detailed results of which may be found on pages 159 and 153 of this volume. A comparison of the analyses made at these two places during the year is given in the following table: —

MERRIMACK RIVER.

Table comparing the Analyses above Lowell with those above Lawrence, 1901.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as		
					Albuminoid.						
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
Number of determinations compared, .	12	12	12	12	12	12	12	12	12	12	12
Mean of analyses above Lowell, . .	.38	4.00	1.70	.0060	.0207	.0170	.0037	.19	.0062	.0001	1.0
Mean of analyses above Lawrence, . .	.41	4.27	1.73	.0092	.0251	.0193	.0058	.24	.0082	.0004	1.3
Increase, ...	.03	0.27	0.03	.0032	.0044	.0023	.0021	.05	.0020	.0003	0.3

In order to compare these results with similar ones obtained in previous years, another table is presented, which shows the increase in impurities as the water passes from a point above Lowell to Lawrence, as given in the last line of the above table, and the corresponding increase in previous years.

Increase in the Amount of Impurities in the Merrimack River Water, from a Point above Lowell to Lawrence, as determined by the Regular Monthly Examinations of Different Years.

[Parts per 100,000.]

DATE.		Residue on Evaporation.		Ammonia.					Nitrogen as		
					Albuminoid.						
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
Increase, 1887-1889, .	0.01	0.23	0.09	.0007	.0027	.0017	.0010	.026	.0003*	.0000	-
Increase, 1890, . .	0.05	0.62	0.22*	.0016	.0023	.0017	.0006	.028	.0020*	.0000	0.2
Increase, 1891, . .	0.02*	0.29	0.07	.0021	.0023	.0021	.0002	.035	.0030*	.0000	0.1
Increase, 1892, . .	0.06	0.48	0.12	.0019	.0037	.0037	.0000	.039	.0013*	.0000	0.0
Increase, 1893, . .	0.09	0.47	0.30	.0031	.0032	.0021	.0011	.035	.0002*	.0001	0.0
Increase, 1894, . .	0.02	0.15	0.04	.0028	.0032	.0032	.0000	.049	.0000	.0000	0.1
Increase, 1895, . .	0.11	0.52	0.33	.0022	.0063	.0046	.0017	.063	.0005	.0001	0.1
Increase, 1896, . .	0.02	0.51	0.24	.0034	.0053	.0047	.0006	.070	.0017	.0002	0.2
Increase, 1897, . .	0.06	0.30	0.08	.0019	.0051	.0033	.0018	.050	.0000	.0000	0.1
Increase, 1898, . .	0.03	0.37	0.07	.0024	.0039	.0019	.0020	.044	.0010	.0002	0.1
Increase, 1899, . .	0.02	0.39	0.07	.0038	.0045	.0023	.0022	.059	.0004*	.0001	0.1
Increase, 1900, . .	0.03	0.41	0.11	.0037	.0027	.0026	.0001	.055	.0011	.0000	0.0
Increase, 1901, . .	0.03	0.27	0.03	.0032	.0044	.0023	.0021	.050	.0020	.0003	0.3

The average flow of the river at Lawrence, for twenty-four hours, during the days on which samples were collected, was for the above periods, respectively, at the rate of 9,145, 9,948, 7,931, 5,434, 8,126, 5,459, 11,634, 5,886, 8,230, 9,402, 7,406, 7,389 and 8,524 cubic feet per second.

* Decrease.

MERRIMACK RIVER.

Chemical Examination of Water from the Merrimack River, above Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1901.														
36125	June 25	Decided.	Cons.	.34	4.80	1.95	.0076	.0332	.0208	.0124	.28	.0100	.0007	0.35	1.1
36548	July 24	Decided.	Cons.	.27	4.95	2.10	.0136	.0304	.0212	.0092	.27	.0080	.0005	0.22	1.6
36979	Aug. 27	Slight.	Cons.	.37	5.20	2.20	.0136	.0240	.0184	.0056	.24	.0060	.0005	0.74	1.6
37358	Sept. 24	Slight.	Cons.	.31	5.35	2.25	.0160	.0208	.0190	.0018	.38	.0040	.0009	0.81	1.8
37697	Oct. 23	Decided.	Cons.	.95	6.00	3.00	.0072	.0436	.0324	.0112	.26	.0030	.0004	1.18	1.3
38155	Nov. 26	Decided.	Cons.	.42	5.35	1.95	.0220	.0460	.0215	.0245	.35	.0090	.0004	0.61	1.4

Averages by Years.

-	1899	-	-	.29	5.56	1.87	.0148	.0368	.0260	.0108	.38	.0060	.0006	0.58	1.6
-	1900	-	-	.30	4.94	1.43	.0210	.0324	.0235	.0089	.41	.0052	.0007	0.65	1.4
-	1901	-	-	.44	5.27	2.24	.0133	.0330	.0222	.0108	.29	.0058	.0006	0.65	1.5

Odor in 1901, vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river, about a mile and a half above the Boston & Maine Railroad bridge, and were made up of several equal portions, collected at different points across the river.

Chemical Examination of Water from the Merrimack River, below Haverhill.

	1901.														
36126	June 25	Decided.	Cons.	.36	4.90	2.00	.0076	.0320	.0208	.0112	.31	.0090	.0007	0.40	1.1
36549	July 24	Slight.	Cons.	.28	5.55	2.15	.0152	.0344	.0220	.0124	.30	.0020	.0005	0.72	1.3
36978	Aug. 27	Decided.	Cons.	.42	5.20	2.25	.0132	.0272	.0212	.0060	.27	.0050	.0006	0.79	1.6
37359	Sept. 24	Slight.	Cons.	.33	4.90	1.60	.0168	.0280	.0232	.0048	.29	.0020	.0010	0.69	1.7
37698	Oct. 23	Decided.	Cons.	.98	6.25	3.50	.0072	.0424	.0320	.0104	.28	.0020	.0004	1.26	1.3
38156	Nov. 26	Decided.	Cons.	.39	5.40	2.10	.0240	.0450	.0230	.0220	.36	.0100	.0004	0.58	1.4

Averages by Years.

-	1899	-	-	.30	5.69	1.98	.0227	.0381	.0263	.0118	.38	.0060	.0006	0.58	1.6
-	1900	-	-	.32	5.03	1.52	.0311	.0335	.0246	.0089	.42	.0056	.0010	0.57	1.2
-	1901	-	-	.46	5.37	2.27	.0140	.0348	.0237	.0111	.30	.0050	.0006	0.74	1.4

Odor in 1901, vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river, near the bridge between Haverhill and Groveland and were made up of several equal portions collected at different points across the river.

Miller's River.

Chemical Examination of Water from Miller's River, above Athol.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36381	July 16	Slight.	Cons.	1.00	3.90	1.80	.0040	.0308	.0264	.0044	.19	.0030	.0000	0.78	0.8
37242	Sept. 16	Slight.	Cons.	1.00	5.30	3.20	.0125	.0420	.0330	.0090	.17	.0030	.0002	1.30	1.1
38162	Nov. 27	Slight.	Cons.	1.00	4.60	2.50	.0040	.0276	.0232	.0044	.29	.0060	.0000	1.15	0.5
38320	Dec. 11	Decided.	Cons.	0.90	4.35	2.35	.0080	.0364	.0246	.0118	.20	.0040	.0001	1.11	1.0

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1899	-	-	1.00	4.60	2.13	.0051	.0296	.0256	.0040	.24	.0013	.0001	0.99	1.0
-	1900	-	-	0.70	5.11	1.82	.0036	.0416	.0250	.0166	.16	.0078	.0001	0.93	1.2
-	1901	-	-	0.97	4.54	2.46	.0071	.0342	.0268	.0074	.21	.0040	.0001	1.08	0.8

Odor of No. 38320, distinctly unpleasant; of the others, distinctly vegetable. —— The samples were collected from the river, at Starrett's mill pond.

Chemical Examination of Water from Miller's River, below Orange.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36022	June 17	Slight.	Cons.	0.76	3.40	1.50	.0030	.0270	.0226	.0044	.17	.0050	.0000	0.75	1.0
36382	July 16	Slight.	Cons.	0.60	3.50	1.65	.0080	.0316	.0212	.0104	.19	.0040	.0002	0.73	1.0
36821	Aug. 16	Slight.	Slight.	0.82	4.55	2.25	.0136	.0280	.0244	.0036	.19	.0030	.0002	1.23	1.4
37259	Sept. 18	Slight.	Cons.	1.00	4.30	2.25	.0084	.0316	.0248	.0068	.18	.0050	.0003	1.04	1.3
37612	Oct. 15	Slight.	Cons.	1.00	4.60	2.90	.0056	.0336	.0300	.0036	.23	.0040	.0002	1.18	1.3
38104	Nov. 19	Slight.	Slight.	1.10	4.25	2.25	.0016	.0284	.0244	.0040	.23	.0040	.0001	0.89	0.6
38408	Dec. 20	Slight.	Cons.	1.10	4.60	2.85	.0048	.0312	.0268	.0044	.19	.0060	.0001	1.26	0.6

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1898	-	-	0.88	3.74	1.88	.0102	.0238	.0200	.0038	.17	.0040	.0001	0.84	0.7
-	1899*	-	-	0.71	3.87	2.15	.0100	.0325	.0258	.0067	.15	.0040	.0001	0.88	0.5
-	1900	-	-	0.71	4.45	1.87	.0069	.0291	.0236	.0055	.24	.0053	.0001	0.89	0.7
-	1901	-	-	0.91	4.17	2.24	.0064	.0302	.0249	.0053	.20	.0044	.0002	1.01	1.0

Odor in 1901, vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river below the lower sewer outlet.

* June and August.

NASHUA RIVER.

Nashua River.

Chemical Examination of Water from the North Branch of the Nashua River, above Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
36049	June 18	Slight.	Slight.	.47	2.80	1.25	.0016	.0178	.0154	.0024	.15	.0010	.0001	0.57	0.5
36500	July 23	V. slight	Slight.	.40	3.15	1.40	.0040	.0224	.0158	.0066	.14	.0040	.0000	0.53	0.2
36887	Aug. 22	V. slight.	V. slight.	.54	3.45	1.65	.0036	.0220	.0168	.0052	.19	.0060	.0001	0.69	0.8
37240	Sept. 17	V. slight	V. slight.	.41	3.90	1.50	.0010	.0142	.0130	.0012	.14	.0140	.0008	0.69	0.6
37669	Oct. 22	V. slight.	V. slight.	.67	4.00	2.25	.0000	.0180	.0170	.0010	.18	.0040	.0001	0.84	0.8
38037	Nov. 20	V. slight.	V. slight.	.43	3.15	1.35	.0006	.0148	.0136	.0012	.17	.0050	.0001	0.60	0.8

Averages by Years.

-	1898	-	-	.69	3.47	1.67	.0012	.0182	.0165	.0017	.17	.0042	.0001	0.71	0.8
-	1899	-	-	.58	3.70	1.81	.0010	.0198	.0178	.0020	.16	.0030	.0000	0.70	0.6
-	1900	-	-	.44	3.39	1.30	.0011	.0177	.0157	.0020	.19	.0051	.0000	0.61	0.7
-	1901	-	-	.49	3.41	1.57	.0018	.0182	.0153	.0029	.16	.0057	.0002	0.65	0.6

Odor in 1901, faintly vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river, a short distance above the Snow mill pond.

Chemical Examination of Water from the North Branch of the Nashua River, below Fitchburg.

	1901.														
34544	Jan. 22	Decided.	Cons.	.30	7.00	2.20	.0920	.0440	.0345	.0095	.76	.0260	.0005	0.69	2.0
34888	Feb. 26	Decided.	Heavy.	.35	11.65	4.75	.3860	.2440	.1800	.0640	.99	.0170	.0008	1.21	2.2
35266	Mar. 28	Decided.	Cons.	.35	6.90	2.00	.0204	.0272	.0188	.0084	.26	.0090	.0002	0.64	1.4
35495	Apr. 23	Decided.	Cons.	.35	3.50	1.50	.0096	.0260	.0186	.0074	.27	.0170	.0002	0.53	1.4
35769	May 22	Decided.	Cons.	.42	4.85	2.25	.0020	.0352	.0220	.0132	.29	.0190	.0006	0.59	1.1
36050	June 18	Decided.	Cons.	.45	7.20	1.80	.0688	.0476	.0302	.0174	.76	.0130	.0012	0.55	2.2
36501	July 23	Decided.	Cons.	.30	9.30	2.20	.1428	.0524	.0372	.0152	.75	.0030	.0024	0.49	2.3
36888	Aug. 22	Decided.	Cons.	.56	8.20	2.60	.0800	.0465	.0320	.0145	.65	.0100	.0018	0.77	2.2
37241	Sept. 17	Decided.	Cons.	.25	9.35	2.25	.1080	.0565	.0365	.0200	.66	.0050	.0003	0.69	2.7
37670	Oct. 22	Decided.	Cons.	.60	8.25	3.30	.0550	.0515	.0365	.0150	.60	.0100	.0010	0.91	2.0
38038	Nov. 20	Decided.	Cons.	.36	8.40	3.35	.1240	.0505	.0360	.0145	.60	.0070	.0012	0.76	1.7
38348	Dec. 17	Decided.	Cons.	.76	5.55	2.35	.0184	.0380	.0222	.0158	.33	.0190	.0002	0.84	1.1

Averages by Years.

-	1893	-	-	.57	7.46	2.16	.0461	.0360	.0257	.0103	.69	.0118	.0018	0.69	2.0
-	1894	-	-	.56	7.39	2.00	.0634	.0346	.0251	.0095	.75	.0152	.0020	0.58	1.9
-	1895	-	-	.59	8.10	2.58	.0832	.0423	.0319	.0104	.75	.0134	.0010	0.74	2.2
-	1896	-	-	.48	8.15	2.40	.0677	.0499	.0343	.0156	.74	.0151	.0017	0.69	2.0
-	1897	-	-	.61	6.82	2.37	.0370	.0420	.0317	.0103	.61	.0120	.0007	0.68	1.8
-	1898	-	-	.51	6.00	2.09	.0435	.0467	.0308	.0159	.48	.0117	.0009	0.64	1.6
-	1899	-	-	.43	7.62	2.40	.0967	.0657	.0412	.0245	.72	.0069	.0009	0.68	1.8
-	1900	-	-	.39	8.10	2.31	.1011	.0660	.0391	.0269	.79	.0072	.0010	0.73	2.0
-	1901	-	-	.42	7.51	2.55	.0922	.0599	.0420	.0179	.58	.0129	.0009	0.72	1.9

Odor in 1901, generally distinctly unpleasant. —— The samples were collected from the river, about half a mile below the point where water from the tail-race of the Falulah Paper Company enters the stream.

NASHUA RIVER.

Chemical Examination of Water from Monoosnock Brook in Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1901.														
36085	June 21	Slight.	Cons.	.60	3.75	2.00	.0124	.0340	.0226	.0114	.23	.0050	.0002	.64	0.6
36597	July 31	Decided.	Heavy.	.55	4.45	2.10	.0095	.0380	.0280	.0050	.22	.0190	.0004	.69	1.1
36987	Aug. 28	Decided.	Cons.	.50	3.95	1.90	.0228	.0332	.0204	.0128	.25	.0060	.0003	.74	1.4
37363	Sept. 25	Decided.	Cons.	.47	6.10	2.50	.1200	.0395	.0280	.0115	.46	.0090	.0020	.74	2.1
37807	Nov. 2	Decided.	Cons.	.62	3.75	2.30	.0048	.0392	.0272	.0120	.21	.0010	.0001	.87	0.8
38168	Nov. 28	Decided.	Cons.	.64	4.80	2.00	.0128	.0368	.0264	.0104	.34	.0110	.0004	.71	1.1

Averages by Years.

-	1899	-	-	.88	5.66	2.57	.0408	.0451	.0331	.0120	.53	.0072	.0009	.82	1.6
-	1900	-	-	.62	4.32	1.83	.0162	.0437	.0289	.0148	.32	.0070	.0004	.75	0.8
-	1901	-	-	.56	4.47	2.13	.0304	.0359	.0254	.0105	.28	.0085	.0006	.73	1.2

Odor of No. 36597, distinctly disagreeable, becoming distinctly musty on heating; of the others, vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the brook, at Whitney Street, above the outlet of the main sewer from the village.

Chemical Examination of Water from the North Branch of the Nashua River, just above its Confluence with the South Branch at Lancaster.

	1901.														
34443	Jan. 14	Decided.	Cons.	.36	10.20	3.20	.1300	.0480	.0290	.0190	.64	.0220	.0006	.67	2.3
34827	Feb. 19	Decided	Cons.	-	8.50	2.15	.1300	.0475	.0380	.0095	.76	.0130	.0008	.67	1.8
35156	Mar. 19	Decided.	Cons.	.42	5.30	1.55	.0275	.0300	.0215	.0085	.36	.0150	.0006	.58	1.7
35421	Apr. 16	Slight.	Cons.	.29	4.10	1.10	.0078	.0180	.0134	.0046	.27	.0240	.0002	.40	1.1
35681	May 13	Decided.	Cons.	.37	3.85	1.45	.0132	.0242	.0182	.0060	.26	.0150	.0003	.50	1.1
36037	June 18	Slight.	Cons.	.32	5.50	1.75	.0312	.0304	.0210	.0094	.45	.0080	.0014	.35	1.7
36457	July 23	Decided.	Cons.	.22	6.90	1.65	.0232	.0448	.0260	.0188	.69	.0080	.0048	.49	2.1
36848	Aug. 20	Slight.	Cons.	.40	6.70	2.20	.0364	.0296	.0272	.0024	.49	.0030	.0050	.60	1.8
37243	Sept. 17	Slight.	Cons.	.32	7.45	2.50	.0254	.0226	.0174	.0052	.54	.0040	.0001	.57	2.3
37676	Oct. 22	Decided.	Cons.	.58	6.10	2.50	.0444	.0328	.0264	.0064	.44	.0150	.0007	.73	1.7
38012	Nov. 19	Decided.	Cons.	.37	7.70	2.25	.0986	.0372	.0260	.0112	.62	.0140	.0006	.72	1.8
38349	Dec. 17	Decided.	Cons.	.75	4.50	2.00	.0128	.0286	.0228	.0058	.28	.0180	.0002	.79	0.8

Averages by Years.

-	1895	-	-	.51	6.96	2.10	.0282	.0269	.0208	.0061	.77	.0236	.0019	.59	1.9
-	1896	-	-	.47	6.16	1.95	.0217	.0293	.0224	.0069	.55	.0155	.0019	.55	1.8
-	1897	-	-	.54	5.29	1.99	.0285	.0290	.0230	.0060	.42	.0150	.0008	.59	1.5
-	1898	-	-	.45	5.07	1.74	.0222	.0268	.0200	.0068	.44	.0168	.0013	.46	1.5
-	1899	-	-	.36	6.38	2.01	.0540	.0316	.0254	.0062	.60	.0132	.0016	.53	1.6
-	1900	-	-	.31	6.34	1.62	.0501	.0322	.0255	.0067	.66	.0152	.0022	.54	1.8
-	1901	-	-	.40	6.40	2.02	.0484	.0328	.0239	.0089	.48	.0132	.0013	.59	1.7

Odor in 1901, generally distinctly unpleasant. —— The samples were collected from the river, near the railroad bridge, a short distance above its mouth.

NASHUA RIVER.

Chemical Examination of Water from the South Branch of the Nashua River, just above its Confluence with the North Branch at Lancaster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
34444	Jan. 14	Decided.	Cons.	.34	9.10	2.50	.0720	.0440	.0250	.0190	1.15	.0580	.0005	.59	2.5
34828	Feb. 19	Decided.	Cons.	-	10.60	2.65	.0660	.0650	.0430	.0220	1.37	.0520	.0014	.65	1.8
35157	Mar. 19	Decided.	Cons.	.46	7.00	1.85	.0480	.0300	.0225	.0075	0.50	.0400	.0008	.59	1.7
35422	Apr. 16	Slight.	Cons.	.30	4.30	1.40	.0170	.0134	.0098	.0036	0.31	.0330	.0002	.43	1.0
35682	May 13	Decided.	Cons.	.40	3.50	1.40	.0074	.0276	.0238	.0038	0.28	.0230	.0002	.56	1.0
36038	June 18	Decided.	Cons.	.31	7.35	2.05	.0048	.0320	.0222	.0098	0.81	.0380	.0012	.35	2.0
36458	July 23	Decided.	Cons.	.36	9.55	2.30	.0284	.0400	.0296	.0104	1.17	.0480	.0030	.41	2.6
36849	Aug. 20	Slight.	Cons.	.32	9.25	2.45	.0354	.0276	.0230	.0046	0.90	.0290	.0020	.50	2.7
37244	Sept. 17	Decided.	Cons.	.30	9.95	3.00	.0382	.0266	.0198	.0068	1.03	.0350	.0020	.57	2.5
37677	Oct. 22	Decided.	Cons.	.46	8.85	3.35	.0264	.0312	.0276	.0036	0.74	.0600	.0014	.60	2.2
38013	Nov. 19	Decided.	Cons.	.26	10.15	2.60	.0256	.0310	.0230	.0080	1.21	.0580	.0012	.51	2.3
38350	Dec. 17	Decided.	Cons.	.70	4.45	1.80	.0074	.0284	.0188	.0096	0.25	.0120	.0003	.74	0.6

Averages by Years.

-	1895	-	-	.53	4.66	1.77	.0167	.0238	.0185	.0053	0.34	.0114	.0008	.61	1.4
-	1896	-	-	.45	4.72	1.69	.0094	.0216	.0180	.0036	0.35	.0134	.0006	.53	1.6
-	1897	-	-	.60	4.47	1.80	.0092	.0257	.0202	.0055	0.32	.0110	.0004	.56	1.3
-	1898	-	-	.50	4.77	1.81	.0327	.0269	.0206	.0063	0.33	.0098	.0010	.48	1.3
-	1899	-	-	.45	7.34	2.12	.1026	.0415	.0310	.0105	0.75	.0087	.0018	.54	1.7
-	1900	-	-	.33	7.73	1.87	.0537	.0346	.0244	.0102	1.00	.0392	.0020	.49	1.9
-	1901	-	-	.38	7.84	2.28	.0314	.0331	.0240	.0091	0.81	.0405	.0012	.54	1.9

Odor in 1901, generally distinctly unpleasant. —— The samples were collected from the river, at the Atherton bridge, a short distance above its mouth and a short distance below the point where the brook from the Clinton sewage filtration area enters the stream.

Chemical Examination of Water from the Nashua River, at Pepperell.

	1901.														
35890	June 10	Slight.	Cons.	.43	4.25	1.40	.0086	.0322	.0278	.0044	.32	.0120	.0004	.52	1.4
36519	July 24	V. slight.	Slight.	.23	5.65	1.85	.0064	.0230	.0194	.0036	.46	.0100	.0009	.51	2.3
36836	Aug. 20	V. slight.	V. slight.	.38	6.70	2.20	.0076	.0280	.0252	.0028	.42	.0100	.0007	.56	2.1
37237	Sept. 17	V. slight.	Slight.	.26	6.70	2.35	.0042	.0176	.0166	.0010	.56	.0030	.0000	.47	2.2
37665	Oct. 22	Slight.	V. slight.	.60	6.20	2.25	.0144	.0262	.0230	.0032	.39	.0080	.0004	.68	1.4
38069	Nov. 21	Decided.	Slight.	.31	6.50	2.30	.0515	.0325	.0260	.0065	.54	.0120	.0004	.56	2.0

Averages by Years.

-	1899	-	-	.28	6.91	2.19	.0167	.0248	.0221	.0027	.78	.0137	.0008	.46	2.1
-	1900*	-	-	.19	6.25	1.72	.0167	.0229	.0210	.0019	.81	.0075	.0011	.40	2.0
-	1901	-	-	.37	6.00	2.06	.0154	.0266	.0230	.0036	.45	.0092	.0005	.55	1.9

Odor in 1901, vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river, just above the drain of the Nashua Paper Company.

* July and August.

NEPONSET RIVER.

·from the Neponset River, at Milton Lower Mills.

.·ts per 100,000.]

				Ammonia.					Nitrogen as			
					Albuminoid.							
					Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
			40	.0420	.0355	.0065	1.02	.0250	.0007	0.89	2.6	
			.0028	.0376	.0290	.0086	0.50	.0150	.0005	0.85	1.8	
			.0016	.0296	.0250	.0046	0.51	.0090	.0001	1.03	1.7	
		..65	.0044	.0428	.0340	.0088	0.57	.0140	.0003	1.12	1.7	
		3.50	.0256	.0436	.0180	.0256	0.87	.0080	.0006	1.06	3.3	
	)	4.00	.0216	.0612	.0546	.0066	0.71	.0070	.0003	1.60	3.1	
	.60	3.15	.0352	.0512	.0412	.0100	1.21	.0060	.0014	1.11	3.3	
	9.20	3.70	.0380	.0480	.0300	.0130	0.84	.0050	.0005	1.19	3.5	
. ·)	8.80	4.90	.0060	.0430	.0345	.0085	0.76	.0080	.0003	1.78	2.6	
).80	10.40	3.65	.0180	.0460	.0360	.0100	1.18	.0120	.0007	1.02	3.0	
1.15	7.15	2.90	.0020	.0320	.0250	.0070	0.47	.0150	.0002	1.20	1.8	
......1.09	8.10	3.31	.0154	.0429	.0330	.0099	0.79	.0113	.0005	1.17	2.6	

unpleasant.—— The samples were collected from the river, above the dam ·mpany's factory, at Milton Lower Mills.

Quaboag River.

(See *Chicopee River.*)

Quinebaug River.

Examination of Water from the Quinebaug River, above Southbridge.

	·· ·1.														
	..e 14	Slight.	Cons.	0.39	3.25	1.15	.0028	.0216	.0168	.0048	0.15	.0020	.0001	0.45	1.0
	..ly 6	Slight.	Cons.	0.58	5.30	1.60	.0244	.0224	.0164	.0060	0.19	.0020	.0001	0.43	1.1
	Aug. 12	V. slight.	Cons.	0.76	4.35	1.80	.0132	.0292	.0268	.0024	0.18	.0090	.0001	0.55	1.7
..7	Sept. 17	Slight.	Cons.	0.44	3.90	1.40	.0072	.0208	.0180	.0028	0.17	.0030	.0000	0.53	1.4
..5	Oct. 8	Slight.	Cons.	0.50	4.45	2.00	.0028	.0236	.0204	.0032	0.15	.0020	.0001	0.59	1.4
..1	Nov. 21	V. slight.	Slight.	0.34	4.10	1.35	.0008	.0186	.0150	.0036	0.26	.0050	.0002	0.46	1.0
Av....	....	....	....	0.50	4.22	1.55	.0085	.0227	.0189	.0038	0.18	.0038	.0001	0.50	1.3

Odor, faintly vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river at the dam above Globe Village.

NEPONSET RIVER.

Chemical Examination of Water from the Neponset River at Norwood.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36091	June 21	Decided.	Heavy.	-	31.50	10.75	.0220	.3240	.1710	.1530	4.90	.0040	.0000	3.74	9.4
37084	Sept. 3	Decided.	Cons.	1.20	17.75	5.50	.0680	.1700	.1110	.0590	3.75	.0030	.0000	1.92	4.7
37392	Sept. 25	Decided.	Heavy.	-	18.15	5.80	.0120	.1055	.0620	.0435	2.55	-	.0090	3.14	5.9
37744	Oct. 24	Decided.	Heavy.	1.92	30.00	11.50	.0090	.1800	.1090	.0710	4.98	.0050	.0000	1.86	10.2
38202	Nov. 30	Decided.	Cons.	1.40	17.00	9.85	.0104	.0604	.0436	.0168	1.62	.0170	.0011	1.60	3.3
38480	Dec. 26	Decided.	Cons.	1.00	8.85	3.50	.0320	.0700	.0588	.0112	1.32	.0270	.0009	1.03	2.2
Av...	....	....	....	1.38	20.54	7.82	.0256	.1517	.0926	.0591	3.19	.0112	.0018	2.21	5.9

Odor of No. 36091, offensive; of No. 38480, distinctly unpleasant; of the others, distinctly disagreeable. —— The samples were collected from the river, below the ink works.

Chemical Examination of Water from the Neponset River at Hyde Park.

	1901.														
34517	Jan. 21	Decided.	Slight.	0.88	9.10	3.75	.0140	.0350	.0320	.0030	1.03	.0220	.0006	1.23	2.9
34857	Feb. 25	Decided.	Cons.	1.00	11.10	4.15	.0215	.0585	.0505	.0080	1.33	.0200	.0008	1.31	3.4
35229	Mar. 25	Slight.	Slight.	0.76	5.60	2.35	.0016	.0348	.0304	.0044	0.55	.0050	.0001	0.96	1.8
35467	Apr. 22	V. slight.	Slight.	0.98	4.90	2.50	.0008	.0340	.0280	.0060	0.57	.0030	.0001	0.90	2.0
35726	May 20	Slight.	Cons.	1.20	5.85	2.85	.0060	.0382	.0348	.0034	0.58	.0040	.0001	1.10	1.6
36098	June 24	Decided.	Cons.	1.20	12.50	4.40	.0056	.0960	.0548	.0412	1.58	.0030	.0003	1.58	4.3
36942	Aug. 26	Decided.	Cons.	1.80	16.10	5.60	.0200	.0960	.0770	.0190	2.02	.0030	.0003	2.17	5.6
37397	Sept. 27	Decided.	Cons.	1.20	15.10	5.35	.0292	.0756	.0636	.0120	1.86	.0060	.0012	1.99	4.7
37638	Oct. 21	Decided.	Slight.	1.55	9.10	4.70	.0210	.0545	.0485	.0060	0.79	.0020	.0002	1.85	2.7
38099	Nov. 25	Decided.	Cons.	1.40	13.50	5.40	.0360	.0790	.0515	.0275	2.24	.0040	.0009	1.55	3.6
38424	Dec. 23	Slight.	Cons.	1.80	8.65	4.00	.0048	.0352	.0304	.0048	0.71	.0150	.0002	1.32	2.2

Averages by Years.

-	1888	-	-	1.02	6.77	2.27	.0030	.0324	-	-	0.83	.0095	.0002	-	-
-	1893	-	-	1.16	7.70	2.49	.0151	.0320	.0254	.0066	1.19	.0154	.0005	0.95	2.4
-	1894	-	-	1.14	9.68	2.69	.0112	.0360	.0277	.0083	1.64	.0062	.0002	1.00	3.0
-	1895	-	-	1.04	8.40	2.81	.0182	.0365	.0312	.0053	1.18	.0064	.0001	1.05	3.0
-	1896	-	-	1.12	8.35	2.69	.0137	.0353	.0315	.0038	1.22	.0077	.0001	1.06	2.7
-	1897	-	-	1.19	8.79	2.84	.0193	.0385	.0333	.0052	1.28	.0067	.0001	1.07	2.9
-	1898	-	-	1.11	7.29	2.89	.0097	.0387	.0315	.0072	0.88	.0060	.0002	1.06	2.4
-	1899	-	-	0.90	10.91	3.36	.0159	.0597	.0463	.0134	1.39	.0052	.0002	1.28	3.6
-	1900	-	-	0.98	8.87	2.83	.0229	.0481	.0338	.0143	1.13	.0058	.0004	1.10	2.9
-	1901	-	-	1.21	10.14	4.10	.0146	.0579	.0456	.0123	1.20	.0079	.0004	1.45	3.2

Odor in 1901, distinctly unpleasant or disagreeable. —— The samples were collected from the river, opposite the works of the Hyde Park Water Company, above the thickly settled portions of the town of Hyde Park.

NEPONSET RIVER.

Chemical Examination of Water from the Neponset River, at Milton Lower Mills.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1901.														
34575	Feb. 26	Decided.	Cons.	-	9.15	3.00	.0140	.0420	.0355	.0065	1.02	.0250	.0007	0.89	2.6
35191	Mar. 21	Decided.	Cons.	0.75	6.00	2.60	.0028	.0376	.0290	.0086	0.50	.0150	.0005	0.85	1.8
35460	Apr. 20	Decided.	Cons.	0.85	4.85	2.40	.0016	.0296	.0250	.0046	0.51	.0090	.0001	1.03	1.7
35736	May 20	Decided.	Cons.	1.16	6.05	2.65	.0044	.0428	.0340	.0088	0.57	.0140	.0003	1.12	1.7
36103	June 24	Decided.	Cons.	1.25	8.65	3.50	.0256	.0436	.0180	.0256	0.87	.0080	.0006	1.06	3.3
36445	July 22	Slight.	Cons.	1.50	9.30	4.00	.0216	.0612	.0546	.0066	0.71	.0070	.0003	1.60	3.1
36902	Aug. 23	Decided.	Cons.	1.00	9.60	3.15	.0352	.0512	.0412	.0100	1.21	.0060	.0014	1.11	3.3
37333	Sept. 24	Decided.	Heavy.	1.00	9.20	3.70	.0380	.0430	.0300	.0130	0.84	.0050	.0005	1.19	3.5
37733	Oct. 25	Decided.	Cons.	1.40	8.80	4.90	.0060	.0430	.0345	.0085	0.76	.0080	.0003	1.78	2.6
38105	Nov. 25	Decided.	Cons.	0.80	10.40	3.65	.0180	.0460	.0360	.0100	1.18	.0120	.0007	1.02	3.0
38414	Dec. 21	Decided.	Slight.	1.15	7.15	2.90	.0020	.0320	.0250	.0070	0.47	.0150	.0002	1.20	1.8
Av.	....	....	....	1.09	8.10	3.31	.0154	.0429	.0330	.0099	0.79	.0113	.0005	1.17	2.6

Odor, generally distinctly unpleasant. —— The samples were collected from the river, above the dam of the Walter Baker and Company's factory, at Milton Lower Mills.

QUABOAG RIVER.

(See *Chicopee River.*)

QUINEBAUG RIVER.

Chemical Examination of Water from the Quinebaug River, above Southbridge.

	1901.														
36011	June 14	Slight.	Cons.	0.39	3.25	1.15	.0028	.0216	.0168	.0048	0.15	.0020	.0001	0.45	1.0
36275	July 6	Slight.	Cons.	0.58	5.30	1.60	.0244	.0224	.0164	.0060	0.19	.0020	.0001	0.43	1.1
36781	Aug. 12	V. slight.	Cons.	0.76	4.35	1.80	.0132	.0292	.0268	.0024	0.18	.0090	.0001	0.55	1.7
37287	Sept. 17	Slight.	Cons.	0.44	3.90	1.40	.0072	.0208	.0180	.0028	0.17	.0030	.0000	0.53	1.4
37565	Oct. 8	Slight.	Cons.	0.50	4.45	2.00	.0028	.0236	.0204	.0032	0.15	.0020	.0001	0.59	1.4
39061	Nov. 21	V. slight.	Slight.	0.34	4.10	1.35	.0008	.0186	.0150	.0036	0.26	.0050	.0002	0.46	1.0
Av.	....	....	....	0.50	4.22	1.55	.0085	.0227	.0189	.0038	0.18	.0038	.0001	0.50	1.3

Odor, faintly vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river at the dam above Globe Village.

QUINEBAUG RIVER.

Chemical Examination of Water from the Quinebaug River, below Southbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36012	June 14	V. slight.	Cons.	.31	3.40	0.90	.0048	.0196	.0144	.0052	0.18	.0050	.0001	0.38	1.1
36276	July 6	Slight.	Cons.	.54	3.85	1.35	.0388	.0360	.0152	.0208	0.21	.0070	.0003	0.45	1.0
36782	Aug. 12	V. slight.	Cons.	.42	4.15	1.85	.0128	.0268	.0256	.0012	0.16	.0060	.0003	0.48	1.4
37288	Sept. 17	Decided.	Cons.	.35	5.90	2.15	.0072	.0228	.0116	.0112	0.19	.0040	.0001	0.36	2.7
37556	Oct. 8	Decided.	Cons.	.55	5.45	2.30	.0064	.0248	.0220	.0028	0.19	.0030	.0018	0.61	2.5
38082	Nov. 21	Slight.	V. slight.	.36	4.40	1.50	.0180	.0092	.0062	.0030	0.22	.0050	.0003	0.45	1.4

Averages by Years.

-	1898	-	-	.64	4.18	2.00	.0064	.0372	.0309	.0063	0.18	.0050	.0003	0.66	0.8
-	1899	-	-	.44	4.32	1.72	.0071	.0298	.0229	.0069	0.23	.0048	.0002	0.54	1.2
-	1900	-	-	.40	4.31	1.56	.0168	.0324	.0211	.0113	0.25	.0024	.0003	0.52	1.0
-	1901	-	-	.42	4.52	1.67	.0147	.0232	.0158	.0074	0.19	.0050	.0005	0.45	1.7

Odor in 1901, faintly vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river, between the villages of Southbridge and Saundersdale.

Salisbury Plain River.

Chemical Examination of Water from Salisbury Plain River, below Brockton.

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
35969	June 12	Slight.	Slight.	.78	8.40	2.90	.0480	.0312	.0254	.0058	1.15	.1750	.0020	0.59	2.7
36315	July 10	Slight.	Cons.	.52	13.40	4.20	.1960	.0220	.0180	.0040	1.82	.1850	.0340	0.58	3.9
36778	Aug. 14	Slight.	Cons.	.24	13.35	4.10	.0188	.0348	.0148	.0200	2.17	.2400	.0160	0.37	3.5
37164	Sept. 11	Decided.	Cons.	.29	11.30	3.30	.0108	.0332	.0280	.0052	1.57	.0920	.0048	0.52	3.0
37948	Nov. 13	Decided.	Cons.	-	13.70	4.30	.4500	.0450	.0340	.0110	2.00	.2050	.0040	1.10	3.9

Averages by Years.

-	1898	-	-	.96	9.23	3.58	.0715	.0386	.0332	.0054	1.09	.0917	.0051	0.88	2.6
-	1899	-	-	.34	11.24	2.97	.0478	.0263	.0214	.0049	1.57	.1572	.0102	0.43	3.3
-	1900	-	-	.39	11.37	2.90	.1030	.0316	.0226	.0090	1.68	.1882	.0088	0.54	3.2
-	1901	-	-	.46	12.03	3.76	.1447	.0332	.0240	.0092	1.74	.1794	.0122	0.63	3.4

Odor in 1901, generally distinctly unpleasant. —— The samples were collected from the river, at Plain Street bridge, above the sewage pumping station.

Seven Mile River.

(See *Chicopee River.*)

Shawsheen River.

Chemical Examination of Water from the Shawsheen River, above Andover.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36306	July 10	Slight.	Cons.	.57	4.65	2.20	.0040	.0372	.0252	.0120	.43	.0050	.0002	0.64	1.1
36751	Aug. 14	Slight.	Cons.	.76	5.45	2.65	.0080	.0340	.0304	.0036	.34	.0040	.0001	0.98	1.6
37160	Sept. 11	Decided.	Cons.	.47	4.75	2.40	.0015	.0370	.0310	.0060	.32	.0040	.0013	0.76	1.7
Av...	....	....	....	.60	4.95	2.42	.0045	.0361	.0289	.0072	.36	.0043	.0005	0.79	1.5

Odor, distinctly unpleasant.——The samples were collected from the river, above the thickly settled portions of the town.

Chemical Examination of Water from the Shawsheen River above the Filter Beds of the Andover Sewage Filtration Area.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36307	July 10	Slight.	Cons.	.57	5.30	2.20	.0024	.0300	.0256	.0044	.43	.0060	.0001	0.59	1.7
36749	Aug. 14	Decided.	Cons.	.80	7.40	3.45	.0080	.0564	.0484	.0080	.46	.0050	.0003	1.22	2.0
37158	Sept. 11	Decided.	Cons.	.45	7.10	3.00	.0015	.0400	.0355	.0045	.54	.0030	.0000	0.84	2.1
Av...	1901	....	....	.61	6.60	2.88	.0040	.0421	.0365	.0056	.48	.0047	.0001	0.88	1.9
Av...	1900	....	....	.51	5.57	2.52	.0074	.0358	.0270	.0088	.42	.0047	.0001	0.81	1.3

Odor of No. 36307, distinctly vegetable; of the others, distinctly unpleasant.——The samples were collected from the river, below the thickly settled portions of the town, but above the sewage filtration area.

Chemical Examination of Water from the Shawsheen River below the Filter Beds of the Andover Sewage Filtration Area.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36308	July 10	Slight.	Cons.	.54	6.00	2.55	.0084	.0356	.0238	.0118	.56	.0130	.0000	0.60	1.6
36750	Aug. 14	Decided.	Heavy.	.78	7.85	3.45	.0080	.0576	.0488	.0088	.56	.0130	.0021	1.19	2.0
37159	Sept. 11	Decided.	Cons.	.47	7.50	3.25	.0040	.0455	.0380	.0075	.57	.0070	.0001	0.88	2.6
Av...	1901	....	....	.60	7.12	3.08	.0068	.0462	.0369	.0093	.56	.0110	.0007	0.89	2.1
Av...	1900	....	....	.49	5.75	2.62	.0077	.0356	.0274	.0082	.48	.0100	.0003	0.76	1.5

Odor of No. 36308, faintly vegetable, becoming stronger on heating; of the others, distinctly unpleasant.——The samples were collected from the river, below the sewage filtration area.

Sudbury River.

(See *Concord River.*)

TAUNTON RIVER.

TAUNTON RIVER.

Chemical Examination of Water from Taunton River, at State Farm, Bridgewater.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
34656	Feb. 4	Slight.	V. slight.	0.70	5.55	2.80	.0068	.0256	.0208	.0048	.66	.0270	.0000	0.90	1.4
34994	Mar. 5	Decided.	Cons.	0.80	5.80	2.25	.0064	.0340	.0300	.0040	.70	.0340	.0003	0.96	1.7
35315	Apr. 3	Slight.	V. slight.	1.02	4.75	2.75	.0052	.0268	.0252	.0016	.46	.0040	.0000	1.15	1.1
35575	Apr. 30	V. slight.	Slight.	1.18	4.15	2.25	.0024	.0248	.0234	.0014	.42	.0030	.0000	1.17	0.6
35866	June 5	V. slight.	Cons.	2.00	4.80	2.80	.0044	.0360	.0314	.0046	.44	.0080	.0001	1.60	1.3
36206	July 1	V. slight.	Cons.	1.24	5.35	3.10	.0088	.0404	.0348	.0056	.53	.0080	.0004	1.28	1.1
36664	Aug. 6	Decided.	Heavy.	0.85	7.30	4.80	.0048	.0564	.0320	.0244	.54	.0010	.0000	1.91	0.8
37099	Sept. 3	V. slight.	Cons.	0.80	5.25	2.85	.0080	.0316	.0252	.0064	.62	.0050	.0002	0.76	1.1
38224	Dec. 3	Decided.	Cons.	1.20	7.25	3.50	.0100	.0368	.0276	.0092	.84	.0150	.0002	1.40	1.6
Av...	1901	....	....	1.09	5.58	2.96	.0063	.0347	.0278	.0069	.58	.0117	.0001	1.24	1.2
Av...	1900	....	....	0.78	6.04	2.22	.0053	.0276	.0242	.0034	.77	.0147	.0001	0.98	1.2

Odor in 1901, generally distinctly unpleasant. —— The samples were collected from the river, near the water works pumping station.

Chemical Examination of Water from the Taunton River, above Taunton.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1901.														
36073	June 20	V. slight.	V. slight.	1.74	5.25	1.00	.0060	.0312	.0290	.0022	.54	.0100	.0002	1.66	1.1
36885	Aug. 22	V. slight.	Slight.	0.70	4.60	2.00	.0052	.0272	.0256	.0016	.58	.0040	.0002	0.84	1.3
37279	Sept. 20	Slight.	Slight.	0.53	5.10	2.10	.0036	.0208	.0176	.0032	.69	.0140	.0000	0.61	1.6
37625	Oct. 17	V. slight.	Slight.	1.00	6.05	2.65	.0038	.0268	.0250	.0018	.69	.0170	.0000	0.94	1.8
38072	Nov. 21	V. slight.	Slight.	0.63	5.05	2.35	.0078	.0232	.0210	.0022	.67	.0150	.0003	0.77	1.1

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
-	1899	-	-	0.94	5.76	2.66	.0019	.0303	.0281	.0022	.61	.0034	.0001	0.96	1.2
-	1900	-	-	0.66	5.92	2.01	.0070	.0248	.0229	.0019	.72	.0100	.0002	0.76	1.1
-	1901	-	-	0.52	5.21	2.02	.0053	.0258	.0236	.0022	.63	.0120	.0001	0.96	1.4

Odor in 1901, distinctly vegetable or unpleasant. —— The samples were collected from the river, opposite the pumping station of the Taunton water works.

TAUNTON RIVER.

Chemical Examination of Water from the Taunton River, below Taunton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1901.														
36074	June 20	V. slight.	Cons.	1.76	5.60	2.40	.0108	.0276	.0268	.0008	0.58	.0140	.0004	1.55	1.0
36886	Aug. 22	Slight.	Slight.	0.76	5.50	2.05	.0156	.0272	.0260	.0012	0.71	.0090	.0006	0.60	1.8
37280	Sept. 20	Decided.	Cons.	0.69	6.40	2.00	.0816	.0244	.0216	.0028	0.93	.0140	.0006	0.67	1.7
37624	Oct. 17	V. slight.	Cons.	0.82	6.15	2.60	.0116	.0250	.0238	.0012	0.72	.0150	.0000	0.82	1.7
38073	Nov. 21	Slight.	Cons.	1.00	7.10	3.20	.0768	.0332	.0294	.0038	0.86	.0150	.0008	0.95	1.8

Averages by Years.

-	1898	-	-	1.39	5.89	2.82	.0095	.0296	.0269	.0027	0.64	.0087	.0003	1.24	1.3
-	1899	-	-	0.93	6.31	2.48	.0176	.0317	.0279	.0038	0.72	.0060	.0004	1.04	1.2
-	1900	-	-	0.71	6.89	1.91	.0205	.0286	.0258	.0028	1.06	.0112	.0006	0.76	1.5
-	1901	-	-	1.01	6.15	2.45	.0293	.0275	.0255	.0020	0.76	.0134	.0005	0.92	1.6

Odor in 1901, generally distinctly vegetable.—The samples were collected from the river, at the wharf of the Taunton gas works, below the bridge at Weir.

Ten Mile River.

Chemical Examination of Water from Ten Mile River, below Attleborough.

	1901.														
35945	June 10	Slight.	Cons.	1.00	5.15	2.25	.0146	.0352	.0280	.0072	0.48	.0150	.0004	0.75	1.7
36299	July 8	Slight.	Cons.	0.72	5.75	2.15	.0108	.0168	.0130	.0038	0.68	.0090	.0003	0.63	1.6
36728	Aug. 13	Decided.	Cons.	0.30	5.90	1.90	.0028	.0330	.0234	.0096	0.76	.0100	.0004	0.42	1.8
37134	Sept. 9	Decided.	Cons.	0.21	6.45	2.10	.0004	.0336	.0168	.0168	0.91	.0200	.0003	0.40	2.0
37510	Oct. 8	Decided.	Slight.	0.24	6.60	2.25	.0044	.0304	.0212	.0092	0.76	.0200	.0003	0.45	2.2
37924	Nov. 11	Slight.	Cons.	0.27	6.70	2.05	.0172	.0252	.0190	.0062	0.69	.0590	.0008	0.43	1.8

Averages by Years.

-	1899	-	-	0.71	6.39	2.15	.0072	.0379	.0288	.0091	0.62	.0133	.0004	0.74	1.7
-	1900	-	-	0.53	6.33	1.74	.0145	.0354	.0241	.0113	0.82	.0184	.0006	0.55	1.9
-	1901	-	-	0.46	6.09	2.12	.0084	.0290	.0202	.0088	0.71	.0222	.0004	0.51	1.8

Odor of No. 37924, faintly unpleasant, becoming stronger on heating; of the others, faintly vegetable becoming stronger on heating —The samples were collected from the river, below Dodgeville.

Ware River.

(See *Chicopee River.*)

Westfield River.

Chemical Examination of Water from the Middle Branch of the Westfield River at Huntington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1901.														
34330	Jan. 3	None.	V. slight.	.08	3.10	0.65	.0008	.0068	.0064	.0004	.13	.0070	.0000	.22	1.3
34486	Jan. 16	None.	V. slight.	.05	3.10	1.00	.0006	.0054	.0046	.0008	.12	.0160	.0000	.15	2.0
34805	Feb. 18	None.	V. slight.	.00	3.10	0.85	.0000	.0066	.0060	.0006	.11	.0170	.0000	.12	1.6
35016	Mar. 6	None.	V. slight.	.08	2.00	0.50	.0000	.0070	.0058	.0012	.14	.0150	.0002	.24	1.7
35317	Apr. 3	Slight.	V. slight.	.19	2.75	1.25	.0004	.0108	.0098	.0010	.08	.0050	.0000	.34	1.0
35581	May 1	V. slight.	V. slight.	.12	2.80	1.35	.0000	.0092	.0074	.0018	.08	.0030	.0000	.21	1.1
35864	June 5	V. slight.	V. slight.	.10	2.80	1.00	.0004	.0082	.0074	.0008	.07	.0050	.0000	.36	1.4
36237	July 3	None.	Slight.	.10	4.25	1.50	.0042	.0112	.0102	.0010	.13	.0070	.0000	.17	1.7
37168	Sept. 11	None.	V. slight.	.09	3.90	1.15	.0004	.0076	.0072	.0004	.12	.0020	.0001	.24	2.3
37476	Oct. 2	None.	V. slight.	.18	3.15	1.25	.0000	.0078	.0074	.0004	.09	.0020	.0000	.39	2.0
37854	Nov. 5	None.	None.	.06	2.70	0.85	.0004	.0094	.0082	.0012	.09	.0040	.0000	.26	1.3
38241	Dec. 4	None.	V. slight.	.08	2.65	1.00	.0006	.0114	.0114	.0000	.14	.0070	.0000	.24	1.1
Av.*.	1901	....	....	.10	3.02	1.05	.0006	.0087	.0079	.0008	.11	.0071	.0000	.25	1.5
Av...	1900	....	....	.09	3.21	0.91	.0004	.0063	.0060	.0003	.09	.0043	.0000	.20	1.5

Odor in October, November and December, 1901, faintly vegetable; at other times, none, occasionally becoming faintly vegetable or unpleasant on heating.

Chemical Examination of Water from the East Branch of the Westfield River, at Huntington.

	1901.														
34329	Jan. 3	None.	V. slight.	.13	3.25	0.75	.0004	.0084	.0074	.0010	.13	.0090	.0000	.30	1.4
34485	Jan. 16	V. slight.	V. slight.	.08	3.15	1.00	.0014	.0126	.0110	.0016	.14	.0130	.0000	.21	2.0
34804	Feb. 18	None.	None.	.02	3.20	0.90	.0002	.0070	.0070	.0000	.11	.0180	.0000	.13	1.4
35015	Mar. 6	None.	None.	.08	2.40	0.60	.0000	.0098	.0088	.0010	.14	.0160	.0001	.26	1.6
35316	April 3	Slight.	Slight.	.22	2.85	1.35	.0014	.0200	.0148	.0052	.08	.0080	.0000	.33	0.8
35580	May 1	V. slight.	V. slight.	.20	2.60	1.25	.0004	.0102	.0088	.0014	.08	.0020	.0000	.30	1.0
35863	June 5	V. slight.	V. slight.	.20	3.00	1.15	.0014	.0128	.0108	.0020	.07	.0010	.0000	.36	1.0
36236	July 3	None.	Slight.	.05	4.30	1.25	.0014	.0070	.0062	.0008	.12	.0100	.0000	.16	1.7
36668	Aug. 7	Slight.	Cons.	.10	3.45	1.45	.0006	.0110	.0074	.0036	.10	.0020	.0001	.20	1.7
37167	Sept. 11	None.	V. slight.	.10	3.50	1.25	.0004	.0096	.0086	.0010	.12	.0020	.0000	.30	1.8
37475	Oct. 2	V. slight.	V. slight	.32	4.05	1.85	.0006	.0128	.0126	.0002	.09	.0010	.0002	.54	1.8
37853	Nov. 5	None.	V. slight.	.16	2.65	0.85	.0006	.0092	.0080	.0012	.08	.0040	.0000	.30	1.3
38240	Dec. 4	V. slight.	V. slight.	.11	3.25	1.25	.0004	.0104	.0102	.0002	.12	.0050	.0000	.35	1.1
Av.*.	1901	....	....	.14	3.20	1.17	.0007	.0109	.0094	.0015	.10	.0067	.0000	.29	1.4
Av...	1900	....	....	.14	3.32	1.00	.0005	.0087	.0083	.0004	.10	.0053	.0000	.29	1.4

Odor in October, November and December, 1901, faintly vegetable; at other times, none, occasionally becoming faintly vegetable or unpleasant on heating.

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

WESTFIELD RIVER.

Chemical Examination of Water from the Westfield River, above Westfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1901.														
35955	June 11	V. slight.	Slight.	.18	3.00	1.00	.0000	.0106	.0096	.0010	.10	.0040	.0000	.32	1.7
36269	July 8	V. slight.	V. slight.	.09	3.90	1.25	.0026	.0118	.0090	.0028	.15	.0040	.0002	.27	2.1
36691	Aug. 8	V. slight.	Cons.	.18	3.95	1.60	.0018	.0174	.0128	.0046	.08	.0040	.0002	.39	1.8
37139	Sept. 10	V. slight.	V. slight.	.17	4.70	2.20	.0010	.0094	.0076	.0018	.09	.0050	.0001	.35	2.1
37881	Nov. 7	V. slight.	V. slight.	.10	3.85	1.85	.0006	.0098	.0088	.0010	.11	.0050	.0004	.32	2.0

Averages by Years.

-	1898	-	-	.25	4.12	1.08	.0015	.0130	.0101	.0029	.11	.0027	.0001	.32	1.6
-	1899	-	-	.17	4.18	1.32	.0012	.0142	.0121	.0021	.14	.0024	.0000	.34	2.0
-	1900	-	-	.23	4.48	1.36	.0011	.0133	.0125	.0008	.15	.0055	.0000	.43	2.2
-	1901	-	-	.14	3.88	1.48	.0012	.0118	.0096	.0022	.11	.0044	.0002	.33	1.9

Odor in June and August, 1901, none; at other times, faintly vegetable or unpleasant. —— The samples were collected from the river, above the thickly settled portions of the town.

Chemical Examination of Water from the Westfield River, below Westfield.

	1901.														
35965	June 11	V. slight.	V. slight.	.21	5.90	1.70	.0036	.0122	.0106	.0016	.12	.0170	.0015	.30	1.6
36298	July 9	Slight.	Slight.	.12	4.80	1.60	.0060	.0228	.0180	.0048	.25	.0060	.0003	.30	2.1
36678	Aug. 7	Slight.	Cons.	.15	4.95	1.60	.0070	.0322	.0194	.0128	.22	.0090	.0005	.35	2.3
37181	Sept. 11	V. slight.	Cons.	.14	5.50	2.15	.0112	.0268	.0208	.0060	.22	.0050	.0006	.40	2.5
37482	Oct. 4	V. slight.	Slight.	.25	4.40	2.05	.0014	.0234	.0216	.0018	.19	.0040	.0001	.63	2.0
37857	Nov. 5	V. slight.	V. slight.	.12	3.90	1.15	.0022	.0152	.0130	.0022	.22	.0100	.0002	.30	2.0

Averages by Years.

-	1898	-	-	.24	3.98	1.52	.0069	.0147	.0113	.0034	.14	.0087	.0002	.31	1.7
-	1899	-	-	.18	4.96	1.60	.0083	.0222	.0179	.0043	.21	.0052	.0002	.33	2.3
-	1900*	-	-	.23	5.01	1.44	.0173	.0271	.0220	.0051	.24	.0087	.0006	.44	2.2
-	1901	-	-	.16	4.91	1.71	.0052	.0221	.0172	.0049	.20	.0085	.0005	.38	2.1

Odor in June, 1901, none; at other times, faintly vegetable or unpleasant, becoming stronger on heating. —— The samples were collected from the river, at Mittineague.

SUMMARY

OF

WATER SUPPLY STATISTICS;

ALSO

RECORDS OF RAINFALL AND FLOW OF STREAMS.

[257]

SUMMARY OF WATER SUPPLY STATISTICS.

A public water supply was introduced during the year 1901 for the first time into the town of Scituate, making the total number of cities and towns in the State provided with public water supplies 167. At the end of the year the State contained 33 cities and 320 towns, and all of the cities and 134 towns were provided with public water supplies. The following table gives the classification by population of cities and towns having and not having public water supplies Dec. 31, 1901. The populations are taken from the census of 1900.

POPULATION (1900).	Number of Places of Given Population having a Public Water Supply.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having a Public Water Supply.	Total Population of Places in Preceding Column.
Under 500,	0	0	37	13,383
500-999,	2	1,650	51	39,792
1,000-1,499,	11	13,994	36	43,435
1,500-1,999,	9	15,893	33	56,669
2,000-2,499,	11	24,429	13	29,003
2,500-2,999,	7	18,755	6	16,598
3,000-3,499,	10	32,018	3	10,020
3,500-3,999,	9	33,123	5	18,590
4,000-4,499,	7	29,878	1	4,364
4,500-4,999,	9	42,170	0	0
Above 5,000,	92	2,365,861	1	5,721
Totals,	167	2,567,771	186	237,575

From the totals given in the table it will be seen that, although but 47 per cent. of the total number of cities and towns in the State have a public water supply, yet the total population of the places supplied represents 91.5 per cent. of the whole population of the State. In this estimate of the total population of municipalities supplied, all the inhabitants in them are included, and it consequently includes rather more than the actual number of persons to whom a public water supply is available; the difference, however, is not large.

There are now ten towns having, by the census of 1900, a population exceeding 3,000 which are not provided with public water supplies. These are given in the following table: —

Town.	Population in 1900.	Town.	Population in 1900.
Blackstone,	5,721	Dartmouth,	3,669
Barnstable,	4,364	Dudley,	3,553
Chelmsford,	3,984	Templeton,	3,489
Pepperell,	3,701	Sutton,	3,328
Tewksbury,	3,683	Hardwick,	3,208

In the following table the various water supplies are classified according to the dates when a fairly complete system was introduced into a city or town: —

Year.	Number of Places supplied.	Year.	Number of Places supplied.
Previous to 1850,	6	1890-1899,	32
1850-1859,	4	1900,	2
1860-1869,	10	1901,	1
1870-1879,	44	Total,	167
1880-1889,	68		

Of the 167 cities and towns having public supplies, all of the cities and 82 of the towns, having an aggregate population of 2,328,432, own their works, while 51 towns, having a population of 239,339, are wholly supplied by private companies.

The following table gives statistics with regard to the consumption of water in cities and towns in this State where such records are kept. The populations for 1901, as given in the table, were obtained by adding one-fifth of the increase in population from 1895 to 1900 to the population as determined by the census taken in the latter year. The daily consumption of water per inhabitant has been obtained by dividing the average daily consumption by the estimated total population of the city or town in 1901. The quantity obtained in this manner is somewhat less than the average quantity used per consumer, because there are in all cities and towns a greater or less number of people who do not use the public water supply.

The difference between the number of inhabitants and the number of consumers would account to a large extent for the low rate per inhabitant in some of the towns where works have been in operation for a short time only and where, in consequence, water has not been generally introduced, or in those towns where there are villages to which the public water supply has not been extended. In some towns the population during the summer months is much greater than that as shown by the census returns, and in such cases the consumption per inhabitant, as given in the table, is somewhat higher than it would be if allowance were made for the increased population in summer.

Statistics in regard to the consumption of water in previous years in those cities and towns in the State where records have been kept are given on pages 589–616 of the annual report for the year 1900.

Statistics relating to the Consumption of Water in Various Cities and Towns.

City or Town.	Estimated Population in 1901.	Average Daily Consumption. Gallons. 1901.	Daily Consumption per Inhabitant. Gallons. 1901.	City or Town.	Estimated Population in 1901.	Average Daily Consumption. Gallons. 1901.	Daily Consumption per Inhabitant. Gallons. 1901.
Metropolitan water district.	844,800	101,492,000	120	Fairhaven, . .	3,613	206,000	57
Abington and Rockland.	9,833	376,000	38	Fall River, . .	107,995	3,618,000	34
Amesbury, . .	9,370	416,000	44	Falmouth, . .	3,669	153,000	42
Andover, . . .	6,947	480,000	69	Foxborough, . .	3,275	166,000	51
Attleborough, . .	11,944	405,000	34	Framingham, . .	11,660	447,000	38
Avon, . . .	1,764	64,000	36	Franklin, . . .	4,993	162,000	33
Ayer, . . .	2,515	93,000	37	Gardner, . . .	11,139	876,000	79
Beverly, . . .	14,300	1,018,000	71	Gloucester, . .	25,703	990,000	39
Billerica, . . .	2,815	58,000	21	Grafton, . . .	4,823	82,000	17
Braintree, . .	6,115	479,000	78	Groton, . . .	2,024	57,000	28
Bridgewater and E. Bridgewater.	9,081	218,000	24	Holliston, . .	2,574	34,000	13
Brockton, . .	41,443	1,226,000	30	Hopkinton, . .	2,551	38,000	15
Brookline, . .	20,689	1,902,000	92	Hyde Park, . .	13,528	848,000	63
Cambridge, . .	93,935	7,690,000	82	Ipswich, . . .	4,646	103,000	22
Canton, . . .	4,574	197,000	43	Lawrence, . .	64,638	3,108,000	48
Cottage City, . .	1,112	100,000	90	Longmeadow, . .	849	67,000	80
Danvers and Middleton.	9,453	780,000	82	Lowell, . . .	97,089	7,059,000	73
Dedham, . . .	7,506	621,000	83	Lynn and Saugus, .	74,946	4,506,000	60
Easthampton, . .	5,766	602,000	104	Manchester, . .	2,651	235,000	89
Easton, . . .	4,914	116,000	24	Mansfield, . .	4,063	147,000	36

Statistics relating to the Consumption of Water in Various Cities and Towns — Concluded.

City or Town.	Estimated Population in 1901.	Average Daily Consumption. Gallons. 1901.	Daily Consumption per Inhabitant. Gallons. 1901.
Marblehead,	7,564	480,000	63
Marlborough,	13,835	502,000	38
Maynard,	3,152	146,000	46
Methuen,	7,876	328,000	42
Middleborough,	6,924	224,000	32
Milford and Hopedale.	14,088	716,000	51
Millbury,	4,308	200,000	46
Milton,	6,790	263,000	39
Montague,	6,168	452,000	73
Nantucket,	3,004	126,000	42
Natick,	9,623	366,000	38
Needham,	4,117	231,000	56
New Bedford,	63,880	5,891,000	92
Newburyport,	14,463	606,000	42
Newton,	34,786	1,844,000	53
North Andover,	4,378	83,000	19
North Attleborough,	7,388	276,000	38
North Brookfield,	4,577	231,000	50
Norwood,	5,661	330,000	58
Orange,	5,552	149,000	27
Peabody,	11,726	1,117,000	95
Provincetown,	4,185	115,000	28
Randolph and Holbrook.	6,268	224,000	36
Reading,	5,019	157,000	31
Rockport,	4,453	217,000	49
Rutland,	1,405	77,000	55
Salem,	36,253	2,867,000	79
Sharon,	2,129	60,000	28
Stoughton,	5,476	173,000	32
Taunton,	31,820	1,738,000	55
Tisbury,	1,178	51,000	43
Wakefield and Stoneham.	15,667	1,157,000	74
Walpole,	3,688	192,000	52
Waltham,	24,002	2,291,000	95
Ware,	8,385	319,000	38
Wareham, Onset Bay.	3,445	27,000	8
Webster,	8,805	463,000	53
Wellesley,	5,241	244,000	46
Weston,	1,859	46,000	25
Whitman,	6,235	125,000	20
Winchendon,	5,103	86,000	17
Woburn,	14,269	1,169,000	82
Worcester,	122,352	9,014,000	74

Rainfall.

The average yearly rainfall in Massachusetts, as deduced from long-continued observations in various parts of the State, is 45.54 inches. The average rainfall for the year 1901 in these places was 51.96 inches, making an excess for the year 1901 of 6.42 inches. The greatest excess occurred in the months of March, April, May and December, while the rainfall in January, February, June, October and November was considerably less than the normal for those months.

The following table gives the normal rainfall in the State for each month as deduced from the observations at various places for a long period of years, together with the average rainfall at those places for each month in 1901 and the departures from the normal: —

Month.	Annual Rainfall. Inches.	Rainfall. 1901. Inches.	Excess or Deficiency. 1901. Inches.	Month.	Annual Rainfall. Inches.	Rainfall. 1901. Inches.	Excess or Deficiency. 1901. Inches.
January,	3.92	1.97	−1.95	August,	4.30	4.53	+0.23
February,	3.73	0.98	−2.75	September,	3.35	3.33	−0.02
March,	4.10	6.57	+2.47	October,	4.05	3.12	−0.93
April,	3.47	7.57	+4.11	November,	4.16	2.19	−1.97
May,	3.80	6.79	+2.99	December,	3.66	8.99	+5.33
June,	3.17	1.30	−1.87				
July,	3.84	4.62	+0.78	Total,	45.54	51.96	+6.42

Flow of Streams.

The flow of streams for the year 1901, as indicated by the records of the Sudbury River, was considerably in excess of the normal. The flow during the months of January, February, March, October and November was less than the normal, the flow during the remaining months being in excess of the normal. The greatest excess occurred in the months of April, May and December.

In order to show the relation between the flow of the Sudbury River during each month of 1901 and the normal flow of the same river, as deduced from observations during the twenty-seven years from 1875 to 1901 inclusive, the following table has been prepared. The area of the water-shed of the Sudbury River above the point of measurement is 75.2 square miles.

Table showing the Average Monthly Flow of Sudbury River for the Year 1901 in Cubic Feet per Second per Square Mile of Drainage Area and in Gallons per Day per Square Mile of Drainage Area, also Departures from the Normal Flow.

Month.	Normal Flow.		Actual Flow for 1901.		Excess or Deficiency.	
	Cubic Feet per Second per Square Mile.	Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Gallons per Day per Square Mile.
January,	1.864	1,205,000	0.676	437,000	−1.188	−768,000
February,	2.923	1,889,000	0.464	300,000	−2.459	−1,589,000
March,	4.523	2,923,000	4.263	2,755,000	−0.260	−168,000
April,	3.211	2,075,000	6.506	4,204,000	+3.295	+2,129,000
May,	1.800	1,163,000	4.571	2,954,000	+2.771	+1,791,000
June,	0.743	480,000	1.165	753,000	+0.422	+273,000
July,	0.300	194,000	0.474	306,000	+0.174	+112,000
August,	0.466	301,000	0.656	424,000	+0.190	+123,000
September,	0.368	238,000	0.472	305,000	+0.104	+67,000
October,	0.802	518,000	0.638	412,000	−0.164	−106,000
November,	1.430	924,000	0.734	474,000	−0.696	−450,000
December,	1.710	1,105,000	4.170	2,695,000	+2.460	+1,590,000
Average,	1.673	1,081,000	2.077	1,342,000	+0.404	+261,000

The next table shows the weekly fluctuation during 1901 in the flow of three of the streams which were carefully measured, viz., the Sudbury, the south branch of the Nashua and the Merrimack rivers. The flow of these streams, particularly the Sudbury and the south branch of the Nashua, serves to indicate the flow of the other streams in eastern Massachusetts.

The water-shed of the Sudbury River above the point of measurement is 75.2 square miles; of the Nashua, 119 square miles; of the Merrimack, 4,664 square miles.

Week ending Sunday.	Flow in Cubic Feet per Second per Square Mile of Water-shed.			Week ending Sunday.	Flow in Cubic Feet per Second per Square Mile of Water-shed.		
	Sudbury River.	South Branch Nashua River.	Merrimack River.		Sudbury River.	South Branch Nashua River.	Merrimack River.
1901.				1901.			
Jan. 6,	0.928	1.157	0.888	July 7,	0.052	0.666	0.547
13,	0.866	0.951	0.688	14,	0.493	0.775	0.689
20,	0.740	1.108	0.725	21,	0.198	0.896	0.536
27,	0.611	0.920	0.703	28,	0.275	0.733	0.550
Feb. 3,	0.506	0.788	0.630	Aug. 4,	0.962	1.111	0.782
10,	0.530	0.678	0.536	11,	0.667	0.885	1.277
17,	0.439	0.629	0.506	18,	0.376	0.709	0.997
24,	0.389	0.573	0.519	25,	1.071	0.732	0.708
March 3,	0.424	0.746	0.481	Sept. 1,	0.664	1.008	0.841
10,	1.575	1.058	0.576	8,	0.434	0.683	0.589
17,	6.678	4.788	2.033	15,	0.418	0.543	0.555
24,	4.088	4.875	2.039	22,	0.692	0.630	0.618
31,	6.034	5.869	4.233	29,	0.183	0.507	0.515
April 7,	8.704	11.316	4.810	Oct. 6,	0.554	0.666	0.528
14,	7.682	7.112	8.896	13,	0.186	0.636	0.512
21,	3.213	3.428	3.637	20,	1.642	1.660	1.675
28,	7.392	9.900	5.456	27,	0.429	0.784	0.870
May 5,	3.995	4.066	3.387	Nov. 3,	0.489	0.600	0.665
12,	3.425	2.943	2.247	10,	0.212	0.639	0.611
19,	3.656	2.923	2.506	17,	0.361	0.780	0.642
26,	5.540	4.851	4.557	24,	0.555	0.650	0.668
June 2,	5.786	6.292	4.336	Dec. 1,	1.916	1.160	0.730
9,	1.990	2.409	2.504	8,	1.239	0.967	0.620
16,	0.885	1.412	1.577	15,	3.664	5.928	1.218
23,	0.696	1.033	0.910	22,	4.541	4.525	4.458
30,	0.480	1.007	0.822	29,	3.878	3.711	1.616

The following table gives the rainfall upon the Sudbury River water-shed and its total yield expressed in inches in depth on the water-shed (inches of rainfall collected) for the year 1901, together with the average of the records of twenty-seven years, from 1875 to 1901 inclusive: —

Rainfall, in Inches, received and collected on Sudbury Water-shed.

Month.	1901.			Mean for 27 Years, 1875-1901.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	1.82	0.779	42.7	4.26	2.149	50.5
February,	1.52	0.483	31.7	4.33	3.068	70.9
March,	6.57	4.912	74.8	4.56	5.215	114.4
April,	8.60	7.257	84.4	3.42	3.582	104.7
May,	7.23	5.269	72.9	3.51	2.075	59.1
June,	1.38	1.299	94.1	2.88	0.828	28.7
July,	5.71	0.545	9.6	3.79	0.345	9.1
August,	4.57	0.756	16.5	4.10	0.536	13.1
September,	3.30	0.527	16.0	3.24	0.412	12.7
October,	2.82	0.734	26.1	4.30	0.925	21.5
November,	2.90	0.819	28.3	4.22	1.596	37.8
December,	9.69	4.808	49.6	3.78	1.971	52.1
Totals and averages,	56.11	28.188	50.2	46.39	22.702	48.9

The Sudbury River records are particularly valuable as a basis for estimating the yield of other water-sheds in Massachusetts, both on account of the accuracy with which the measurements have been made and the absence of abnormal conditions, which would unfavorably affect the results.

The following table gives the records relative to the yield of this water-shed for each of the past twenty-seven years, the flow from the water-shed being expressed in gallons per day per square mile of water-shed, in order to render the table more convenient for use in estimating the probable yield of water-sheds used as sources of water supply.

*Yield of the Sudbury River Water-shed in Gallons per Day per Square Mile.**

Month.	1875.	1876.	1877.	1878.	1879.	1880.	1881.
January,	103,000	643,000	658,000	1,810,000	700,000	1,121,000	415,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000
March,	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,374,000	4,004,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000	1,546,000
May,	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000	965,000
June,	870,000	222,000	597,000	506,000	413,000	176,000	1,338,000
July,	321,000	183,000	202,000	128,000	158,000	177,000	276,000
August,	396,000	405,000	121,000	475,000	395,000	119,000	148,000
September,	207,000	184,000	60,000	160,000	141,000	80,000	197,000
October,	646,000	234,000	632,000	516,000	71,000	101,000	186,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000
December,	584,000	454,000	1,289,000	3,177,000	462,000	175,000	775,000
Av. for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000
Av. for driest six months,	574,000	384,000	502,000	532,000	230,000	148,000	330,000

Month.	1882.	1883.	1884.	1885.	1886.	1887.	1888.
January,	1,241,000	335,000	995,000	1,285,000	1,461,000	2,589,000	1,053,000
February,	2,403,000	1,033,000	2,842,000	1,354,000	4,800,000	2,829,000	1,951,000
March,	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000	2,868,000	3,237,000
April,	867,000	1,350,000	2,853,000	1,815,000	1,947,000	2,620,000	2,645,000
May,	1,292,000	938,000	1,030,000	1,336,000	720,000	1,009,000	1,632,000
June,	529,000	300,000	417,000	426,000	203,000	414,000	422,000
July,	86,000	115,000	224,000	62,000	115,000	114,000	117,000
August,	55,000	78,000	257,000	240,000	94,000	214,000	380,000
September,	306,000	91,000	44,000	121,000	118,000	111,000	1,155,000
October,	299,000	186,000	83,000	336,000	146,000	190,000	1,999,000
November,	210,000	205,000	175,000	1,178,000	673,000	368,000	2,758,000
December,	314,000	193,000	925,000	1,174,000	1,020,000	643,000	3,043,000
Av. for whole year,	862,000	533,000	1,129,000	901,000	1,087,000	1,154,000	1,697,000
Av. for driest six months,	211,000	145,000	200,000	391,000	223,000	234,000	953,000

* The area of the Sudbury River water-shed used in making up these records included water surfaces amounting to about 2 per cent. of the whole area, from 1875 to 1878 inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1879, to 3.5 per cent. in 1885, to 4 per cent. in 1894 and to 6.5 per cent. in 1898. The water-shed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

Yield of the Sudbury River Water-shed in Gallons per Day per Square Mile — Concluded.

Month.	1889.	1890.	1891.	1892.	1893.	1894.	1895.
January,	2,782,000	1,254,000	3,018,000	1,870,000	433,000	693,000	1,034,000
February,	1,195,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000
March,	1,339,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000
April,	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000
May,	880,000	1,366,000	582,000	1,259,000	2,883,000	840,000	636,000
June,	653,000	568,000	414,000	428,000	440,000	419,000	174,000
July,	633,000	108,000	149,000	214,000	158,000	161,000	231,000
August,	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000
September,	824,000	458,000	203,000	229,000	108,000	150,000	89,000
October,	1,230,000	2,272,000	210,000	126,000	221,000	374,000	1,379,000
November,	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000
December,	2,241,000	997,000	544,000	485,000	797,000	716,000	1,782,000
Av. for whole year,	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000
Av. for driest six months,	944,000	747,000	239,000	327,000	237,000	356,000	460,000

Month.	1896.	1897.	1898.	1899.	1900.	1901.	Mean for 27 Years, 1875 to 1901, inclusive.
January,	1,084,000	845,000	1,638,000	2,288,000	794,000	437,000	1,205,000
February,	2,676,000	1,067,000	3,022,000	1,381,000	3,800,000	300,000	1,889,000
March,	3,835,000	2,565,000	2,604,000	4,205,000	3,654,000	2,755,000	2,923,000
April,	1,494,000	1,515,000	1,829,000	2,521,000	1,350,000	4,204,000	2,075,000
May,	360,000	915,000	1,246,000	511,000	1,312,000	2,954,000	1,163,000
June,	399,000	962,000	530,000	66,000	316,000	753,000	480,000
July,	95,000	658,000	231,000	19,000	—18,000	306,000	194,000
August,	57,000	591,000	1,107,000	—35,000	—34,000	424,000	301,000
September,	388,000	182,000	369,000	94,000	65,000	305,000	238,000
October,	592,000	94,000	1,160,000	115,000	186,000	412,000	518,000
November,	659,000	909,000	1,986,000	304,000	663,000	474,000	924,000
December,	657,000	1,584,000	1,799,000	220,000	1,096,000	2,695,000	1,105,000
Av. for whole year,	1,019,000	991,000	1,450,000	973,000	1,082,000	1,342,000	1,081,000
Av. for driest six months,	314,000	564,000	777,000	93,000	194,000	445,000	441,000

EXPERIMENTS

UPON THE

PURIFICATION OF SEWAGE AND WATER

AT THE

LAWRENCE EXPERIMENT STATION,

DURING THE YEAR 1901.

EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION.*

By HARRY W. CLARK, *Chemist of the Board.*

The following report presents a summary of the investigations upon the purification of sewage and water made at the Lawrence Experiment Station during the year 1901 and the results obtained. Considerable other work has been done at the station during the year in connection with various investigations made by the Board, such as the examination of sea water and shellfish from uncontaminated and sewage-polluted sources, the treatment of mill wastes, etc., the results of which either have been or will be given in special reports of the Board.

PURIFICATION OF SEWAGE. — DISCUSSION OF THE CHARACTER OF THE EFFLUENTS OF FILTERS OF COARSE MATERIALS.

A special study has been made at Lawrence during 1901, as for several years past, of filters constructed of coarse materials and operated at high rates, although intermittent sand filters have also been kept in operation. The effluents of the intermittent sand filters at the station are, during a very large portion of the year, not only well purified but are also clear and practically free from odor. There is, however, a period of the year when these effluents are not as efficiently purified as might perhaps be desired, nor of as good an appearance as during the remainder of the year. It is true, nevertheless, that even when turbid they resemble in this respect a large proportion of the effluents of the filters of coarse material which we have operated at much higher rates, these coarse filters being poor strainers, as the considerable size of the pieces of the materials of which they are constructed allows much suspended mineral and

* The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., member of the State Board of Health, with the writer in direct charge. A full account of the work done at the Lawrence Experiment Station for the years 1888 and 1889 is contained in a special report of the State Board of Health upon the purification of sewage and water, 1890. A similar account for the years 1890 and 1891 is contained in the twenty-third annual report of the Board for 1891. Since 1891 the results have been published yearly in the annual reports.

organic matter present in the sewage to pass through them and appear in their effluents. There is this difference, however, in the effluents from the two classes of filters: when the effluents of sand filters are turbid and of poor appearance, they are generally low in nitrates; while the effluents of the coarse filters may, and when the filters are in good operation do, contain high nitrates, notwithstanding their turbidity, due to the mineral and organic matters in suspension in them.

In previous years, while investigations have been made of the degree of purification of sewage that could be obtained by these filters of coarse material and of the degree of nitrification that would take place within them when operated in different ways and at different rates, etc., comparatively little study has been made of the degree of bacterial oxidation which the organic matter left in suspension and in solution in such effluents has undergone, and the liability of its changing — that is, putrefying or oxidizing — after flowing from the filters. A knowledge of the condition of this organic matter is of great importance, however, owing to the considerable amount generally present, and during 1901 much time has been devoted to studying this point quite thoroughly with the idea of determining, if possible, the degree of purification and change of organic nitrogen to nitrates which it is necessary to accomplish in contact or other coarse filters to ensure stable effluents. In other words, to find the extent of the bacterial, chemical and mechanical or straining action necessary in the filters to produce effluents which, while perhaps turbid and poor in appearance, will not deteriorate after the effluent has passed from the filter, owing to the stable character of the remaining organic matter. Studies have also been carried on to determine the chemical examinations of the effluent which are necessary to determine this point satisfactorily. These studies and their results are given largely in a special paper beyond, but there is given here a brief statement of the character of the matter in suspension in the effluents and experiments showing the great difference between it and the organic matter in suspension in the sewage.

Character of Organic Matter in Effluents of Contact and Other Filters of Coarse Material.

As an example of the character of the matter in suspension in the effluents of some of our coarse filters the results of experiments with the sediment in the effluents of Filters Nos. 135 and 136 may be taken.

During the year 1901 these filters, to be more fully described beyond, have been continued in operation. They are constructed of broken stone and receive sewage in what we have called the intermittent continuous method, — that is, a stream of sewage passes through the filters at least twenty hours daily, but always in contact with air, — and the average rate of operation of each filter during 1901 was approximately 1,400,000 gallons per acre daily. The broken stone of which they are constructed is of so large a size that the filters are poor strainers, and a considerable portion of the matter in suspension in the sewage eventually passes through them and escapes in their effluents, a large amount, however, being changed to soluble forms and nitrified. It is evident from observation that very little of the matter in suspension in the applied sewage of one day escapes in the effluent of that day, and it has been found that, notwithstanding the large amount of sediment in their effluents, these effluents will remain without change in the warm laboratory for considerable periods. Examinations and analyses of this matter in suspension, which settles out readily, show clearly that a portion of it has undergone such bacterial and chemical changes while passing through the filter that it is both in character and in appearance very different from the sediment separated from untreated sewage, while other portions are probably stable matters, such as cellulose primarily present in the sewage, which have had easily decomposable substances separated from them and oxidized during their passage through the filter. Analyses of the matters in suspension, filtered out from sewage and from the effluents of Filters Nos. 135 and 136 and dried, gave the following characteristic results: —

Analyses of Sediments from Sewage and Effluents of Filters Nos. 135 and 136.

	Sewage Sediment.	Sediment of Filter No. 135.	Sediment of Filter No. 136.
Per cent. of total nitrogen (Kjeldahl),	2.37	1.37	1.41
Per cent. of nitrogen determined as albuminoid ammonia,	1.30	.70	.78
Per cent. that albuminoid ammonia is of total nitrogen (Kjeldahl).	55.00	51.00	55.30
Albuminoid ammonia, parts per 100,000,	1,575.00	851.00	952.00
Loss on ignition, parts per 100,000,	58.50	27.60	31.50

These analyses, although proving that about 50 per cent. of the organic matter in suspension in the sewage was not present in the effluents, show incompletely the physical and chemical differences between the sewage and the effluent sediments. The effluent sediment, when dried, is distinctly different from the sewage sediment in that it is granular and loam-like in appearance, brown in color, inoffensive in odor, very slowly changed by bacterial action, and even when wet absorbs oxygen slowly. In fact much of this matter is apparently as stable as the organic matter or humus in ordinary loam. The following experiment illustrates its slow oxygen absorption, and in this experiment comparisons are made of the stability of the sediment from the filters just discussed with that of sediment from other coarse filters operating less favorably.

Oxygen absorbed by Sediment from Filter Effluents and Sewage Sludge.

Sewage and effluents were filtered through paper and the matter which was collected was carefully dried at a low temperature. Two-tenths of a gram of the several sediments were placed in glass-stoppered bottles holding 4,000 cubic centimeters, these bottles then being filled with water, closed tightly, and incubated at 80° F. for five days. River water was used and an equal volume of this water was incubated. At the end of five days the samples were examined for dissolved oxygen by siphoning from the large bottles into dissolved oxygen bottles and determining as usual. The result of the experiment was as follows: —

SAMPLE.	Weight taken (Grams).	Milligrams of Oxygen in Water.	Milligrams of Oxygen in Water after Five Days.	Milligrams of Oxygen absorbed.
River water,	-	54.4	29.2	25.2
Filter No. 134, sediment and river water,	.2	54.4	39.2	15.2
Filter No. 135, sediment and river water.	.2	54.4	32.8	21.6
Filter No. 136, sediment and river water,	.2	54.4	24.4	30.0
Filter No. 137, sediment and river water,	.2	54.4	11.6	42.8
Sewage sediment and river water,	.2	54.4	0.0	54.4

Studying this experiment we find that the water in the bottles containing the sediment from Filters Nos. 134 and 135 contained at the end of five days' incubation as much or more oxygen than did the river water itself at the end of the period of incubation. The water in the bottle containing sediment from Filter No. 136 contained slightly less oxygen than the river water at the end of the period, while the matter strained out from sewage consumed all the oxygen, and the matter from Filter No. 137 consumed a considerable percentage of it.

This experiment was repeated with the same volume of water and weight of sediment, and the results, expressed somewhat differently, were as follows: —

Experiments with Water and Sediments (River Water saturated with Oxygen).	Dissolved Oxygen at End of Five Days (Per Cent. of Saturation).
River water at end of five days,	90.0
Filter No. 134 sediment and river water,	100.0
Filter No. 135 sediment and river water,	100.0
Filter No. 136 sediment and river water,	76.0
Filter No. 137 sediment and river water,	36.0
Sewage sediment,	1.5

Filters Nos. 134, 135 and 136 were, at the time the experiment was made, in a state of active nitrification, while in Filter No. 137 nitrification was feeble. All these filters were producing effluents containing much matter in suspension. Studies of the character of these sediments are being continued.

Comparison of the Effluents of Contact and Intermittent Continuous Filters.

In connection with this subject of the degree of purification produced by contact and intermittent continuous filters, and especially in regard to the nature of the organic matter left in suspension and in solution in these effluents, continual comparisons have been made during the year between the contact filters and the deep filters operated in what we have called the intermittent continuous manner. These studies have proved quite conclusively that, while the intermittent continuous filter of coarse material is perhaps more difficult to operate on account of the necessity of uniform distribution of the sewage over the surface, etc., yet with the sewage experimented with at Lawrence such filters can be operated at higher rates than contact filters, and will generally give better purification results; that is, nitrification within them is generally more active, the organic matter remaining in the effluents more thoroughly changed, and the appearance of the effluents somewhat better. While their effluents generally contain considerable matter in suspension, it is more completely oxidized than that in the effluents of most contact filters, and settles more readily, leaving a clear liquid. The reason that better results in this respect are obtained in these intermittent continuous filters than in contact filters is undoubtedly the greater volume of air that comes into contact with the sewage as it passes through these filters, and the thinner streams of sewage. In the intermittent continuous filter the sewage is from the top to the bottom of the filter continually passing in thin layers over the filtering material, and is thus continually in contact with the bacteria upon the filtering material and also in contact with air; while in contact filters the main volume of sewage is, when the filter is standing full, not in contact with the material, but filling the voids between, and ærobic bacterial action is limited by the volume of air remaining in the filter after filling as much as possible of the open space of the filter with sewage.

Another interesting and practical point in this connection is that, while the matter in suspension in the sewage is held by both the contact and the continuous filters for a time, yet it accumulates more slowly within the intermittent continuous filter; for, when reaching a certain degree of change or bacterial oxidation, it is continually falling from the filtering material in flakes and appearing in the effluent. In the contact filter, on the other hand, this tendency to loosen from the material is less marked, and hence these filters lose a greater percentage of their open space, — a serious matter in all filtration at high rates by means of coarse filters, but more especially so with contact filters. That is, with contact filters in the operation of which the rate really depends upon the open space, it is a serious matter to lose any appreciable percentage of this space; but with the intermittent continuous filter, the condition and volume of the open space do not have such an important bearing upon the rate of operation of the filter.

When Nitrification occurs in Contact Filters.

There is considerable discussion as to whether, in the operation of contact filters, nitrification occurs when these filters are free from sewage or when they are full, and during the year certain experiments have been made to gain information upon this point. These experiments have been carried on as follows: —

A contact filter showing good nitrification is operated as usual and the usual time allowed for draining. Then, before flooding with sewage, river water is applied, the filter filled and quickly drained, and this followed generally by the operation of the filter as usual with sewage, the sewage being applied immediately after the river water has been drained from the filter. On several occasions the filter has been filled several times with water and drained quickly before sewage has been applied. For instance, an experiment was made with Filter No. 163, when the average amount of nitrates present in the effluent of the filter was about 1.5 parts per 100,000. The filter was filled rapidly with water and then drained immediately, the filling and draining covering a period of not more than fifty minutes. Samples of the effluent were taken every five minutes during the period of draining, and the nitrates varied from 1.34 parts in the first sample to .84 part per 100,000 in the last sample, a small amount of nitrites being present in some of the samples collected. Immediately after draining, the filter was again flooded with river water and again drained as rapidly as possible, samples being taken during this second draining every five minutes and the nitrates varying from .71 of a part in the first sample to .47 of a part in the last sample. After this draining, the filter was flooded as usual with sewage and allowed to stand the usual time before draining. The nitrates in the samples of effluent of the filter collected during this period varied from .45 to .57 of a part per 100,000, the lower nitrates being found in samples collected when the filter began to drain, and the higher nitrates towards the end of the period of draining. High nitrites were also present in the samples collected during this period when sewage was being treated in the filter.

From all these observations it appears that, while nitrification is more active in the filter when standing empty, nitrification certainly occurs when the filter is filled with sewage until such time as the air is exhausted.

Clogging of Contact Filters.

Loss of Open Space.

Considerable has been said in past reports in regard to the loss of open space in contact filters, which necessarily decreases their rate of operation and which, if continued, implies that the material of such filters will eventually have to be cleaned in some manner if they are to continue in operation. All our studies have shown that it is exceedingly desirable that the sewage, before passing to contact filters, should be treated by some method, such as settling, straining or bacterial action in the so-called septic tank, that will remove from it as much as possible of the matters in suspension; and they have apparently proved that, if contact filters are to be kept in operation for a considerable number of years, they must receive sewage which has been clarified in some such way, or else the filter must be of such coarse and smooth material that all suspended matter will pass readily through it.

During 1901 contact filters have been operated, receiving treated and untreated sewage, that is, sewage directly from the sewers and sewage that has by various means had considerable of its mineral and organic matter removed from it. For example, two filters, Nos. 175 and 176 (see page 299), of the same construction and containing 5 feet in depth of broken coke, have been operated during a large portion of the year, one receiving sewage just as it is pumped at the station, and the other receiving sewage which has first passed through a coal strainer at a high rate. The filters have both given as satisfactory a degree of purification as we expect from contact filters, as shown by tables beyond, and nitrification has been active within them, the filter receiving the strained sewage giving somewhat better purification results. The difference in the loss of open space occurring in the two filters is noticeable, the capacity of Filter No. 175, which received the strained sewage, having decreased about 10 per cent. during its period of operation, largely during the first few weeks, and the capacity or open space of Filter No. 176, receiving untreated sewage, having decreased about 16 per cent.

A third coke contact filter, Filter No. 163, containing 4½ feet in depth of broken coke (see page 301), was put into operation in January, 1901, and has received sewage which has first passed through contact Filter No. 137 (see page 302). This filter has lost 16 per cent. of its open space during the year. Filter No. 137, constructed of 5 feet in depth of broken stone, has lost 40 per cent. of its open space during the year. Filter No. 103, constructed of coke (see page 288) and receiving septic sewage, has lost 6 per cent. of its open space during the year, and in four years has lost 35 per cent. of its open space. The large loss of open space in Filter No. 137 has evidently been due to clogging in the lower portion of the filter, this clogging material acting as a strainer and holding back suspended matter that otherwise would have passed off with the effluent. Clogging did not occur in this filter to any great extent during the first year and a half of its operation, but when once started it increased rapidly.

Clogging at Different Depths.

Measuring the proportion of the depth of contact filters which is filled by a given volume of sewage, we find that in the case of the filters of broken stone which we have had in operation it is the lower portion of the filter that becomes most seriously clogged. Measurements made with Filter No. 137 towards the end of the year showed that the lower half of the filter contained 75 per cent. of the accumulated mineral and organic matter, this being partly due, however, to reasons given above. In the contact filters of rough material the accumulation is more evenly distributed; that is, the rough material holds the matter more evenly and prevents its slipping towards the bottom of the filter.

Underdrainage.

Special examinations of Filter No. 137, constructed of a material of uniform grade throughout its entire depth and without open underdrains, and other contact filters having the usual underdrains, have indicated that this clogging in the lower strata of filtering material can probably be prevented to a considerable extent by better or more open underdrains, and this is being investigated.

Removal of Clogging Material by Flushing.

We removed from several of the contact filters at the end of the year considerable of the organic and mineral accumulations within their open space by applying large volumes of sewage to them within a limited period, and at the same time leaving their outlets wide open. The three principal filters upon which this method of removing clogging has been tried are Filters Nos. 103, 137 and 163. Filters Nos. 103 and 163 are constructed of coke, and Filter No. 137 of broken stone. All the filters are without underdrains and were so constructed because they were of such a limited area and of such coarse material that it was thought that for all practical purposes of their operation, in regard to showing the degree of purification of sewage that could be obtained by them, underdrains were not necessary. It has been made evident, however, especially in the case of the filter of broken stone, that they probably would not have become so seriously clogged in their lower portion, thus causing eventually more or less clogging throughout the entire depth of the filter, if very coarse gravel or other open underdrains had been placed in them. The lack of underdrains has also prevented the easy removal of clogging matter by flushing.

Septic Sewage.

Experiments with septic tanks and the purification of their effluents have been continued throughout the year. Beginning in 1897 and continuing to the present time, this subject has been investigated by us with considerable care, with different sewages and with tanks so operated that the sewage remains in them for different periods of time, etc. The results, as given in previous reports and in a subsequent portion of this report, indicate quite strongly that with certain sewages and under certain conditions the process may be a successful addition to a sewage purification plant, but that success cannot be depended upon with all sewages and under all conditions. The results indicate that, when treating ordinarily fresh domestic sewage, an accumulation of sludge within the septic tank must be expected, amounting to a considerable percentage of that primarily present in the sewage entering the tank. With an older sewage, which has undergone considerable mechanical, chemical and bacterial action before entering the tank, such as the sewage entering Septic Tank A (see page 282), it is possible, as in this instance, that the action of the tank will be as nearly perfect as could be desired, that the accumulation within it will be small, that much matter in suspension will be removed from the sewage and liquefied or changed to gaseous forms, and that its effluent will be easily purified upon sand or contact filters. With a still older sewage, however, like that entering the Andover septic tank (see page 286), the bacterial processes in the tank may be not only unnecessary but harmful, in that they render the sewage difficult to purify by subsequent oxidation.

Septic Tank B (see page 283), put into operation with the idea of treating concentrated sewage or sludge only in the tank and thus lessening the necessary size of such a tank, has been successful in changing a considerable percentage of the suspended organic matter entering the tank with the sewage into other forms; but the sewage treated has contained too much of this matter to be entirely eliminated in this way, and, after about twenty-seven months' operation of the tank, the accumulations of organic and mineral matter within it were of such a volume as to need removal if the tank was to continue in operation. The effluent of this tank, moreover, has been difficult to purify in contact filters owing to the slow passage of the sewage through the tank and its consequent condition of putrefaction when applied to filters, as stated in previous reports and mentioned farther along in this report. It is evident that with all septic tanks which we have operated the sludge is concentrated, that is, a given volume contains a larger percentage of solid matter and a consequent smaller percentage of water than the sludge from ordinary sedimentation or chemical precipitation. The various detailed results of this work are given beyond.

Straining Sewage through Coal.

For a number of years experiments were carried on at the station upon the effectiveness of coke, when used in suitable depths, as a strainer through which to pass sewage for the removal of the suspended matters in the sewage. During 1901 strainers constructed of coal have been tried at the station. Two such strainers have been in operation, each containing 12 inches in depth of "buckwheat" coal, that is, hard coal in pieces of such size that all would pass through a screen with a ½-inch mesh and practically none through a screen with a ⅛-inch mesh, and details of their work are given beyond.

Analyses of Sewage.

The following table gives the average analyses of the various samples of sewage collected during the year, "regular sewage" being the average of samples collected at the experiment station on at least four days each week, "Lawrence Street sewage" being the average of samples collected weekly from the sewer from which the sewage is pumped to the experiment station, and "sewage applied to Filters Nos. 1, 6 and 9A" being the average of samples collected from all sewage applied to these filters. These averages are as follows: —

[Parts per 100,000.]

	Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.				
		Total.	In Solution.			
Regular sewage,	4.54	.75	.35	10.03	4.51	1,760,000
Lawrence Street sewage,	3.12	.92	.57	11.05	8.05	1,199,000
Sewage applied to Filter No. 1,	4.60	.79	-	11.45	5.20	-
Sewage applied to Filter No. 6,	4.69	.80	-	10.81	4.92	-
Sewage applied to Filter No. 9A,	4.60	.89	-	10.75	4.92	-

The average temperature of the regular station sewage when applied to the filters has varied from 47° F. in January to 74° F. in July. The sewage flowing in the Lawrence Street sewer has varied in temperature from 48° F. in February to 73° F. in August.

Septic Sewage and its Purification.

Septic Tank A has been continued in operation during the year, the rate of operation being such that the sewage passes through the tank in about twenty-two hours. The average monthly analyses of the sewage entering and the effluent from this tank are as follows: —

Sewage as it enters Septic Tank A.

[Parts per 100,000.]

1901.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
			Total.	In Solution.	In Suspension.			
January,	39	6.70	1.10	.61	.49	8.37	6.11	2,425,500
February,	40	5.47	0.94	.49	.45	6.63	5.68	34,420,000
March,	38	4.43	0.98	.48	.50	6.74	7.16	2,060,000
April,	46	5.67	0.85	.50	.35	9.48	4.81	1,983,000
May,	55	4.50	0.65	.32	.33	10.29	4.06	1,173,000
June,	65	5.73	0.79	.44	.35	13.54	4.69	1,910,000
July,	74	4.38	0.67	.35	.32	14.42	4.06	920,000
August,	72	6.35	0.80	.38	.42	10.90	4.20	360,000
September,	70	5.88	0.68	.29	.39	14.59	4.01	448,000
October,	57	6.35	1.04	.44	.60	12.69	5.47	540,000
November,	44	6.90	1.27	.59	.68	13.19	6.68	670,000
December,	39	4.13	0.78	.40	.38	6.61	4.02	540,000
Average,	53	5.54	0.88	.44	.44	10.62	5.08	3,954,000

Effluent of Septic Tank A.

[Parts per 100,000.]

1901.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	47	5.65	0.62	.41	.21	7.93	4.08	1,673,000
February,	43	5.27	0.59	.38	.21	7.68	3.80	1,505,000
March,	46	4.03	0.48	.35	.13	6.60	5.14	1,070,000
April,	51	5.00	0.49	.31	.18	8.92	3.12	375,000
May,	54	4.78	0.39	.28	.11	9.75	2.64	478,000
June,	62	4.93	0.37	.24	.13	11.10	2.39	900,000
July,	73	4.03	0.34	.17	.17	11.87	2.43	451,000
August,	70	5.05	0.31	.21	.10	13.69	2.32	219,000
September,	68	5.30	0.31	.20	.11	13.73	2.22	181,000
October,	57	5.26	0.39	.27	.12	15.87	2.65	229,500
November,	48	5.60	0.48	.37	.11	9.75	3.82	-
December,	47	3.88	0.42	.28	.14	7.95	2.86	295,000
Average,	56	4.90	0.43	.29	.14	10.40	3.12	671,000

The temperature of the sewage entering the tank has varied from 39° F. in January to 74° F. in July, and that of the effluent of the tank has varied from 43° F. in February to 73° F. in July. The average amount of organic matter removed from the sewage by the bacterial actions in the tank, and by the retention of matter in the tank during the year, has been as follows: 50 per cent. of that determined as albuminoid ammonia and 40 per cent. of that determined as oxygen consumed. At the end of the year the accumulation of sediment in the tank was no greater than at the end of the previous year, being about 22 per cent. of the tank capacity. The tank was first put into operation in December, 1897, and as yet no sediment has been removed from it.

Septic Tank B was also kept in operation during the year, this tank receiving, as explained in previous reports, concentrated sewage from allowing ordinary station sewage to stand for sedimentation to take place, and passing the heavy sewage at the bottom of the sedimentation tank into Septic Tank B. The average monthly analyses of the sewage entering this tank and the effluent from it are given in the following tables: —

Sewage as it enters Septic Tank B.

[Parts per 100,000.]

1901.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	43	5.68	3.45	.45	3.00	12.14	21.76	9,805,000
February,	42	5.40	2.92	.49	2.43	12.01	6.71	13,695,000
March,	46	3.50	2.14	.24	1.90	5.34	13.10	6,000,000
April,	49	6.50	3.74	.46	3.28	9.37	20.10	9,960,000
May,	56	5.10	2.93	.33	2.60	11.97	13.15	44,773,000
June,	64	4.87	2.92	.32	2.60	15.64	13.77	8,013,000
July,	74	3.85	0.81	.20	0.61	10.00	5.65	290,000
August,	70	4.70	3.89	.29	3.60	12.52	17.90	1,230,000
September,	64	4.33	3.76	.25	3.51	13.65	20.08	2,145,000
October,	57	6.34	5.87	.34	5.53	14.72	30.00	2,000,000
November,	45	5.75	8.80	.28	8.52	9.56	25.90	2,010,000
December,	51	2.15	7.20	.25	6.95	6.09	29.20	4,080,000
Average,	55	4.84	4.04	.33	3.71	11.08	18.11	8,667,000

Effluent of Septic Tank B.

1901.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	43	7.04	1.12	.37	0.75	11.42	6.86	3,666,000
February,	41	6.37	1.44	.35	1.09	9.44	8.26	1,365,000
March,	47	5.80	1.76	.35	1.41	7.35	10.60	-
April,	50	9.00	0.76	.35	0.41	10.44	4.71	850,000
May,	56	9.78	0.78	.27	0.51	11.22	5.42	644,000
June,	65	12.00	1.13	.33	0.80	13.70	6.43	487,000
July,	69	10.65	0.94	.22	0.72	11.04	6.50	310,000
August,	70	11.33	0.86	.25	0.61	14.08	5.37	83,000
September,	66	11.33	0.61	.24	0.37	14.11	3.96	227,000
October,	57	11.70	1.87	.24	1.63	13.66	12.67	80,500
November,	46	11.67	1.13	.26	0.87	12.42	6.59	120,500
December,	39	10.25	0.78	.43	0.35	9.39	3.64	93,500
Average,	54	9.74	1.10	.31	0.79	11.52	6.75	720,600

The average temperature of the sewage entering this tank has varied from 42° F. in February to 74° F. in July, and the average temperature of the effluent of the tank has varied from 39° F. in December to 70° F. in August. The quantity of organic matter removed from the sewage by the bacterial life in the tank and its mechanical retention of suspended matters, as shown by the analyses given, has amounted to 73 per cent. of the organic matter determined as albuminoid ammonia and 63 per cent. of that determined as oxygen consumed. The average solids of the sewage entering and the effluent from the tank during the year were as follows: —

[Parts per 100,000.]

	Sewage entering Septic Tank B. Total.	Sewage entering Septic Tank B. In Solution.	Effluent of Septic Tank B. Total.	Effluent of Septic Tank B. In Solution.
Total,	293.05	58.81	105.16	58.83
Loss on ignition,	196.51	25.46	48.95	20.26
Fixed,	96.54	33.35	56.21	38.57

These figures show 64 per cent. reduction of total solid matter and 75 per cent. reduction of organic matter as determined by the loss on ignition. At the end of the year the accumulation of sludge within the tank amounted to about 50 per cent. of the tank capacity, completely filled one compartment of the tank, and practically prevented its operation, and the average analyses of the mixed sewage and sludge in the three compartments of the tank were as follows: —

[Parts per 100,000.]

	First Compartment.	Second Compartment.	Third Compartment.
Total solids,	3,060.00	4,410.00	5,702.00
Loss on ignition,	1,806.00	2,337.20	2,878.00
Fixed,	1,254.00	2,072.80	2,824.00
Solids in solution,	62.60	61.00	69.80
Loss on ignition,	31.00	24.40	27.80
Fixed,	31.60	36.60	42.00
Free ammonia,	10.00	13.00	15.00
Albuminoid ammonia, total,	39.00	63.35	73.10
Albuminoid ammonia, in solution,	.61	.65	.50
Organic nitrogen, by Kjeldahl,	85.98	119.87	164.43
Oxygen consumed, total,	232.00	296.00	472.00
Oxygen consumed, in solution,	2.68	2.68	3.76
Chlorine,	8.69	8.60	8.80

Taking into consideration the volume of sewage in the tank, these analyses show that the tank at this time contained about 20 per cent. of the organic matter of the sewage which had entered it during its period of operation, as calculated from the loss on ignition. As the effluent of the tank during its period of operation contained, as shown by the determinations of the loss on ignition which we have made, about 22 per cent. of the organic matter of the sewage entering the tank, about 58 per cent. of the organic matter in the sewage entering the tank was liquefied or otherwise changed and given off as gas by the tank action during its period of operation. It is noticeable that about 19 per cent. of the nitrogen of the applied sewage is not accounted for by the analyses of the effluent of the tank and the sewage remaining in the tank.

Andover Septic Tank.

The experimental septic tank of the Board at Andover has been continued in operation during the year. The tank was operated at such a rate during the first six months of the year that the sewage was about fourteen hours in passing through it, then for six weeks it was seventeen and one-half hours in passing through, and during the remainder of the year it was twenty hours in passing through.

The liquid in the tank had at the end of the year a hard, tenacious scum from 1 to 3 inches in thickness over a large portion of its surface, and the accumulated sludge on the bottom of the tank occupied about 11 per cent. of the tank capacity. The following tables give the average monthly analyses of the sewage entering and the effluent from this tank: —

Monthly Averages of Analyses of Andover Sewage.

[Parts per 100,000.]

1901.	Temperature. Deg. F.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	45	5.15	0.49	0.40	0.09	6.58	2.96	2,180,000
February,	34	4.80	1.12	0.16	0.96	7.55	4.20	1,550,000
March,	41	6.45	1.25	0.73	0.52	6.60	8.65	2,640,000
April,	44	4.70	0.92	0.72	0.20	6.89	5.76	1,560,000
May,	49	5.13	1.33	0.61	0.72	5.84	6.83	2,260,000
June,	55	5.75	1.06	0.71	0.35	8.14	4.50	1,185,000
July,	63	6.40	1.79	0.54	1.25	6.90	8.88	453,000
August,	66	4.85	0.45	0.32	0.13	4.69	2.94	40,000
September,	71	6.40	0.57	0.48	0.09	6.39	3.08	560,000
October,	63	8.77	1.38	0.86	0.52	7.23	7.37	2,730,000
November,	54	11.10	1.98	1.13	0.85	8.10	9.60	5,200,000
December,	42	7.60	1.33	0.78	0.55	6.05	5.92	1,220,000
Average,	52	6.43	1.14	0.62	0.52	6.74	5.89	1,798,000

Monthly Averages of Analyses of Sewage from the Experimental Septic Tank in Andover, Mass.

January,	43	8.70	0.77	0.62	0.15	10.51	6.70	1,160,000
February,	33	6.00	0.56	0.48	0.08	7.47	4.04	1,050,000
March,	42	3.35	0.63	0.31	0.32	5.89	4.12	2,100,000
April,	47	1.27	0.15	0.09	0.06	2.92	1.12	480,000
May,	49	2.50	0.31	0.21	0.10	4.15	1.95	2,280,000
June,	58	5.60	0.59	0.34	0.25	8.22	3.94	975,000
July,	67	7.00	0.64	0.42	0.22	12.79	4.47	250,000
August,	67	7.20	0.64	0.44	0.20	10.05	4.65	40,000
September,	66	7.50	0.78	0.56	0.22	11.95	5.08	932,000
October,	62	8.47	0.66	0.42	0.24	9.07	4.33	345,000
November,	53	8.50	0.86	0.61	0.25	10.67	4.90	301,000
December,	46	6.67	0.71	0.51	0.20	7.69	3.85	215,000
Average,	53	6.06	0.61	0.42	0.19	8.45	4.10	844,000

As stated in previous reports, the length of time required for the sewage to reach the filtration area where the tank is located is great, and consequently the age of the sewage is such as to prevent its easy and satisfactory purification by bacterial action. Additional bacterial treatment in a septic tank causes still further putrefaction of the organic matter, and increases the difficulty of treatment.

Purification of Septic Sewage A by Filtration.

The sewage from Septic Tank A has been applied during the year to four filters. One of these, Filter No. 100, contains 5 feet in depth of sand of an effective size of 0.23 millimeter. This filter has received septic sewage at the rate of 255,000 gallons per acre daily during the year, with the result shown by the following table of average monthly analyses: —

Effluent of Filter No. 100.

[Parts per 100,000.]

1901.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	222,200	47	43	10m.	Slight.	1.12	2.8000	.2310	8.12	1.06	.0080	1.93	96,600
February,	300,000	43	46	1h. 31m.	Slight.	0.60	1.8800	.1600	6.91	2.19	.0080	0.92	64,200
March,	184,600	46	50	2h. 45m.	Decided.	-*	4.2000	.2420	8.86	0.35	.0060	2.47	65,000
April,	142,300	51	50	10m.	Decided.	0.33	2.4500	.1660	7.54	3.48	.0035	1.41	48,600
May,	300,000	54	58	13m.	V. slight.	0.26	0.1809	.0543	10.11	3.26	.0016	0.45	26,800
June,	312,000	62	61	8m.	V. slight.	0.31	0.1649	.0522	11.48	4.22	.0020	0.42	29,100
July,	288,900	73	73	8m.	V. slight.	0.30	0.2872	.0553	11.46	3.35	.0026	0.41	4,400
August,	300,000	70	70	9m.	V. slight.	0.36	0.4465	.0575	15.78	3.25	.0100	0.49	21,000
September,	288,000	68	65	28m.	V. slight	0.31	0.6600	.0420	16.70	3.85	.0180	0.44	18,300
October,	248,100	57	59	12h. 53m.	V. slight	1.81	3.0250	.1570	13.40	1.05	.0121	1.69	-
November,	203,800	48	50	-	V. slight.	0.32	0.3000	.0640	10.55	3.70	.0028	0.53	-
December,	269,000	47	47	-	V. slight.	0.31	0.0192	.0640	7.29	2.38	.0012	0.40	41,100
Average,	254,900	56	56	1h. 52m.	-	0.55	1.3678	.1121	10.68	2.68	.0063	0.96	41,500

* Yellow.

The filter was operated without difficulty and the sewage passed into it readily from the beginning of the year until October, when surface clogging occurred. The filter was then dug over to a depth of 6 inches and allowed to rest for one week. Following this the method of operation of the filter was changed, and the effluent of Filter No. 103 was applied at the rate at first of 500,000 gallons per acre daily.

Filters Nos. 116 and 118, containing 5 feet in depth of sand of an effective size of 0.17 and 0.23 millimeter respectively, and receiving septic sewage A, were continued in operation until the end of March. These two filters were put into operation during 1898, and the reason for operating them and the results that have been obtained by them have been thoroughly discussed in previous reports. Both were in good condition when put out of operation, and the average analyses of their effluents for the first three months of 1901 are as follows: —

Effluent of Filter No. 116.

[Parts per 100,000.]

Temperature. Deg. F.	Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Free.	Albuminoid.		Nitrates.	Nitrites.		
52	.33	.3438	.0427	8.86	3.71	.0007	.49	1,074

Effluent of Filter No. 118.

47	.88	.9388	.1130	8.10	2.53	.0081	.96	11,396

Filter No. 103, also receiving septic sewage A, contains 5 feet in depth of coke of such size that all will pass through a sieve with a ½-inch mesh and practically none through a sieve with a ⅛-inch mesh. It has always been operated as a contact filter, and at the beginning of the year received septic sewage A at the rate of 660,000 gallons per acre daily. This rate was decreased during the year, owing to the decrease of open space of the filter, until in October the rate was 520,000 gallons per acre per day, the filter during the entire period of its operation to this date being filled but once daily. Upon November 15 the method of operation was changed, however, and the filter was filled in three applications of sewage at hourly intervals, allowed to stand full one hour, and then drained, five hours being allowed for draining, and was then filled and drained again in the same manner, this increasing the rate to 1,000,000 gallons per acre per day. The average rate of operation for the year and the average purification results are shown by the following table: —

Effluent of Filter No. 103.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January, .	660,000	47	43	Slight.	.38	0.6450	.1160	.1020	.0140	8.29	2.68	.0085	1.22	61,100
February, .	540,000	43	45	Slight.	.39	0.3650	.1100	.0960	.0040	7.41	2.95	.0047	0.89	158,300
March, .	540,000	46	50	Slight.	.58	0.5300	.0870	.0780	.0090	8.41	2.35	.0085	0.84	26,500
April, . .	290,800	51	51	Slight.	.53	0.2900	.0700	.0620	.0080	7.40	2.64	.0077	0.57	29,400
May, . .	540,000	54	58	V. slight.	.49	0.4913	.0794	-	-	10.42	1.81	.0118	0.62	24,200
June, . .	561,600	62	68	V. slight.	.47	0.5715	.0970	-	-	11.65	2.59	.0073	0.58	64,100
July, . .	500,700	73	72	V. slight.	.40	0.1650	.0740	-	-	10.39	3.08	.0030	0.49	30,600
August, .	520,000	70	72	V. slight.	.42	0.2205	.0750	-	-	15.40	3.12	.0050	0.59	35,000
September, .	499,200	68	65	Slight.	.35	0.2050	.1020	-	-	16.27	3.78	.0035	0.62	11,700
October, .	520,000	57	59	Slight.	.34	0.3073	.0833	-	-	13.30	3.72	.0100	0.70	48,700
November, .	751,900	48	49	Decided.	.90	2.1500	.2200	.1500	.0700	10.30	2.81	.0450	1.38	-
December, .	1,010,000	47	50	Decided.	.65	1.5200	.2030	.1160	.0870	9.02	0.86	.0085	1.31	111,500
Average, .	577,900	56	56	-	.49	0.6217	.1097	.1007	-	10.69	2.70	.0103	0.82	54,600

Filtration of Septic Sewage B.

As before stated, there has been no difficulty during the year in maintaining good nitrification in sand and contact filters to which septic sewage A has been applied. As in previous years, however, considerable difficulty has been encountered in our efforts to cause septic sewage B to nitrify in contact filters. A study showing the reason for this was given in the report of the Board for 1900, this reason as determined being that the sewage contained organic matter in such a condition and gases of such a nature that the oxygen primarily present in the contact filters was exhausted (by direct oxidation of carbonaceous matter) before nitrification could become established. This has been more clearly brought out during 1901, as the following filtration experiments show: —

Beginning March 1, septic sewage B was applied to contact Filter No. 167, containing 4 feet in depth of broken stone of walnut size. The sewage was applied in three doses, one hour apart, and the filter then allowed to stand full for two hours before draining.

From March 1 until August 15 no nitrification occurred within this filter, the sewage passed through it practically without change, and its effluent did not contain dissolved oxygen. Upon this latter date the method of operation was so altered that the sewage, before reaching the filter, was thoroughly aerated by being passed to it in fine streams. Following this change, nitrification became active almost immediately, and reached a maximum of over 5 parts nitrates per 100,000 parts within six weeks. Upon October 1, when the nitrates in the effluent were 5.37 parts per 100,000, the method of flooding the filter was changed back to that in use before August 15. Following this, nitrification became less, and practically ceased by the middle of December, although the filter was within the station and hence protected from the weather. The average analyses of the effluent of this filter during the year were as follows: —

Effluent of Filter No. 167.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Turbidity.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.			Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
March,	616,700	47	49	Great.	4.4000	.3880	.3180	.0700	8.03	0.02	.0000	2.62	1,190,000
April,	333,000	50	50	Great.	7.0000	.6720	.1260	.5460	11.24	0.01	.0000	3.36	143,500
May,	616,700	56	60	Great.	8.8750	.4250	.1720	.2530	10.25	0.02	.0000	2.44	311,200
June,	444,000	65	71	Decided.	9.9000	.4750	.1900	.2850	12.27	0.17	.0000	2.82	283,200
July,	354,300	69	73	Decided.	11.0500	.3850	.1960	.1890	12.63	0.02	.0200	1.96	81,400
August,	308,300	70	73	Decided.	6.6000	.2567	.1653	.0914	14.83	0.81	.1223	1.46	91,200
September,	320,000	66	71	Decided.	3.5500	.1800	.1340	.0460	14.73	4.50	.0130	1.06	21,700
October,	333,000	57	57	Great.	5.0000	.2880	.1760	.1120	13.05	5.37	.0130	1.58	78,400
November,	307,400	46	43	Great.	5.8000	.3420	.2160	.1260	11.93	2.07	.0003	1.82	22,700
December,	333,000	39	48	Great.	4.6000	.5200	.2600	.2600	9.85	0.42	.0000	1.82	46,200
Average,	396,600	57	60	-	6.6275	.3932	.1953	.1979	11.88	1.34	.0159	2.09	227,000

Filter No. 145, containing 4 feet in depth of sand of an effective size of 0.24 millimeter, was kept in operation during the first three months of the year, receiving septic sewage B at an average rate of 140,000 gallons per acre daily. Nitrification was active within the filter and its effluent was of good appearance, although containing a large amount of free and albuminoid ammonia, and in order to improve the effluent in this respect the rate of operation of the filter was decreased from time to time. The average analyses of the effluent were as follows: —

Effluent of Filter No. 145.

[Parts per 100,000.]

1901.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	192,600	50	47	8h. 32m.	Slight.	.62	0.3025	.1575	12.13	3.78	.0041	0.93	66,300
February, .	154,200	47	46	6h. 7m.	Slight.	.91	5.3000	.2200	8.77	0.54	.0069	1.37	204,800
March, .	73,100	48	50	16h.	V. slight.	.38	2.0000	.0620	7.19	7.38	.0100	0.57	44,200
Average,	140,000	48	48	10h. 13m.	-	.64	2.5342	.1465	9.36	3.90	.0070	0.96	105,100

Filtration of Andover Septic Sewage.

The three filters in operation at Andover during 1900 have been continued during 1901, namely, the intermittent sand filter $\frac{1}{200}$ of an acre in area, containing five feet in depth of sand of an effective size of 0.23 millimeter, the coke contact filter $\frac{1}{200}$ of an acre in area, containing 5 feet in depth of coke, and the small coke contact filter, containing 4 feet in depth of coke. All three of these filters received during a large part of the year the sewage that had passed through the septic tank.

The sand filter has been operated at rates varying from 56,400 to 116,000 gallons per acre daily, and has given throughout the year an effluent containing little or no sediment or turbidity, and good nitrification has occurred within the filter, although the free and albuminoid ammonia in the effluent have been high.

The large coke contact filter has been operated at rates varying from 380,000 to 600,000 gallons per acre per day at different periods of the year. The sewage has passed through this coke filter practically without change, there has been practically no nitrification within the filter during the year, and the effluent has not contained dissolved oxygen.

To the small coke filter the effluent of the large coke filter has been applied at rates varying from 352,000 to 522,000 gallons per acre per day during different periods of the year. From the beginning of operation of this filter until the middle of October, 1901, the effluent of the large coke filter passed through the small filter practically without change, and nitrification did not occur in the filter to any extent. Beginning on this latter date, however, the large coke filter received Andover sewage which had not passed through the septic tank, and, although nitrification did not occur in the large filter, yet when the effluent of the large filter was applied to the small filter fairly good nitrification ensued in this second contact filter, the nitrates in the effluent of this filter averaging during the month of December 1.47 parts per 100,000, and the free and albuminoid ammonia being lower than during any other month of the year. The cause of the non-nitrification of the septic sewage, when applied first to one coke contact filter and then to another, was undoubtedly as previously stated: that the gases were of such a nature or the carbonaceous organic matter in the sewage that had passed through this septic tank was in such an unstable or easily oxidized condition, that even the oxygen introduced by double contact filtration was not sufficient to enable nitrification to occur. When, however, the stale Andover sewage was applied first to one contact filter and then to another, without having first been passed through the septic tank, nitrification occurred in the secondary filter.

The following tables give the average monthly analyses of the effluent of each of the three filters in operation during the year: —

Effluent of the Andover Experimental Sand Filter.

[Parts per 100,000.]

1901.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	43	37	Slight.	2.53	3.7500	.1550	9.10	0.67	.0006	1.53	58,000
February,	33	-	-	-	-	-	-	-	-	-	-
March,	42	39	Decided.	2.18	4.2000	.3540	5.98	0.27	.0024	1.83	130,000
April,	47	47	V. slight.	0.38	3.9000	.1080	3.67	2.55	.0022	0.53	4,000
May,	49	52	None.	0.18	2.1000	.0487	4.64	4.55	.0093	0.26	4,900
June,	58	63	None.	0.10	0.1524	.0292	6.76	5.76	.0062	0.21	3,800
July,	67	72	None.	0.17	0.7035	.0385	9.43	6.10	.0054	0.31	714
August,	67	72	None.	0.16	0.8750	.0370	10.82	5.06	.0016	0.34	63
September,	66	68	V. slight.	0.20	1.4000	.0660	9.74	4.09	.0089	0.52	833
October,	62	60	V. slight.	0.28	2.1500	.1047	10.43	3.16	.0340	0.72	1,369
November,	53	49	V. slight.	1.30	3.8750	.3180	11.72	1.25	.0250	1.98	7,100
December,	46	39	V. slight.	1.33	5.2333	.2627	7.26	0.35	.0095	1.60	11,800
Average,	53	54	-	0.80	2.5763	.1383	8.14	3.07	.0096	0.89	20,234

Effluent of the Large Andover Experimental Coke Contact Filter.

[Parts per 100,000.]

1901.	Temperature. Deg. F.		Turbidity.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Sewage.	Effluent.			Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January,	43	41	Decided.	6.1000	.3950	.3400	.0550	9.66	0.02	.0000	2.80	690,000
February,	33	47	Great.	6.4000	.6400	.4120	.2280	10.09	0.03	.0000	3.32	2,230,000
March,	42	42	Great.	5.3500	.4040	.3260	.0780	8.28	0.03	.0000	2.51	1,820,000
April,	47	44	Slight.	1.5000	.1240	.1020	.0220	3.39	0.12	.0024	0.74	410,000
May,	49	51	Slight.	1.9933	.2087	.1400	.0687	4.50	0.08	.0015	1.12	1,075,000
June,	58	61	Slight.	3.9000	.3360	.2530	.0830	7.48	0.02	.0000	1.98	318,200
July,	67	67	Slight.	5.9333	.4193	.3433	.0760	11.03	0.01	.0000	2.57	87,000
August,	67	68	Decided.	6.8000	.4300	.3340	.0960	10.40	0.02	.0000	2.95	15,500
September,	71	67	Great.	7.3000	.5200	.3100	.2100	12.90	0.01	.0000	3.30	725,800
October,	63	62	Decided.	7.5667	.5000	.3627	.1373	9.42	0.02	.0000	3.18	610,000
November,	54	53	Great.	7.5000	.6400	.5350	.1050	9.98	0.02	.0000	3.36	18,500
December,	42	41	Slight.	4.8000	.3340	.2413	.0927	6.16	0.02	.0044	1.62	210,000
Average,	53	54	-	5.4286	.4126	.3083	.1043	8.61	0.03	.0007	2.45	684,000

Effluent of the Small Experimental Coke Contact Filter at Andover.

January,	43	34	Decided.	6.5500	.4350	.3050	.1300	9.63	0.02	.0000	3.48	460,000
February,	33	33	Great.	9.3000	.7100	.4480	.2620	11.59	0.03	.0000	3.80	1,960,000
March,	42	38	Great.	6.3400	.5230	.3980	.1250	8.58	0.02	.0000	3.32	950,000
April,	47	46	Slight.	2.4000	.2120	.1600	.0520	3.57	0.29	.0010	0.96	140,000
May,	49	55	Slight.	2.2000	.2493	.1433	.1060	4.86	0.32	.0009	1.21	680,000
June,	58	70	Slight.	3.3000	.3320	.1810	.1510	7.78	0.02	.0000	1.71	198,000
July,	67	74	Slight.	3.7833	.4013	.1987	.2026	11.12	0.02	.0000	2.21	31,800
August,	67	74	Slight.	4.6000	.3600	.1620	.1980	11.09	0.01	.0000	2.29	18,500
September,	71	65	Slight.	4.7500	.3850	.1420	.2430	12.25	0.01	.0000	2.52	102,000
October,	63	60	Slight.	4.9000	.3160	.1187	.1973	9.81	0.11	.0000	1.97	66,000
November,	54	43	Decided.	4.4000	.3810	.2440	.1370	10.72	1.18	.0008	2.02	242,000
December,	41	-	Slight.	2.6000	.2387	.1373	.1014	5.95	1.47	.1313	1.28	53,500
Average,	53	54	-	4.5936	.3786	.2198	.1588	8.91	0.29	.0112	2.23	408,500

Straining Sewage through Twelve Inches of "Buckwheat Coal."

Two strainers have been operated, each at the rate of approximately 1,000,000 gallons per acre daily, Strainer E having been in operation eleven months and Strainer F seven months. Owing to the greater specific gravity of this material, it does not have the same tendency to float that coke has, and for this reason a large proportion of the matters removed from the sewage remain nearer the surface of the strainer than is the case with coke, and generally less of the straining material has to be removed when accumulations of organic matter are removed from its surface. Strainer E has been scraped twice during the year, while Strainer F has not required scraping.

One of the reasons for the use of such materials as coke or coal for the straining of sewage is that in operating any such strainer at a high rate it is assumed that a portion of the material of which the strainer is composed will probably have to be removed when the organic matter accumulated upon its surface is removed, and when the strainers are composed of coke or coal this matter can be burned as readily as the dried organic matters which have been removed.

These methods of removing matters in suspension in sewage that we have experimented with are also intended to be quite different in their end results from those obtained when removing such matters by chemical precipitation, in that the organic matter removed by the strainers and septic tanks is either destroyed or left in a compact mass, rather than mixed with many times its volume of water.

The following table gives the average analyses of the sewage applied to and the effluents from each of these strainers during 1901: —

Sewage applied to Strainer E.

[Parts per 100,000.]

Temperature. Deg. F.	Ammonia.			Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.				
		Total.	In Solution.			
55	5.83	.74	.41	9.82	3.81	1,207,000
Effluent of Strainer E.						
61	6.41	.35	.29	9.70	2.08	383,000
Sewage applied to Strainer F.						
59	4.91	.65	.34	11.75	3.43	1,085,000
Effluent of Strainer F.						
62	4.38	.44	.29	11.61	2.52	760,000

Comparison of Results obtained when treating Strained Sewage in a Contact Filter and in an Intermittent Continuous Filter.

The effluent of Strainer E has been applied during 1901 to intermittent continuous Filter No. 135 at an average rate of about

1,420,000 gallons per acre per day, and the effluent of this filter during a large part of this period has been well nitrified, practically odorless and subject to only very slight changes, as previously described and discussed, and as shown by the table on page 298. The effluent of coal Strainer F has been applied to coke contact Filter No. 175 at an average rate of 910,000 gallons per acre per day,— only about 65 per cent. as great a rate per day as that of intermittent continuous Filter No. 135,—and the resulting effluent has contained about the same amount of organic matter as the effluent of Filter No. 135, but nitrification has not been as active as in Filter No. 135, and the matter in suspension in the effluent has been of a character more liable to change than the matter in the effluent of Filter No. 135. Comparing the actual amount of nitrogenous matter applied to each filter and the amount of nitrogen in the effluent, we can understand, what is very apparent from an examination of the filters, that in proportion to the volume of sewage applied the interspace of Filter No. 175 has retained more organic matter than the interspace of Filter No. 135.

Anærobic followed by Ærobic Filtration.

Filters Nos. 133 and 134, first put into operation in 1899, were continued throughout the year. These two filters, each $\frac{1}{20000}$ of an acre in area, contain broken stone of such a size that all will pass through a sieve with one mesh to the linear inch, 24 per cent. through a sieve with a ½-inch mesh, and none through a sieve with a ¼-inch mesh. As described in previous reports, Filter No. 133 is an anærobic filter, and sewage was passed upward through it continuously during the year, the effluent of this filter being then passed down through Filter No. 134, which was operated as an intermittent continuous filter. The rate of operation of Filter No. 133 varied during the year from 2,969,000 gallons per acre daily in February to 680,000 gallons per acre daily in June, the average rate for the entire year being 1,583,000 gallons per acre daily. Filter No. 134 was operated at rates varying from 2,752,000 gallons per acre daily in February to 211,000 gallons per acre daily in July, the average rate for the year being 1,131,000 gallons per acre daily. The following tables give the monthly averages of the analyses of the effluents of these two filters for the year:—

Effluent of Filter No. 133.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	2,657,000	47	55	6.3750	.3735	.2625	9.20	.01	.0000	2.51	919,800
February,	2,969,000	44	53	5.4000	.2560	.1960	7.49	.01	.0000	2.52	680,500
March,	2,841,000	45	55	4.8000	.3560	.2440	8.81	.06	.0000	4.28	337,500
April,	2,157,700	49	54	5.1000	.2500	.1680	11.57	.02	.0000	2.32	412,300
May,	1,310,300	57	60	5.2250	.1920	.1275	10.92	.01	.0000	1.59	223,800
June,	680,000	67	72	5.4333	.2213	.1133	12.51	.01	.0000	1.38	174,200
July,	1,032,000	76	76	4.0667	.1747	.0873	13.71	.01	.0000	1.10	118,000
August,	982,000	73	72	4.8667	.1667	.1087	14.21	.01	.0000	1.19	120,200
September,	922,700	70	68	4.8000	.1733	.1147	15.01	.01	.0000	1.49	53,300
October,	1,047,000	58	67	4.1000	.1380	.0820	12.07	.01	.0000	1.32	90,500
November,	1,221,300	47	56	5.9000	.2540	.1920	10.98	.01	.0000	2.20	90,500
December,	1,174,200	47	58	3.7200	.1880	.1260	7.96	.01	.0000	1.84	24,000
Average,	1,582,900	57	62	4.9822	.2286	.1518	11.20	.02	.0000	1.98	270,300

Effluent of Filter No. 134.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	2,492,000	55	49	0.68	4.3250	.1920	.1575	9.08	0.88	.0147	1.51	188,000
February,	2,752,000	53	48	0.73	3.7000	.1260	.1010	7.41	1.08	.0032	1.06	16,500
March,	2,631,000	55	53	1.14	5.5000	.2060	.1300	10.11	0.30	.0100	1.40	-
April,	1,615,400	54	52	0.84	4.1000	.1780	.1260	10.71	0.67	.0146	1.14	234,000
May,	1,202,600	60	59	1.22	4.9000	.1400	.0995	10.85	0.12	.0036	0.97	37,500
June,	284,000	72	70	0.72	3.3467	.1440	.0927	12.74	0.08	.0023	0.69	11,700
July,	211,000	76	73	0.56	2.7333	.1133	.0853	12.72	1.19	.0433	0.73	17,100
August,	226,000	72	73	0.49	1.5467	.0880	.0753	14.18	3.40	.0147	0.68	52,700
September,	362,800	68	68	0.54	1.2000	.0907	.0607	15.08	3.09	.0227	0.78	28,800
October,	419,000	67	64	0.44	0.9350	.0800	.0620	11.31	1.90	.0130	0.83	10,500
November,	579,300	56	52	0.82	1.5400	.1820	.0810	11.17	3.59	.0170	1.78	64,500
December,	798,700	58	50	0.47	0.2520	.1760	.0480	8.21	2.98	.0100	1.58	5,000
Average,	1,131,200	62	59	0.72	2.8398	.1425	.0933	11.13	1.61	.0141	1.10	60,600

Taking the average rate of operation of Filter No. 133, and comparing it with the open space of the filter as determined at the end of the year, it shows that the applied sewage passed through the filter during the year in about six hours, or nearly four times as fast as similar sewage passed through Septic Tank A. Comparing the resulting effluents of this filter and of Septic Tank A, we find that that from anærobic Filter No. 133 contained much less organic matter, — but slightly more than one-half as much as shown by the albuminoid ammonia determinations, and less than two-thirds as much as shown by the determinations of oxygen consumed. These results are similar to those obtained in previous years. That is, the greater the surface for bacterial growth, such as is the case in this tank filled with broken stone, the better the results in anærobic as well as in ærobic filtration. The principal obstacle in operating an anærobic filter such as this, compared with the operation of a septic tank, is the greater difficulty in removing accumulated sludge, if we assume, as seems reasonable, that in both cases sludge will, when treating most sewages, eventually accumulate to such an extent that its removal will be imperative. This anærobic filter, after having been in operation for twenty-eight months and having had sewage passed through it at an average rate of about 1,550,000 gallons per acre daily, had lost 65 per cent. of its open space. This clogging material could be partially removed by reversing the flow through the tank, that is, by washing the filtering material by means of the application of large volumes of sewage or water. We found, however, that with material as fine as that in this anærobic filter, especially as it was without coarse underdrains, this method of cleansing was not as effective as desired. It is believed, however, that with coarser material and open underdrains this can be successfully done without impairing the bacterial results of the filter except for a short period, and experiments are being made to determine this.

Intermittent Continuous Filters Nos. 135 and 136, $\frac{1}{20000}$ of an Acre in Area.

These two filters, first put into operation in November, 1899, were continued in operation throughout the year 1901. Each has contained during the year 11 feet 10 inches in depth of broken stone of such a grade that all will pass through a screen with a 1-inch mesh, 40 per cent. through a screen with a ½-inch mesh and 4 per cent. through a screen with a ¼-inch mesh. Filter No. 135 has received sewage which has first been passed through a coal strainer (see page 298), and Filter No. 136 has received sewage which has first been passed through a septic tank. At the beginning of the year both were being operated at the rate of approximately 2,000,000 gallons per acre per day, and nitrification was feeble in both filters, owing to the conditions prevailing, as described in a previous report. That is, the great depth of the filters compared with their surface area caused the accumulation of nitrogen and carbonic acid gas within them, and the difficulty with which these gases could escape and oxygen enter prevented bacterial oxidation. To remedy this, on May 27 openings, four in number, were made on the side of each filter about 4½ feet from the top of the filtering material. Following this, nitrification began to be active in both filters and continued so throughout the remainder of the year. The average rate of filtration of Filter No. 135 for the entire year was 1,407,000 gallons per acre per day, and for Filter No. 136, 1,403,000 gallons per acre per day.

The following tables give the average analyses for the year of the sewage applied to and the effluents of these filters:—

Sewage applied to Filter No. 135.

[Parts per 100,000.]

Temperature. Deg. F.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
61	6.41	.35	.29	9.70	2.08	383,300

Sewage applied to Filter No. 136.

Temperature. Deg. F.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
60	5.98	.39	.29	8.73	2.58	352,000

Effluent of Filter No. 135.

[Parts per 100,000.]

1901.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	1,892,000	50	53	0.97	4.6500	.2820	.2465	9.50	0.01	.0000	1.94	342,400
February, .	2,405,000	44	48	0.90	4.3000	.1920	.1600	7.38	0.24	.0090	1.39	124,800
March, . .	2,168,000	48	52	1.30	6.5000	.3200	.2447	7.53	0.02	.0000	2.14	165,000
April, . .	1,880,800	55	54	1.17	5.1667	.2107	.1727	8.50	0.01	.0000	1.56	103,000
May, . .	1,055,000	62	58	1.07	5.8000	.2670	.1650	8.75	0.15	.0150	1.36	120,600
June, . .	602,700	71	67	0.61	2.1333	.2533	.1287	8.93	3.56	.0520	1.36	6,300
July, . .	909,000	76	74	0.44	1.0000	.1693	.0767	11.78	3.31	.0153	1.03	1,400
August, .	1,265,000	72	71	0.48	1.0267	.2147	.0647	10.97	5.20	.0157	1.83	5,400
September, .	1,072,400	68	67	0.62	1.6000	.1520	.0647	13.43	3.68	.0187	1.44	3,500
October, .	1,130,000	66	59	0.64	1.7900	.2020	.0960	11.05	5.45	.0095	1.77	-
November, .	1,126,700	49	50	0.73	2.1867	.1440	.0953	8.98	5.14	.0152	1.14	-
December, .	1,376,700	56	54	0.77	1.8200	.2660	.1080	6.48	2.02	.0075	1.91	1,000
Average, .	1,406,900	60	59	0.81	3.1645	.2228	.1353	9.44	2.40	.0182	1.57	87,300

Effluent of Filter No. 136.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	1,946,000	50	53	0.90	4.1850	.2950	.1705	9.20	0.80	.0034	1.83	109,000
February, .	2,419,000	48	49	0.90	4.4500	.2360	.1490	4.94	0.02	.0002	1.43	114,700
March, . .	1,793,000	51	51	1.07	5.8667	.3067	.1833	7.04	0.02	.0001	1.75	304,300
April, . .	2,154,600	56	54	0.96	4.4667	.2027	.1540	8.16	0.09	.0012	1.37	115,500
May, . .	926,500	62	57	0.68	4.1550	.1785	.1473	8.74	1.25	.0045	1.02	17,200
June, . .	520,000	69	66	0.58	0.8235	.2038	-	8.99	6.50	.0161	1.15	11,800
July, . .	886,500	77	75	0.80	2.5667	.1973	-	8.19	1.81	.0115	2.08	35,200
August, .	977,000	73	71	0.69	2.3267	.2640	.0878	10.08	3.59	.0140	2.41	8,200
September, .	1,178,600	69	67	0.82	3.0867	.1867	.0953	11.10	2.10	.0167	1.56	2,400
October, .	1,226,500	-	60	0.74	2.7500	.2380	.1170	11.50	3.74	.0130	2.05	-
November, .	1,386,700	51	49	0.88	4.1067	.2120	.1320	9.05	2.77	.0117	1.43	-
December, .	1,418,000	55	54	0.84	2.2000	.2760	.1080	6.48	1.36	.0110	2.03	11,800
Average, .	1,402,700	60	59	0.82	3.4153	.2331	.1344	8.62	2.00	.0086	1.67	73,000

Comparison of the Purification of Untreated Sewage and of Strained Sewage in Contact Filters.

Filters Nos. 175 and 176.

These two filters were put into operation on June 3, 1901, and were constructed of 5 feet in depth of coke, this coke being of such size that all would pass through a screen with a 1-inch mesh, 75 per cent. through a screen with a ½-inch mesh and practically none through a screen with a ¼-inch mesh. The effluent of coal Strainer F was applied to Filter No. 175, and Filter No. 176 received regular station sewage. Notes in regard to the difference in the degree of filling of open space of these two filters have already been given on page 278. The filters were both contact filters, and Filter No. 175 was operated during the year at an average rate of 910,000 gallons per acre daily, and Filter No. 176 at an average rate of 849,400 gallons per acre daily. From the time of first being put into operation until October 1 the filters were flooded in four applications of sewage one hour apart, allowed to stand full for two hours and then drained slowly. From October 1 to November 7 each was flooded in four applications of sewage one hour apart and allowed to stand full for four hours before being drained. Beginning November 7 each filter was filled in one application of sewage, about forty-five minutes being taken to fill each filter to its surface. The changes in the manner of flooding made comparatively little difference in the degree of purification obtained by each filter, although the best results were obtained during October.

The following tables present the average analyses of the effluent of each filter: —

Effluent of Filter No. 175.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Appearance. Turbidity.	Appearance. Color.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
June, . .	930,000	65	66	Slight.	.53	3.9500	.2040	.1290	.0750	11.09	0.06	.0090	0.90	104,300
July, . .	900,000	75	79	Slight.	.46	1.4700	.1680	.1070	.0610	11.55	0.86	.0130	0.79	48,000
August, .	900,000	73	72	Slight.	.49	1.1567	.1280	.0873	.0407	11.60	1.20	.0167	0.85	240,200
September,	859,000	71	69	Slight.	.55	1.0000	.1360	.0880	.0480	14.38	0.87	.0800	0.88	193,500
October, .	840,000	64	58	Decided.	.61	1.1150	.1680	.1200	.0480	11.82	2.24	.0073	1.09	193,000
November,	678,500	50	47	Great.	-	1.9200	.2800	.2340	.0460	11.87	2.20	.0010	2.00	108,000
December,	1,261,000	46	-	Slight.	.50	0.8550	.1170	.1010	.0160	7.90	1.97	.0110	0.87	33,500
Average,	909,800	63	65	-	.52	1.6381	.1716	.1238	.0478	11.46	1.34	.0197	1.05	131,500

Effluent of Filter No. 176.

June, . .	907,500	68	67	Slight.	.86	4.9500	.2660	.1610	.1050	10.92	0.20	.0040	0.98	214,800
July, . .	855,000	75	80	Slight.	.41	1.9500	.1780	.0850	.0930	10.21	0.50	.0040	0.80	287,000
August, .	855,000	73	72	Slight.	.53	1.2800	.1513	.1080	.0433	11.28	0.87	.0213	0.90	194,000
September,	816,000	71	70	Slight.	.50	0.7800	.1560	.1100	.0460	14.30	0.81	.0280	1.04	531,000
October, .	808,100	58	55	Decided.	.59	0.9800	.1893	.1273	.0620	9.48	2.53	.0049	1.22	244,000
November,	577,300	48	47	Great.	-	1.2600	.2280	.1860	.0420	7.99	0.24	.0006	1.74	1,283,000
December,	1,127,000	51	-	Slight.	.41	0.8600	.1210	.0980	.0230	6.76	1.05	.0044	0.77	23,500
Average,	849,400	63	65	-	.55	1.7229	.1842	.1250	.0592	10.13	0.89	.0096	1.06	396,800

was 1,027,000 gallons per acre daily. The results obtained during the year were very poor, no nitrification occurring within the filter. Much better results were obtained during 1900, when the rate of operation was only one-half as great and the filter was comparatively free from clogging. The effluent of the filter was applied to coke Filter No. 163 at an average rate of 737,000 gallons per acre daily, this latter filter being a coke contact filter containing 4 feet 6 inches in depth of comparatively fine coke. The average analyses of the effluents of these two filters during 1901 were as follows: —

Effluent of Filter No. 137.

[Parts per 100,000.]

Temperature. Deg. F.	Color.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.		
58	.79	2.9381	.2912	.1843	10.14	.14	.0016	2.04	383,800

Effluent of Filter No. 163.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Appearance. Turbidity.	Appearance. Color.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. In Solution.	Albuminoid Ammonia. In Suspension.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	840,000	50	50	Great.	.75	2.6800	.2480	.1920	.0560	8.50	0.78	.0110	1.56	423,500
February, .	785,000	46	45	Great.	.88	2.5700	.2050	.1565	.0485	6.81	0.45	.0023	1.28	286,600
March, .	780,000	51	50	Great.	.88	2.9400	.2520	.1480	.1040	7.13	0.88	.0006	1.62	-
April, .	570,000	49	51	Great.	.50	1.6800	.1740	.0790	.0950	7.88	1.00	.0014	1.18	328,800
May, . .	766,700	58	58	Decided.	.62	2.1067	.1627	.0807	.0820	8.84	1.16	.0055	0.97	291,000
June, . .	720,000	67	66	Slight.	.66	1.4300	.1300	.0760	.0540	10.46	1.73	.0160	0.83	155,500
July, . .	720,000	75	74	Decided.	.58	1.2000	.1500	.0733	.0767	11.09	1.09	.0193	1.11	143,300
August, .	720,000	72	72	Decided.	.52	1.1600	.1333	.0893	.0440	12.79	1.49	.0193	0.89	301,000
September,	691,000	69	67	Decided.	.65	1.3500	.1560	.0970	.0590	13.97	1.06	.0210	1.16	239,500
October, .	720,000	62	-	Decided.	.60	1.3000	.1650	.0970	.0680	11.50	2.04	.0160	1.12	115,500
November,	686,200	49	49	Decided.	.77	1.1300	.1790	.1350	.0440	10.44	1.42	.0095	1.26	120,500
December,	848,000	52	52	Decided.	.67	1.0300	.1420	.1210	.0210	10.48	0.99	.0032	1.07	79,500
Average,	737,200	58	58	-	.67	1.7147	.1748	.1121	.0627	9.99	1.17	.0104	1.17	225,900

Filter No. 164.

This filter, containing 4 feet 6 inches in depth of coke of a considerably finer grade than that in Filter No. 163, was in operation during the first six months of the year at an average rate of 765,000 gallons per acre daily, the effluent of Filter No. 137 being applied to it, as in the case of Filter No. 163. During its period of operation it produced an effluent much better purified than that of Filter No. 163, but the loss of open space increased more rapidly. The following table shows the average analyses of its effluent: —

Effluent of Filter No. 164.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
January,	888,000	50	52	Decided.	.55	1.4800	.1880	.1240	.0640	8.62	1.71	.0120	1.10	379,500
February,	796,000	46	47	Decided.	.61	0.9350	.1430	.1120	.0310	6.46	1.80	.0068	1.01	324,600
March,	783,400	51	53	Decided.	.63	0.5750	.1670	.1360	.0310	7.22	2.39	.0072	1.19	270,000
April,	567,800	49	53	Decided.	.75	1.8700	.1510	.0920	.0590	7.86	1.79	.0051	1.00	90,900
May,	777,000	58	61	Slight.	.50	0.8367	.1033	.0720	.0313	8.73	2.42	.0180	0.68	148,800
June,	777,000	67	68	V. slight.	.49	0.6150	.0840	.0740	.0100	10.55	2.88	.0480	0.65	48,200
Average,	764,900	54	56	-	.59	1.0520	.1394	.1017	.0377	8.24	2.17	.0162	0.94	210,300

On the Action of Iron in the Purification of Sewage.

Filters Nos. 88, 150 and 165.

The experiments described in the reports of the last two years showing the influence of iron oxides in the purification of sewage have been continued. The previous results have been confirmed, but no new facts of importance have been added.

Filter No. 88, composed of sand and iron filings, has been discontinued during the year, owing to the fact that the mass of sand and iron oxide became consolidated to such an extent as to prevent the passage of sewage. The results for the six months in which it was operated are given in the following table. These final results were uncertain and irregular, owing to the advancing consolidation, and were not characteristic of the action of this filter. It may be well to recall what was said of this filter in the report for 1900, that, operated at a rate of 115,000 gallons per acre daily, it gave more uniformly satisfactory results than any intermittent filter which has ever been installed at the station. That this favorable action was due to the hydrous oxide of iron formed on the surface of the iron filings there seems no reason to doubt.

Effluent of Filter No. 88.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	115,200	50	50	3h. 35m.	None.	.15	0.0094	.0080	9.89	2.29	.0022	0.08	95
February,	91,300	47	46	10h. 33m.	V. slight.	.30	0.5680	.0330	7.60	2.36	.0200	0.24	852
March,	115,200	48	50	2h. 44m.	None.	.08	0.0066	.0094	4.91	1.75	.0016	0.08	372
April,	39,900	49	55	12h.	None.	.24	1.4278	.0605	10.09	0.50	.0032	0.44	22
May,	81,200	57	-	18h.	Slight.	.57	3.7067	.1587	9.13	0.01	.0010	1.25	150
June,	59,900	68	-	35m.	-	-	-	-	-	-	-	-	-
Average,	83,800	53	50	9h. 29m.	-	.27	1.1437	.0539	8.32	1.38	.0056	0.42	298

The experiment of substituting a natural hydrous oxide of iron in place of the iron filings was described in the last report. Filter No. 150 consists of a mixture of equal bulks of sand of an effective size of 0.23 millimeter and an iron ore — brown hematite — in fragments of an effective size of 1 millimeter. This iron ore is a ferric hydrate belonging to the mineral class of limonites. To the five months of its operation in 1900 are now added the twelve months of 1901.

For the latter half of the year the rate of this filter was about 115,000 gallons per acre daily, with highly satisfactory results both chemically and bacteriologically, but not equal to the results obtained from Filter No. 88, as described in the report for 1900.

It was scarcely to be expected that the hard, natural limonite, containing silica, alumina and other mineral matters, would be as susceptible to the influence of organic matter in the sewage as the highly porous and nearly pure ferric hydrate freshly formed on the surface of the iron filings. But that this natural product is capable of acting as an oxidizing agent was conclusively proved in the case of Filter No. 125 (described in the last report), where iron went into solution in the ferrous condition when the sewage was allowed to stand in contact with the limonite for some days.

Effluent of Filter No. 150.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	100,000	50	49	8m.	None.	.07	.0102	.0136	8.77	3.25	.0057	.14	210
February,	100,000	47	46	10m.	None.	.07	.0084	.0124	8.05	3.25	.0064	.13	-
March,	100,000	48	50	52m.	None.	.08	.0100	.0131	5.99	3.74	.0034	.14	1,123
April,	69,200	49	53	10m.	None.	.08	.0088	.0144	10.85	4.08	.0060	.11	1,496
May,	100,000	57	59	5m.	None.	.07	.0066	.0140	9.68	3.62	.0053	.12	2,770
June,	119,600	68	65	7m.	None.	.11	.0162	.0202	9.63	3.89	.0085	.18	5,800
July,	110,700	75	73	5m.	None.	.10	.0042	.0152	9.00	3.95	.0028	.13	97
August,	115,000	73	72	5m.	None.	.10	.0037	.0154	12.90	2.81	.0028	.12	398
September,	110,000	71	65	5m.	None.	.08	.0036	.0151	11.56	3.12	.0022	.14	2,500
October,	115,000	58	57	8m.	None.	.04	.0034	.0162	9.27	3.08	.0008	.17	420
November,	115,000	48	53	49m.	V. slight.	.18	.0412	.0260	9.97	3.61	.0022	.19	361
December,	115,000	51	54	30m.	None.	.07	.0079	.0169	7.65	3.52	.0009	.14	422
Average,	105,800	58	58	16m.	-	.09	.0104	.0160	9.44	3.49	.0039	.14	1,418

Whether the natural limonite would prove effective in a contact filter was not satisfactorily answered by Filter No. 125, since the material was too fine for this purpose. Filter No. 165, which has been in operation for eleven months of 1901, consists of 5 feet in depth of coarse limonite over 3 inches of underdrains. It has been treated as a contact filter, receiving four doses of regular sewage, one hour apart, standing full two hours and then slowly drained. At an average rate of about 650,000 gallons per acre daily the results did not materially differ from those obtained by filters composed of broken stone or similar material. A different result was not to be expected, since the time of contact of the sewage and the iron oxide was very much less than with the filters acting at a much lower rate, and the oxidizing action of the natural ferric hydrate is, under any conditions, very slow.

While, therefore, the experiments with iron filings and with the natural hydrous hematite are interesting, and while we recognize a distinct advantage in the purification of sewage when this hydrated oxide of iron is mixed with the sand in intermittent filtration, still we cannot say at the present time that the advantage is great enough to justify the use of iron either in the metallic or oxidized condition in the formation of filter-beds on a large scale.

Effluent of Filter No. 165.

[Parts per 100,000.]

1901.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.		Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.		
February, .	700,000	47	46	Decided.	.73	2.7667	.1707	.1280	.0427	5.19	0.01	.0008	0.97	252,700
March, .	700,000	48	51	Decided.	.90	4.7000	.2080	.1590	.0490	7.63	0.04	.0000	1.53	155,500
April, .	457,700	49	52	Decided.	-*	4.0500	.2260	.1240	.1020	6.34	0.02	.0000	1.18	52,300
May, . .	700,000	57	57	Decided.	.62	4.1850	.1625	.1105	.0520	8.99	0.39	.0023	0.92	252,400
June, . .	700,000	68	67	Slight.	.66	1.2300	.1530	.1280	.0250	9.69	2.01	.0180	0.87	114,800
July, . .	539,600	75	74	Slight.	.54	0.3650	.1270	.0790	.0480	9.24	1.92	.0150	0.84	5,700
August, .	610,000	73	72	Slight.	.54	0.3400	.1047	.0840	.0207	10.44	2.28	.0173	0.71	279,500
September,	586,000	71	68	Slight.	.65	0.2350	.0930	.0900	.0030	10.58	2.95	.0280	0.89	190,400
October, .	610,000	58	58	Slight.	.49	0.4360	.1840	.1070	.0270	8.17	2.52	.0100	0.93	137,400
November,	610,000	48	49	Decided.	.88	0.7700	.1330	.1310	.0020	9.35	2.64	.0395	0.97	35,100
December,	907,100	51	52	Decided.	.63	1.6600	.2120	.1520	.0600	10.38	0.60	.0090	1.29	80,800
Average,	647,300	59	59	-	.66	1.8852	.1567	.1175	.0392	8.73	1.40	.0127	1.01	141,500

* Yellow, black.

Application to Filters of Differing Volumes of Sewage containing Equal Amounts of Organic Matter.

The volume of sewage that can in intermittent sand filtration be applied to a filter and be satisfactorily purified varies with the degree of concentration of the sewage. To illustrate this fact, Filters Nos. 128, 129 and 130 were put into operation in August, 1899, and two of them — namely, Filters Nos. 128 and 130 — were continued in operation until the end of June, 1901. Each filter contained 5 feet in depth of sand of an effective size of 0.26 millimeter. To Filter No. 128 station sewage was applied at an average rate of 95,000 gallons per acre daily, and to Filter No. 130 an equal volume of sewage plus twice as much river water, making the average rate for the year 287,000 gallons per acre daily. Both filters have produced good effluents, and the filter receiving the large volume of weak sewage has been operated as easily as the filter receiving the smaller volume of strong sewage. The following table shows the average analysis of the effluent of each filter: —

Effluent of Filter No. 128.

[Parts per 100,000.]

Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
Sewage Applied.	Effluent.		Free.	Albu-minoid.		Nitrates.	Nitrites.		
53	56	.15	.2804	.0366	8.30	4.09	.0033	.30	2,600

Effluent of Filter No. 130.

49	52	.29	.0404	.0306	2.82	1.25	.0044	.34	15,800

Degree of Purification in Shallow Intermittent Sand Filters of Fine and Coarse Sand.

Filters Nos. 140 and 141 A.

These two filters were continued in operation throughout the first six months of the year. Filter No. 140 contained 2 feet in depth of fine sand of an effective size of 0.11 millimeter and Filter No. 141 A contained 2 feet in depth of sand of an effective size of 0.24 millimeter. Filter No. 140 was operated at an average rate of 48,600 gallons per acre per day, and Filter No. 141 A at an average rate of 47,800 gallons per acre per day. Neither filter produced quite as good an effluent as it would if it had been of greater depth, and the filter of coarse sand did not produce an effluent of quite as good a quality as the filter of fine sand. The following table gives the average analysis of each filter during its period of operation in 1901: —

Effluent of Filter No. 140.

[Parts per 100,000.]

Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
Sewage Applied.	Effluent.		Free.	Albu-minoid.		Nitrates.	Nitrites.		
53	51	.30	0.9848	.0416	8.55	2.31	.0076	.43	1,800

Effluent of Filter No. 141 A

53	51	.27	1.4722	.0613	8.68	2.35	.0088	.53	12,400

Other Filters in Operation at the Station during 1901.

Various other filters have been in operation during 1901 for special studies, etc., but the results obtained from some of them are not of especial importance, and others were put into operation so near the end of the year that their results will be given in a subsequent report. Among these last were three sand filters started for the purpose of studying the action of various disinfectants in preventing nitrification, this study being made in connection with the disposal of the sewage of hospitals.

Operation of the Large Intermittent Filters, $\frac{1}{200}$ of an Acre in Area.

As stated in the last report, no sewage was applied to these filters for three weeks during December, 1900, owing to a break in our sewer pipe, and nitrification practically ceased within them. This caused their effluents to be of very poor quality during the first part of 1901, and not until warm weather returned did nitrification become active within them. During the winter of 1901–1902 the effluents of these filters were generally of a character never before observed in connection with them; that is, nitrification practically ceased within the filters, but the effluents, instead of becoming turbid, containing high albuminoid ammonia and being subject to putrefaction, were clear, low in albuminoïd ammonia, although containing high free ammonia, and would remain without change even when incubated at 80° F. for five days.

The following table shows the period of service of each of them, together with the date upon which they were started, their rate of operation, etc.: —

Average Purification, etc., of Filters Nos. 1 to 10, inclusive, 1901.

Number of Filter.	Dimensions of Filter.		Date when Sewage was first applied.	Actual Number of Gallons applied to Jan. 1, 1902.	Gallons per Acre.	Average Rate of Filtration (Gallons per Acre Daily) Six Days in a Week — 1901.	Average (1901) Per Cent. Removal of		
	Depth (Inches).	Mean Diameter (Inches).					Albuminoid Ammonia.	Oxygen Consumed	Bacteria.
1,	63	200	Jan. 10, 1888,	1,615,100	323,020,000	75,200	85	78	97.64
2,	60	200	Dec. 19, 1887,	840,778	168,155,600	36,300	92	88	99.98
4,	60	200	Dec. 19, 1887,	538,376	107,675,200	20,400	97	97	99.99
5 B,	60	200	Mar. 5, 1898,	543,735	108,747,000	131,500	89	88	98.43
6,	44	200	Jan. 12, 1888,	1,214,389	242,977,800	57,600	89	82	99.63
9 A,	60	200	Nov. 18, 1890,	1,128,589	225,717,800	53,900	88	80	98.85
10,	60	200	July 18, 1894,	318,760	63,752,000	27,800	91	86	99.63

Filter No. 1.

Filter No. 1 contains 60 inches in depth of coarse sand of an effective size of 0.48 millimeter, and is $\frac{1}{200}$ of an acre in area. The surface of this filter has been raked 1 inch deep each week and spaded over to a depth of 6 to 10 inches upon May 6 and 18 and September 24. During January, 4½ inches of snow and 4⅝ inches of ice were removed from its surface; during February, 5½ inches of snow and 8¼ inches of ice; during March, 1 inch of snow; during November, ¼ inch of ice; and during December, 19¼ inches of snow and ⅞ inch of ice. The filter was allowed to rest from September 23 to September 28 inclusive. April 7 to April 15 experiment was interrupted by freshet. See table, page 312.

Filter No. 2.

This filter is $\frac{1}{200}$ of an acre in area and contains 60 inches in depth of fine sand of an effective size of 0.08 millimeter with two circular trenches 1 foot wide and 2 feet deep, of medium sand of an effective size of 0.19 millimeter, the surface of these trenches being below the surface of the remainder of the filter, and the sewage being applied to them. The surface of the trenches has been raked 1 inch deep each week and they were spaded to a depth of 6 inches on May 7 and September 24. August 3, the grass and weeds on surface were cut. During January, 5 inches of snow and 1⅝ inches of ice were removed from the surface of the filter; during February, 6 inches of snow and 2½ inches of ice from the surface of the filter and 4⅜ inches of ice from the trenches; during March, 1 inch of snow from the surface; and during December, 15½ inches of snow and ⅛ inch of ice from the surface. The filter was allowed to rest from September 23 to September 28 inclusive. April 7 to April 15 the experiment was interrupted by a freshet. See table, page 312.

Filter No. 4.

This filter is $\frac{1}{200}$ of an acre in area and contains 60 inches in depth of fine river silt of an effective size of 0.04 millimeter, with two circular trenches about 14 inches wide and 12 inches deep, of coarse sand of an effective size of 0.48 millimeter. The surface of these trenches is below the surface of the remainder of the filter, and to them the sewage is applied. They have been raked 1 inch deep each week and spaded to a depth of 6 inches on May 6 and September 24. August 3, the grass and weeds on the surface were cut. During January, 6½ inches of snow and ⅞ inch of ice were removed from the surface of the filter and 2⅛ inches of ice from the trenches; during February, 4½ inches of snow and 2⅞ inches of ice from the surface of the filter and 5¾ inches of ice from the trenches; during March, 1 inch of snow from the surface; and during December, 17½ inches of snow and ⅜ inch of ice from the surface. The filter was allowed to rest from September 23 to September 28 inclusive. April 7 to April 15 the experiment was interrupted by a freshet. See table, page 312.

Filter No. 5 B.

This filter is $\frac{1}{200}$ of an acre in area and contains 60 inches in depth of a mixture of cinders and ashes from the combustion of soft coal. It was first put into operation on March 5, 1898, and was operated during that year at an average rate of 73,000 gallons per acre daily. During 1899 the average rate was 81,700 gallons per acre daily, and during 1900, 109,200 gallons per acre daily; but during a considerable portion of the year the rate was from 140,000 to 150,000 gallons per acre daily. Owing to the coarseness of the material in this filter the sewage enters it more readily than it does any of the other large filters, and this is a condition especially favorable for good work during cold winter weather. The surface of the filter has been raked 1 inch deep each week and spaded to a depth of 6 inches on May 6. During January, 7½ inches of snow and ⅛ inch of ice were removed from the surface of the filter; during February, 5½ inches of snow and ⅞ inch of ice; during March, 1½ inches of snow; and during December, 16½ inches of snow and ¼ inch of ice. The filter was allowed to rest from September 23 to September 28 inclusive. April 7 to April 15 the experiment was interrupted by a freshet. See table, page 312.

Filter No. 6.

This filter is $\frac{1}{200}$ of an acre in area and contains 44 inches in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter. The surface of the filter has been raked to a depth of 1 inch each week and spaded to a depth of 6 inches on May 6 and September 24. During January, 5¾ inches of snow and 3¼ inches of ice were removed from the surface of the filter; during February, 7 inches of snow and 5¾ inches of ice; during March, 1 inch of snow and ⅛ inch of ice; and during December, 18¼ inches of snow and 1 inch of ice. The filter was allowed to rest from September 23 to September 28 inclusive. April 7 to April 15 the experiment was interrupted by a freshet. See table, page 312.

Filter No. 9 A.

This filter is $\frac{1}{200}$ of an acre in area and contains 5 feet in depth of sand of an effective size of 0.17 millimeter. The surface of the filter has been raked 1 inch deep each week and spaded to a depth of 6 to 10 inches on May 6, June 3 and September 24. Two flat-bottomed trenches, 7 inches deep, 5 feet wide and 11 feet long, were constructed and sewage applied to these trenches beginning October 8. During January, 6½ inches of snow and 6¼ inches of ice were removed from the surface of the filter; during February, 1½ inches of snow and 10¾ inches of ice; during March, 1½ inches of snow and ½ inch of ice; during November, ¾ inch of ice; and during December, 18¾ inches of snow and 2¼ inches of ice. The filter was allowed to rest from September 23 to September 28 inclusive. April 7 to April 15 and April 24 to April 28 the experiment was interrupted by a freshet. See table, page 312.

Filter No. 10.

This filter is $\frac{1}{200}$ of an acre in area and contains 5 feet in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter. No underdrains are beneath the sand except directly above and around the outlet pipe. A partition extending 3 feet below the surface separates the quarter of the surface farthest from the underdrains from the remainder of the surface. To this quarter of the surface the sewage is applied, and over the remainder of the surface is a layer of loam 8 inches in depth, this keeping the body of the filter freer from frost than is the case with most of the other filters and hence allowing better nitrification, as a general thing, in the winter weather, this being aided also by the small surface to which a comparatively large volume of sewage is applied. The surface of the filter has been raked 1 inch deep each week and spaded to a depth of 6 inches on May 6 and September 24. During January, 7 inches of snow and 1¼ inches of ice were removed from the surface of the filter; during February, 5 inches of snow and 5⅜

inches of ice; during March, 1½ inch o
and during December, 19¾ inches of s
filter was allowed to rest from Septem r
sive. April 7 to April 15 and April 2
was interrupted by a freshet. See tab.

Effluent of Filter

[Parts per 100

Quantity Applied. — Gallons per Acre Daily for six Days in a Week	Temperature. Deg. F. Sewage.	Effluent.	Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance. Turbidity.	Color.	Am. Free.
57,200	58	55	1h. 33m.	Slight.	.87	2...

Effluent of Filter

38,300	58	56	2h. 55m.	None.	.37	1.290

Effluent of Filter N

20,400	58	56	2h. 32m.	None.	.08	0.529

Effluent of Filter N

131,500	58	56	1h. 23m.	Slight.	.57	1.6674

Effluent of Filter N

57,600	58	56	2h. 3m.	None.	.67	1.656

Effluent of Filter

58,900	57	54	2h. 6m.	None.	.75	2...

Effluent of Filter

27,800	57	54	1h. 45m.	Slight.	.55	1.4

PURIFICATION OF WATER.

The investigations upon the purification of water have been continued during the year. Experimental filters have been operated for the purpose of studying the elimination of disease germs by sand filtration, as determined by the efficiency of these filters in removing *B. coli communis*, a characteristic organism of sewage. In this study very many comparative determinations have been made of the liability of detecting this bacillus when examining 1, 10 and 100 cubic centimeters of the same water. In this work not only have the Merrimack River water, the Lawrence city filtered water and the effluents of our experimental filters been examined, but also a number of the public water supplies of the State within easy access of the experiment station. All of this work is giving us valuable information in regard to the degree of pollution or purity of a water as based upon the volume which it is necessary to examine to determine the presence of *B. coli*.

We have also continued our studies upon the removal of color from water, and considerable time has been devoted to investigating methods for the removal of iron from water supplies in the State. A paper upon the purification of water by freezing was given in the last annual report, and much additional data along this line have been obtained during 1901. The usual summary of all this work is omitted here, however, to be given in a future report. The usual tables showing the work of the Lawrence city filter for 1901 are, however, here given.

Work of the Lawrence City Filter during 1901.

This filter is 2.5 acres in area and is unprotected from the weather by any roof. It was first put into operation in September, 1893, and supplies filtered water to the city of Lawrence. As in previous years, numerous samples have been collected for chemical analysis of the Merrimack River water as it flows upon this filter, of the effluent of the filter collected at the pumping station, and also of the filtered water from three other points upon the distributing system, namely, the outlet of the reservoir, a tap at the Lawrence city hall and a tap at the experiment station. Besides these samples, moreover, during nearly eight months of the year samples have been collected almost daily for bacterial analysis.

Bacterial Efficiency of Lawrence City Filter.

Averaging the monthly averages of bacteria found in the Merrimack River water applied to and the effluent from the Lawrence city filter, we find that the average number of bacteria in the river water for the year has been 3,017 and the average number of bacteria in the effluent 26, giving a bacterial efficiency for the entire year of 99.14 per cent. The average number of bacteria in the samples collected at the outlet of the reservoir was 19 per cubic centimeter, in the samples collected from a tap at the city hall 18 per cubic centimeter, and in the samples collected from a tap at the experiment station 20 per cubic centimeter. Tables showing the results of the chemical and bacterial analyses of the applied water and filtered water are here given.

Number of Bacteria per Cubic Centimeter in the Merrimack River Water, at the Intake of the Lawrence City Filter, 1901.

Day of Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1, ...	2,500	2,100	4,100	1,900	-	-	-	-	-	-	-	-
2, ...	6,000	2,400	3,300	-	-	-	1,200	-	-	-	-	1,700
3, ...	4,100	-	-	-	-	1,800	-	-	100	-	-	1,200
4, ...	81,700	2,000	5,400	2,700	-	-	-	-	-	-	100	4,200
5, ...	3,500	2,700	-	-	-	-	-	3,300	-	-	600	1,000
6, ...	-	2,300	5,800	-	1,000	-	-	-	-	-	2,400	2,000
7, ...	3,100	2,000	48,200	-	-	-	-	-	-	-	2,000	1,300
8, ...	800	2,000	3,100	-	-	-	900	-	-	-	400	-
9, ...	2,800	5,000	1,500	-	-	-	-	-	3,200	3,100	-	1,500
10, ...	4,000	-	-	-	-	500	-	-	-	-	-	1,800
11, ...	3,600	2,100	9,600	-	-	-	-	-	-	-	900	1,600
12, ...	4,800	3,000	11,000	-	-	-	-	300	-	-	800	800
13, ...	-	900	8,600	-	-	-	-	-	-	-	700	700
14, ...	3,800	3,900	31,000	-	1,400	-	-	-	-	-	2,500	900
15, ...	2,500	1,800	5,500	-	-	-	4,500	-	-	-	200	-
16, ...	2,000	-	3,800	900	-	-	-	-	300	-	500	5,500
17, ...	3,600	-	-	-	-	-	-	-	-	-	-	6,000
18, ...	2,700	2,100	1,500	900	-	6,600	-	-	-	3,100	700	3,000
19, ...	2,800	3,200	-	-	-	-	-	2,200	-	-	1,900	1,800
20, ...	-	2,400	-	-	1,700	-	-	-	-	-	1,100	-
21, ...	2,000	2,200	3,800	-	-	-	-	-	-	1,200	4,700	-
22, ...	3,200	-	-	1,900	-	-	1,100	-	-	-	2,500	-
23, ...	1,200	2,200	-	-	-	-	-	-	3,200	-	1,100	2,800
24, ...	1,200	-	-	-	-	3,100	-	500	-	-	-	11,000
25, ...	800	-	2,500	-	-	-	-	-	-	-	200	-
26, ...	700	3,700	-	1,200	-	-	-	-	-	-	1,800	8,000
27, ...	-	2,100	-	-	-	-	-	-	-	-	200	19,700
28, ...	2,100	3,200	3,200	-	1,400	-	-	-	-	800	-	12,800
29, ...	2,300	-	-	400	-	-	1,100	-	-	-	900	-
30, ...	2,200	-	-	-	-	-	-	-	2,000	-	1,600	10,100
31, ...	1,800	-	-	-	-	-	-	-	-	-	-	19,100
Average, . .	5,600	2,500	8,900	1,400	1,400	3,000	1,760	1,580	1,760	1,900	1,300	5,100

Number of Bacteria per Cubic Centimeter in the Effluent of the Lawrence City Filter, taken from a Tap at the Pumping Station, 1901.

DAY.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	28	20	65	25	-	-	-	-	-	-	-	-
2,	36	25	48	-	-	-	13	-	-	-	-	27
3,	33	-	-	-	-	120	-	-	-	-	-	22
4,	33	61	60	9	-	-	-	-	14	-	6	15
5,	35	45	-	-	-	-	-	33	-	-	12	2
6,	-	32	145	-	13	-	-	-	-	-	2	17
7,	24	12	42	-	-	-	-	-	-	45	14	11
8,	33	31	75	-	-	-	9	-	-	-	1	-
9,	96	17	40	-	-	-	-	-	12	-	2	17
10,	123	-	-	-	-	17	-	-	-	-	-	19
11,	390	-	64	-	-	-	-	-	-	-	4	12
12,	118	13	69	-	-	-	-	11	-	-	4	6
13,	-	17	28	-	-	-	-	-	-	-	3	9
14,	108	33	27	-	2	-	-	-	-	-	4	7
15,	311	7	25	-	-	-	14	-	-	-	5	-
16,	15	7	14	13	-	-	-	-	22	-	2	11
17,	30	-	-	-	-	-	-	-	-	-	-	12
18,	18	27	73	22	-	8	-	-	-	7	11	7
19,	34	20	-	-	-	-	-	18	-	-	9	9
20,	-	28	-	-	6	-	-	-	-	-	22	-
21,	9	16	-	-	-	-	-	-	-	19	-	-
22,	28	-	14	12	-	-	4	-	-	-	11	-
23,	6	24	-	-	-	-	-	-	6	-	9	51
24,	7	-	-	-	-	87	-	-	-	-	-	6
25,	12	11	50	-	-	-	-	-	-	-	13	-
26,	12	22	-	11	-	-	-	-	-	-	2	98
27,	-	36	-	-	-	-	-	11	-	-	1	11
28,	36	27	14	-	11	-	-	-	-	15	-	44
29,	24	-	-	12	-	-	15	-	-	-	10	-
30,	36	-	-	-	-	-	-	-	19	-	7	26
31,	24	-	-	-	-	-	-	-	-	-	-	57
Average,	61	24	50	15	8	58	11	18	15	22	7	22

Number of Bacteria per Cubic Centimeter in Filtered Water at the Outlet of the Distributing Reservoir, 1901.

Day.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	52	20	13	26	-	-	-	-	-	-	-	-
2,	71	42	12	-	-	-	9	-	-	-	-	10
3,	94	-	-	-	-	150	-	-	-	-	-	7
4,	31	37	13	11	-	-	-	-	8	-	1	5
5,	20	28	27	-	-	-	-	22	-	-	7	9
6,	-	20	22	-	11	-	-	-	-	-	10	15
7,	53	18	58	-	-	-	-	-	-	6	8	12
8,	10	14	15	-	-	-	5	-	-	-	2	-
9,	26	12	9	-	-	-	-	-	16	-	1	10
10,	47	-	-	-	-	13	-	-	-	-	-	14
11,	64	24	28	-	-	-	-	-	-	-	12	13
12,	33	33	23	-	-	-	-	4	-	-	7	7
13,	-	21	43	-	-	-	-	-	-	-	2	11
14,	60	16	23	-	7	-	-	-	-	-	19	8
15,	28	23	25	-	-	-	9	-	-	-	4	-
16,	24	-	18	19	-	-	-	-	7	-	2	14
17,	58	-	-	-	-	-	-	-	-	-	-	22
18,	42	16	17	12	-	9	-	-	-	10	9	11
19,	104	21	-	-	-	-	-	14	-	-	9	22
20,	-	20	-	-	11	-	-	-	-	-	15	-
21,	22	10	-	-	-	-	-	-	-	7	-	-
22,	30	-	14	9	-	-	8	-	-	-	15	-
23,	11	-	-	-	-	-	-	-	17	-	6	44
24,	7	-	-	-	-	23	-	-	-	-	-	25
25,	14	11	18	-	-	-	-	-	-	-	11	-
26,	10	20	-	13	-	-	-	-	-	-	5	32
27,	-	16	-	-	-	-	-	4	-	-	8	36
28,	20	19	18	-	20	-	-	-	-	5	-	51
29,	54	-	-	24	-	-	9	-	-	-	4	-
30,	25	-	-	-	-	-	-	-	14	-	8	79
31,	22	-	-	-	-	-	-	-	-	-	-	103
Average,	38	21	22	16	12	49	8	11	12	7	8	24

Number of Bacteria per Cubic Centimeter in Filtered Water collected from a Tap at Lawrence City Hall, 1901.

DAY.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	95	35	16	26	-	-	-	-	-	-	-	-
2,	18	33	13	-	-	-	33	-	-	-	-	5
3,	52	-	-	-	-	58	-	-	-	-	-	6
4,	50	34	30	17	-	-	-	-	4	-	2	4
5,	42	13	42	-	-	-	-	23	-	-	5	6
6,	-	15	15	-	8	-	-	-	-	-	7	15
7,	24	7	16	-	-	-	-	-	-	8	19	9
8,	14	8	14	-	-	-	12	-	-	-	1	-
9,	21	8	22	-	-	-	-	-	12	-	-	21
10,	17	-	-	-	-	19	-	-	-	-	-	15
11,	65	13	25	-	-	-	-	-	-	-	4	10
12,	85	15	48	-	-	-	-	6	-	-	2	15
13,	-	17	23	-	-	-	-	-	-	-	2	16
14,	40	6	13	-	6	-	-	-	-	-	2	22
15,	30	9	21	-	-	-	6	-	-	-	2	-
16,	26	-	49	18	-	-	-	-	12	-	3	12
17,	48	-	-	-	-	-	-	-	-	-	-	18
18,	37	10	32	23	-	1	-	-	-	17	11	12
19,	44	11	-	-	-	-	-	7	-	-	5	12
20,	-	110	-	-	11	-	-	-	-	-	7	-
21,	22	8	-	-	-	-	-	-	-	9	9	-
22,	21	-	31	7	-	-	4	-	-	-	8	-
23,	16	9	-	-	-	-	-	-	9	-	9	52
24,	15	-	-	-	-	21	-	-	-	-	-	110
25,	8	28	42	-	-	-	-	-	-	-	15	-
26,	14	14	-	14	-	-	-	-	-	-	14	31
27,	-	286	-	-	-	-	-	21	-	-	4	36
28,	29	16	21	-	10	-	-	-	-	8	-	49
29,	21	-	-	15	-	-	3	-	-	-	4	-
30,	26	-	-	-	-	-	-	-	6	-	3	54
31,	30	-	-	-	-	-	-	-	-	-	-	57
Average,	34	32	26	17	9	25	12	14	9	11	6	26

Number of Bacteria per Cubic Centimeter in Filtered Water collected from a Tap at the Lawrence Experiment Station, 1901.

Day.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	65	15	10	19	11	84	9	11	-	2	-	-
2,	435	46	12	-	26	-	4	52	-	-	-	6
3,	17	-	-	-	158	115	7	8	6	-	-	6
4,	95	22	61	20	77	70	-	-	6	-	3	2
5,	21	22	43	21	-	8	7	15	9	-	11	7
6,	-	21	53	11	17	17	15	7	4	-	3	6
7,	27	10	21	-	14	11	-	109	25	6	9	8
8,	21	18	14	-	85	6	7	9	-	-	1	-
9,	26	13	11	-	18	-	9	7	11	-	4	8
10,	37	-	-	-	16	18	5	28	11	-	-	5
11,	35	48	9	-	84	62	2	-	8	-	4	13
12,	33	10	40	-	-	10	11	10	147	-	6	4
13,	-	9	17	-	72	12	11	7	67	-	3	10
14,	44	7	17	-	7	14	-	3	4	-	6	12
15,	18	21	34	-	15	9	5	15	-	-	8	-
16,	40	9	9	10	8	-	6	6	7	-	6	14
17,	39	-	-	17	17	-	3	5	4	-	-	20
18,	31	8	57	10	7	15	24	-	30	8	4	6
19,	37	13	-	-	-	15	5	2	-	-	9	17
20,	-	13	-	22	3	6	3	5	19	-	7	-
21,	22	14	-	-	6	18	-	9	16	9	-	-
22,	27	-	27	13	9	31	21	5	-	-	10	-
23,	20	13	-	9	17	-	6	9	20	-	8	28
24,	15	-	-	17	55	4	1	142	3	-	-	21
25,	3	6	26	54	53	8	9	-	5	-	8	-
26,	8	12	-	8	-	3	4	2	-	-	4	15
27,	-	6	-	17	11	14	3	5	5	-	1	28
28,	65	11	21	-	26	6	-	5	7	6	-	27
29,	19	-	-	56	10	9	9	1	-	-	13	-
30,	37	-	-	9	-	-	5	5	-	-	3	62
31,	25	-	-	-	38	-	4	5	-	-	-	122
Average,	47	16	27	20	33	21	8	18	20	6	6	19

REPORT OF THE CHEMIST OF THE BOARD

UPON THE

EXPERIMENTAL FILTRATION OF THE WATER SUPPLY OF SPRINGFIELD AT LUDLOW, MASS.,

FROM

DEC. 21, 1900, TO JAN. 31, 1902.

Water from the Outlet of the Distributing Reservoir.

[Parts per 100,000.]

1901.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	37	.45	.0069	.0104	.0095	.26	.040	.0001	.30	1.4
February,	-	.34	.0094	.0082	.0082	.28	.046	.0000	.24	1.5
March,	36	.35	.0079	.0085	.0081	.26	.047	.0001	.24	1.5
April,	46	.49	.0056	.0087	.0078	.22	.044	.0000	.29	1.5
May,	57	.43	.0024	.0096	.0096	.21	.045	.0001	.32	1.4
June,	66	.46	.0033	.0099	.0096	.21	.048	.0000	.30	1.7
July,	78	.35	.0030	.0104	.0088	.24	.036	.0004	.29	1.6
August,	75	.30	.0028	.0096	.0090	.23	.033	.0005	.34	1.9
September,	70	.32	.0040	.0107	.0099	.23	.035	.0003	.35	1.7
October,	56	.37	.0022	.0096	.0096	.26	.042	.0000	.35	1.8
November,	46	.48	.0044	.0125	.0116	.25	.041	.0000	.39	1.6
December,	37	.53	.0090	.0119	.0114	.26	.048	.0000	.39	1.7
Average,	55	.41	.0051	.0100	.0094	.24	.042	.0001	.32	1.6

Water from a Tap at Lawrence City Hall.

[Parts per 100,000.]

1901.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	38	.38	.0064	.0099	.26	.043	.0000	.31	1.4
February,	-	.35	.0088	.0070	.27	.047	.0001	.24	1.5
March,	37	.42	.0074	.0104	.25	.049	.0001	.28	1.4
April,	47	.49	.0049	.0092	.22	.045	.0000	.28	1.4
May,	57	.39	.0020	.0102	.22	.048	.0000	.31	1.3
June,	64	.39	.0032	.0104	.21	.053	.0000	.29	1.5
July,	75	.36	.0008	.0091	.23	.036	.0000	.26	1.6
August,	73	.26	.0010	.0085	.23	.039	.0000	.30	1.8
September,	70	.30	.0014	.0097	.22	.036	.0000	.32	1.7
October,	59	.38	.0012	.0098	.25	.046	.0000	.33	1.8
November,	48	.46	.0037	.0117	.26	.045	.0000	.38	1.6
December,	48	.47	.0059	.0108	.27	.048	.0000	.37	1.7
Average,	56	.39	.0039	.0097	.24	.045	.0000	.31	1.6

Water from a Tap at Lawrence Experiment Station.

[Parts per 100,000.]

1901.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	46	.35	.0027	.0091	.27	.045	.0000	.30	1.3
February,	42	.29	.0056	.0076	.27	.049	.0000	.22	1.5
March,	44	.30	.0030	.0080	.26	.050	.0000	.24	1.4
April,	46	.42	.0012	.0072	.22	.046	.0000	.25	1.3
May,	51	.33	.0009	.0078	.21	.047	.0000	.28	1.4
June,	57	.31	.0009	.0097	.21	.051	.0000	.28	1.5
July,	69	.29	.0004	.0080	.23	.036	.0000	.25	1.6
August,	70	.20	.0003	.0069	.23	.042	.0000	.29	1.8
September,	67	.26	.0006	.0088	.22	.036	.0000	.30	1.7
October,	59	.30	.0008	.0082	.25	.042	.0000	.28	1.8
November,	55	.44	.0014	.0121	.26	.042	.0000	.37	1.6
December,	50	.46	.0036	.0099	.27	.049	.0000	.36	1.7
Average,	55	.33	.0018	.0086	.24	.045	.0000	.29	1.6

REPORT OF THE CHEMIST OF THE BOARD

UPON THE

EXPERIMENTAL FILTRATION OF THE WATER SUPPLY OF SPRINGFIELD AT LUDLOW, MASS.,

FROM

DEC. 21, 1900, TO JAN. 31, 1902.

REPORT OF THE CHEMIST OF THE BOARD

UPON THE

EXPERIMENTAL FILTRATION OF THE WATER SUPPLY OF SPRINGFIELD AT LUDLOW, MASS.,

FROM

DEC. 21, 1900, TO JAN. 31, 1902.

BOSTON, MASS., May 14, 1902.

To HIRAM F. MILLS, A.M., C.E., *Chairman of the Committtee on Water Supply and Sewerage of the State Board of Health.*

SIR: — The following report embodies the results of the investigations upon filtration carried on at Ludlow Reservoir during the period from Dec. 21, 1900, to Jan. 31, 1902. This investigation was undertaken to learn what could be done by filtration to improve the present water supply of Springfield, and included experiments upon the filtration both of water from Ludlow Reservoir and of water from the canal which empties into this reservoir.

EXPERIMENTS WITH RESERVOIR WATER.

The object primarily of the experiments upon the filtration of Ludlow Reservoir water was to see if the odors and tastes, which at certain seasons of the year render this water entirely unsuitable for use in the city, could be removed by sand filters at a practical rate of filtration. All the experiments made upon this water centered upon this point. In order to remove these tastes and odors it was evident that it would be necessary that not only the organisms which cause the odor should be removed, but that the odor-giving principle in the water — either oil produced by the living organisms, or organic matter in solution and oil caused or set free by the decay of these organisms — should also be removed by the filters. There is also at times a large amount of organic matter in the reservoir water taken from the decaying vegetable matter upon its bottom, which it was evident should be removed by the filters if the water was to be made an entirely satisfactory city supply.

CONDITION AND QUALITY OF THE RESERVOIR WATER DURING THE EXPERIMENTS.

The laboratory established at Ludlow was not equipped sufficiently to enable the determination of organisms and chemical examinations of the water to be made until Feb. 1, 1901, — and was not thoroughly equipped even then, — so that the statements made subsequently for the month of January are based upon the examinations of water made at the State House laboratory.

Organisms present in the Reservoir Water during the Experiments.

The total number of organisms per cubic centimeter present in the reservoir water during January, as shown by the four State House examinations, varied from 16 to 101 per cubic centimeter. During February the number varied from 214 to 895 per cubic centimeter, and *Dinobryon* were present in considerable numbers, as shown by weekly examinations.

Studying now from this time the almost daily determinations of organisms which were made, we find that during the first nine days of March the number of organisms per cubic centimeter present upon different days in the reservoir water applied to the filters varied from 670 to 2,054, this number being about equally divided between *Asterionella*, *Dinobryon* and *Zoöspores*, with a considerable number of *Scenedesmus* upon each date.

For the week ending March 16 the total number of organisms per cubic centimeter varied from 1,150 to 3,736 upon different days, and by far the greater number of these was *Dinobryon*, varying upon different days from 436 to 2,680 per cubic centimeter, although there was also a considerable number of *Asterionella* and *Zoöspores*.

For the week ending March 23 the total number of organisms present varied upon different days from 1,432 to 2,792 per cubic centimeter, and by far the larger proportion was *Dinobryon*, varying upon different days from 784 to 2,114 per cubic centimeter, although a considerable number of *Asterionella* was present.

For the week ending March 30 the total number of organisms, as shown by the daily examinations, varied from 1,496 to 3,422 per cubic centimeter, of which the larger proportion was *Dinobryon*, varying from 908 to 2,302 per cubic centimeter, the *Asterionella* beginning to grow fewer in number at this date.

For the week ending April 5 the total number of organisms present as shown by the daily examinations varied from 406 to 656 per cubic centimeter, the larger number being *Asterionella*, the number of *Dinobryon* present in the water having diminished very rapidly, until on the last day of the week only 26 per cubic centimeter were found.

From this date until about May 13 the number of organisms present in the reservoir water was comparatively small, the highest number upon any one day being found upon April 16, when the water contained 825 per cubic centimeter, and the smallest number upon April 29, when it contained only 102 per cubic centimeter. During all this period by far the larger number of the organisms present was *Asterionella*, although *Dinobryon* was found in small numbers upon nearly every day of examination.

About May 13 the number of *Asterionella* present in the water began to increase very rapidly, and large numbers were found from that date until June 18, the greatest number being found upon May 28, when there were 9,452 organisms per cubic centimeter present in the water, of which 7,808 were *Asterionella*, and the smallest number of *Asterionella* during the period just mentioned was 560 per cubic centimeter, found upon May 15. During a considerable portion of this period comparatively large numbers of *Tabellaria* were found, and small numbers of various infusoria, but only occasionally was *Dinobryon* present in the water, and only once or twice was either *Synura* or *Uroglena* found upon examination.

From June 19 to July 18 was a period when a low number of organisms was found in the reservoir water by the daily examinations, and these were of very many different kinds. Beginning on this latter date, however, the number began to increase, the increase being largely due to the presence of large numbers of *Tabellaria;* but *Anabœna*, which was first found regularly by the daily examinations beginning July 12, increased in numbers rapidly until it reached a maximum of 5,656 per cubic centimeter upon August 7, very few other organisms being found at this time, except a few *Asterionella* and *Staurastrum*. The total number of organisms per cubic centimeter present upon the day when *Anabœna* was first found — July 12 — was 6,576.

From August 8 until August 16, *Anabœna* was only once found in numbers greater than 2,000 per cubic centimeter, but from this latter date there was a period of four or five days when higher numbers were present, the greatest number — 10,912 per cubic centimeter — being found upon August 21, the total number of organisms per cubic centimeter upon this day being 10,976. From this time it was uniformly present in the water in comparatively large numbers until September 14, when the number grew rapidly less and the organism had practically disappeared from the water by September 25. That is, there was a period of seventy-six days from July 12 to September 25 when *Anabœna* was present in the reservoir water, and during several weeks of this period in large numbers. During almost this entire period of marked numbers of *Anabœna* comparatively few other organisms were found in the water, and appearing about August 15 and lasting a number of days a thick scum of *Anabœna* was seen along the south shore of the reservoir, reaching out about 50 feet. From September 25 until the end of the investigation, comparatively few organisms were found in the reservoir water, seldom more than 400 or 500 per cubic centimeter, and these of many varieties.

It is noticeable, studying the various daily examinations of the water for organisms, that, although quite a large variety was found from time to time, the three varieties found in large numbers were *Dinobryon*, *Asterionella* and *Anabœna*, all among the class of organisms known to cause odors in water.

Monthly Averages of Total Number of Organisms in Ludlow Reservoir Water.

Month.	Total Organisms per Cubic Centimeter.	Month.	Total Organisms per Cubic Centimeter.
1901.			
February,	402	September,	1,491
March,	1,855	October,	500
April,	430	November,	225
May,	1,856	December,	236
June,	3,609	**1902.**	
July,	837	January,	176
August,	2,715		

Odor of the Reservoir Water.

The odor of the reservoir water in January was generally faintly vegetable when cold, although grassy odors were noted from time to time, and distinctly vegetable when heated, grassy odors also being prominent, of course, in the heated sample when noticed in the cold sample. The odor through February was almost always faintly vegetable when cold and when hot, but by the middle of March, after *Dinobryon* had been present in the reservoir water for some time, the odor of this water, while generally but slightly vegetable when cold, was at times slightly fishy when cold, and, generally, fishy when heated, varying from slight to decided, the character of the water in respect to this odor persisting until the end of the first week in April. From this time until the end of April the water had generally a slightly vegetable odor or was odorless when cold, but upon heating a fishy odor was generally developed, varying from slight to decided at different times, and at times the aromatic odor due to *Asterionella* was detected upon heating the sample. During the first two weeks in May the water had practically no odor when cold, but was generally fishy when heated, and from that date until June 1 the water continued odorless when cold, but usually a fishy or an aromatic odor was detected in the heated sample, varying from slight to decided. During this period of several weeks *Asterionella* was found in considerable numbers, as before stated.

During June the odor of the reservoir water both when hot and when cold was quite noticeable, being almost invariably either fishy or aromatic when cold, and decidedly grassy when heated, this condition as regards the odor of the heated sample continuing through the first two weeks of July, although the odor when cold was less. No *Anabœna* had been found at this time, however, to account for this grassy odor. During the remainder of July the odor of the water was generally designated as unpleasant when cold and faintly grassy when heated, due to the *Anabœna* present, and during the first week in August this odor increased very materially, until it was decidedly grassy — that is, the odor of *Anabœna* — both when cold and when heated, this condition continuing and the odor increasing until the 20th of the month, when the increase in numbers and also the decay of *Anabœna* gave a still stronger odor to the water, especially when it was heated. This condition lasted for several days, when the odors, although very noticeable and recorded as distinctly grassy both when the water was cold and when heated, began on the first of September to grow less intense, although still quite decided, and by the 24th the grassy odor had disappeared from the water, only a faint earthy odor being noticed in both the cold and the heated samples. From that date the water, while continuing to have a slight odor noticeable to an expert, was during the remainder of the period of investigation practically odorless, except, perhaps, at times when heated.

Color of the Reservoir Water.

The color of the reservoir water, the canal-water and the effluents of the various filters in operation at Ludlow has been read at the Ludlow Experiment Station upon the platinum scale. The average color of the reservoir water applied to these filters at the beginning of the year was about .40, this general average lasting through February, March, April, May, June and July, the color being slightly less than .40, however, during May, or an average of .38, and slightly more during July, or an average of .45. During the last few days of July the color of the water increased quite rapidly, and this continued until August 9, when the color was .70. During the remainder of the month the color fluctuated, being as high as .86 on the 20th and as low as .45 on the 31st. During the last week of the month the average color was .61, the average for the month being .64. During the first half of September the color increased again, the average color of the water for the first week of the month being .66, and for the second week, .72. From this date the color decreased quite rapidly, the average for the last week of the month being .38, and it continued to decrease steadily until the middle of November, and then remained about constant until the end of January, 1902.

Character of the Reservoir Water in Other Respects during the Experiments.

Owing to the large amount of microscopic work, the chemical work of the laboratory at Ludlow was somewhat limited, and only those determinations were made daily which it appeared would be the most necessary in showing the changing quality of the reservoir water during the year, and the effect of this change upon the filtration of the water and the operation of the filters. Hence, the chemical work at Ludlow was largely confined to three determinations: (1) an almost daily determination was made of the dissolved oxygen in the reservoir and the canal water and in the effluents of the filters receiving these two waters, together later in the year with determinations of the dissolved oxygen in the applied water after passing certain aerators. (2) The iron in the applied water and effluents was also determined almost daily, because it was considered quite possible that during a portion of the year it would be one of the principal coloring matters in the water. It was believed, moreover, that during hot weather fermentation of the organic matter in the bottom of the reservoir might cause much iron to pass into solution in the water from this decaying matter which should be removed by the filters. It was also believed, owing to previous experience of the Board of the difficulty of the removal of iron when in water in connection with organic matter, that the amount going into solution, together with the expected disappearance of the dissolved oxygen at times during hot weather owing to the known character of the water and the large amount of organic matter that would be present in the water, might, besides giving an increase in color, cause difficulties in filtration. (3) Hardness determinations were also made almost daily, as it was desired to learn whether filtration would cause an increase in the hardness of the water and also as it was thought quite possible that during the course of the investigation the Springfield water board might cause the installation of mechanical filters for experimental work upon this water, and it would be advantageous to have on record the difference in hardness of the effluents caused by simple sand filtration and by mechanical filters. Besides the analytical work at the Ludlow Experiment Station, however, samples of the reservoir and the canal water and the effluents of all the filters were collected each week and forwarded to the State House laboratory for examination, these samples undergoing the usual chemical determinations.

The determinations of dissolved oxygen showed that at the beginning of the period of making this determination the water in the reservoir contained oxygen equal to about 50 per cent. of saturation. This gradually increased during the last part of March and during the months of April, May and the first part of June. During the week ending June 1 the dissolved oxygen was 88 per cent. of saturation. From this high point it grew gradually less, the average amount in the reservoir water applied to the filters during the week ending September 14 being 41 per cent. of saturation, and during the week ending September 21, 30 per cent. of saturation. On three different days during this period determinations of the dissolved oxygen in the water at different depths in the reservoir were made, where the total depth of water was about 14 feet, and the results are given in the following table, organisms also having been determined on these days, as shown on the table: —

Series of Determinations of Dissolved Oxygen and Organisms in Ludlow Reservoir.

Date.	Depth (Feet).	Dissolved Oxygen.		Organisms.	Remarks.
		Parts per 100,000.	Per Cent. of Saturation.		
1901.					
Aug. 21,	5	-	100.0	3,136	Organisms mainly *Anabœna.*
	10	-	61.9	1,920	
	14	-	32.4	1,232	
Sept. 13,	0	-	76.5	1,224	Organisms all *Anabœna.*
	3	-	63.1	792	Surface of water rippled by strong breeze.
	6	-	53.4	1,176	
	9	-	52.0	664	
	12	-	44.2	144	
	14	-	44.1	184	
Sept. 23,	0	.488	52.5	224	Strong wind blowing.
	3	.442	47.0	164	
	6	.455	48.4	204	
	9	.403	43.0	100	
	12	.348	37.0	248	
	14	.330	35.1	116	

On each of these days there was a steady decrease of oxygen from the surface water downward, but in so shallow a depth of water it would probably be rare to find a point where samples could be collected where the oxygen was entirely absent, unless the water contained as much or more *Anabœna* and other organic matter and for a longer period than occurred during the year 1901. With a reservoir bottom such as that at Ludlow, however, it is quite possible that amongst the decaying roots, grasses, etc., there is at times much water containing no oxygen. With the water from the reservoir, moreover, pumped into a supply tank with its sides exposed to the heat of the summer sun, it seemed probable that at times oxygen might be rapidly consumed by the organic matter in the water in this tank. The smallest amount of dissolved oxygen in the reservoir water applied to the filters during the period of operation, as shown by our determinations, was upon September 19, when there was only 5.4 per cent. of saturation.

The amount of iron in the reservoir water at the beginning of the period of experiment amounted to about .030 part per 100,000, and while varying considerably it was not generally greater than this until the last of June, when the amount present gradually increased, owing undoubtedly to the exhaustion of oxygen in certain portions of the reservoir and the passing of iron into solution under these conditions. During the week ending August 3 the amount present in the water was .124 part per 100,000. During the week ending August 10 the amount present was .194 part per 100,000, and the amount of iron present was high from this date until the middle of October, averaging nearly .100 part per 100,000. (See tables beyond.)

The determinations of free and albuminoid ammonia in the weekly samples of water, made at the State House laboratory, gave results as follows: during the period from January 1 to August 1 the free ammonia was never higher than .0072 part per 100,000, and the albuminoid ammonia was never higher than .0294 part per 100,000, during a large portion of this period the amounts of free and albuminoid ammonia being considerably less than is shown by these figures. During the first week of August, however, the character of the water changed rapidly, and the amounts of free and albuminoid ammonia increased very quickly, until the free ammonia upon August 21 was .0352 part per 100,000 and the albuminoid ammonia upon August 28 was .1380 part per 100,000. The ammonia decreased slowly during the following two weeks, but quite rapidly thereafter, so that by September 25 the water, as far as the amount of free and albuminoid ammonia present was concerned, was of about the same character as before August 1. (See tables beyond.)

The average monthly amount of organic matter present, as shown by the determinations of oxygen consumed made at the State House laboratory, varied comparatively little during the first eight months of the year, although occasional samples were found in which the amount of oxygen consumed, as shown by the determinations, reached comparatively high figures, the variation being about as follows: the lowest amount found from January 1 to April 31 was .38 part per 100,000 and the highest amount was .56 part per 100,000. From May 1 until October 31 the highest amount found was .55 part per 100,000, an abnormal result apparently, the next highest being .49 part per 100,000, and the lowest amount found being .20 part per 100,000. These low figures during the summer months are somewhat misleading, however, as it is probable that, if this determination had been made in the water when first taken from the reservoir, a considerably higher figure would have been given, but during the period necessarily elapsing in transit between the reservoir and the Boston laboratory, oxidation of the unstable organic matter had occurred to such an extent, as shown by the change in the appearance of the samples even, that these low figures were obtained. The following are the monthly averages of the analyses of the reservoir water made at the Ludlow Experiment Station and at the State House laboratory: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in Reservoir Water.

Ludlow Experiment Station.

Month.	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Parts per 100,000. Iron.	Parts per 100,000. Hardness.
1901.				
February,	.42	51.2	.030	-
March,	.40	61.4	.028	0.73
April,	.41	82.3	.035	0.73
May,	.38	81.6	.037	0.92
June,	.43	77.9	.040	0.91
July,	.45	60.7	.070	1.08
August,	.64	56.9	.121	1.05
September,	.57	40.1	.102	1.31
October,	.28	61.3	.075	0.99
November,	.24	75.3	.029	0.79
December,	.26	76.8	.030	0.91
1902.				
January,	.25	74.1	-	0.89

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved	Albuminoid. Sus-pended.		Nitrates.	Nitrites.				
1901.													
January,	3.20	1.50	.0069	.0227	.0200	.0027	.17	.0060	.0001	.51	1.0	.0290	Reservoir.
February,	3.25	1.20	.0075	.0237	.0208	.0029	.16	.0090	.0001	.45	0.9	.0210	Reservoir.
March,	3.35	1.50	.0025	.0243	.0205	.0038	.14	.0080	.0001	.46	0.9	.0230	Reservoir.
April,	2.70	1.15	.0025	.0223	.0175	.0048	.18	.0040	.0001	.41	0.6	.0230	Reservoir.
May,	2.70	1.05	.0027	.0206	.0156	.0050	.12	.0020	.0001	.41	0.7	.0290	Reservoir.
June,	2.75	1.20	.0032	.0224	.0181	.0043	.14	.0030	.0001	.38	0.6	.0280	Reservoir.
July,	2.85	1.35	.0059	.0234	.0190	.0044	.12	.0020	.0001	.39	0.7	.0480	Reservoir.
August,	3.25	1.75	.0169	.0884	.0396	.0488	.12	.0030	.0002	.43	0.9	.0380	Reservoir.
September,	3.45	1.85	.0158	.0607	.0320	.0287	.11	.0040	.0002	.33	0.9	.0540	Reservoir.
October,	2.70	1.25	.0036	.0214	.0163	.0051	.12	.0150	.0002	.27	0.9	.0440	Reservoir.
November,	2.35	1.10	.0016	.0175	.0153	.0022	.18	.0150	.0001	.27	0.7	.0140	Reservoir.
December,	2.40	1.20	.0014	.0193	.0153	.0040	.17	.0150	.0001	.25	0.5	.0120	Reservoir.
1902.													
January,	2.40	1.05	.0022	.0142	.0119	.0023	.15	.0120	.0000	.28	0.6	.0080	Reservoir.

FILTRATION OF THE RESERVOIR WATER.

When the experiments were begun at Ludlow, two filters were put into operation, each being $\frac{1}{200}$ of an acre in area and containing about 5 feet in depth above the underdrains of sand of an effective size of 0.28 millimeter, this sand having a uniformity coefficient of 3.2. The water passed to these filters from the reservoir and canal, as well as to all the other filters in operation, was pumped from the reservoir and canal into two large storage tanks placed on high land above the filters, these tanks holding practically a day's supply for the experimental filters in operation. All the filters in operation at Ludlow were designated by letters, the two largest filters being known as Filters A and B.

Filter A received reservoir water from December 21 until July 13, when, owing to the fact that it was at a less elevation than Filter B, canal water was applied to it in order that reservoir water might be applied to its duplicate, Filter B, which was at a greater elevation, and hence its effluent could, as was desired, be run upon a second filter for an experiment upon double filtration. That is, up to July 13 the reservoir water was applied to Filter A and after that date to Filter B. The filter receiving reservoir water was first put into operation at a rate of 2,500,000 gallons per acre daily, and was continued at this rate from Dec. 21, 1900, to Jan. 15, 1901, inclusive. Between this latter date and April 11, inclusive, the rate of this filter was changed a number of times by the engineer of the Springfield water board, but upon April 12 it was again placed at 2,500,000 gallons per acre daily, and so continued until in September, when the rate was increased to 3,000,000 gallons per acre daily.

Besides this filter two other filters were put into operation during March and May, receiving reservoir water, namely, Filters C and E. Filter C was a duplicate in construction of Filter A, containing the same grade of sand, etc., but it was $\frac{1}{20000}$ of an acre in area instead of $\frac{1}{200}$ of an acre, and to it reservoir water was applied at the rate of 5,000,000 gallons per acre daily, or twice the rate maintained generally by Filter A. This filter was put into operation upon March 11 and continued until August 17, when it was stopped on account of an accident, but it was again put into operation on August 30 and continued until the end of the period of investigation.

Filter E was $\frac{1}{20000}$ of an acre in area and contained above gravel underdrains 3 feet 6 inches in depth of material composed of 90 per cent. by volume of sand similar to that in the large filters and 10 per cent. by volume of fine loam, and above this 1 foot in depth of sand similar to that in the large filters. It was put into service on May 18 and continued in operation until August 17. Its rate of operation was 1,000,000 gallons per acre per day.

Results of Filtration of Reservoir Water obtained by the Large Filter.

Removal of Organisms.

From the beginning of operation of this filter the only organisms found in its effluent in any considerable numbers up to March 30 were *Zoöspores*, these being found almost daily in numbers varying from 1 to 253 per cubic centimeter. During April *Zoöspores* were still found in small numbers and also *Glenodinium* — a member of the group of *Infusoria* — in numbers varying from 1 to 20 per cubic centimeter. During many days in May no organisms were found in this effluent, and when found they were very few in number, varying from 1 to 10 per cubic centimeter, chiefly *Diatomaceæ*. During June, twenty-two of the twenty-three daily examinations showed no organisms present, and only 2 per cubic centimeter were found on the remaining day. During July practically no organisms were found, and this condition lasted through the first part of August. Beginning August 21 *Anabæna* began to appear in the effluent, reaching a maximum of 1,120 per cubic centimeter upon August 23, then rapidly decreasing, but found occasionally until September 17. From that date until the end of the investigation, upon Jan. 21, 1902, no organisms of any kind were found in the effluent of this filter.

Removal of Odor.

From Dec. 21, 1900, when this filter was put into operation, until the week ending Aug. 3, 1901, its effluent was practically without odor, either cold or hot. At times slightly vegetable, earthy or aromatic odors were noted, but these odors were so slight that they could generally be detected only immediately after the collection of the sample from the effluent pipe. None of the fishy odors that might have been expected, owing to the presence of large numbers of *Dinobryon* in the reservoir water applied to this filter during February and March, were noticed in its effluent, except upon a few occasions and then only faintly, but a slight trace of the aromatic odor caused by *Asterionella* in the reservoir water was noticed during May and June. During July the effluent was entirely odorless, but during a large portion of August and September the effluent had a grassy odor both when hot and when cold, caused by the large number of *Anabæna* in the reservoir during this period. From the last of September until the end of the period of investigation, Jan. 31, 1902, the effluent was without odor when cold except on a few occasions, when faint odors could be detected, and practically without odor when heated. A faint acrid odor was detected at times by the observer at the Ludlow laboratory, but it was not detected in the samples as they reached the State House laboratory.

Filtration of the Reservoir Water.

When the experiments were begun at Ludlow, two filters were put into operation, each being $\frac{1}{200}$ of an acre in area and containing about 5 feet in depth above the underdrains of sand of an effective size of 0.28 millimeter, this sand having a uniformity coefficient of 3.2. The water passed to these filters from the reservoir and canal, as well as to all the other filters in operation, was pumped from the reservoir and canal into two large storage tanks placed on high land above the filters, these tanks holding practically a day's supply for the experimental filters in operation. All the filters in operation at Ludlow were designated by letters, the two largest filters being known as Filters A and B.

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Filter E was $\frac{1}{20000}$ of an acre in area and contained above gravel underdrains 3 feet 6 inches in depth of material composed of 90 per cent. by volume of sand similar to that in the large filters and 10 per cent. by volume of fine loam, and above this 1 foot in depth of sand similar to that in the large filters. It was put into service on May 18 and continued in operation until August 17. Its rate of operation was 1,000,000 gallons per acre per day.

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From Dec. 21, 1900, when this filter was put into operation, until the week ending Aug. 3, 1901, its effluent was practically without odor, either cold or hot. At times slightly vegetable, earthy or aromatic odors were noted, but these odors were so slight that they could generally be detected only immediately after the collection of the sample from the effluent pipe. None of the fishy odors that might have been expected, owing to the presence of large numbers of *Dinobryon* in the reservoir water applied to this filter during February and March, were noticed in its effluent, except upon a few occasions and then only faintly, but a slight trace of the aromatic odor caused by *Asterionella* in the reservoir water was noticed during May and June. During July the effluent was entirely odorless, but during a large portion of August and September the effluent had a grassy odor both when hot and when cold, caused by the large number of *Anabœna* in the reservoir during this period. From the last of September until the end of the period of investigation, Jan. 31, 1902, the effluent was without odor when cold except on a few occasions, when faint odors could be detected, and practically without odor when heated. A faint acrid odor was detected at times by the observer at the Ludlow laboratory, but it was not detected in the samples as they reached the State House laboratory.

Removal of Color.

When this filter was first put into operation, it behaved like all sand filters, removing practically all the color from the applied water during its first few days of operation. After this the color of the effluent increased quite rapidly, and for the period from Jan. 16, 1901, when colors first began to be read at Ludlow, up to March 30, the color was about 83 per cent. as high as that of the applied water, that is, the color removal was about 17 per cent. With the beginning of warmer weather in April, and the increase in bacterial action in the filter, the color of the effluent decreased somewhat, and during April, May and June it was only about 68 per cent. as high as that of the applied water, or a color removal of about 32 per cent. During July, August, September and October the color removal by the filter was considerably greater than during the previous periods, the average color of the applied water during these months being .49 and the average color of the effluent being .18, or a color removal of 63 per cent. This result was due to a number of reasons, as follows: the increased temperature, as stated, enlivened bacterial oxidation in the filter and caused a considerable difference by this means, but the color of the reservoir water during these months averaged considerably greater than during the earlier months of the year, caused partly by the fermentation taking place in the reservoir, and the taking of organic coloring matter into solution and suspension from the bottom and sides of the reservoir, together with considerable iron, already mentioned, and partly by the increase in color of the canal water entering the reservoir, the color of the reservoir water reaching as high a point as .86, as noted previously. We had found previously, however, that when water is colored under the conditions prevailing in this reservoir by taking organic matter and iron into solution from decaying wood, soil impregnated with organic matter, etc., during a state of what may perhaps be called fermentation, this coloring matter was more easily removed by sand filters than is often the case with coloring matter taken from the leaves, soil, etc., under different conditions. Owing to this fact, together with the increased bacterial activity in the filters because of warm weather, the color removal was much greater than during the colder period of the year. During a small portion of this period, however, the effluent became upon standing much more highly colored than the applied water, this being due to the entire exhaustion of the oxygen in the water as it passed through the filter and the consequent reduction of iron and manganese oxides in the sand and the taking of iron and manganese into solution in the effluent of the filter. Some organic coloring matter also passed into solution, taken from the decaying matter accumulated on the surface of the filter, but this had but a slight influence on the increased color upon standing, this increase being almost entirely due to the oxidation of the iron and manganese. Determinations of the amount of manganese in the effluent were made, and showed at one time .1930 part per 100,000, while the iron reached as high a figure as .0620 part per 100,000.

The weekly chemical analyses of the effluent of this filter made at the State House laboratory showed comparatively slight changes from the ammonias of the applied water during January, February and March, but at the beginning of April, when the warm weather began, the filter was very efficient in removing organic matter, and this efficiency increased from this time until August 7 inclusive. During the months of August and September, when the difficulties already mentioned in regard to dissolved oxygen were experienced, the filter gave somewhat poorer results in the removal of organic matter, but still the percentage removal was very great. Beginning about the last of September and continuing until the end of the investigation, the efficiency of the filter was remarkably good in this respect, free ammonia was practically absent from the effluent, and the albuminoid ammonia did not average more than .0100 part per 100,000. The removal of organic matter shown by the determinations of oxygen consumed was remarkably good throughout the period of investigation.

The following tables give (1) the average monthly analyses as made at Ludlow of the applied water and effluent of this filter, and (2) the average monthly State House analyses of applied water and effluent: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in Reservoir Water applied to and Effluent of Large Filter.

Ludlow Experiment Station.

Month.	Reservoir.				Effluent of Large Filter.			
	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
1901.								
February,	.42	51.2	.030	-	.38	68.2	.022	-
March,	.40	61.4	.028	0.73	.34	59.6	.022	0.79
April,	.41	82.8	.035	0.73	.30	70.3	.022	0.78
May,	.38	81.6	.037	0.92	.27	62.5	.021	0.98
June,	.43	77.9	.040	0.91	.28	53.6	.022	0.95
July,	.45	60.7	.070	1.08	.24	34.6	.018	1.16
August,	.64	56.9	.121	1.05	.25	23.3	.018	1.17
September,	.57	40.1	.102	1.31	.17	4.1	.025	1.40
October,	.28	61.3	.075	0.99	.09	42.7	.010	0.94
November,	.24	75.3	.029	0.79	.15	74.2	.010	0.83
December,	.26	76.8	.030	0.91	.18	72.8	.011	0.89
1902.								
January,	.25	74.1	-	0.89	.21	78.3	-	0.99

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.				
				Total.	Dissolved.	Suspended.							
1901.													
January,	3.20	1.50	.0069	.0227	.0200	.0027	.17	.0060	.0001	.51	1.0	.0290	Reservoir.
	3.50	-	.0067	.0191	-	-	.17	.0060	.0001	.45	1.3	.0200	Effluent Filter A.
February,	3.25	1.20	.0075	.0237	.0208	.0029	.16	.0090	.0001	.45	0.9	.0210	Reservoir.
	3.35	-	.0086	.0201	-	-	.17	.0120	.0005	.42	0.9	.0180	Effluent Filter A.
March,	3.35	1.50	.0025	.0243	.0205	.0038	.14	.0080	.0001	.46	0.9	.0230	Reservoir.
	3.65	-	.0051	.0184	-	-	.16	.0070	.0001	.36	1.0	.0160	Effluent Filter A.
April,	2.70	1.15	.0025	.0223	.0175	.0048	.13	.0040	.0001	.41	0.6	.0230	Reservoir.
	2.95	-	.0042	.0140	-	-	.14	.0080	.0001	.36	0.7	.0150	Effluent Filter A.
May,	2.70	1.05	.0027	.0206	.0156	.0050	.12	.0020	.0001	.41	0.7	.0290	Reservoir.
	2.55	-	.0006	.0105	-	-	.13	.0060	.0000	.27	0.9	.0080	Effluent Filter A.
June,	2.75	1.20	.0032	.0224	.0181	.0043	.14	.0030	.0000	.38	0.6	.0280	Reservoir.
	2.95	-	.0005	.0101	-	-	.13	.0070	.0000	.29	0.9	.0070	Effluent Filter A.
July,	2.85	1.35	.0059	.0234	.0190	.0044	.12	.0020	.0001	.39	0.7	.0480	Reservoir.
	2.70	-	.0001	.0103	-	-	.13	.0060	.0001	.27	1.0	.0130	Effluent Filter B.
August,	3.25	1.75	.0169	.0884	.0396	.0488	.12	.0030	.0002	.43	0.9	.0380	Reservoir.
	2.95	-	.0036	.0158	-	-	.13	.0100	.0011	.25	1.4	.0050	Effluent Filter B.
September,	3.45	1.85	.0158	.0607	.0320	.0287	.11	.0040	.0002	.33	0.9	.0540	Reservoir.
	3.25	-	.0091	.0177	-	-	.12	.0100	.0007	.25	1.1	.0180	Effluent Filter B.
October,	2.70	1.25	.0036	.0214	.0163	.0051	.12	.0150	.0002	.27	0.9	.0440	Reservoir.
	2.40	1.00	.0002	.0094	-	-	.14	.0270	.0001	.21	0.9	.0500	Effluent Filter B.
November,	2.35	1.10	.0016	.0175	.0153	.0022	.13	.0150	.0001	.27	0.7	.0140	Reservoir.
	2.25	0.90	.0000	.0112	-	-	.14	.0210	.0000	.23	0.6	.0070	Effluent Filter B.
December,	2.40	1.20	.0014	.0193	.0153	.0040	.17	.0150	.0001	.25	0.5	.0120	Reservoir.
	2.30	1.15	.0001	.0087	-	-	.17	.0200	.0000	.22	0.5	.0070	Effluent Filter B
1902.													
January,	2.40	1.05	.0022	.0142	.0119	.0023	.15	.0120	.0000	.28	0.6	.0080	Reservoir.
	2.25	0.95	.0005	.0096	-	-	.16	.0170	.0000	.25	0.7	.0060	Effluent Filter B.

Filtration of Reservoir Water by Filter C.

Filter C, as has been stated, was a duplicate of the large filters in respect to grade and depth of sand. It was put into operation on March 11, 1901, and was continued until Jan. 31, 1902, with the exception of a period from August 17 to August 30. Its rate of operation was practically twice that of the large filter receiving reservoir water, namely, 5,000,000 gallons per acre daily. Operating at this greater rate it produced during a considerable portion of its period of operation results nearly as good as those produced by the large filter. During its entire period of operation the odor of the effluent both when hot and when cold was practically the same as that of the effluent of the large filter; that is, generally no odor was present when none was present in the effluent of the large filter, and during the periods when odors were present in the effluent of the large filter they were also present in the effluent of this filter and to about the same degree, the large filter at the lower rate being somewhat more efficient in this respect.

The color removal, although good, was somewhat less than that obtained by the large filter operating at half the rate of this filter. The percentage of dissolved oxygen in the effluent of this filter was nearly the same throughout the greater portion of the period of operation, but during August and September, when the reservoir water contained large numbers of *Anabœna* and the oxygen in it was low, on several occasions the oxygen had entirely disappeared from the water by the time it had reached the outlet of this filter, both because of the low amount present in the water applied and because of the rapid oxidation occurring in the filter. This was so for three successive days during the first week of September, for three days during the second week, and from September 16 to 20 inclusive. After this last date its effluent always contained free oxygen. While the iron removal by this filter was not as good as that obtained by the large filter at the lower rate, still only during the month of September was there an objectionable amount in its effluent, the hardness was practically the same, and after the first few weeks of operation of this filter few organisms were found in its effluent, and, although a few were found on a number of days during May, June and July, none were found from July 18, 1901, until the filter went out of operation, on Jan. 31, 1902. It is especially noticeable that during the period when dissolved oxygen was absent from the effluent of this filter, no organisms were found in its effluent, in distinction from the large numbers found for a number of days in the effluent of the large filter receiving reservoir water when operating under like conditions.

The chemical analyses made at the State House laboratory showed a good removal of organic matter by the filter. During May, June, July and the first week in August the free ammonia was very low, varying from .0000 to .0028 part per 100,000, and the albuminoid ammonia was also low, varying from .0086 to .0132 part per 100,000. During the period in August and September when the presence of dissolved oxygen was maintained with difficulty while the water passed through the filter, or was entirely absent, much poorer results were obtained, the poorest result being that of September 11, when the free ammonia was .0200 and the albuminoid ammonia .0530 part per 100,000. The removal of the organic matter shown by the determinations of oxygen consumed was good throughout the period of operation.

The following tables give (1) the average monthly analyses made at Ludlow of the applied water and effluent, and (2) the average of the State House analyses of applied water and effluent: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in Reservoir Water applied to and Effluent of Filter C.

Ludlow Experiment Station.

Month.	Reservoir. Color.	Reservoir. Dissolved Oxygen (Per Cent. of Saturation).	Reservoir. Iron (Parts per 100,000).	Reservoir. Hardness (Parts per 100,000).	Effluent of Filter C. Color.	Effluent of Filter C. Dissolved Oxygen (Per Cent. of Saturation).	Effluent of Filter C. Iron (Parts per 100,000).	Effluent of Filter C. Hardness (Parts per 100,000).
1901.								
March,	.40	65.1	.029	0.78	.31	66.7	.026	0.74
April,	.41	82.8	.035	0.73	.35	76.9	.033	0.70
May,	.38	81.6	.037	0.92	.32	68.7	.030	0.87
June,	.43	77.9	.040	0.91	.33	53.6	.024	0.96
July,	.45	80.7	.070	1.08	.24	25.3	.021	1.18
August,	.64	56.9	.121	1.05	.24	14.3	.026	1.12
September,	.57	40.1	.102	1.31	.23	13.7	.070	1.42
October,	.28	61.3	.075	0.99	.09	50.7	.009	1.01
November,	.24	75.3	.029	0.79	.14	83.9	.010	0.84
December,	.26	76.8	.030	0.91	.14	74.6	.010	0.97
1902.								
January,	.25	74.1	-	0.39	.16	71.2	-	0.96

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Source.
1901.													
May,	2.70	1.05	.0027	.0206	.0156	.0050	.12	.0020	.0001	.41	0.7	.0290	Reservoir.
	2.55	-	.0019	.0113	-	-	.13	.0080	.0000	.31	0.7	.0230	Effluent Filter C.
June,	2.75	1.20	.0032	.0224	.0181	.0043	.14	.0030	.0000	.38	0.6	.0280	Reservoir.
	3.20	-	.0007	.0109	-	-	.13	.0060	.0000	.27	0.8	.0100	Effluent Filter C.
July,	2.85	1.35	.0059	.0234	.0190	.0044	.12	.0020	.0001	.39	0.7	.0480	Reservoir.
	2.85	-	.0003	.0112	-	-	.13	.0050	.0001	.26	1.0	.0120	Effluent Filter C.
August,	3.25	1.75	.0169	.0884	.0396	.0488	.12	.0080	.0002	.43	0.9	.0380	Reservoir.
	2.80	-	.0027	.0160	-	-	.11	.0030	.0006	.27	1.0	.0140	Effluent Filter C.
September,	3.45	1.85	.0158	.0607	.0320	.0287	.11	.0040	.0002	.33	0.9	.0540	Reservoir.
	3.30	-	.0101	.0265	-	-	.12	.0050	.0006	.26	1.0	.0370	Effluent Filter C.
October,	2.70	1.25	.0036	.0214	.0163	.0051	.12	.0150	.0002	.27	0.9	.0440	Reservoir.
	2.80	-	.0004	.0108	-	-	.14	.0230	.0000	.16	1.1	.0050	Effluent Filter C.
November,	2.35	1.10	.0016	.0175	.0153	.0022	.13	.0150	.0001	.27	0.7	.0140	Reservoir.
	2.40	-	.0000	.0107	-	-	.15	.0180	.0000	.16	0.6	.0100	Effluent Filter C.
December,	2.40	1.20	.0014	.0193	.0153	.0040	.17	.0150	.0001	.25	0.5	.0120	Reservoir.
	2.50	-	.0006	.0114	-	-	.17	.0170	.0000	.13	0.6	.0070	Effluent Filter C.
1902.													
January,	2.40	1.05	.0022	.0142	.0119	.0023	.15	.0120	.0000	.28	0.6	.0080	Reservoir.
	2.30	-	.0004	.0094	-	-	.16	.0170	.0000	.16	0.6	.0060	Effluent Filter C.

FILTRATION OF RESERVOIR WATER BY FILTER E.

This filter was put into operation May 18 and contained, as has been previously stated, 5 feet in depth of filtering material, 3 feet 6 inches of this depth being composed of a mixture of 90 per cent. by volume of sand with 10 per cent. by volume of fine loam, above which was one foot in depth of sand of a grade similar to that used in all the filters, stratification at the junction of the sand and loam with the sand being prevented by mixing the materials at this point. While it was not considered that filters of loam would be a practical success in the filtration of this water upon a large scale, owing to the large area of such filters which would be necessary and the consequent cost of construction and the probable difficulty of continued operation, it was nevertheless believed that filters of this character should be operated for a while in order to obtain data in regard to their efficiency in purifying this water. Filter E was operated at the rate of 1,000,000 gallons per acre daily, was started May 18, 1901, and was put out of operation on August 17. During its operation the filter did efficient work and upon only one day were any organisms found in its effluent.

The average color of its effluent, omitting the first two weeks of operation, when the color of the applied water was practically all removed, was .21. The filter also removed until the first week in August a very large proportion of the odor of the reservoir water. Its effluent had generally, during the first ten weeks of its operation, a faint aromatic odor that could be detected if the sample was examined immediately after it was collected, this odor disappearing quickly, however, so that by the time the sample was heated in order to determine its hot odor, all odor had generally disappeared or only a slight musty odor could be detected. This condition lasted until August 5, and from that date until the filter was put out of operation the odor of its effluent both when hot and when cold was generally grassy, varying from faint to decided, this, of course, being due to the *Anabœna* in the reservoir water applied. The effluent always had a turbidity, varying from decided at first to very slight at the end of its period of operation, due apparently to the very fine loam in suspension in it, which was continually passing from the filter, this giving the effluent at first a slightly milky appearance. The removal of iron by the filter was good and the removal of organic matter excellent, the highest free ammonia found being .0032 part per 100,000 and the highest albuminoid ammonia until the first of August being .0086 part per 100,000. During a considerable portion of its period of operation no free ammonia was present in the effluent. The removal of organic matter as shown by the determinations of oxygen consumed was especially good, the average determination for the entire period being .17 part per 100,000.

The following tables give (1) the average monthly analyses made at Ludlow of the applied water and effluent of this filter, and (2) the average monthly State House analyses of applied water and effluent: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in Reservoir Water applied to and Effluent of Filter E.

Ludlow Experiment Station.

Month.	Reservoir.				Effluent of Filter E.			
	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
1901.								
May, ...	.40	82.1	.035	0.94	.00	64.8	.007	0.62
June, ...	.43	77.9	.040	0.91	.20	45.5	.032	0.90
July, ...	.45	60.7	.070	1.08	.20	14.3	.026	1.17
August, . .	.61	64.3	.144	1.10	.20	13.2	.030	1.23

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
				Albuminoid.									
	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.				
1901.													
June, . . .	2.75	1.20	.0032	.0224	.0181	.0043	.14	.0030	.0000	.38	0.6	.0280	Reservoir.
	2.75	-	.0021	.0076	-	-	.13	.0060	.0000	.11	0.6	.0150	Effluent Filter E.
July, . . .	2.85	1.35	.0059	.0234	.0190	.0044	.12	.0020	.0001	.39	0.7	.0480	Reservoir.
	2.85	-	.0002	.0077	-	-	.13	.0030	.0003	.18	0.8	.0190	Effluent Filter E.
August, . .	3.25	1.75	.0169	.0884	.0396	.0488	.12	.0030	.0002	.43	0.9	.0380	Reservoir.
	2.70	-	.0002	.0118	-	-	.12	.0040	.0001	.23	1.1	.0120	Effluent Filter E.

Other Filters receiving Reservoir Water.

During the latter part of the season four other filters $\frac{1}{20000}$ of an acre in area were put into operation, filtering reservoir water.

Filter H, put into operation by the engineer of the Springfield water board in order to obtain certain data in which he was interested, contained over the underdrains 2 feet in depth of sand of an effective size of 0.28 millimeter, over this being 6 inches in depth of a very fine sand of an effective size of 0.06 millimeter. The filter was started August 13 and continued until September 14. Its rate at starting was 2,500,000 gallons per acre daily, but, owing to the stratification of the filter and the character of the applied water, this rate rapidly decreased, so that by August 31 the rate was only 200,000 gallons per acre daily and reached a still lower figure before the end of its period of operation. No organisms were found in its effluent during the short period it was operated, although odors and tastes were detected.

The following tables present the average analyses for the period of operation of the water applied to and the effluent from this filter, the tables giving the results both of the State House and the Ludlow Experiment Station examinations: —

Average of Color, Dissolved Oxygen, Iron and Hardness in Reservoir Water applied to and Effluent of Filter H, from Aug. 13 to Sept. 14, 1901.

Ludlow Experiment Station.

Reservoir.				Effluent of Filter H.			
Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
.68	45.1	.098	1.12	.09	42.0	.011	1.56

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.				
1901.													
Aug. 13-Sept. 14,	3.45	1.75	.0208	.1016	.0423	.0593	.13	.0030	.0002	.43	0.9	.0470	Reservoir.
Aug. 13-Sept. 14,	3.15	-	.0409	.0119	-	-	.15	.0050	.0035	.18	1.4	.0050	Effluent Filter H.

Filter I.

Filter I was put into operation September 16 and was continued until October 11. It contained 2½ feet in depth of sand of an effective size of 0.28 millimeter and was operated at an average rate of 3,000,000 gallons per acre daily. It was put into operation for the purpose of showing whether Ludlow Reservoir water of the character prevailing during September would at a rate of 3,000,000 gallons pass through a filter containing only one-half as great a depth of sand as Filters B and C without losing its dissolved oxygen, that is, giving less time and opportunity for bacterial oxidation than obtained in the deeper filters, and thus preventing the exhaustion of oxygen and the consequent reducing action upon the sand in the filter. Unfortunately, the filter was not started until the worst condition of the reservoir water had passed. During its first week of operation its effluent invariably contained dissolved oxygen, the average amount for the week being 13.5 per cent. of saturation, while free oxygen was absent from the effluents of the deeper filters receiving reservoir water. Little organic matter had accumulated upon or within this filter, however, compared with the deeper filters. During the following weeks, also, less oxygen was consumed than in the deeper filters. The general results obtained by it were very good, no organisms being found in its effluent and the effluent being also practically odorless.

The following tables show the average chemical analyses of the applied water and effluent of the filter, these tables giving the results of both the State House and the Ludlow Experiment Station examinations: —

Average of Color, Dissolved Oxygen, Iron and Hardness in Reservoir Water applied to and Effluent of Filter I, from Sept. 16 to Oct. 11, 1901.

Ludlow Experiment Station.

Reservoir.				Effluent of Filter I.			
Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
.39	49.3	.099	1.21	.12	53.2	.017	1.26

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
				Albuminoid.									
	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.				
1901.													
Sept. 16-Oct. 11,	2.75	1.30	.0063	.0237	.0185	.0052	.12	.0120	.0003	.28	1.0	.0530	Reservoir.
	2.85	-	.0025	.0127	-	-	.14	.0160	.0001	.18	1.1	.0060	Effluent Filter I.

Filter K.

Filter K was constructed and put into operation according to the directions of the engineer of the Springfield water board for the purpose of making tests in which he was interested. It contained in order over the underdrains 1 foot in depth of finely ground quartz sand, 4 inches of polarite, followed by another foot in depth of quartz sand. It was started at the rate of 3,000,000 gallons per acre daily and was in operation from Sept. 17 to Oct. 11, 1901. During this period no organisms were found in its effluent, the effluent had only a very faint odor, and the color removal was good. In other respects this filter did not begin to produce an effluent equal to that of Filter I, just described, which was of the same depth but constructed entirely of sand, and which was operated at the same rate and during exactly the same period as Filter K. Filter K, containing polarite, increased the solids, did not remove organic matter and iron as efficiently as Filter I, and increased the hardness threefold.

The following tables give the average results of the chemical analyses of the applied water and effluent of the filter, made both at the Ludlow Experiment Station and at the State House laboratory: —

Average of Color, Dissolved Oxygen, Iron and Hardness in Reservoir Water applied to and Effluent of Filter K, from Sept. 17 to Oct. 11, 1901.

Ludlow Experiment Station.

Reservoir.				Effluent of Filter K.			
Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
.39	49.3	.099	1.21	.15	36.9	.031	3.50

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
				Albuminoid.									
	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.				
1901.													
Sept. 17–Oct. 11,	2.65	1.30	.0071	.0263	.0191	.0072	.11	.0140	.0004	.24	0.8	.0670	Reservoir.
	4.90	-	.0112	.0144	-	-	.14	.0140	.0009	.14	3.1	.0140	Effluent Filter K.

Filter L.

Filter L was $\frac{1}{20000}$ of an acre in area and contained 5 feet in depth of sand of an effective size of 0.22 millimeter. It was operated intermittently at the rate of 1,000,000 gallons per acre daily. It was put into operation on Sept. 20, 1901, after the reservoir water had begun to improve in quality, and was continued until Jan. 31, 1902. No organisms were found in its effluent, which was also practically odorless.

The following tables show the average results of the chemical analyses of the water applied and the effluent from this filter: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in Reservoir Water applied to and Effluent of Filter L.

Ludlow Experiment Station.

Month.	Reservoir.				Effluent of Filter L.			
	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
1901.								
September,	.38	47.2	.105	1.31	.11	81.9	.028	1.15
October,	.28	61.2	.075	1.00	.09	88.0	.018	1.06
November,	.24	75.3	.029	0.79	.12	88.4	.010	0.89
December,	.26	76.8	.030	0.91	.13	87.3	.010	1.08
1902.								
January,	.25	74.1	-	0.89	.14	87.7	-	0.94

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.				
1901.													
September,	2.85	1.45	.0122	.0290	.0243	.0047	.13	.0060	.0002	.27	1.0	.0530	Reservoir.
	2.70	-	.0009	.0075	-	-	.11	.0060	.0001	.16	1.1	.0200	Effluent Filter L.
October,	2.70	1.25	.0036	.0214	.0163	.0051	.12	.0150	.0002	.27	0.9	.0440	Reservoir.
	2.55	-	.0054	.0109	-	-	.14	.0210	.0001	.16	0.9	.0060	Effluent Filter L.
November,	2.35	1.10	.0016	.0175	.0158	.0022	.13	.0150	.0001	.27	0.7	.0140	Reservoir.
	2.55	-	.0003	.0107	-	-	.16	.0170	.0000	.14	0.6	.0060	Effluent Filter L.
December,	2.40	1.20	.0014	.0193	.0153	.0040	.17	.0150	.0001	.25	0.5	.0120	Reservoir.
	2.50	-	.0006	.0106	-	-	.18	.0170	.0000	.12	0.6	.0080	Effluent Filter L.
1902.													
January,	2.40	1.05	.0022	.0142	.0119	.0023	.15	.0120	.0000	.28	0.6	.0080	Reservoir.
	2.20	-	.0002	.0082	-	-	.16	.0130	.0000	.15	0.6	.0070	Effluent Filter L.

Refiltration of Reservoir Water.

Filter G.

After this investigation had been continued for some months, and especially when the odor of *Anabœna*, etc., began to increase in the reservoir water, it became evident that sand filtration as represented by the filters already in operation would not be successful in satisfactorily purifying this water and removing its odors, tastes, etc., during the period when these factors were most prominent in the water. It seemed likely, however, from the experience with experimental filters previously operated at the Lawrence Experiment Station, which had received highly colored water with its organic matter in a state of fermentation, that this water could be satisfactorily purified by double filtration and aeration. Hence, Filter G was constructed and was put into operation on August 9. It was a duplicate of Filter C in all respects; that is, it was 20 inches in diameter ($\frac{1}{20000}$ of an acre in area) and contained 5 feet in depth of sand of an effective size of 0.28 millimeter. To it was applied, after the date of construction, with one interruption, the effluent of the large filter receiving reservoir water. The experiment was stopped on August 16 because no odor was present in the effluent of the large filter, but it was started again August 22 and was continued until Jan. 31, 1902, at the rate of 10,000,000 gallons per acre daily, the same rate as that followed from August 9 to August 16.

During the whole of this period it produced a satisfactory effluent, the average color of this effluent being .13, and it was bright and free from turbidity. The effluent was practically odorless, but occasionally very faint odors were detected when the effluent was just collected from the outlet pipe, these odors not being such as would ordinarily be noticed even at the time of collection, and, moreover, they disappeared rapidly. Dissolved oxygen was always present in the effluent of this filter, the iron removal was good, and its hardness but very slightly increased over the hardness of the applied water, this increase being largely during the first few weeks of its operation. No organisms passed through the filter during its period of operation, as shown by our daily determinations. The removal of organic matter by the filter was very good, the average amount of free ammonia during its period of operation being .0004 part per 100,000, and the average amount of albuminoid ammonia being .0101 part per 100,000.

Filter G was not put into operation until August 9, yet this was some time before the reservoir water had reached its worst condition during 1901 and before Filter B, receiving reservoir water, had begun to produce its poorest results, that is, from August 27 to September 20. During this period of twenty-four days when the effluent of Filter B not only had a strong odor of *Anabæna*, but also a color (on standing) greater than that of the reservoir water, the effluent of Filter G was of very low color and practically odorless and tasteless.

The following tables give (1) the average monthly results in regard to color, dissolved oxygen, iron and hardness, and (2) the average analyses made in the State House laboratory: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in Water applied to and Effluent of Filter G.

Ludlow Experiment Station.

Month.	Effluent of Filter B (Reservoir).				Effluent of Filter G.			
	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
1901. August,	.28	28.0	.019	1.17	.17	51.8	.019	1.31
September,	.17	4.1	.025	1.40	.11	46.8	.013	1.52
October,	.09	42.7	.010	0.94	.08	74.8	.003	1.04
November,	.15	74.2	.010	0.33	.13	80.4	.008	0.88
December,	.18	72.6	.011	0.89	.15	81.6	.009	0.99
1902. January,	.21	78.3	-	0.99	.16	82.3	-	0.92

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.				
1901.													
August,	2.95	-	.0036	.0158	-	-	.18	.0100	.0011	.25	1.4	.0050	Effluent Filter B.
	3.30	-	.0015	.0106	-	-	.12	.0430	.0002	.23	1.3	.0110	Effluent Filter G.
September,	3.25	-	.0091	.0177	-	-	.12	.0100	.0007	.25	1.1	.0180	Effluent Filter B.
	3.10	-	.0003	.0102	-	-	.14	.0120	.0001	.19	1.4	.0060	Effluent Filter G.
October,	2.40	1.00	.0002	.0094	-	-	.14	.0270	.0001	.21	0.9	.0050	Effluent Filter B.
	2.95	1.30	.0000	.0091	-	-	.14	.0280	.0000	.17	1.2	.0040	Effluent Filter G.
November,	2.25	0.90	.0000	.0112	-	-	.14	.0210	.0000	.23	0.6	.0070	Effluent Filter B.
	2.30	1.10	.0000	.0104	-	-	.15	.0210	.0000	.18	0.6	.0050	Effluent Filter G.
December,	2.30	1.15	.0001	.0116	-	-	.17	.0200	.0000	.22	0.5	.0070	Effluent Filter B.
	2.40	1.05	.0004	.0116	-	-	.17	.0200	.0000	.15	0.6	.0060	Effluent Filter G.
1902.													
January,	2.25	0.95	.0005	.0096	-	-	.16	.0170	.0000	.25	0.7	.0060	Effluent Filter B.
	2.30	0.95	.0003	.0086	-	-	.16	.0160	.0000	.18	0.6	.0060	Effluent Filter G.

General Summary.

Rates of Filtration.

In the foregoing report the rate of operation of the various filters has always been given as the rate at which they were intended to be operated, the actual rate being in most instances somewhat less, owing to the usual causes common to water filtration. This difference, however, has been comparatively slight when averaging the whole season of operation. For instance, from April 12 to September 15, inclusive, the large filter receiving reservoir water was intended to be run at the rate of 2,500,000 gallons per acre daily, and the lowest average rates for any weeks during this period were 2,160,000, 2,370,000 and 2,428,000 gallons, respectively. Moreover, during a number of weeks of this period the average weekly rate was considerably greater than 2,500,000 gallons per acre daily. Filter C, receiving reservoir water at the intended rate of 5,000,000 gallons per acre daily, was operated during two weeks at as low average rates as 4,030,000 and 4,170,000 gallons per acre daily, but during many weeks of its operation it was operated at a greater average rate than its intended 5,000,000 gallon rate. Filter E, intended to be operated at a rate of 1,000,000 gallons per acre daily, averaged just about this rate during its entire period of operation. Filter G, which received the effluent of Filter B and was intended to be operated at 10,000,000 gallons per acre daily, never averaged less than 9,000,000 gallons per acre daily with the exception of one week, and during a number of weeks its rate of operation was slightly greater than its intended rate of 10,000,000 gallons per acre daily.

The actual average rates are not of particular moment, as it is evident from the operation of the large filter that a rate of 2,500,000 gallons per acre per day could be maintained, if desired, during a considerable portion of the year without aeration of the water, and that a rate of even 5,000,000 gallons per acre daily — the rate of Filter C receiving reservoir water — could be maintained without difficulty during a large portion of the year without aeration of the water, and during the entire year if enough oxygen could be introduced into the reservoir water not to become exhausted by bacterial oxidation during filtration. The large filter receiving reservoir water began to be operated at a rate of 3,000,000 gallons per acre daily upon September 16, and this was continued until the end of the investigation, and on but few weeks was the average rate less than the intended rate.

Scraping and Raking.

In regard to scraping and raking these filters to insure a surface open enough to allow the passage of water at the rate desired, it was found at Lawrence during the years 1896, 1897 and 1898 that, when water filters were operated with water containing little mineral matter, — that is, when surface clogging was caused almost entirely by organic matter alone, — it was not necessary to scrape the filters as often as would be the case if operated with river water such as that flowing in the Merrimack River, containing both silt and organic matter; or, in other words, that raking from time to time and dependence upon the removal of much organic clogging matter by oxidation would suffice for long periods without scraping. Hence, as the Ludlow Reservoir and canal water contained little mineral matter in suspension, it was considered that it would be possible to operate these filters in the way mentioned, — that is, seldom scraping them, but raking them at times of surface clogging, — and this was found to be true. The following tables show the dates of scraping and raking the large filter receiving reservoir water and Filters C and G, together with the loss of head on these dates: —

Large Filter receiving Reservoir Water.

	Loss of Head.			Loss of Head.	
	Date.	Feet.		Date.	Feet.
	1901.			1901.	
	May 24,	7.21		Aug. 23,	1.59
Scraped May 25, . . .	May 25,	-	Raked August 28, . .	Aug. 28,	-
	May 26,	0.18		Aug. 29,	1.42
	June 7,	6.02		Sept. 10,	2.42
Scraped June 8, . . .	June 8,	-	Raked September 11, . .	Sept. 11,	-
	June 9,	0.15		Sept. 12,	1.78
	June 30,	6.23		Sept. 16,	2.10
Raked July 1, . . .	July 1,	6.78	Scraped September 17, .	Sept. 17,	-
	July 2,	0.20		Sept. 18,	0.64
	July 28,	3.98		Oct. 10,	1.77
Raked July 30, . . .	July 30,	-	Raked October 12, . .	Oct. 12,	2.63
	Aug. 2,	0.48		Oct. 14,	0.26
	Aug. 11,	2.20		Nov. 7,	1.75
Raked August 12, . .	Aug. 12,	-	Raked November 9, . .	Nov. 9,	2.02
	Aug. 13,	1.56		Nov. 11,	0.40
	Aug. 13,	1.56		Dec. 25,	1.94
Scraped August 17, . .	Aug. 17,	2.49	Scraped December 27, . .	Dec. 27,	2.01
	Aug. 21,	1.14		Dec. 29,	0.44

Available head, 5.7 feet to July 13, 5 feet from July 13 to August 9, 2.7 feet from Aug. 9, 1901, to Jan. 31, 1902, this last being due to running effluent upon Filter G.

Reservoir — Filter C.

	Loss of Head.			Loss of Head.	
	Date.	Feet.		Date.	Feet.
	1901.			1901.	
Scraped May 25,	May 24,	4.80	Raked September 17,	Sept. 16,	4.68
	May 25,	-		Sept. 17,	-
	May 26,	0.49		Sept. 18,	4.43
Scraped June 6,	June 5,	5.19	Scraped September 18,	Sept. 16,	4.68
	June 6,	5.80		Sept. 18,	4.43
	June 7,	0.44		Sept. 20,	3.26
Scraped June 15,	June 14,	5.28	Raked October 9,	Oct. 8,	5.25
	June 15,	5.79		Oct. 9,	-
	June 16,	0.75		Oct. 10,	2.34
Raked June 29,	June 28,	5.01	Scraped October 24,	Oct. 22,	4.33
	June 29,	5.81		Oct. 24,	5.01
	June 30,	0.56		Oct. 26,	2.33
Raked July 18,	July 17,	5.78	Raked November 3,	Nov. 1,	4.87
	July 18,	5.82		Nov. 3,	5.19
	July 19,	0.59		Nov. 5,	2.17
Raked August 3,	Aug. 2,	3.59	Raked November 19,	Nov. 17,	5.30
	Aug. 3,	3.71		Nov. 19,	5.80
	Aug. 5,	3.47		Nov. 21,	2.50
Raked and scraped August 6,	Aug. 5,	3.47	Raked December 3,	Dec. 1,	5.58
	Aug. 6,	-		Dec. 3,	5.81
	Aug. 7,	1.84		Dec. 5,	5.15
Raked August 16,	Aug. 15,	5.00	Scraped December 7,	Dec. 5,	5.15
	Aug. 16,	-		Dec. 7,	3.96
	Aug. 17,	5.50		Dec. 9,	4.00
Raked September 3,	Sept. 2,	4.73	Scraped December 17,	Dec. 15,	5.77
	Sept. 3,	-		Dec. 17,	5.55
	Sept. 4,	4.58		Dec. 19,	4.09
Raked September 9,	Sept. 8,	3.09	Scraped December 31,	Dec. 29,	4.75
	Sept. 9,	-		Dec. 31,	4.95
	Sept. 10,	3.80		1902.	
Scraped September 12,	Sept. 10,	3.80		Jan. 2,	3.89
	Sept. 12,	5.18			
	Sept. 14,	3.06			

Available head, 5.6 feet.

Filter G.

	Date.	Feet.		Date.	Feet.
	1901.			1901.	
Scraped August 29,	Aug. 28,	2.58	Raked September 17,	Sept. 14,	2.19
	Aug. 29,	4.35		Sept. 17,	-
	Aug. 30,	2.12		Sept. 18,	4.62
Raked September 3,	Sept. 2,	3.75	Scraped September 18,	Sept. 14,	2.19
	Sept. 3,	-		Sept. 18,	4.62
	Sept. 4,	3.70		Sept. 24,	3.21
Raked September 8,	Sept. 6,	4.05	Raked September 22,	Sept. 18,	4.62
	Sept. 8,	5.58		Sept. 22,	-
	Sept. 10,	2.30		Sept. 24,	3.21
Raked September 13,	Sept. 12,	2.83			
	Sept. 13,	-			
	Sept. 14,	2.19			

Available head, 5.6 feet.

Dissolved Oxygen present in Reservoir Water and Effluents and Introduction of Oxygen by Aeration.

Under the discussion given on previous pages of the condition of the reservoir water during the period of experiment, statements have been made in regard to the percentage of dissolved oxygen in this water, and a table given showing the average monthly amount. During the last part of August, however, and the first portion of September, when the reservoir water was comparatively low in free oxygen and contained the large amount of *Anabæna* and organic matter previously mentioned, bacterial oxidation was so active in the filters that the oxygen was practically exhausted, as before stated, before the water reached the underdrains; and from August 23 until September 25 inclusive there was a very small amount of dissolved oxygen in the effluent of Filter B, and on a number of days an entire absence of free oxygen. This also occurred during a large portion of this period with Filter C.

Attempts were made to introduce enough oxygen into the large filter by operating it intermittently, and it was operated intermittently from August 13 to 22 in such a way that the surface sand of the filter was uncovered two hours each day. Beginning August 23 it was operated in such a way that the surface sand was uncovered one hour, this continuing until September 12. This method of operation, however, did not supply oxygen enough to last in the water while it was passing through the filter, and, moreover, when following this method of operation the large filter was for some unknown reason so disturbed that passages were in some manner made in the sand through which *Anabæna* passed for a number of days, beginning August 21 and continuing until September 17.

Upon September 22 an aerator was placed upon this filter, which was intended to increase the amount of dissolved oxygen in the water above that normally present to as great an extent as possible. Beginning at this time the filter did much better work, oxygen being found invariably in its effluent, but this was due, not only to the increased amount added by the aerator, but also to the somewhat improved condition of the reservoir water, beginning at about the time of the installation of this aerator, *Anabæna* having become very much reduced in numbers, although in other respects — in regard to organic matter, iron, etc., — the water was still in a condition that might be considered difficult to filter successfully.

An aerator was also placed above Filter C upon September 25, with results similar to those obtained by that on Filter B, and, indeed, in this case, with the greater rate of operation and hence the quicker flow of water through the filter, a much larger amount of dissolved oxygen was found in the effluent of Filter C than in the effluent of Filter B, operating at a less rate. Determinations of the dissolved oxygen at this time in the water applied to Filter B before passing the aerator show that the aerator doubled the amount of dissolved oxygen present and that the amount present in the effluent of Filter B was increased many times by the aerator upon Filter C, to which the effluent of Filter B was applied. Determinations upon September 23 showed that the effluent of Filter B contained 3.4 per cent. of saturation of dissolved oxygen, the water upon the surface of Filter C after passing the aerator contained 73 per cent. of saturation, and the effluent of Filter G 48 per cent. of saturation. The same effect was, of course, produced by the aerator upon Filter C.

Upon this date also — September 23 — a series of dissolved oxygen determinations was made in the reservoir water, determinations being made of the water at the surface and at each foot in depth down to a total depth of 14 feet, which was the maximum depth of the reservoir at the place of collecting samples, these determinations showing the surface water to contain 52 per cent. of saturation of oxygen and with a steady decrease to the maximum depth, where 35 per cent. of saturation was found. In fact, the figures of the investigation seem to show that the water in the supply tank during the last part of August and the first of September contained, owing to reasons previously given, less free oxygen than the water in the upper portion of the reservoir, and that, while there was a period when oxygen was often absent in the effluent of the filters receiving this water, still, with proper aeration, such as was afterwards produced, this difficulty could be overcome.

Removal of Organisms.

From the beginning of the period of operation of the large filter — namely, Dec. 21, 1900 — until Aug. 21, 1901, very few organisms were found in its effluent, and these few were chiefly *Diatoms* and *Zoöspores*. Beginning, however, on this latter date, there was a period of poor operation of the filters, owing to the various causes already stated, during which *Anabæna* passed through the filter, and upon several days in large numbers. This period lasted until September 17, after which time the effluent was free from organisms. None of the organisms that passed through this filter, however, passed through Filter G, receiving this effluent, and it is especially noticeable that Filter C, operating at a higher rate than the large filter and receiving also reservoir water, allowed no organisms to pass through it, even during the period when the reservoir water was in its worst condition, its good work in this respect being due undoubtedly to the fact that by better operation of the filter no disturbance of the sand had occurred. Filter E also eliminated all organisms reaching it in the applied water.

Removal of Odor.

Summarizing the discussions upon this point given upon previous pages, it has been found that practically all positive odors were removed by single filtration except during the period of high numbers of *Anabæna* and fermentation of organic matter in the reservoir. During this period single filtration through sand filters at rates of 2,500,000 and 5,000,000 gallons per acre daily failed to remove the odors, but double filtration, even with the secondary filter operating at a rate of 10,000,000 gallons per acre daily, was entirely successful in removing all odors remaining in the water that had passed through the primary filter, although this primary filter was poorly operated at this time. This result was aided by the aeration of the water before passing to the surface of the secondary filter.

Tastes.

During the months of January, February and March, 1901, there was generally a faintly vegetable taste in the reservoir water, but none in the effluents of the filters receiving this water. During the larger part of April, May and June, and until the latter part of July, the reservoir water was free from tastes, as well as the effluents. During the last part of July tastes were again noted in the reservoir water, and they soon became distinctly oily and unpleasant, and during August this condition continued. The same taste was noticed on most days, but to a much less degree, in the effluents of Filters B and C. The effluent of Filter G, however, the secondary filter, was without taste during this month. This condition lasted throughout September, the same taste being noted in the reservoir water and in the effluents of Filters B and C, but the effluent of Filter G being without taste. Beginning about October 1, and lasting until the end of the period of investigation, no taste was noted in the effluents of these filters.

Color.

A discussion upon the removal of coloring matter from the reservoir water by filtration has been given in each section of this report dealing with the separate filters. It has also been noted that the color in this water during the summer months is more easily removed by filtration than the color in some highly colored waters, for causes already explained in this report. The following table shows the color of the reservoir water applied to each filter during its period of operation, together with the color of the effluent of each filter and the percentage of color removed: —

Color of Applied Water and Effluents of Filters.

Filter.	Applied Water.	Effluent.	Per Cent. Removed.	Filter.	Applied Water.	Effluent.	Per Cent. Removed.
Large filter,	.39	.23	41	H,	.69	.09	87
C,	.38	.23	39	I,	.39	.12	69
E,	.48	.21	56	K,	.39	.17	56
G,	.17	.13	24	L,	.26	.12	54

In studying the table it must be remembered that Filter G, operated from August 9 until the end of January, 1902, received the effluent of Filter B during its entire period of operation. It must also be noted that the color removal of Filters A—B (large filter) and C during a considerable portion of their period of operation was much greater than these figures indicate. Filter B during July, August, September and October removed 63 per cent. of the coloring matter in the applied water; that is, the color of the applied water during these months was .49 and that of the effluent .18. Filter C gave nearly as good a percentage of color removal during this period.

Determinations of Bacteria.

Beginning the second week of May and continuing until the end of September, 1901, determinations of the number of bacteria per cubic centimeter in the reservoir water, the canal water and the various filter effluents were made daily. These determinations showed but a comparatively small number of bacteria in the applied water and a fairly good reduction in numbers in the effluents, taking into consideration the small number in the water applied. Examinations for the presence of *B. coli* were made with considerable frequency, and this organism was never found in either the applied water or the effluents. The following table gives the average number of bacteria per cubic centimeter in the reservoir water and in the effluents of the filters receiving this water during their period of operation up to the end of September, 1901: —

Average Number of Bacteria per Cubic Centimeter in Reservoir Water and Effluents of Filters.

	Bacteria per Cubic Centimeter.		Bacteria per Cubic Centimeter.
Reservoir water,	108	Effluent of Filter H,	6
Effluent of large filter (A—B),	20	Effluent of Filter I,	16
Effluent of Filter C,	27	Effluent of Filter K,	41
Effluent of Filter E,	52	Effluent of Filter L,	14
Effluent of Filter G,	8		

EXPERIMENTS WITH CANAL WATER.

The water for these experiments was taken directly from the canal which enters Ludlow Reservoir and in which flows the water from the various brooks and small ponds that form a part of the water supply of the city of Springfield. The studies that were made with this water were, in general, duplicates of the studies made with the reservoir water, all the physical, chemical, microscopical and bacterial examinations being the same as with the reservoir water. The determinations of color, odor, organisms, dissolved oxygen and iron were made almost daily at the Ludlow laboratory, and complete analyses once each week at the State House laboratory. Only three filters were in operation receiving canal water during the period of investigation, and only single filtration was tried. The condition of the water during the period covered by the experiments, in regard to organisms, odor, color, etc., was as follows: —

Organisms.

As was the case in the examination of the reservoir water, no determinations of organisms were made at the Ludlow laboratory until February, 1901, and the organisms present from Dec. 27, 1900, when the experiments were begun, until Feb. 1, 1901, are known only through the weekly analyses made in the State House laboratory. Beginning February 1, however, almost daily examinations to determine the number of organisms present were made until October 11, after which time the examinations were made three times each week.

During January, 1901, the average number of organisms present in this water was 61 per cubic centimeter, about half of these being *Synedra*. During February the average number present was 43 per cubic centimeter, the larger part of these, as in the previous month, being *Synedra*. During March, April and May the number of organisms present in this water continued very low in comparison with the number present in the reservoir water, *Dinobryon* and *Asterionella* being found in small numbers during a portion of these months. In May the number of organisms increased slightly, although the average number for the month in the samples examined was but 132 per cubic centimeter, and about half of this number was *Asterionella*. During the month of June the numbers increased somewhat more, the average number for the month being 323 per cubic centimeter, of which the greater proportion was still *Asterionella*. During July the number present reached the highest average of any of the months of the year, being 503 per cubic centimeter. During this month and until the 23d of August *Anabœna* was found almost daily, and on a few days of this period in comparatively large numbers, the greatest number found in the samples examined being upon July 22, when the sample contained 3,304 per cubic centimeter, the next highest number being found on July 19, when the sample contained 500 per cubic centimeter. The presence of these organisms was largely due to a break in the bank of the canal at Belchertown Reservoir, which allowed considerable water from this reservoir, rich in *Anabœna*, to flow into the canal. *Anabœna* was found occasionally in the canal water after the 23d of August, but always in very small numbers. The following table shows the monthly average number of organisms present in this water from Jan. 1, 1901, to Jan. 31, 1902: —

Monthly Averages of Total Number of the Organisms in the Canal Water.

Month.	Total Organisms per Cubic Centimeter.
1901.	
January,	61
February,	43
March,	67
April,	93
May,	132
June,	323
July,	503
August,	235
September,	111
October,	188
November,	188
December,	172
1902.	
January,	262

Odor of the Canal Water.

The odor of the canal water from the time the experiments were begun, through the month of January, 1901, and until about the 12th of February, was very faintly vegetable both when cold and when hot. After the latter date this water was practically odorless when cold, until the beginning of June, although faint odors were detected from time to time and described as faintly vegetable, faintly musty, etc. During most of this period, however, an odor could be detected in the sample when heated, this being generally slightly vegetable or musty up to the last part of March, when from time to time slightly fishy odors were detected by the observer on some days. In April the hot odors varied between fishy, aromatic and musty on different days, these odors being very slight, however, or a fishy odor on one day would certainly have persisted in the water and been found on the next. That is, the odors were so slight at times that it was difficult to detect them sufficiently to describe them accurately. This condition lasted through the month of May. Beginning the first week in June the water had an odor when cold that was generally slightly vegetable or musty, although aromatic odors were detected from time to time, and the odors in the heated sample were more pronounced than during the previous period, being musty, fishy, etc., and often decidedly so. During the first three weeks of July the same condition continued, the water having an odor both when cold and when hot, generally faint, but sometimes quite distinct, and beginning about July 20, distinctly grassy odors were noticed in both the cold and the heated samples for a few days, owing to the *Anabœna* in the water, as before mentioned. This condition disappeared quickly, however, and from the end of July up to the end of the period of investigation the odors of this water, both when cold and when hot, while prominent enough to be detected by the laboratory observer, were, nevertheless, very slight, and described as either earthy, musty or bitter.

Color of the Canal Water.

The color of the canal water and of the effluents of the filters receiving this water was read at the Ludlow Experiment Station upon the platinum scale. The color of this water at the beginning of the period of operation of these filters was about .30, and while this color increased considerably month by month, this increase was much more uniform and its variation from day to day much less than was the case with the reservoir water. Although this water was highly colored during the late summer and early fall, a considerable portion of the coloring matter present was of a different nature, or, if of the same nature, in a different condition from that in the reservoir water, and was not so easily oxidized in the filters, and hence not so large a percentage was removed by filtration. The color of the water reached its maximum in the month of October, when it averaged .63 part per 100,000, although the average color for August was practically the same as this. The high color in the autumn is usual with waters from similar sources, and quite distinct from the high color imparted to the reservoir water by fermentation of the organic matter in the hot summer weather. A table on the following page gives the average color of the water during each month of the experiments from Jan. 1, 1901, to Jan. 31, 1902.

Character of the Canal Water in Other Respects during the Period of Investigation.

As stated, the same examinations of this water were made at Ludlow as of the reservoir water, and also samples of this water and of the effluents of the filters to which it was applied were shipped each week to the State House laboratory for examination. The canal water was quite different in many particulars from the reservoir water. Its difference in number of organisms and in the character of its coloring matter has already been mentioned. Another difference which enabled filters receiving this water to be operated without difficulty throughout the period of investigation was that, owing not only to the smaller amount of organic matter present in it, but also to the more stable condition of this organic matter, a supply of dissolved oxygen plentiful enough not to become exhausted by bacterial oxidation in the filters was present in it during the entire period of investigation. The water flows in a shallow stream with considerable rapidity at places through several miles of canal, this being a condition favorable to the absorption of oxygen. The average amount found when the chemical examinations were first made at the Ludlow Experiment Station — namely, in February — was about 69 per cent. of saturation. This monthly average increased until June, when it reached its maximum of 93 per cent. of saturation. During the following four months of July, August, September and October the amount present varied but little, being between 74 and 80 per cent. of saturation.

Studying more in detail the amount of oxygen present during the summer months, we find that during the last week of May the water was practically saturated with oxygen, and this continued through the first two weeks of June. During the remainder of this month the smallest amount found upon any day was 79 per cent. of saturation. During July the amount present was always large, with the exception of the first day of the month, and this condition prevailed also through the warm month of August, on a number of days during this month this water as applied to the filter being entirely saturated with oxygen. These determinations, moreover, as in the case of the reservoir water, were made with the water flowing upon the filters after various periods of storage in the storage tank to which it was pumped from the canal and from which it ran to the filters.

The amount of iron present in the canal water was at the beginning of the year 1901 about .020 part per 100,000. This amount gradually increased, and during the warm months of July, August and September, when, undoubtedly owing to the exhaustion of oxygen in certain portions of the ponds or reservoirs from which this canal water flows, fermentation and the absorption of iron by the water occurred and the amount of iron grew much greater, the maximum average amount being found in August, when it was .111 part per 100,000, and on many days during the last part of July and the first part of August the amount present was much greater than this.

As in the case of the reservoir water, samples shipped to the State House laboratory were given a complete analysis. Studying the results, it is noticeable — as has always been the case — that the character of this water varied greatly from that of the reservoir water, especially in the amount of free and albuminoid ammonia found during the summer months.

The following tables show the monthly average results of the examinations made at the Ludlow Experiment Station and at the State House laboratory: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in the Canal Water.

Ludlow Experiment Station.

Month.	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts Per 100,000).
1901.				
January,	.34	-	-	-
February,	.30	69.4	.022	-
March,	.35	73.1	.031	0.71
April,	.41	83.1	.033	0.72
May,	.52	84.6	.045	0.93
June,	.56	92.5	.049	1.00
July,	.59	75.8	.097	1.22
August,	.62	75.5	.111	1.30
September,	.53	74.1	.074	1.55
October,	.63	79.3	.065	1.42
November,	.44	85.7	.042	1.17
December,	.46	73.9	.036	1.17
1902.				
January,	.36	76.6	-	0.96

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source
				Albuminoid.									
	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.				
1901.													
January,	3.60	1.10	.0013	.0108	.0095	.0013	.17	.0070	.0000	.35	1.4	.0170	Canal.
February,	3.70	1.05	.0014	.0101	.0086	.0015	.18	.0160	.0001	.27	1.3	.0110	Canal.
March,	3.50	1.50	.0103	.0287	.0231	.0056	.16	.0090	.0001	.62	0.9	.0160	Canal.
April,	2.85	1.20	.0013	.0161	.0133	.0028	.14	.0050	.0001	.45	0.7	.0130	Canal.
May,	3.20	1.35	.0011	.0168	.0142	.0026	.13	.0040	.0001	.52	0.9	.0280	Canal.
June,	3.20	1.20	.0015	.0192	.0142	.0050	.12	.0020	.0000	.46	0.9	.0210	Canal.
July,	3.90	1.45	.0067	.0232	.0172	.0060	.13	.0010	.0001	.46	1.2	.0510	Canal.
August,	4.15	1.85	.0035	.0241	.0206	.0035	.16	.0020	.0001	.61	1.5	.0250	Canal.
September,	4.20	1.65	.0038	.0209	.0169	.0040	.16	.0030	.0001	.55	1.5	.0590	Canal.
October,	4.10	2.05	.0013	.0223	.0174	.0049	.18	.0040	.0001	.59	1.3	.0350	Canal.
November,	3.60	1.35	.0008	.0162	.0111	.0051	.17	.0060	.0000	.44	1.0	.0250	Canal.
December,	3.80	1.55	.0014	.0138	.0114	.0024	.18	.0090	.0001	.47	1.0	.0210	Canal.
1902.													
January,	3.15	1.20	.0008	.0154	.0098	.0056	.15	.0100	.0001	.42	0.8	.0260	Canal.

Filtration of the Canal Water. — Large Filter (B—A).

When the experiments at Ludlow Reservoir were inaugurated, one of the large filters, $\frac{1}{200}$ of an acre in area, was put into operation, receiving canal water at the rate of 2,500,000 gallons per acre daily. This filter contained above its underdrains 5 feet in depth of sand of an effective size of 0.28 millimeter, this sand having a uniformity coefficient of 3.2, the filter being an exact duplicate in all respects of the large filter receiving reservoir water. It was called Filter B, and received canal water from Dec. 27, 1900, until July 13, 1901, when it began to receive reservoir water, and canal water was applied to duplicate Filter A, for reasons given in the report upon the filtration of reservoir water. The rate at which this filter was started was continued until Jan. 15, 1901, but between this date and May 19 the rate was changed several times, being finally, upon May 19, again put at 2,500,000 gallons per acre daily, and so continued.

Removal of Organisms.

From the beginning of the operation of this filter organisms were found in its effluent in only nineteen of the almost daily examinations, and the largest number found on any day was 12 per cubic centimeter.

Removal of Odors.

From the time of putting this filter into operation until the first of June there was practically no odor in its effluent when cold, although slight odors were detected often in the heated sample, these being described as slightly earthy, slightly musty, etc. Beginning about the first of June slightly aromatic odors were detected in both the cold and the heated samples, and this condition of the water continued for several weeks. Towards the end of the month the water began to be odorless when cold and when hot, and this condition continued through the first week of July. Beginning the second week of July very faint aromatic or earthy odors could be detected occasionally for a few days in both the cold and the heated effluent, and towards the last of the month the effluent had a very faint grassy odor when cold and when hot, due to *Anabœna* in the applied water. This condition lasted but a few days, however, and beginning July 27 and continuing until the end of the investigation the effluent was practically odorless both cold and when heated.

Removal of Color.

When this filter was first put into operation, it acted for a few days as do all sand filters, removing all the color from the applied water. After this the color of the effluent increased, the average color of the applied water during January, 1901, being .34, and of the effluent .20 part per 100,000. A table following shows the average color of the canal water and of the effluent of this filter, and it will be noticed that the color removal was much less than that of the duplicate filter receiving reservoir water, this being due to reasons already given. Nevertheless, the color removal was equal to that generally obtained by sand filtration of surface waters of the character of the canal water, the average color removal for the period of investigation being 33 per cent.

Dissolved Oxygen.

Dissolved oxygen was always present in the effluent of this filter, the difference in this respect between this filter and its duplicate, receiving reservoir water, being due to three factors: (1) the smaller amount of organic matter present; (2) the different character of this matter from that in the reservoir water, which caused it to be less easily and quickly destroyed by bacterial oxidation during warm weather than the organic matter in the reservoir water; (3) the greater amount of dissolved oxygen in the water when it passed to the surface of the filter.

During the last ten days of July the amount of oxygen in the effluent of the filter was very small, this being largely due to the accidental entrance into the canal of water from Belchertown Reservoir, rich in *Anabœna* and of a character similar to that in Ludlow Reservoir. A second reason was that upon July 13 the canal water began to be applied to the filter previously receiving reservoir water.

Removal of Organic Matter.

The water applied to this filter contained during a considerable portion of the period a smaller amount of organic matter than the reservoir water applied to the duplicate filter, and a large portion of this matter was, during the warmer months, in a more stable condition and less easily oxidized than the matter in the reservoir water; hence, the removal of organic matter by the filter was not so great as the removal of organic matter from the reservoir water by the duplicate filter, but, nevertheless, the work of the filter in this respect was quite satisfactory during the entire period, as tables following show. The average amount of organic matter determined as albuminoid ammonia in the effluent was not much more than half of that in the applied water, the average amount removed by the filter being 45 per cent. for the entire period of investigation, and the removal during the warm months being considerably greater than this.

The organic matter as determined by the amount of oxygen consumed was less successfully removed than by the filter receiving reservoir water, this being due, as already stated, to the more stable character of this carbonaceous organic matter.

The filter was entirely successful in removing the iron, which was high at times in the applied water.

The following tables show the average monthly analyses, made at the Ludlow laboratory and at the State House laboratory, of the samples of applied water and effluent of this filter: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in Canal Water applied to and Effluent of Large Filter.

Ludlow Experiment Station.

Month.	Canal.				Effluent of Large Filter.			
	Color.	Dissolved Oxygen (Per Cent of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
1901.								
February,	.26	69.4	.022	-	.19	70.9	.019	-
March,	.35	73.1	.031	0.71	.31	68.3	.017	0.73
April,	.41	88.1	.033	0.72	.37	79.8	.024	0.83
May,	.52	84.6	.045	0.93	.38	67.2	.021	1.02
June,	.56	92.5	.049	1.00	.42	77.4	.023	1.04
July,	.59	75.8	.097	1.23	.31	33.3	.017	1.30
August,	.62	75.5	.111	1.30	.32	43.5	.017	1.32
September,	.53	74.1	.074	1.55	.26	56.9	.016	1.47
October,	.83	79.3	.065	1.42	.38	64.9	.013	1.39
November,	.44	85.7	.042	1.17	.30	80.6	.012	1.21
December,	.46	73.9	.036	1.17	.37	79.8	.012	1.32
1902.								
January,	.36	76.6	-	0.96	.27	76.8	-	1.00

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.					Nitrogen as					
	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.	Source.
1901.													
January, . .	3.60	1.10	.0013	.0108	.0095	.0013	.17	.0070	.0000	.35	1.4	.0170	Canal.
	3.80	-	.0010	.0083	-	-	.18	.0090	.0000	.26	1.4	.0130	Effluent Filter B.
February, . .	3.70	1.05	.0014	.0101	.0086	.0015	.18	.0160	.0001	.27	1.3	.0110	Canal.
	3.65	-	.0013	.0072	-	-	.18	.0160	.0001	.20	1.3	.0100	Effluent Filter B.
March, . .	3.50	1.50	.0103	.0287	.0231	.0056	.16	.0090	.0001	.62	0.9	.0160	Canal.
	4.10	-	.0039	.0157	-	-	.16	.0090	.0001	.49	1.1	.0120	Effluent Filter B.
April, . .	2.85	1.20	.0013	.0161	.0133	.0028	.14	.0050	.0001	.45	0.7	.0130	Canal.
	3.20	-	.0129	.0122	-	-	.14	.0070	.0001	.39	0.9	.0120	Effluent Filter B.
May, . .	3.20	1.35	.0011	.0168	.0142	.0026	.13	.0040	.0001	.52	0.9	.0280	Canal.
	3.55	-	.0087	.0118	-	-	.16	.0060	.0008	.38	1.2	.0110	Effluent Filter B.
June, . .	3.20	1.20	.0015	.0192	.0142	.0050	.12	.0020	.0000	.46	0.9	.0210	Canal.
	3.40	-	.0005	.0103	-	-	.12	.0050	.0000	.39	1.0	.0110	Effluent Filter B.
July, . .	3.90	1.45	.0067	.0232	.0172	.0060	.13	.0010	.0001	.46	1.2	.0510	Canal.
	3.55	-	.0002	.0105	-	-	.14	.0170	.0013	.35	1.2	.0110	Effluent Filter A.
August, . .	4.15	1.85	.0035	.0241	.0206	.0035	.16	.0020	.0001	.61	1.5	.0250	Canal.
	3.90	-	.0005	.0106	-	-	.16	.0040	.0001	.46	1.7	.0060	Effluent Filter A.
September, .	4.20	1.65	.0038	.0209	.0169	.0040	.16	.0030	.0001	.55	1.5	.0590	Canal.
	4.15	1.55	.0004	.0105	-	-	.16	.0060	.0001	.43	1.5	.0080	Effluent Filter A.
October, . .	4.10	2.05	.0013	.0223	.0174	.0049	.18	.0040	.0001	.59	1.3	.0350	Canal.
	4.05	1.80	.0000	.0129	-	-	.19	.0040	.0000	.49	1.4	.0060	Effluent Filter A.
November, .	3.60	1.35	.0008	.0162	.0111	.0051	.17	.0060	.0000	.44	1.0	.0250	Canal.
	3.50	1.30	.0001	.0080	-	-	.17	.0090	.0000	.37	1.2	.0070	Effluent Filter A.
December, .	3.80	1.55	.0014	.0138	.0114	.0024	.18	.0090	.0001	.47	1.0	.0210	Canal.
	3.65	1.45	.0006	.0095	-	-	.19	.0100	.0001	.43	1.1	.0070	Effluent Filter A.
1902.													
January, . .	3.15	1.20	.0008	.0154	.0098	.0056	.15	.0100	.0001	.42	0.8	.0260	Canal.
	2.90	1.05	.0002	.0066	-	-	.15	.0120	.0000	.33	0.8	.0070	Effluent Filter A.

Filter F.

Filter F was a duplicate in every respect of Filter C, which received reservoir water. It was 20 inches in diameter and contained 5 feet in depth of sand of an effective size of 0.28 millimeter and with a uniformity coefficient of 3.2. It was constructed and put into operation on May 18, and received canal water at the rate of 5,000,000 gallons per acre daily.

Upon July 19 the sand was removed from the filter, as it seemed probable from the quick loss of head that for some reason the filter had become clogged below the surface. Upon removing the sand it was found that at a depth of 4 feet there was a layer of fine sand, due to faulty work at the time of construction, upon which had gathered organic matter, both causing stratification. The filter was reconstructed immediately and again put into operation at the same rate. The work of this filter was as follows: —

Removal of Organisms.

Almost daily determinations of the organisms in the effluent of this filter were made, and organisms were found on only seven days, the highest number on any of these days being 6 per cubic centimeter, on July 8, 1901.

Removal of Odor.

The odor of the effluent of this filter when cold was slightly aromatic, musty or vegetable from the time of its first being put into operation until the last week in July, the same odor being detected on most days in the heated sample until the middle of June. After this date, however, until the last week in July the heated sample was generally odorless, this necessarily showing the small amount of odor in the cold sample. Beginning about the last week in July its odor was distinctly grassy when cold and faintly grassy when heated, this condition lasting about ten days, when the effluent returned to its former condition — that is, only faint or slight odors were detected in either the cold or the hot sample, and these odors were generally described as faintly earthy or faintly bitter. The effluent from about September 1 to November 5 was without odor either cold or hot, then for a few days a slight odor was again detected, but for the remainder of the period of operation it was practically odorless.

The odor of the cold sample was generally determined immediately after collection, and considerable of the odor first present disappeared by the time the odor of the heated sample was taken.

Removal of Color.

The filter removed 33 per cent. of the color of the applied water during its period of operation, this removal of color, while satisfactory, being much less than that obtained by the duplicate filter receiving reservoir water, the reason for this having already been stated.

Removal of Iron.

A considerable percentage of the large amount of iron found at times in the canal water was generally removed by the filter. The largest amount of iron found in its effluent during any period was during the last two weeks of July and the first week of August, 1901, when enough was present in the effluent on a number of days to precipitate when complete oxidation occurred. There was a very large amount of iron in the canal water at this time, however, partly owing to the entrance of water from Belchertown Reservoir and partly to a flushing out of the canal. The large filter, receiving this water at a rate only one-half as great, removed a much greater amount of iron during this period than did this filter; that is, the slower rate of the large filter allowed more complete oxidation and precipitation of the iron upon the surface of the filter.

Character of the Effluent in Other Respects.

During the period of operation of this filter there was much more dissolved oxygen present in the applied water than in the reservoir water during the same period. Up to the end of June the dissolved oxygen in the effluent of this filter did not get lower than 50 per cent. of the amount necessary for saturation except on one occasion, and generally the amount present in the effluent was considerably greater than 50 per cent. of saturation. During July the smallest amount of dissolved oxygen found on any day was 22 per cent. of saturation, and on most days a considerably greater percentage was present, on many days even 60 or 65 per cent. of the oxygen necessary for saturation being found in the effluent. During August the amount of dissolved oxygen in the effluent was never below 30 per cent. of saturation, and, as the colder months approached, the amount averaged considerably more.

The following tables show the average monthly results of analyses of the effluent of this filter made at the Ludlow Experiment Station and at the State House laboratory: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in Canal Water applied to and Effluent of Filter F.

Ludlow Experiment Station.

Month.	Canal.				Effluent of Filter F.			
	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
1901.								
May,	.59	87.6	.035	0.95	.41	88.7	.027	0.95
June,	.56	92.5	.049	1.00	.44	78.0	.028	1.01
July,	.59	75.8	.097	1.22	.38	45.0	.034	1.25
August,	.62	75.5	.111	1.30	.35	50.3	.037	1.40
September,	.53	74.1	.074	1.55	.28	47.2	.019	1.44
October,	.65	79.3	.065	1.42	.39	58.3	.015	1.41
November,	.44	85.7	.042	1.17	.29	78.9	.013	1.32
December,	.46	73.9	.036	1.17	.36	76.7	.011	1.28
1902.								
January,	.36	76.6	-	0.96	.26	74.9	-	1.07

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
				Albuminoid.									
	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.				
1901.													
June,	3.20	1.20	.0015	.0192	.0142	.0050	.12	.0020	.0000	.46	0.7	.0210	Canal.
	3.35	-	.0011	.0108	-	-	.14	.0030	.0000	.40	0.9	.0140	Effluent Filter F.
July,	3.90	1.45	.0067	.0232	.0172	.0060	.13	.0010	.0001	.46	1.2	.0510	Canal.
	3.50	-	.0020	.0128	-	-	.13	.0030	.0000	.35	1.1	.0230	Effluent Filter F.
August,	4.15	1.85	.0035	.0241	.0206	.0035	.16	.0020	.0001	.61	1.5	.0250	Canal.
	4.05	-	.0010	.0120	-	-	.15	.0030	.0001	.48	1.1	.0120	Effluent Filter F.
September,	4.20	1.65	.0038	.0209	.0169	.0040	.16	.0030	.0001	.55	1.5	.0590	Canal.
	4.40	-	.0007	.0092	-	-	.17	.0040	.0000	.40	1.4	.0070	Effluent Filter F.
October,	4.10	2.05	.0013	.0223	.0174	.0049	.18	.0040	.0001	.59	1.3	.0350	Canal.
	4.15	-	.0001	.0130	-	-	.19	.0040	.0000	.46	1.4	.0060	Effluent Filter F.
November,	3.60	1.35	.0008	.0162	.0111	.0051	.17	.0060	.0000	.44	1.0	.0250	Canal.
	3.55	-	.0001	.0077	-	-	.18	.0070	.0000	.41	1.1	.0100	Effluent Filter F.
December,	3.80	1.55	.0014	.0138	.0114	.0024	.18	.0090	.0001	.47	1.0	.0210	Canal.
	3.75	-	.0005	.0090	-	-	.19	.0100	.0001	.39	1.1	.0100	Effluent Filter F.
1902.													
January,	3.15	1.20	.0008	.0154	.0098	.0056	.15	.0100	.0001	.42	0.8	.0260	Canal.
	3.00	-	.0002	.0072	-	-	.15	.0100	.0000	.29	0.7	.0060	Effluent Filter F.

Filter D.

This filter was put into operation March 11, 1901. It consisted of a galvanized iron tank 20 inches in diameter ($\frac{1}{20000}$ of an acre in area), and contained above the usual underdrains 4 feet in depth of sand similar to that in the large filters, above which was 1 foot of material composed of 90 per cent. by volume of the same sand and 10 per cent. by volume of fine yellow loam, the effective size of this mixture being 0.05 millimeter and the uniformity coefficient being 6.4. Where the mixture of loam and sand joined the sand layer there was a mingling of the two materials to prevent stratification as much as possible. It was put into operation at the rate of 1,000,000 gallons per acre daily and was so continued until August 9, when it was put out of operation. It was neither raked nor scraped during its period of operation and its final loss of head was 2.22 feet. The work accomplished by this filter was as follows: —

Removal of Organisms.

During its period of operation the only microscopical growth found in its effluent was *Crenothrix*, which was present in very small numbers on two occasions.

Removal of Odor.

Slightly earthy odors were noticed in its effluent when cold during the first two or three weeks of the filter's operation, and slightly earthy and musty odors in the effluent when heated. From the end of the first week in April until the beginning of June the effluent was free from odor both cold and when heated. During June and the first three weeks of July its odor was generally slightly aromatic when cold, but it was seldom that any odor could be detected in the heated sample. Beginning about July 21 and continuing for a week there was a faint grassy odor in both the cold and the heated samples, and after this, faint earthy or aromatic odors were noticeable for a few days. Following this the effluent was odorless until the filter was put out of operation on August 9.

Removal of Color.

This filter was not quite as efficient as the large filter (B—A) and Filter F in removing color, however 31 per cent. of the coloring matter of the applied water was removed during the period of operation, as indicated by the color readings. The apparent color of this effluent, however, was undoubtedly considerably greater than its real color, owing to the fact that the effluent up to nearly the end of July had a slight milky turbidity, and this, interfering with the color readings, made the observations higher than the actual color of the effluent. The matter causing this turbidity, however, was so fine that it could not be removed by passing the water through filter paper.

Characteristics of the Effluent in Other Respects.

The effluent of this filter always contained a large amount of free oxygen, the iron removal was entirely satisfactory, and the effluent contained considerably less organic matter than the effluents of the large filter (B—A) and Filter F, receiving the same water. The removal of organic matter as shown by the determinations of albuminoid ammonia and oxygen consumed was 56 and 30 per cent., respectively.

The following tables show the average monthly analyses of the applied water and effluent of this filter, made both at the Ludlow Experiment Station and at the State House laboratory: —

Monthly Averages of Color, Dissolved Oxygen, Iron and Hardness in Canal Water applied to and Effluent of Filter D.

Ludlow Experiment Station.

MONTH.	CANAL.				EFFLUENT OF FILTER D.			
	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).	Color.	Dissolved Oxygen (Per Cent. of Saturation).	Iron (Parts per 100,000).	Hardness (Parts per 100,000).
1901.								
March,	.39	75.3	.043	0.62	.17	66.8	.027	0.60
April,	.41	83.1	.033	0.72	.38	78.6	.051	0.60
May,	.52	84.6	.045	0.93	.38	65.1	.047	1.01
June,	.56	92.5	.049	1.00	.43	65.3	.033	0.97
July,	.59	75.8	.097	1.22	.33	29.6	.026	1.29
August,	.57	74.6	.185	1.16	.26	36.7	.028	1.24

State House Laboratory.

[Parts per 100,000.]

Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	Source.
	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.				
1901.													
May,	3.20	1.35	.0011	.0168	.0142	.0026	.13	.0040	.0001	.52	0.9	.0280	Canal.
	3.35	-	.0013	.0098	-	-	.13	.0040	.0000	.37	0.7	.0290	Effluent Filter D.
June,	3.20	1.20	.0015	.0192	.0142	.0050	.12	.0020	.0000	.46	0.9	.0210	Canal.
	3.80	-	.0001	.0093	-	-	.15	.0050	.0000	.35	0.8	.0210	Effluent Filter D.
July,	3.90	1.45	.0067	.0232	.0172	.0060	.13	.0010	.0001	.46	1.2	.0510	Canal.
	3.45	-	.0001	.0092	-	-	.14	.0050	.0005	.31	1.2	.0180	Effluent Filter D.
August,	3.80	1.60	.0022	.0182	.0126	.0056	.15	.0010	.0001	.29	1.3	.0220	Canal.
	3.10	-	.0004	.0062	-	-	.15	.0050	.0003	.18	1.3	.0110	Effluent Filter D.

The following table summarizes the work of these filters in removing color and organic matter: —

[Parts per 100,000.]

	Filter B—A. Applied Water.	Filter B—A. Effluent.	Filter B—A. Per Cent. Removed.	Filter F.* Applied Water.	Filter F.* Effluent.	Filter F.* Per Cent. Removed.	Filter D.* Applied Water.	Filter D.* Effluent.	Filter D.* Per Cent. Removed.
Color,	.49	.33	33	.52	.35	33	.51	.35	31
Free ammonia,	.0027	.0020	26	.0025	.0007	72	.0029	.0005	83
Albuminoid ammonia: —									
Total,	.0185	.0102	45	.0194	.0102	47	.0194	.0036	56
In solution,	.0145	-	-	.0148	-	-	.0146	-	-
In suspension,	.0040	-	-	.0046	-	-	.0048	-	-
Oxygen consumed,	.48	.38	21	.50	.40	20	.43	.30	30

* Operated for a shorter period than the large filter, as previously stated.

Bacteria.

Beginning May 8 and continuing until the first of October daily determinations of the number of bacteria in the canal water and in the effluents of these filters were made, and the results are shown on the following table. A number of tests for *B. coli* were also made, but this organism was not detected in either the canal water or the effluents.

Average Number of Bacteria per Cubic Centimeter in Canal Water and in Effluents of Filters.

	Bacteria per Cubic Centimeter.		Bacteria per Cubic Centimeter.
Canal water,	159	Effluent of Filter D,	23
Effluent of large filter (B—A),	20	Effluent of Filter F,	16

SUMMARY.

Studying the general results of the investigations made upon the feasibility of sand filtration of the Ludlow canal water, we find that all three filters were entirely successful in removing the organisms present in the water applied. The odor of the effluents of all three filters was generally very slight, and at times the effluents were entirely odorless, although during the last week in July, after the break in the canal bank by the side of Belchertown Reservoir and the consequent flow from this reservoir into the canal of water containing *Anabœna*, the effluent of each filter had the odor of this organism. Double filtration, however, would probably remove this odor as successfully as it did in the case of the reservoir water.

The removal of iron was satisfactorily accomplished by the large filter (B—A), even during the weeks when the amount in the canal water was very high. Filter F, however, failed on a few days, when the iron in the canal water was quite high, to remove this iron as efficiently as necessary; that is, its rate of 5,000,000 gallons per acre daily was apparently too great to allow sufficient time for complete oxidation and precipitation to occur, as previously explained. Considerable iron was found in the effluent of Filter D during April and May, but this was largely due to the turbid effluent, and considerable of the iron found was iron included in the particles producing this turbidity. The low rate of operation and the abundant supply of free oxygen always present in this effluent caused undoubtedly an almost complete removal of the iron of the applied water. It is noticeable that during the last portion of the period of operation of the filter, when the turbidity of its effluent was least and the iron in the applied water highest, but little iron was found in its effluent.

The removal of color and organic matter, while not equal at all times of the year to that obtained in the filtration of reservoir water, was very good, and as great as usually expected with sand filtration of surface waters resembling this canal water. The small amount of suspended matter in the canal water passed to these filters is shown by the few scrapings of the surface needed during the period of operation.

Canal — Large Filter (B—A).

	Loss of Head. Date.	Feet.		Loss of Head. Date.	Feet.
	1901.			1901.	
Scraped May 18,	May 17,	2.39	Raked November 15 and 16,	Nov. 13,	2.10
	May 18,	-		Nov. 15,	2.01
	May 19,	0.14		Nov. 17,	1.28
Raked August 12,	Aug. 11,	2.31	Scraped November 30,	Nov. 29,	2.02
	Aug. 12,	-		Nov. 30,	-
	Aug. 13,	0.32		Dec. 1,	1.16
Raked September 4,	Sept. 2,	1.63	Scraped December 13,	Dec. 9,	1.51
	Sept. 4,	2.42		Dec. 13,	-
	Sept. 6,	1.96		Dec. 15,	0.55
Scraped September 6,	Sept. 4,	2.42		1902.	
	Sept. 6,	1.96	Raked January 23,	Jan. 22,	1.96
	Sept. 10,	0.31		Jan. 24,	1.41
				Jan. 26,	1.26
Raked October 17,	Oct. 16,	1.99	Scraped January 31,	Jan. 30,	1.83
	Oct. 17,	-		Jan. 31,	-
	Oct. 18,	0.68		Feb. 1,	0.59

Available head, 5.5 feet.

Canal — Filter F.

	Date.	Feet.		Date.	Feet.
	1901.			1901.	
Raked July 14,	July 13,	4.30	Scraped November 13,	Nov. 11,	4.33
	July 14,	5.60		Nov. 13,	5.19
	July 15,	5.68		Nov. 15,	2.71
Scraped July 15,	July 14,	5.60	Raked November 25,	Nov. 23,	4.42
	July 15,	5.68		Nov. 25,	5.80
	July 16,	5.65*		Nov. 27,	4.92
Raked September 26,	Sept. 24,	4.31	Scraped November 27,	Nov. 25,	5.80
	Sept. 26,	1.23		Nov. 27,	4.92
	Sept. 28,	1.43		Nov. 29,	2.89
Raked October 12,	Oct. 10,	4.70	Scraped December 11,	Dec. 9,	5.04
	Oct. 12,	4.78		Dec. 11,	4.76
	Oct. 14,	2.85		Dec. 13,	3.40
Scraped October 22,	Oct. 20,	3.38	Scraped December 31,	Dec. 29,	4.29
	Oct. 22,	4.55		Dec. 31,	5.12
	Oct. 24,	5.02†		1902.	
				Jan. 2,	5.15
Scraped October 24,	Oct. 22,	4.55	Scraped January 18,	Jan. 16,	5.01
	Oct. 24,	5.02		Jan. 18,	5.73
	Oct. 26,	2.22		Jan. 20,	3.14
Raked November 9,	Nov. 7,	4.15	Scraped January 28,	Jan. 26,	5.22
	Nov. 9,	5.22		Jan. 28,	-
	Nov. 11,	4.33		Jan. 30,	1.90

Available head, 5.8 feet.

* Stratification; filter reconstructed, as previously stated.

† Scraping not deep enough, hence, repeated on the 24th.

Respectfully submitted,

H. W. CLARK,
Chemist.

A STUDY OF THE STABILITY

OF THE

EFFLUENTS OF SEWAGE FILTERS OF COARSE MATERIALS,

INCLUDING

INVESTIGATIONS UPON PUTREFACTION AND SECONDARY DECOMPOSITION.

By H. W. CLARK, *Chemist of the Board.*

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All organic matter is presumably subject to change by bacteria. It may be in such a state or condition that bacteria change it easily, or it may be in such a condition that bacteria can change it but slowly. Most of the organic matter present in sewage is illustrative of the first condition, and that present in soil and loam is illustrative of the second condition. One of the objects of the following paper is to show that organic matter of the first class can be so changed by bacterial agencies, working under favorable conditions in sewage filters of coarse material, that this matter practically takes its place in the second class; that this change can occur in filters operated at high rates; and that this matter, when changed to a more or less stable condition, can, as far as the effluent itself is concerned, safely remain in the effluent instead of being strained or filtered out from it. That is, it will not under ordinary conditions rob this effluent of its dissolved oxygen and subsequently putrefy.

It was observed at the experiment station for a number of years that very turbid, poor appearing effluents from filters of coarse materials operated at high rates of filtration would often remain without change for an indefinite period of time, and that the matter coming from these filters in suspension in their effluents and rendering them turbid to eventually deposit as sediment, or washed from them purposely at times to relieve clogging, was apparently in a stable condition quite different from the condition of the putrefying, ill-smelling matters in suspension in the sewage itself when applied to such filters. The cause of this was supposed to be that the organic matter in the sewage had been, while passing through these coarse filters, so thoroughly changed by the bacteria that the putrefactive stage had been passed, and the material was comparatively stable. This was first mentioned in the report of the Lawrence Experiment Station for 1895 (see page 469), and has been referred to frequently since. It seems probable that the organic matter, both that in solution and that in suspension, is worked over and digested by the bacteria in the filter, first by the anaerobic and then by the aerobic bacteria. By this process the matter is, in the first place, rendered unsuitable food for the anaerobic bacteria and perhaps toxic to them. When in this condition, however, it is suitable food for ærobic bacteria, which rapidly at first and then more slowly change it to this stable condition.

The term "secondary decomposition" has been used for a number of years by various authorities to describe the change occurring in the effluents of sewage filters whereby odors are developed and a blackening of the liquid occurs, owing to putrefactive agencies. The term is somewhat misleading, however, as implying decomposition by different bacterial actions from those active within the filter. Decomposition in its true sense is a change of organic matter in the presence of air, while putrefaction, which is generally meant by the above expression, occurs only in the absence of air. In this paper, therefore, care has been taken not only to use these terms distinctively, but also to show that the changes are very different, and also the cause for this.

Early in the year a series of samples of effluents was collected for study and examination from five of our filters of coarse materials operated at high rates of filtration, four of these being contact filters and one an anaerobic filter. These effluents were of varying degrees of purity as collected from the outlets of the filters, for the rate and manner of operation of the filters, together with the varying materials of which they were constructed, had allowed different stages of bacterial action and consequent purification of the sewage to occur within them. The results obtained from a study of these samples caused further studies to be made.

Series No. 1.

The effluents of Filters Nos. 82, 103, 137, 138 and 133 were taken for the first experiment. The construction and rate of operation of each of these filters at this time was as follows: Filter No.

82 was constructed of cinders and was operated at the rate of 400,000 gallons per acre daily; Filter No. 103 was constructed of small pieces of coke and was operated at the rate of 660,000 gallons per acre daily; Filter No. 137 was constructed of broken stones and was operated at the rate of 800,000 gallons per acre daily; Filter No. 138 was constructed of broken stones and was operated at the rate of 480,000 gallons per acre daily; and Filter No. 133 was constructed of broken stones and was operated continuously in such a manner that air was not admitted and only putrefaction occurred within it, its rate of operation being 2,700,000 gallons per acre daily. All were contact filters with the exception of Filter No. 133.

The manner of making this experiment was as follows: from each filter a considerable volume of the effluent was collected and twelve one-gallon bottles were filled with each effluent. These bottles stood in the laboratory stoppered, and once a week the liquid in one of the bottles was taken for analysis.

Studying the results in detail as given in Table No. 1, we find that the dissolved oxygen and the nitrates disappeared more or less rapidly from the effluents of Filters Nos. 82, 137 and 138, and the free ammonia increased in amount, as did eventually the oxygen consumed, and the amount of nitrogen found as albuminoid ammonia decreased slowly, the appearance of each sample deteriorated and an increased odor was noticeable. The results with these three effluents showed that all organic matter in the sewage at the time that this sewage appeared as effluent at the outlets of these filters had not been sufficiently broken down by anaerobic action, and subsequently oxidized, to become stable. Oxidation and nitrification were occurring in the filters and a large portion of this organic matter present in the effluents was in a condition for slow oxidation to occur, but some of the organic matter present in these effluents was not ready for this under the conditions prevailing, without some further anaerobic bacterial action, and this occurred after the dissolved oxygen present in these effluents and the oxygen of the nitrates had been consumed. That is, this matter had not, while passing through the filter, reached such a state of stable equilibrium that it was not affected appreciably by the bacteria of putrefaction, and hence these effluents deteriorated.

The organic matter in the effluent of Filter No. 103, however, which received septic sewage, — that is, sewage which had undergone prolonged anaerobic bacterial action before application to the filter, — had evidently passed the putrefactive stage. Slight oxidation only occurred in this effluent, the very slight odor primarily present disappeared and dissolved oxygen was present at the end of eleven weeks, notwithstanding the very considerable quantity of organic matter present. In other words, the organic matter in this effluent, although considerable in amount, as shown by the high free and albuminoid ammonia and oxygen consumed, was in a condition of fairly complete oxidation, the anaerobic action having been carried to its limit in the septic tank and in the filter, and good oxidation having occurred in the filter.

The effluent of the anaerobic Filter No. 133 continued, on standing in the laboratory, to undergo putrefaction. The analyses follow.

Series No. 1.

Effluent of Filter No. 82.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
0, ...	1.60	V. slight.	1.5200	.2400	.1720	7.85	.28	.0000	1.52	1.5	426,000
7, ...	0.90	Decided.	1.5200	.2220	.1020	7.88	.01	.0000	1.62	0.0	-
14, ...	0.85	V. strong.	1.6000	.1600	.1040	8.05	.01	.0000	1.88	0.0	350,000
21, ...	0.85	V. strong.	1.5200	.1640	.0980	7.95	.01	.0000	2.06	0.0	37,500
28, ...	0.85	Strong.	1.5200	.1480	.0800	8.00	.01	.0000	1.90	0.0	11,200
35, ...	1.00	V. strong.	1.5600	.1440	.1060	7.98	.01	.0000	1.90	0.0	46,500
42, ...	1.10	Strong.	1.6400	.1520	.0820	8.02	.01	.0000	2.18	0.0	7,900
49, ...	1.10	Strong.	1.4800	.1400	.0700	8.05	.01	.0000	2.06	0.0	2,600
56, ...	-	Decided.	1.5600	.1560	.0880	8.20	.01	.0000	2.02	0.0	5,400
63, ...	1.00	V. strong.	1.6400	.1840	.0880	7.78	.01	.0000	2.04	0.0	560
70, ...	Green.	Decided.	1.3200	.2320	.0640	7.78	.01	.0000	1.96	0.0	-
84, ...	Yellow, green.	Strong.	1.4800	.1880	.0900	7.78	.01	.0000	2.26	0.0	291

Period covered by experiment, January 23 to April 17, inclusive.

Effluent of Filter No. 103.

0, ...	.38	V. slight.	.4600	.1120	.1040	7.75	2.81	.0064	.82	3.6	223,600
7, ...	.42	Slight.	.4400	.1180	.0900	7.77	2.66	.0720	.84	5.7	23,600
14, ...	-	V. slight.	.4000	.1120	.0760	7.73	2.33	.0010	.79	2.2	-
21, ...	.41	V. slight.	.4500	.1120	.0680	7.79	2.32	.0060	.75	2.3	2,300
28, ...	.40	Slight.	.5000	.0960	.0560	7.74	2.11	.0006	.64	1.0	1,300
35, ...	.37	V. slight.	.5200	.0740	.0420	7.76	2.11	.0014	.61	0.7	1,100
42, ...	.35	V. slight.	.6200	.0520	.0440	7.77	2.29	.0010	.59	0.8	600
49, ...	.27	V. slight.	.4900	.0520	.0380	7.77	2.33	.0004	.64	0.7	300
56, ...	.35	V. slight.	.5400	.0700	.0340	7.80	1.84	.0064	.55	0.7	310
70, ...	.42	V. slight.	.5400	.0680	.0460	7.79	1.84	.0050	.60	0.8	265
77, ...	.35	None.	.4800	.0760	.0360	7.80	2.37	.0014	.55	1.8	320
84, ...	.25	None.	.5800	.0500	.0320	7.78	2.42	.0024	.50	1.6	119

Period covered by experiment, February 4 to April 29, inclusive.

Effluent of Filter No. 137.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
0, ...	.70	Slight.	3.0000	.3680	.1600	8.97	.23	.0004	2.08	10.0	564,500
7, ...	.70	Slight.	3.6000	.2960	.1320	9.00	.01	.0000	1.98	0.0	21,500
14, ...	.75	Strong.	3.6000	.2480	.1100	9.09	.01	.0000	2.62	0.0	9,600
21, ...	Black.	V. strong.	3.6000	.1920	.1020	9.00	.01	.0000	3.04	0.0	15,500
29, ...	Black.	V. strong.	3.8000	.2040	.0960	9.00	.01	.0000	2.80	0.0	2,300
35, ...	Black.	V. strong.	3.8000	.2680	.1040	9.00	.01	.0000	2.80	0.0	12,000
42, ...	.75	V. strong.	3.6000	.2200	.1000	9.00	.01	.0000	2.64	0.0	19,000
49, ...	Pink.	Decided.	3.2000	.3480	.1760	9.00	.01	.0000	3.04	0.0	5,700
56, ...	.80	V. strong.	3.8000	.2120	.0088	9.00	.01	.0000	2.76	0.0	4,000
63, ...	Pink.	Decided.	3.3000	.4560	.1920	9.00	.01	.0000	2.68	0.0	-
70, ...	Greenish.	Strong.	3.5000	.1880	.1000	9.00	.01	.0000	2.32	0.0	-

Period covered by experiment, April 23 to July 2, inclusive.

Effluent of Filter No. 138.

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
0, ...	Yellow brown.	Decided.	2.8400	.3440	.2000	8.02	.78	.0100	2.40	5.4	234,000
7, ...	.58	Decided.	2.8800	.3120	.1520	8.05	.01	.0000	2.14	0.0	137,500
14, ...	.90	Decided.	3.3200	.3400	.1340	7.30	.01	.0000	2.44	0.0	19,000
21, ...	.95	V. strong.	3.2000	.2760	.1340	-	.01	.0000	2.26	0.0	8,000
35, ...	Black.	Strong.	3.4000	.1960	.1140	-	.01	.0000	2.70	0.0	764,600
42, ...	Dark brown.	V. strong.	3.5000	.2320	.1002	-	.01	.0000	2.74	0.0	21,000
49, ...	Dark brown.	V. strong.	3.2000	.2120	.0900	-	.01	.0000	2.80	0.0	1,100
56, ...	Yellow black.	V. strong.	3.1000	.2000	.0880	-	.01	.0000	2.80	0.0	1,700
63, ...	Yellow green.	V. strong.	3.1000	.3000	.1920	-	.01	.0000	2.96	0.0	1,300
68, ...	Yellow brown.	Strong.	2.8000	.3480	.2000	-	.01	.0000	2.96	0.0	600
76, ...	Greenish yellow.	Decided.	3.0000	.3200	.1720	-	.01	.0000	3.08	0.0	1,211

Period covered by experiment, March 14 to May 29, inclusive.

Effluent of Filter No. 133.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
0,	Yellow brown.	Strong.	5.9000	.3880	.2760	9.30	.01	.0000	3.48	0.0	443,000
7,	Yellow brown.	V. strong.	6.1000	.2840	.1440	9.29	.02	.0000	3.36	0.0	198,000
14,	Yellow brown.	Strong.	5.7000	.2640	.1440	9.32	.01	.0000	3.40	0.0	105,000
21,	Yellow brown.	Strong.	6.4000	.2920	.1680	9.36	.01	.0000	3.16	0.0	203,000
28,	Dark brown.	V. strong.	5.4000	.4960	.3280	9.45	.01	.0000	4.44	0.0	52,200
35,	Green.	V. strong.	5.5000	.4040	.1640	9.29	.01	.0000	4.20	0.0	-
49,	Green.	V. strong.	4.2000	.6040	.3640	-	.02	.0000	4.48	0.0	42,000
56,	Dark green.	V. strong.	4.5000	.8360	.4280	-	.02	.0000	4.72	0.0	22,000
63,	Dark green.	Strong.	3.8006	.7300	.5200	-	.02	.0000	4.76	0.0	6,000
70,	Dark green.	Strong.	4.0000	.7100	.4640	-	.02	.0000	4.88	0.0	1,700
77,	Yellow green.	V. strong.	4.2000	.6500	.4200	-	.02	.0000	4.44	0.0	2,500
84,	Yellow brown.	Strong.	4.2500	.8600	.6000	-	.02	.0000	4.64	0.0	4,281

Period covered by experiment, February 26 to May 21, inclusive.

Series No. 2.

In this series the effluents of six filters were studied, the method of procedure being as follows: an average sample of the effluent of each filter was siphoned into five one-gallon bottles, each bottle being completely filled. These bottles then stood in the warm laboratory tightly stoppered, and analyses were made weekly for five weeks, using one of the samples for each analysis. The sample for the determination of oxygen dissolved was obtained by siphoning it from the bottle into the flask in which the determination was to be made as soon as the bottle containing the sample to be examined was unstoppered.

Two of the filters from which samples of effluent were collected were the intermittent-continuous Filters Nos. 135 and 136 (see page 297), constructed of broken stone, operated at a rate of rather more than 1,400,000 gallons per acre daily, and producing a highly nitrified effluent, but also containing considerable free ammonia and nitrogenous organic matter found as albuminoid ammonia; one filter was No. 103, previously described, and operated at this time at the rate of 520,000 gallons per acre daily; one filter, No. 133, was the anaerobic filter operated at this time at the rate of 1,000,000 gallons per acre daily, and through which the sewage was passed for putrefaction to occur, as previously explained; and two filters, Nos. 137 and 163, were contact filters, one constructed of broken stone and one of coke, the rate of operation of these two filters being 960,000 and 720,000 gallons per acre daily respectively.

Studying the analyses of the effluents as given in the table, we find that the changes in the effluent of each filter showed a variation as follows: the effluent of Filter No. 103 remained practically unchanged for reasons previously explained, and dissolved oxygen was present in it at the end of the period. The large amount of residual organic matter in the effluents of Filters Nos. 135 and 136 had been, owing to the aerobic conditions prevailing in these filters, as evidenced by the high nitrates in the effluents, so changed by the bacteria and air that it was in a fairly stable condition. The effluents of these two filters — Nos. 135 and 136 — contained dissolved oxygen at the end of the period of experiment notwithstanding the large amount of organic matter present, no putrefaction took place, odors did not develop, and the organic matter present remained practically without change. The effluents of Filters Nos. 137 and 163 contained less organic matter than the effluents of Filters Nos. 135 and 136, but were, nevertheless, in a much lower state of nitrification; dissolved oxygen either was not present or disappeared quickly, and putrefaction occurred. Instead of the amount of nitrogen present as free ammonia remaining constant, as in the effluents of Filters Nos. 135 and 136, it increased. The amount of oxygen consumed, instead of decreasing, increased eventually in the effluent of Filter No. 137, and the anaerobic actions in the bottles containing this effluent and the formation of gas were quite noticeable, odors developing also.

Series No. 2.

Effluent of Filter No. 103.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed, corrected for Nitrites.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
0,	.33	V. slight.	0.3600	.1080	.0680	13.60	3.60	.0140	0.83	2.0	-
7,	.36	V. slight.	0.3900	.1160	.0660	-	2.66	.2400	0.83	21.9	4,300
14,	.38	V. slight.	0.3600	.1000	.0520	-	2.91	.0800	0.75	9.5	3,500
21,	.31	V. slight.	0.4000	.0840	.0420	-	2.76	.0600	0.71	8.6	1,200
28,	.29	V. slight.	0.4000	.0840	.0380	-	3.06	.0240	0.64	2.2	4,890

Effluent of Filter No. 135.

0,	.69	V. slight.	2.4400	.2840	.1200	11.50	5.18	.0120	2.44	34.3	-
7,	.72	V. slight.	2.2000	.2720	.1000	-	4.42	.6000	1.95	15.3	137,700
14,	.69	V. slight.	2.3600	.2360	.0900	-	4.91	.1100	2.09	9.9	7,000
21,	.80	V. slight.	2.3600	.2520	.0940	-	4.62	.1300	2.15	13.2	5,700
28,	.70	V. slight.	2.4400	.2480	.0860	-	3.94	.2000	2.13	7.7	1,700

Effluent of Filter No. 136.

0,	.63	V. slight.	1.6000	.2880	.1320	12.00	5.28	.0120	2.56	51.7	7,700
7,	.59	V. slight.	1.6000	.2520	.0820	-	5.08	.1100	1.94	15.5	26,000
14,	.58	V. slight.	1.6000	.2280	.0740	-	4.97	.0500	1.83	5.0	9,700
21,	.61	V. slight.	1.6000	.2200	.0740	-	4.73	.0180	1.71	1.6	11,600
28,	.59	V. slight.	1.6400	.2280	.0720	-	4.40	.0004	1.84	0.3	7,100

Effluent of Filter No. 137.

0,	.70	Decided.	2.6000	.2400	.1760	12.00	0.62	.0240	1.74	0.0	113,000
7,	Black.	H_2S, strong.	2.8000	.2200	.1320	-	0.01	.0000	2.28	0.0	20,500
14,	Black.	V. strong.	2.9000	.2000	.1000	-	0.01	.0000	2.48	0.0	41,600
21,	Black.	V. strong.	3.2000	.1760	.0960	-	0.01	.0000	2.32	0.0	7,500
28,	Black.	V. strong.	3.2000	.1560	.1120	-	0.01	.0000	2.32	0.0	900

Effluent of Filter No. 163.

0,	.60	Slight.	1.8000	.2000	.1220	13.38	1.49	.0120	1.18	46.2	115,500
7,	.42	Slight.	1.8000	.1640	.0760	-	0.66	.0006	1.08	0.0	63,500
14,	.47	Slight.	1.8400	.1360	.0740	-	0.53	.0020	1.00	0.0	40,200
21,	.42	Slight.	1.9600	.1200	.0760	-	0.16	.0004	0.94	0.0	4,000
28,	.40	Slight.	2.1200	.1120	.0480	-	0.25	.0160	0.86	0.0	29,000

Period covered by experiments, October 8 to November 5, inclusive.

SERIES No. 3.

In this series of experiments the effluents were mixed with equal parts of river water containing dissolved oxygen. The gallon bottles were only partially filled and were allowed to stand in the laboratory without being stoppered. One sample of each mixture was analyzed each week for a period of four weeks. This manner of experimentation was used to make the conditions resemble, as nearly as possible upon a laboratory scale, the conditions prevailing if such effluents ran in large volumes into ordinarily pure ponds or rivers.

The effluents of Filters Nos. 103, 135, 136, 137 and 163 and sewage were experimented with. Treating the effluents in this way, — that is, mixing them with water containing dissolved oxygen and also allowing access of air, — they improved in character in every instance. The comparatively well-purified effluents of Filters Nos. 103, 135 and 136 showed slight or decided decreases in free and albuminoid ammonia and oxygen consumed, with an oxidation of organic nitrogen to nitrites and nitrates; the poorly purified effluents of Filters Nos. 137 and 163 showed remarkable improvement in the reduction of organic matter and the production of nitrites and nitrates, together with a reduction in color and odor. Sewage, when mixed in this way and allowed to remain in contact with air, showed at first putrefaction for a period of two weeks, followed by rapid oxidation and the production of high nitrites. The explanation of this is that, although the surface of the sewage in the bottle was exposed to the air and hence oxygen must have been continually passing into the sewage, yet the organic matter on the surface water of this mixture consumed this oxygen so rapidly that the conditions below the surface favored the development of anaerobic bacteria, as shown by the formation of sulphuretted hydrogen, and only after this putrefactive action had been carried on for a certain period was the matter in a condition for aerobic bacteria to attain ascendency and for oxidation to occur. During the first period, however, ammonium carbonate, determined as free ammonia, was forming, thus showing that some oxidation was occurring. The free ammonia increased during the first two weeks from 2.70 parts to 4.20 parts per 100,000, then in two weeks it fell to 1.15 parts, the nitrites and nitrates were reduced at first, then the nitrites increased in two weeks from .00 to 1.70 parts per 100,000.

Putrefaction did not occur in any of the samples of effluent and water, although decomposition or change in the presence of oxygen did occur. In the mixture of sewage and water, however, we first had putrefaction, followed by decomposition; that is, oxidation.

SERIES NO. 3.

Effluent of Filter No. 103.

[Parts per 100,000.]

TIME ELAPSED (DAYS).	Color.	Odor.	AMMONIA. Free.	AMMONIA. ALBUMINOID. Total.	AMMONIA. ALBUMINOID. In Solution.	Chlorine.	NITROGEN AS Nitrates.	NITROGEN AS Nitrites.	Oxygen Consumed, corrected for Nitrites.	Bacteria per Cubic Centimeter.
0,	.58	V. slight.	1.0200	.1180	.0920	5.15	0.87	.0090	.96	11,800
7,	.48	Slight.	1.0200	.1180	.0640	-	0.87	.0140	.85	8,700
14,	.68	Slight.	0.9600	.0840	.0580	-	0.89	.0140	.74	5,900
21,	.47	V. slight.	0.9600	.0840	.0580	-	0.96	.0320	.76	6,400
28,	-	None.	0.8000	.0780	.0500	-	0.91	.3000	.61	19,500

Effluent of Filter No. 135.

0,	.47	None.	0.8000	.0660	.0480	8.00	2.42	.0036	.70	3,500
7,	.42	None.	0.8000	.0580	.0420	-	2.46	.0060	.68	500
14,	.37	None.	0.7600	.0540	.0400	-	2.50	.0120	.65	759
21,	.26	V. slight.	0.5000	.0540	.0380	-	2.68	.0024	.61	3,600
28,	-	None.	0.5200	.0500	.0320	-	2.64	.0000	.59	863

Effluent of Filter No. 136.

0,	.53	None.	1.2000	.1000	.0740	4.68	2.54	.0140	.82	5,400
7,	.47	None.	1.2000	.0940	.0640	-	2.52	.0320	.72	500
14,	.44	None.	1.0500	.0740	.0640	-	2.44	.0900	.67	2,500
21,	.33	V. slight.	0.6000	.0680	.0500	-	2.76	.3200	.62	2,400
28,	-	None.	0.5400	.0600	.0480	-	2.69	.0000	.64	14,200

Effluent of Filter No. 137.

0,	.83*	Slight.	1.4800	.1420	.1200	5.30	0.03	0.0002	1.40	71,000
7,	.50	Slight.	1.4800	.1600	.0700	-	0.01	0.0000	1.30	13,200
14,	.53	V. slight.	1.4800	.1560	.0560	-	0.01	0.0160	1.10	13,100
21,	.38	V. slight.	0.2000	.1160	.0380	-	0.00	1.1000	0.96	15,200
28,	-	None.	0.0060	.0960	.0340	-	1.19	0.0014	0.98	10,900

Effluent of Filter No. 163.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed corrected for Nitrites.	Bacteria per Cubic Centimeter.
0, ...	.65	V. slight.	0.7000	.1200	.0920	5.70	0.74	0.0070	1.02	23,500
7, ...	.64	V. slight.	0.7600	.1000	.0540	-	0.54	0.0140	0.93	12,500
14, ...	.50	V. slight.	0.7800	.0800	.0480	-	0.82	0.0400	0.82	7,900
21, ...	.33	V. slight.	0.0200	.0700	.0380	-	0.47	0.8500	0.86	8,100
28, ...	-	V. slight.	0.0080	.0620	.0320	-	1.63	0.0002	0.78	7,000

Sewage.

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed corrected for Nitrites.	Bacteria per Cubic Centimeter.
0, ...	Sewage.	Decided.	2.7000	.3600	.2880	4.80	0.09	0.0060	2.20	180,000
7, ...	.80	Strong.	3.8000	.3200	.1400	-	0.01	0.0000	1.88	83,500
14, ...	.69	H_2S, v. strong.	4.2000	.3200	.1200	-	0.00	0.0000	1.68	53,500
21, ...	.57	Decided.	2.7500	.2600	.1000	-	0.00	0.9000	0.90	13,500
28, ...	-	Slight.	1.1500	.2300	.0640	-	0.00	1.7000	1.00	53,500

Period covered by experiments, November 26 to December 24, inclusive.

* Turbid.

Series No. 3 A.

In this series the same effluents were experimented with as in Series No. 3, and the same mixture with river water was made, but the bottles were stoppered and air was prevented from entering. The samples then stood in the laboratory one month.

In the effluents of Filters Nos. 103, 135 and 136 there was a continual slow oxidation of the organic matter present, largely at the expense of the dissolved oxygen present, which was not entirely consumed, however, although some oxygen from the nitrates was also used. Odors did not develop in these effluents, but in fact became less. In the effluents of Filters Nos. 137 and 163, which were less satisfactorily purified than the effluents of the filters already named, decomposition occurred, — the oxygen of the water being quickly consumed, — followed by putrefaction, the effluents becoming dark colored and having a strong odor.

At the end of the month the effluent of Filter No. 163 was allowed to stand with its surface exposed to the air in an open bottle. During the period of putrefaction the free ammonia had increased from 1.30 parts to 1.52 parts per 100,000, and the nitrates had decreased from .4700 to .0100 part per 100,000. During the month when air was allowed access to the surface of the effluent in the bottle the free ammonia decreased from 1.5200 to .0140 parts and the nitrates increased from .0100 part to 1.5900 parts per 100,000.

The sewage quickly consumed the dissolved oxygen present in the water added, and continued to putrefy during the period of experiment.

Series No. 3 A.

Effluent of Filter No. 103.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
0,	.48	V. slight.	0.2100	0.0600	.0520	7.19	1.66	.0140	0.79	65.9	28,300
7,	.43	V. slight.	0.2200	0.0600	.0340	-	1.53	.0050	0.70	0.8	200
14,	.49	V. slight.	0.2700	0.0600	.0400	-	1.45	.0006	0.73	1.3	18,100
21,	.42	None.	0.2700	0.0500	.0380	-	1.19	.0048	0.69	2.4	5,500
28,	.43	None.	0.2800	0.0400	.0360	-	1.22	.0120	0.68	1.6	3,000

Effluent of Filter No. 135.

0,	.62	V. slight.	1.1400	0.0680	.0540	5.30	2.51	.0040	0.94	75.1	1,200
7,	.57	None.	1.1000	0.0620	.0400	-	2.40	.0200	0.84	17.0	492
14,	.63	V. slight.	1.0800	0.0580	.0400	-	2.61	.0320	0.87	3.7	800
21,	.52	V. slight.	1.0000	0.0600	.0460	-	2.59	.0450	0.86	5.9	900
28,	.56	None.	1.0200	0.0500	.0340	-	2.34	.0375	0.88	4.3	1,000

Effluent of Filter No. 136.

0,	.69	V. slight.	1.3000	0.2060	.0940	5.60	2.32	.0050	1.88	74.7	4,400
7,	.62	V. slight.	1.4000	0.1880	.0600	-	2.06	.0500	1.56	4.9	3,600
14,	.75	V. slight.	1.4000	0.1800	.0600	-	2.31	.0240	1.66	2.1	1,000
21,	.62	V. slight.	1.4000	0.1600	.0560	-	2.10	.0080	1.62	1.1	700
28,	.62	V. slight.	1.4800	0.1600	.0520	-	2.14	.0140	1.68	1.3	500

Effluent of Filter No. 137.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
0, ...	.87	Decided.	2.4500	0.1960	.1480	6.41	0.02	.0000	2.32	47.8	81,500
7, ...	.90	Strong.	2.7000	0.1640	.0980	-	0.01	.0000	1.60	0.0	50,000
14, ...	Black.	V. strong.	2.7000	0.1240	.0840	-	0.01	.0000	1.76	0.0	4,500
21, ...	Dark yellow.	V. strong.	2.7200	0.1280	.0920	-	0.01	.0000	1.88	0.0	700
28, ...	Dark yellow.	Strong.	2.7600	0.1200	.0740	-	0.01	.0000	1.82	0.0	8,000

Effluent of Filter No. 163.

First Period.

0, ...	.62	Slight.	1.3000	0.1280	.0880	7.19	0.47	.0200	1.12	69.2	193,000
7, ...	.51	Slight.	1.4500	0.1420	.0660	-	0.16	.0004	1.08	0.4	36,000
14, ...	.62	Slight.	1.5000	0.1060	.0520	-	0.01	.0000	1.08	0.0	21,500
21, ...	.52	Slight.	1.4000	0.1060	.0560	-	0.01	.0002	1.06	0.0	11,000
28, ...	.63	Slight.	1.5200	0.1040	.0520	-	0.01	.0000	1.05	0.0	17,500

Second Period.

35, ...	.46	Slight.	1.5200	0.0860	.0420	-	0.02	.0280	1.02	-	-
42, ...	.46	V. slight.	1.1600	0.0740	.0460	-	0.29	.0090	0.96	-	-
49, ...	.85	V. slight.	0.7000	0.0740	.0340	-	0.74	.0068	0.94	-	-
56, ...	-	None.	0.0140	0.0660	.0340	-	1.59	.0080	0.90	75.0	-

Sewage.

0, ...	Sewage.	Decided.	2.6000	0.3600	.2360	4.80	0.10	.0060	2.20	0.0	160,000
7, ...	.72	Strong.	3.7000	0.2400	.1120	-	0.01	.0000	2.04	-	70,500
14, ...	Black.	H_2S, v. strong.	3.7000	0.2400	.1300	-	0.00	.0000	2.28	-	83,500
21, ...	Black.	H_2S, v. strong.	3.7000	0.2200	.1600	-	0.00	.0000	2.28	-	42,500
28, ...	Black.	V. strong.	3.7000	0.2000	.1300	-	0.00	.0000	2.16	-	693,000

Series No. 4.

In this series the effluents experimented with were from anaerobic Filter No. 133, the coarse and high rate Filters Nos. 134, 135 and 136, and the coke contact Filters Nos. 175 and 176. Five bottles of each effluent were filled and stoppered and placed in an incubator, the temperature of which was maintained at 80° F., one sample being examined each day, the period covered being nearly five days.

The effluent of Filter No. 133, containing no nitrates or dissolved oxygen, putrefied, rapidly becoming black and ill-smelling, although the oxygen consumed from permanganate increased but slightly. The effluents of Filters Nos. 134 and 135, although containing but a small amount of dissolved oxygen at the beginning of the experiment, were three days in exhausting this oxygen, and subsequently a small amount of the oxygen of the nitrates was consumed. Neither effluent developed any odor nor changed in appearance. The effluent of Filter No. 136 deserves especial mention as it contained at the beginning of the experiment 1.24 parts per 100,000 of albuminoid ammonia, 9.03 parts of nitrates, and 22 per cent. of saturation of dissolved oxygen; and it is noticeable that, notwithstanding the enormous amount of organic matter present in the effluent determined as albuminoid ammonia, it was in an almost stable condition, the oxygen consumed from permanganate remaining practically constant during the period of incubation, the nitrates being reduced to 5.76 parts per 100,000 in the course of the experiment, the dissolved oxygen not being quite exhausted, and the effluent showing no change in appearance and not developing an odor.

The effluents of the coke contact Filters Nos. 175 and 176 were also incubated for the same period without any appreciable change of their organic contents, or the development of odors. The rate of operation of each of these two filters was at this time about 1,200,000 gallons per acre daily, and nitrification was active within them.

Series No. 4.

Effluent of Filter No. 133.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
			Free.	Albuminoid. Total.	Albuminoid. In Solution.		Nitrates.	Nitrites.			
1,	.92	Decided.	6.5000	0.2120	.1300	10.03	0.00	.0000	1.48	0.0	73,500
2,	-	Decided.	7.0000	0.1650	.1220	-	0.00	.0000	1.46	0.0	32,500
3,	-	Strong.	6.7500	0.2400	.1220	-	0.00	.0000	1.58	0.0	44,000
4,	-	Strong.	6.6250	0.2800	.1120	-	0.00	.0000	1.60	0.0	24,000
5,	Black.	Strong.	6.8750	0.2100	.1220	-	0.00	.0000	1.60	0.0	13,000

Effluent of Filter No. 134.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
1, ...	.45	V. slight.	1.0000	0.1920	.0720	10.00	4.90	.0320	1.68	64.8	3,500
2, ...	–	V. slight.	1.0800	0.1760	.0600	–	4.50	.0800	1.52	33.4	77,500
3, ...	–	V. slight.	1.0800	0.1880	.0600	–	4.42	.0700	1.76	5.0	40,000
4, ...	–	V. slight.	0.9200	0.2840	.0680	–	4.41	.0800	2.46	–	5,000
5, ...	.45	V. slight.	1.0400	0.2160	.0640	–	3.49	.1200	1.78	1.3	20,000

Effluent of Filter No. 135.

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
1, ...	.51	V. slight.	0.7000	0.1560	.0880	9.20	5.53	.0060	1.22	46.6	4,300
2, ...	–	None.	0.7000	0.1600	.0780	–	5.53	.0100	1.18	29.7	4,200
3, ...	–	None.	0.6200	0.1400	.1020	–	5.26	.0160	1.12	0.6	2,400
4, ...	–	None.	0.6200	0.1560	.0760	–	5.43	.0300	0.94	0.0	1,000
5, ...	.50	None.	0.7000	0.1120	.0880	–	4.50	.0800	1.22	0.0	1,800

Effluent of Filter No. 136.

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
1, ...	.68	Slight.	1.4800	1.2400	.1980	8.68	9.03	.0260	6.00	22.1	28,000
2, ...	–	Slight.	1.8500	1.3300	.2160	–	8.33	.5600	6.24	25.8	28,100
3, ...	–	Slight.	1.8500	1.0100	.1960	–	7.15	.4000	6.20	42.3	65,000
4, ...	–	Slight.	2.0000	1.0800	.1960	–	7.11	.4500	6.05	29.4	11,200
5, ...	.68	V. slight.	2.0500	1.0100	.2120	–	5.76	.4000	6.20	23.9	4,800

Effluent of Filter No. 175.

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
1, ...	.49	V. slight.	0.6100	0.0960	.0680	7.25	2.19	.0120	0.65	37.5	33,500
2, ...	–	V. slight.	0.6600	0.0840	.0740	–	2.19	.0060	0.63	–	25,500
3, ...	–	None.	0.7000	0.0780	.0520	–	2.18	.0160	0.62	–	18,500
4, ...	–	V. slight.	0.6800	0.0600	.0440	–	2.19	.0120	0.61	–	9,000
5, ...	.50	V. slight.	0.7000	0.0800	.0540	–	2.07	.0040	0.59	20.0	6,500

Effluent of Filter No. 176.

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
1, ...	.40	V. slight.	0.4600	0.1160	.0900	5.71	1.18	.0060	0.64	29.0	23,500
2, ...	–	V. slight.	0.4700	0.1200	.0600	–	1.18	.0080	0.63	–	62,000
3, ...	–	None.	0.4900	0.1180	.0740	–	1.19	.0018	0.63	–	14,500
4, ...	–	V. slight.	0.5200	0.1000	.0740	–	1.10	.0032	0.64	–	24,000
5, ...	.40	Slight.	0.5200	0.1220	.0600	–	1.09	.0080	0.53	10.0	23,000

SERIES NO. 5.

This series of experiments was with the effluents of Filters Nos. 135 and 136, the suspended matter having been largely removed by filtration of the effluents through paper. It was an incubation experiment covering a period of five days at a temperature of 80° F., and the effluents remained practically unchanged, as shown by the tables.

SERIES NO. 5.

Effluent of Filter No. 135.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
1, ...	.72	V. slight.	.4500	.1120	.1020	3.42	1.84	.0060	1.00	85.1	11,100
2, ...	-	V. slight.	.4000	.1100	.0880	-	2.09	.0170	1.06	68.4	14,600
3, ...	-	V. slight.	.3100	.0980	.0660	-	1.92	.0600	1.04	7.3	13,000
4, ...	-	V. slight.	.3000	.0960	.0660	-	1.90	.0800	1.02	2.3	19,000
5, ...	.72	V. slight.	.2800	.0960	.0660	-	1.90	.0800	0.98	2.0	29,500

Effluent of Filter No. 136.

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
1, ...	.72	V. slight.	.6000	.1740	.1280	3.30	3.69	.0090	1.28	82.1	12,800
2, ...	-	V. slight.	.5400	.1960	.1220	-	3.68	.0160	1.22	76.0	2,200
3, ...	-	V. slight.	.5000	.2040	.1000	-	3.66	.0400	1.24	25.5	8,000
4, ...	-	V. slight.	.5000	.1680	.1000	-	3.64	.0600	1.22	1.3	7,000
5, ...	.70	V. slight.	.5000	.1640	.1000	-	3.64	.0600	1.22	1.3	15,500

Period covered by experiment, December 15 to 20, inclusive.

SERIES NO. 6.

Two experiments, covering a period of five weeks, were made with the effluents of Filters Nos. 135 and 136, the effluents not being incubated, but standing in the laboratory for this period of time in gallon bottles open to the air. Both effluents improved in quality, the free ammonia of the effluent of Filter No. 135 decreasing from 2.00 parts to .90 part per 100,000 and the nitrates increasing from 4.02 parts to 5.10 parts per 100,000; the free ammonia in the effluent of Filter No. 136 decreasing from 4.00 parts to .90 part per

100,000, and the nitrates increasing from 1.56 parts to 3.43 parts per 100,000.

Various other experiments of a like nature were made with similar results.

SERIES No. 6.

Effluent of Filter No. 135.

[Parts per 100,000.]

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
0,	0.85	V. slight.	2.0000	.1520	.0820	10.59	4.02	.0280	1.40	31.4	4,900
3,	-	V. slight.	1.8800	.1280	.0700	-	4.16	.0600	1.32	-	-
5,	-	V. slight.	1.5600	.1440	.0580	-	3.49	.1200	1.48	-	-
11,	-	V. slight.	0.8400	.1080	.0580	-	4.42	.2400	1.48	-	-
14,	-	V. slight.	0.8000	.1280	.0620	-	4.93	.0000	1.32	-	-
17,	-	None.	0.8000	.1160	.0500	-	5.06	.0000	1.28	-	-
20,	-	None.	0.8000	.1240	.0480	-	5.10	.0000	1.22	-	-
35,	-	None.	0.9000	.1120	.0500	-	4.87	.0000	1.18	-	-

Effluent of Filter No. 136.

Time Elapsed (Days).	Color.	Odor.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Oxygen Dissolved (Per Cent. of Saturation).	Bacteria per Cubic Centimeter.
0,	1.16	Slight.	4.1000	.1920	.1140	11.00	1.56	.0160	1.60	6.5	3,900
3,	-	Slight.	3.6000	.1560	.0940	-	1.67	.0500	1.56	-	-
5,	-	Slight.	3.6000	.1760	.0980	-	1.61	.0600	1.50	-	-
11,	-	Slight.	3.1000	.1280	.0780	-	1.58	.2800	1.50	-	-
14,	-	Slight.	2.6000	.1600	.0680	-	2.20	.3600	1.76	-	-
17,	-	None.	2.0000	.1400	.0580	-	2.23	.6000	1.86	-	-
20,	-	None.	1.3000	.1560	.0660	-	3.18	.3400	1.68	-	-
35,	-	None.	0.9000	.1240	.0480	-	3.43	.0000	1.34	-	-

Period covered by experiment, September 13 to October 18, inclusive.

SUMMARY.

The changes which go on in contact or other filters of coarse material are not always the same, but are dependent on the presence or absence of oxygen, and this in turn is dependent on various conditions, such as the character of the sewage, time of filling, time of contact and time of drawing off the effluent, etc. But that both anaerobic and aerobic actions usually go on in contact filters with the results described there can be no reasonable doubt. Further, that a limited period of anaerobic action, whether taking place within the contact filter or in the septic tank, is a favorable preparation of the organic matter for the subsequent action of the aerobic or oxidizing bacteria seems to be well proven. Thus we have within a contact filter usually both putrefaction and decomposition going on, and one or both of these processes is generally continued in the effluent. If the bacterial changes within the filter are very incomplete, the phenomenon of "secondary decomposition" (more properly called putrefaction) is the one to manifest itself in the effluent.

It is evident, moreover, from a study of all these results that the amount of organic matter determined as albuminoid ammonia and oxygen consumed in the effluent of a sewage filter constructed of coarse material, and operated at a high rate of filtration, is not a true index of the degree of purification of such an effluent, if we mean by purification the oxidation in the filter of the organic matter of the sewage to a more or less stable condition, and the production of an effluent which will not, when having free access to the air, putrefy. In order that such a stable effluent may be produced, it is only necessary that sewage shall have been for a comparatively short period of time in thin layers in contact with an abundance of air and that aerobic bacterial life shall have been active without the added straining out of organic matter obtained by sand or other filters of fine material. Such an effluent will show good nitrification and the presence of dissolved oxygen when running from the filter, irrespective of the amount of stable organic matter that it contains. These effluents, produced either by intermittent-continuous filters or by the best of contact filters, show little tendency to change when excluding air, and maintained at summer temperature for a considerable period. When mixed with water containing oxygen they invariably improve in quality. Even much poorer effluents improve when under the conditions last named, although they decompose and putrefy under the first-named conditions.

If such an effluent, showing good oxidation and nitrification occurring in the filter, contains dissolved oxygen, and habitually retains this dissolved oxygen, for a considerable period, it is fairly certain that putrefaction will not occur in it under ordinary conditions, as when exposed to air. Slow oxidation may and probably will occur, this latter action improving the effluent without producing odors.

This is abundantly proved by the experiments above described. If, on the other hand, the effluent as it runs from the filter does not contain dissolved oxygen, or if the oxygen present disappears with comparative rapidity, it may be taken as assured that such an effluent will putrefy eventually unless mixed with a considerable volume of water containing dissolved oxygen, even though it contains a smaller amount of organic matter, determined as albuminoid ammonia and oxygen consumed, than other effluents of the character just described, and even though a considerable amount of nitrates is at first present.

In the purification of untreated sewage by sand filtration there is upon many of these filters a constant tendency for surface clogging caused by the accumulation of the coarser and more stable organic matter of the sewage, and in order to keep these filters in operation, this matter either has to be scraped from the beds from time to time, or ploughing with periods of rest has to be resorted to. With an intermittent continuous filter of broken stone, on the other hand, much of this coarse organic matter passes through the filter, as already stated, and appears in the effluent, and surface clogging does not occur. Moreover, as this matter passes through and encounters aerobic conditions, it is, as illustrated by the experiments, oxidized to an innocuous condition, and can be easily strained from the effluent at very high rates, if desired, leaving this effluent well purified, clear and highly nitrified, or about equal to the average effluents of sand filters, and produced by a rate of filtration many times as great. It is, of course, unnecessary to dwell here upon the fact of the desirability of producing filter effluents as free from matter in suspension as possible, such as can be obtained by sand filtration, notwithstanding the fact that turbid but nevertheless fairly stable effluents can be produced by rapid methods of filtration.

Studies of Incubation Tests.

Studying the results of the many determinations of oxygen consumed from permanganate that have been made during these various experiments, we find (1) that the oxygen consumed from permanganate invariably decreases in effluents which are in such condition when collected that they undergo slow oxidation only; (2) that with effluents that finally putrefy the amount of oxygen consumed generally decreases at first, if any amount of nitrates and dissolved oxygen is primarily present in the effluent, to increase later when putrefaction occurs; (3) that in one instance, when the effluent of anaerobic Filter No. 133 was incubated at 80° F. for five days, the oxygen consumed increased only very slightly, although the change in the appearance and odor of the sample was very marked, owing to the putrefaction occurring within it; and (4) that in one instance, although the amount of oxygen consumed increased largely in this effluent when it was kept for a period of eleven weeks, yet during the first three weeks it decreased. These results, taken in connection with the complete analyses of the samples in each series, seem to throw some doubt upon the significance of the so-called five-day incubation test with the determination of oxygen consumed only, used to determine the stability or instability of the organic matter of the effluents of sewage filters, that is, to determine their liability to undergo the so-called secondary decomposition. This determination is very much depended upon, however, in England, to show the character of the effluents of sewage filters, as being a much shorter way than complete analyses of these effluents. It would seem, however, that in most instances a determination of the dissolved oxygen present at the beginning and the end of the period of incubation, together with observations of the change in appearance of the sample, if any occurs, would be a more satisfactory simple test.

Owing to the results obtained in this previous work, a series of incubation tests was undertaken, in connection with complete analyses of effluents of filters of many kinds, producing effluents of varying degrees of purification. Some of these results are shown in a following table.

Studying these results as carried on with twenty-one samples of effluent, we find only three instances where the oxygen consumed from permanganate increased at the end of the five days' incubation, although in ten of the twenty-one effluents examined there was no dissolved oxygen present at the end of the period, and in two of the samples — both of the same effluent, however — there was no dissolved oxygen present at the beginning of this period. Several of these effluents, showing less oxygen consumed at the end of five days, putrefied, as evidenced by their change in appearance and by the development of gas and odors. In a number of them secondary decomposition occurred, — if we use the word "decomposition" in its true sense, meaning change of organic matter in the presence of oxygen,—although odors did not develop in these samples, as the change was oxidation instead of putrefaction.

[Parts per 100,000.]

Filter Number.	Ammonia.			Nitrogen as		Oxygen Consumed.	Oxygen Consumed after 5 Days.	Per Cent. Saturation.	
	Free.	Albuminoid. Total.	Albuminoid. In Solution.	Nitrates.	Nitrites.			Oxygen Dissolved.	Oxygen Dissolved after 5 Days.
5,	0.4600	.0300	-	3.08	.0002	0.40	0.35	82.4	83.8
6,	0.0154	.0336	-	4.39	.0008	0.35	0.34	69.2	66.9
100,	0.4830	.0650	-	3.07	.0080	0.57	0.61	80.3	14.6
103,	0.4150	.0810	-	1.75	.0050	0.69	0.65	22.8	2.1
103,	0.2210	.0800	-	2.90	.0040	0.61	0.54	18.8	2.9
133,	4.8000	.2000	.1600	0.00	.0000	1.68	1.64	0.0	0.0
133,	4.6000	.1760	.0840	0.00	.0000	1.46	1.44	0.0	0.0
134,	1.7200	.1080	.0820	2.80	.0140	0.78	0.67	72.8	-
134,	1.4800	.0880	.0780	3.68	.0120	0.83	0.70	6.3	1.1
135,	0.3900	.0940	.0560	3.77	.0100	1.00	0.92	64.6	4.0
135,	0.8000	.2720	.0580	5.77	.0110	2.76	2.76	41.5	0.0
136,	1.4800	.7360	.0840	3.07	.0120	7.50	6.00	39.7	6.7
136,	1.7000	.4200	.0900	4.21	.0120	5.20	4.60	42.9	0.0
137,	2.4000	.2120	.1160	0.00	.0000	1.82	1.88	1.8	0.0
137,	2.7600	.2600	.1200	0.00	.0000	1.94	1.90	5.8	0.0
150,	0.0042	.0152	-	3.95	.0028	0.13	0.13	92.0	100.3
163,	0.8200	.1080	.0580	1.30	.0200	0.91	0.85	5.9	0.0
163,	1.2000	.1120	.0920	1.53	.0140	0.98	0.97	8.4	0.0
163,	1.3200	.1800	.0980	0.85	.0320	1.30	1.16	6.4	0.0
165,	0.3500	.1080	.1000	2.52	.0280	0.89	0.82	1.2	0.8
167,	3.0000	.2400	.1640	0.02	.0400	1.50	1.56	20.3	0.0

BACTERIOLOGICAL STUDIES

AT THE

LAWRENCE EXPERIMENT STATION,

WITH SPECIAL REFERENCE TO

THE DETERMINATION OF B. COLI.

By STEPHEN DEM. GAGE, *Biologist at the Lawrence Experiment Station.*

I. CHANGES IN THE METHODS FOR THE DETECTION OF B. COLI IN WATER, ETC.
II. REVIEW OF ROUTINE B. COLI STUDIES.
III. ON THE METHODS FOR THE DIFFERENTIATION OF BACTERIA.
IV. PROPOSED CLASSIFICATION OF BACTERIA.
V. DESCRIPTION OF SPECIES OF BACTERIA ISOLATED DURING THE ROUTINE STUDIES.

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SPECIAL REFERENCE TO THE DETERMINATION OF B. COLI.

By STEPHEN DEM. GAGE, *Biologist at the Lawrence Experiment Station.*

Since the introduction of bacterial methods of water analysis, the constant aim of bacteriologists working along this line of the science has been to perfect methods of more significance than the mere determination of the numbers of bacteria present in a given volume of water. Especially has it been desired to perfect methods whereby pathogenic bacteria may be accurately determined by some easily applied method.

Although much has been accomplished, it is still true to-day that tests for the bacillus of typhoid fever in polluted water are unsatisfactory.

As early as 1893[1] it was proposed that the colon bacillus was a direct indication of pollution by sewage, and was suggested that tests should be made for that organism.

Various methods for making these tests were offered by different observers, and, as a result of studies of the different methods at the Experiment Station during 1896–97, the Lawrence methods[2] were elaborated, and routine studies were begun on the sanitary significance of the presence of B. coli in filtered waters. With the exception of a few minor changes and additions, which experience has dictated, these methods have been in constant use at the Experiment Station since they were first devised. The results of these tests and their interpretation as bearing on the questions of the purity of water, etc., have been published in the annual reports of the Board since 1898, under the filtration of water.

It is the purpose of the writer, in the present paper, to tabulate and discuss some of the points of these studies from the bacteriological side, showing the results and value of some of the different tests as applied to cultures in routine work, the amount of the work done and the scope of the work at present in this laboratory, and also to describe some of the species of bacteria which have made their appearance in the routine work, and to show their possible position in the grouping of bacteria as related to the colon group.

The paper is divided into five parts, the first two treating of the routine work, and the others of a more extended study of the different species which have been isolated during recent routine tests, in which an attempt has been made to isolate every abnormal species or variety which has made its appearance at any portion of the tests for B. coli.

This work was begun under the direction of Mr. H. W. Clark, through whose co-operation many portions have been made possible. Credit should also be given to all the members of the laboratory force, and especially to Messrs. E. B. Phelps and A. I. Kendall, for assistance and suggestions in the study of the species.

I. — Changes in the Lawrence Methods for the Detection of B. Coli.

The principal change in the methods as first published has been in extending the final reading on the liquefaction of gelatin to fourteen days instead of ten days, as was done during the earlier portion of the work. The reason for this is obvious, as shown in the records of cultures examined during the latter portion of the work (Table No. II.). It should be noted that the more slowly liquefying cultures were those having the final form of a cup, many cultures which showed a cup form during the earlier portion of their development changing to the funnel or stratified forms later; and, roughly speaking, it may be said that the number of cultures showing the cup form in the table is probably the number which would not show liquefaction until after the tenth day.

A study of a considerable number of cultures incubated longer than fourteen days has convinced us that this is sufficiently long to continue the tests; and, although there may still be some few cultures which would show liquefaction if grown longer, the percentage of these is so small as to be negligible in routine work.

We have also come to look for the presence of wrinkles in the surface growth of gelatin in the non-liquefying cultures, and such cultures have been unhesitatingly thrown out as non-colon, although they may possibly have passed all the other tests.

In the fermentation tubes we have made observations of the presence of a scum, since B. coli should never form a pellicle in fluid media.

Since the publication of the methods for making the qualitative test in one cubic centimeter, we have added a method for making tests in larger volumes,[3] which is not limited by the size of the fermentation tube. The results of tests in one and one hundred cubic centimeters of the same waters have already been published. Since the medium for the test in large volumes contains phenol, while the usual dextrose broth used in the fermentation tube contains no phenol, the following figures are inserted to show the relative accuracy of the two methods: —

	One Cubic Centimeter.	One Hundred Cubic Centimeters.
Number of samples tested,	5,172	1,375
Number of samples giving preliminary fermentation,	1,036	474
Per cent. of samples giving fermentation proved to contain B. coli,	70	71

These figures include the work up to the first of January, 1901, the records not being separated after that time.

This difference of one per cent. represents the exclusion of outside species by the phenol, and also probably some of the weaker strains of B. coli.

Media.

With few exceptions, the media in use is the same as when the methods were first published. Changes have been made in the gelatin, agar and dextrose broth. The gelatin and agar have been made to conform strictly to that recommended by the bacteriological committee.[6] Studies in connection with species determinations have shown us that equally good results are obtained in the fermentation tube in our B. coli work, if the amount of dextrose is reduced to one per cent., and the broth made without meat; and during the present year the dextrose broth has had the following composition: one per cent. of pepton (Witte), dissolved in tap water, with one per cent. of dextrose added after the pepton is dissolved. With the elimination of the meat, additions of acid or alkali to change the reaction become unnecessary, and less change in the final re action is noted after sterilization.

II. — Review of Routine Colon Studies.

Up to the first of May, 1902, we have examined over 10,800 samples of water for the presence or absence of B. coli, and over 5,600 samples of water, sewage, etc., for the numbers of B. coli in one cubic centimeter. We have also examined about 460 samples of shellfish and over 800 samples of ice for the presence of this germ.

During the earlier part of the work the main interest in the colon tests lay on the side of the filtration of water, most of the work being done along this line; and the records of the cultures were kept from that stand-point, little attempt being made to study the cultures further than was necessary to decide whether or not they should be included in the colon group. Up to the first of January, 1901, we had isolated some 3,000 cultures suspected of being B. coli, of which 1,555 came from supposedly unpolluted water, isolated by the qualitative tests; and the others, from water known to be polluted, were isolated directly from the Wurtz agar plates. In tabulating the cultures obtained from the plate test we have thought it well to divide them into two groups: "A," those where the colonies selected were chosen as representing a large number of colonies on the plate; and "B," where all of the colonies on the plate were transferred. This was done to eliminate as much as possible the personal factor, as, in fishing a plate, if there are a large number of colonies present, one unconsciously selects more characteristic colonies than if all of the colonies are to be fished. Also, in some of the work, plates were made from waters which were only suspected to be polluted, and in such a case one would fish any doubtful colonies.

For convenience, the tests have been recorded in the following order, although many of the tests were made at the same time: —

1. Characteristic appearance on agar streak.
2. Gas production in dextrose broth.
3. Coagulation of milk.
4. Production of nitrites in nitrate broth.
5. Production of indol in Dunham's solution.
6. Non-liquefaction of gelatin.

In the following table are shown the percentage of cultures remaining after each successive test, and, indirectly, the relative value of each medium as a differential test, also the relative accuracy of the preliminary test by the fermentation method and by the Wurtz agar plate. The results are tabulated by years, showing the variation even with waters of the same class.

TABLE NO. I. — *Showing Percentage Elimination of Suspected Cultures of B. Coli, by Successive Tests in Routine Work.*

	Total Number of Cultures.	PER CENT. OF CULTURES PASS—					
		Agar Streak.	Fermentation Tube.	Milk Test.	Nitrate Test.	Indol Test.	Gelatin Test.
1898.							
Qualitative Method,	178	96	95	95	95	90	76
Quantitative Method, A,	141	94	94	94	89	89	86
Quantitative Method, B,	80	91	90	90	88	83	79
Total, 1898,	399	94	93	93	91	86	79
1899.							
Qualitative Method,	661	98	97	97	96	95	91
Quantitative Method, A,	528	92	88	87	86	85	79
Quantitative Method, B,	271	87	83	80	80	77	69
Total, 1899,	1,460	94	91	90	89	88	82
1900.							
Qualitative Method,	716	95	94	94	94	91	82
Quantitative Method, A,	325	86	83	83	83	83	78
Quantitative Method, B,	95	76	74	73	73	73	65
Total, 1900,	1,136	91	89	89	89	87	78
TOTAL, 1898-1900.							
Qualitative Method,	1,555	97	96	95	94	93	85
Quantitative Method, A,	994	90	87	86	85	84	78
Quantitative Method, B,	446	85	82	81	79	77	70
Total, three years,	2,995	93	91	90	89	88	80

It appears from this table that the fermentation test is somewhat more apt to show the colon bacillus than the plate method; and this is true from another stand-point as shown by the fact that in the earlier part of the work, when tests were made on the same water by both methods, we frequently would obtain negative or doubtful reactions on the plates, when we would get a strong positive reaction in the dextrose broth. This can probably be accounted for by the greater facility for the development of bacteria in fluid than in solid media.

Concerning the necessity for the second inoculation into the fermentation tube, for cultures obtained directly from the fermentation tests, it should be borne in mind that in the preliminary fermentation we are dealing with mixed cultures, and that the organism which gives the preliminary gas production may not pass the Wurtz agar plate, while some other species may give us a red colony, and thus come up for confirmation. The figures in the table show the possibility of this, and also its relative infrequency. The necessity for the use of milk, when we use milk sugar in the Wurtz agar, has also been questioned. The figures in the table also sustain this, although the percentage reduction is small. In fact, there are some figures in the table which would sustain the omission of either the milk, nitrate or indol tests, for a certain class of work and during a certain period; but, since the bacterial flora from any given source is never constant, we find that each of these tests is necessary at some point. With regard to the possible utility of additional tests, undoubtedly there are some tests which might well be added. The tests as applied, however, give us reactions which are typical not only of B. coli communis, but also of certain other species of fæcal bacteria which should also be included in the colon group; and a further extension of the tests, which would exclude these species, would seriously impair the value of tests which are made with the specific object of the determination of fæcal pollution, rather than the isolation of a certain well-defined species.

Since the latter part of 1900 the applicability of the colon tests to other than filtered water samples has been recognized, and the scope of the tests has been considerably enlarged. The tests have now been applied to spring waters, surface waters, well waters, ice, sewage and effluents from sewage filters, shellfish and sea water, in connection with different researches and investigations, some of which have already been published by the Board, and others of which are still under study. Beginning in the middle of October, 1900, a more complete record of the cultures obtained from the different sources was attempted, records being kept of the more prominent characteristics of each culture, all types varying from the true colon type being set aside for further more complete study.

As the species of bacteria present in the samples from the different sources have varied considerably, the records of the tests on the cultures have been grouped according to the source. Under shellfish have been included all cultures from samples of clams, oysters, quahaugs, scallops, etc., and also cultures from samples of sea water which usually accompanied these; since many of these samples were suspected of contamination by sewage, we have in them a combination of the sewage and marine flora. In the case of springs, wells and surface waters, only a few cultures were obtained from each, and these are all grouped under one head. Under sewage have been included all cultures from the different kinds of sewage and from the effluents of sewage filters operating at the higher rates, which in general appear to pass B. coli more or less readily.

In the following table are shown the tabulations of the records of the cultures which were studied during the past eighteen months. The method of expression of results is somewhat different from that in the preceding table, and confusion will be avoided if one bears in mind the characteristics of the colon group which we have included as a heading to the table.

TABLE NO. II. — *Showing Percentage Elimination of Suspected Cultures of B. Coli by the Various Tests in Routine Work.*

Source of Culture.	Number of Cultures made.	Agar Streak. Per Cent. of Cultures. Characteristic.	Agar Streak. Per Cent. of Cultures. No Growth.*	Agar Streak. Per Cent. of Cultures. Dull — wrinkled.	Agar Streak. Per Cent. of Cultures. Viscous.	Number of Cultures inoculated into Confirmatory Media.	Per Cent. of Cultures. Fermentation Tube. Produce Gas.	Per Cent. of Cultures. Fermentation Tube. Produce Scum.	Per Cent. of Cultures. Coagulate Milk.	Per Cent. of Cultures. Reduce Nitrates.	Per Cent. of Cultures. Produce Indol.	Gelatin Stab. Not Liquefied. Characteristic.	Gelatin Stab. Not Liquefied. Wrinkled.	Gelatin Stab. Liquified. Time. Four Days.	Gelatin Stab. Liquified. Time. Seven Days.	Gelatin Stab. Liquified. Time. Ten Days.	Gelatin Stab. Liquified. Time. Fourteen Days.	Gelatin Stab. Liquified. Form. Funnel.	Gelatin Stab. Liquified. Form. Cup.	Gelatin Stab. Liquified. Form. Stratiform.	Per Cent. of Total Number of Cultures, called B. Coli.
B. coli communis,		+	0	0	0		+	0	+	+	+	+	0	0	0	0	0	0	0	0	
Merrimack River,	273	86	0	13	1	236	81	13	86	82	73	69	1	21	25	28	30	10	4	16	59
Filtered water,	1,485	83	9	4	4	1,236	84	3	90	76	71	83	4	4	7	9	13	5	5	3	58
Sewage, etc.,	160	37	4	8	1	140	75	0	88	70	75	84	1	9	9	10	15	6	2	7	59
Shellfish,	312	64	33	2	1	201	68	3	91	67	75	84	0	9	9	9	16	6	2	8	48
Spring waters,	53	74	0	4	23	39	56	0	67	67	59	72	0	15	18	28	28	20	0	8	41
Ice,	79	72	16	8	0	57	67	5	88	42	88	63	7	25	25	26	30	5	4	21	48
Total,	2,362	81	11	5	3	1,908	80	4	88	74	71	80	3	8	10	13	17	6	5	6	58

* Including cultures which failed to grow on agar, and certain cultures giving a very scanty, non-characteristic growth.

The percentage result of each test is better shown in this table than in Table No. I., as here we have a more complete record of each culture. There is a considerable reduction in the percentage of cultures passed as B. coli over that in Table No. I. This is due in a considerable extent to the fact that, in the larger variety of samples examined during this portion of the work, a larger variety of species has been encountered, with many of which we were unfamiliar.

A considerable number of cultures have been marked doubtful at the start, but which it has been necessary should be confirmed by further tests, until the characteristics of such species could be readily diagnosed. Consequently, the results shown in Table No. I. represent more nearly those which would be obtained in the routine examination of a single water, while those in Table No. II. are probably more nearly representative of the results in a laboratory where a large and varied list of samples were to be examined. The slightly increased strictness in reading the tests, as explained elsewhere, has also had a tendency to restrict the number of cultures passed as belonging to the colon group, while making the results of the diagnosis agree more nearly with the typical B. coli communis.

In some laboratories there is a demand that the time required for the making of the analysis shall be cut to the least possible limit, and in some cases the time required for the colon tests is reduced by making the final reading on the gelatin in seven or even in four days.

The percentage value of the gelatin tests as reported in four, seven or ten days, as compared with the fourteen-day reading, for different classes of samples, can be roughly estimated from the figures in the table.

In neither of the tables has the efficiency of the Wurtz agar plate in throwing out samples suspected of pollution been included. The following figures will show the percentage of positive tests in preliminary fermentation which were also positive on the Wurtz agar plate: —

	Per Cent.
From ice,	73
From spring waters, etc.,	78
From shellfish, etc.,	72
From filtered waters,	76

During the past two years one species has caused considerable trouble. This produces a colony on the Wurtz agar plate which is of a different shade of red from that which we have been accustomed to consider as typical of colon, and the plates have a strong acid odor. This has been thrown out by the confirmatory tests, and with experience it can safely be thrown out on the plate test alone, but, until perfectly sure of our diagnosis, we have been obliged to include the culture for confirmation. Later studies of this type have shown that it is a micrococcus or streptococcus; that it grows rapidly in sugar solutions, producing acid without the production of gas, usually overgrowing and crowding out the gas-producing species, which, however, may have formed sufficient gas during the earlier portion of the incubation to give us a positive preliminary fermentation test, which we are unable to confirm. In order to avoid this, it will probably be necessary to make the time for the preliminary fermentation test considerably less than has been the usual practice. While we cannot include this species in the colon group, it is still possible that its identification may be of considerable sanitary value. Houston[4] has described this form, giving it the name of sewage streptococcus; and, quite recently, Winslow and Hunnewell[5] have suggested that its presence is an indication of fæcal pollution.

This form was not observed at Lawrence prior to the winter of 1900–1901, but has since been isolated from a number of sources, being especially common during the winter months.

Another type which causes some trouble produces a small, compact, brick-red colony on the Wurtz agar plate. This type does not give the proper cultural reactions on milk, nitrates or Dunham's solution; and its appearance on the plate is so well marked, that, after one is sure of the characteristics, it may be readily thrown out without further confirmation.

This form also appears to be a micrococcus, although its cultural characteristics are different from the acid form just mentioned.

SPECIES STUDIES.

In the following pages it is proposed to set down all of the different species and races of bacteria which we have isolated during the routine studies heretofore reported, and to indicate some of the methods of study of these species, and to show wherein these methods have differed from the standard methods recommended by the bacteriological committee, together with the reasons for those differences. As has been previously stated, it has been our endeavor, during the past two years, to isolate and study every type of culture differing from the standard colon bacillus which has appeared in the course of the routine studies. In all we have isolated and studied about one hundred and fifty cultures, from which we have obtained forty-six cultures, as indicated in Table No. IV., which are either different species or are varieties or strains of the known species. Some of these are types which would probably never be confounded with the true colon type, while others would be included by many observers in the colon group, from which they differ only in minor characteristics.

III. — On the Methods for the Differentiation of Bacteria.

The recommendations of the bacteriological committee leave little to be desired with regard to the preparation and reaction of media, and, with few exceptions, we have followed the procedure proposed by them. Some of the tests which they recommend have been omitted, as not of sufficient diagnostic value in the present studies. These are as follows: —

Morphology: vacuoles, crystals.

Gelatin plate: size, color and description of colony.

Gelatin stab: rate of growth, surface characteristics in non-liquefying colonies, and detailed description of growth.

Agar plate: detailed description of colony.

Nutrient broth: time elapsing before appearance of sediment; pellicle and turbidity; color, thickness and structure of pellicle; color and amount of deposit; appearance of tube after shaking; color of broth; quantitative reaction after a stated time.

Milk: color of milk, amount of whey, formation of gas.

Range of reaction.

This latter test for range of reaction appears to be of doubtful value, as it is well known that all cultures are sensitive to both acids and alkalis, if the range is only extended far enough in either direction; and, while the determination of the optimum reaction may have some value as a differential test, we are inclined to think that, from the data at hand, it should be included with the thermal death point as factors that are directly influenced by the previous history of the culture.

With regard to the time of incubation, we have made readings of the biological features on the fourth, seventh, tenth and fourteenth days. We have considered that the time in which a reaction was produced was of minor value, and have recorded a reaction as plus, at whatever time it appeared, or as negative if it was not manifest by the fourteenth day.

We have also followed a uniform procedure of incubation of all cultures at 20° C. in an incubator. While all of our cultures have grown more or less readily at body temperature, and probably many of the biochemical reactions could have been obtained earlier at this temperature, we have considered that, for cultures of water bacteria, a standard incubation at the lower temperature was the better procedure.

Preliminary Cultivation.

During the earlier portion of the study of the species the cultures were put through the preliminary cultivation as recommended by Fuller and Johnson[7] in their paper on the differentiation of water bacteria, after which the usual tests were made. Some of the results obtained after this revivification were rather contrary, and we were led to believe that a more extended course of treatment would be of advantage. The principal discrepancies noted seemed to be in the motility, the turbidity in broth and the reaction in the fermentation tube.

After some study of these points with different methods of preliminary cultivation, the following method was adopted and applied to all cultures before making species tests: —

Incubate forty-eight hours in broth, plate out on gelatin and incubate for forty-eight hours, fish to agar streak and incubate forty-eight hours, then put through two successive generations in broth of forty-eight hours each, after which the cultures were brought back to agar streak, and inoculations made into the various culture media from the forty-eight hour streak culture. During the course of study of these cultures, extending over nearly two years, all of the cultures have been put through the cultural tests a number of times, at intervals of from two to three months, and in each case this method of revivification has been rigidly followed before making cultural tests.

The practice in storage of cultures has been the usual one of keeping them on agar, transferring to fresh streaks about once a month. The regeneration which the cultures have had at intervals has undoubtedly helped to keep them up to strength, and it seems advisable that revivification should be practised periodically on all stock cultures.

With regard to the theory of preliminary cultivation, the writer is inclined to believe that the cultural characteristics of a species are more apt to vary when first transferred from water to media than later, when it has, so to speak, become acclimated to the laboratory environment.

Since it is manifestly impossible to study a species in its natural habitat, *i.e.*, in water, and is frequently embarrassing to study it immediately on its isolation, it seems to be advisable to allow a culture to remain on media of the same reaction and similar composition to that on which it is to be studied, for a space of time greater or less, as future experience may dictate, before attempting to describe it. The relatively greater constancy of results of old stock cultures over cultures recently isolated would seem to confirm this.

With the exception of the gas formula in the fermentation tube, which will be discussed elsewhere, the cultural, biochemical and morphological features of our cultures appear to have been constant after the different intervals of storage during the time that the cultures were under study.

Flagella Preparations.

The determination of the flagellation of motile bacteria, while recognized to be of importance, has been neglected in the majority of published descriptions of water bacteria, mainly because of the supposed great difficulty in the methods for the differentiation. In a classification such as the one proposed in this paper this determination becomes of paramount importance; and we have given some study to the methods for the staining of flagella, all of which appear

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Of the methods which we have tried, we have had fairly good success with all, but have given preference to two, — Lowit's method, and the Pitfield method as modified by Robert Muir.[8] The former possesses the advantage that all staining and mordaunting is done in the cold, and any possible distortion due to heating is eliminated. This method has the disadvantage, however, that the stain must be applied for a considerable length of time to ensure good results. The Muir-Pitfield method is much more rapid, and in our hands has given equally good results with the Lowit method. By this method we have with very few exceptions been able to make satisfactory preparations after one or two trials, the exceptions being due probably to the cultures not being in the proper condition, rather than to any difficulty in the staining itself.

The process which we have employed in getting the cultures ready for staining has differed from that usually recommended, and to its use much of our success can undoubtedly be attributed. The procedure is as follows: —

Fresh agar streak cultures are made of the organism which it is desired to stain just after it has come through the preliminary cultivation, these being incubated over night at 20° C. In the morning a small loop from the young culture is transferred to a tube of sterile tap water, the loop being held in the water for a few moments without shaking, until a slight turbidity appears in the water in the vicinity of the loop.

The water culture is then incubated at the body temperature, if the organism grows well at that temperature, for five or six hours; or at room temperature, if the culture does not grow at 38° C., for eighteen to twenty-four hours. After incubation, two or three large loopfuls of this water culture, taken from just below the surface, are transferred without shaking to the cover glass and allowed to dry spontaneously in the air, after which the preparation is fixed very slightly in the flame, and then mordaunted and stained. Since the majority of species of bacteria live and multiply readily in water culture, we have only young, well-flagellated specimens on our preparation, the older individuals, whose life history is complete, having settled to the bottom; and, if sufficient care is taken in the transfer not to shake or stir up the specimen, so that the flagella are not broken or disarranged in handling, we get preparations in which the arrangement of the flagella is as nearly normal as is possible in a fixed specimen.

On the Use of Sugar Solutions in the Differentiation of Bacteria.

Since Smith[1] first published his notable work on the fermentation tube, the value of sugar solutions has been generally recognized in bacteriological diagnosis. This diagnosis has been usually divided into five heads, as follows, —

1. Production or non-production of gas.
2. Production or non-production of acid in the absence of gas production.
3. Amount of gas produced.
4. Amount of acid produced.
5. Percentage of carbon dioxide in the gas formed, —

all of the above tests being applied to the three sugars, dextrose, lactose and saccharose. Smith,[9] working with a few selected cultures, came to the conclusion that all of the above features were of good diagnostic value, although his published results varied considerably among themselves, and were open to the criticism, in the light of present knowledge, that no regular method of revivification was practised. Russell[18] has made the gas ratio $X - CO_2 = 1 - 2$ the criterion of B. coli communis, excluding from the colon group all forms which give a different percentage of carbon dioxide. Grimbert,[10] and later Pammel and Bennett,[11] studying B. coli communis, found that both the amount of gas produced and the percentage of carbon dioxide obtained from the same culture, under identical conditions, were widely variable.

Fuller and Johnson,[7] in their work on water bacteria at Cincinnati, found that, with recently isolated cultures, even after preliminary cultivation, the amounts of gas and acid produced were so irregular that they were of little value; and they further came to the conclusion that it would be better to use only dextrose, omitting the other sugars.

In the present work we have studied each of these points, giving special attention to the gas ratio. We had hoped that after a more extended course of preliminary cultivation, it would be possible to obtain gas ratios which would be comparable, and consequently be of very considerable value in species differentiation. In this point we have failed, the same culture at different times giving entirely different percentages of carbon dioxide, although all the conditions under which the tests were applied were kept as nearly uniform as possible. We have been compelled to adopt the conclusions of the observers last mentioned with regard to the acid and gas production; but from our own work we think that the use of the different sugars is of sufficient value to warrant their continued use.

In all, the studies have included about one hundred different cultures, of which more than one-third were different species or races; but only a few of the great number of tests made are produced here, as representative of the variation in the results of the tests made at different times with all of the cultures. In Table No. III., the successive columns headed A, B, C, D, show the results of tests made with the same cultures at different times, an interval of from two to three months generally elapsing between the successive tests, which in every case were only applied after preliminary cultivation as described elsewhere. The individual figures in each column are the results of the duplicate or triplicate tests made at the same time.

TABLE NO. III. — *Showing the Variation in the Percentages of Carbon Dioxide in the Gas produced in Dextrose Broth in the Fermentation Tube by the Same Culture at Different Times.*

Species Number.	Determination.			
	A.	B.	C.	D.
43,	33 33	47 42 33	- 55 50	- -
46,	41 45	- 56 53	- 65 61	- -
49,	100 100	- 100 100	0 0 0	11 15
50,	61 60	- 58 61	- 33 42	64 64
51,	50 52	- 51 50	35 39 38	41 47
56,	85 92	- 63 68	0 0 13	38 38
82,	31 22	- 0 18	0 0 0	- -
86,	72 75	- 56 57	- 63 69	- -
116,	80 60	58 56 53	- 66 67	- -
117,	31 33	- 63 68	59 63 56	- -

The figures in the above table are sufficient to establish the inefficiency of the gas ratio determination. In cultures Nos. 49 and 56 we see an especially marked irregularity, the percentage of carbon dioxide varying between none at all and 100 per cent., and some of the other cultures show nearly as much variation. The reason for such variation may be partly attributed to very slight differences in the composition of the culture media, since this is subject not only to the variation which necessarily must occur in media made with meat, but which is also subject to slight changes in composition during sterilization. Very slight changes in the condition of the culture and in the temperature of incubation may also make considerable differences in the results obtained, and these variations appear to be ouside of the control of the most careful operator.

Recent experiments on media have indicated that the omission of the meat will give us a more constant medium for tests in sugar solutions, and a pepton dextrose solution without beef broth has been recently substituted for the usual Smith's solution in the routine colon work at the station. Studies of the gas ratio, acid production, etc., are in progress, but the results are not sufficiently complete to be reported at this time.

In the use of the fermentation tube we have revived one test originally proposed by Smith, but lately fallen into disuse, which appears to have some value, and which has given constant results in our hands. This consists in the addition of sterile litmus solution to one or more of the tubes at the time of inoculation. Besides the usual appearance of the acid reaction, we have noted that some of the cultures bleached the litmus, while others, although they may have produced turbidity in the closed arm, did not bleach it.

Reduction of Nitrates.

In the study of the reaction of bacteria on broth containing nitrates too little attention has been paid in the past to the different ways in which this reduction may go. The fact that a reduction to nitrites has taken place has been the usual test; and more recently bacteriologists have made tests for ammonia in case nitrites were not fonnd, or for a loss of nitrogen in case neither nitrites nor ammonia were found.

Wolff[12] has shown that this reduction may take place in a number of different ways, with the formation of nitrites, ammonia and free nitrogen, or any one of these, or any combination may be formed; and, furthermore, that this reduction to the different forms may take place simultaneously, or that one reaction may be complete before the second begins.

With this in mind we have made tests for both nitrites and ammonia in all cultures, and in some cases tests also for reduction to free nitrogen. As the latter test involves considerable quantitative chemistry, it is possible that its application may be of somewhat doubtful value except in cases where neither nitrites nor ammonia are reported, in which case of course it is important. In a number of instances, however, varieties of similar cultures have been reported which show different nitrate reductions.

Production of Indol.

In testing for the production of indol we have found it better to use the older and less complex medium known as Dunham's solution, rather than the sugar-free broth, as proposed by Smith.[13] The reasons for this are threefold: 1. In a series of experiments made in this laboratory it was found that a simplification of the usual culture media leads to better bacterial development. The meat broth is one of the most complex and the most subject to variation of all the ingredients of our culture media; and to this, in the process of freeing it from sugar, we introduce the complications of the products of bacterial decomposition, toxins, enzymes, etc., wholly unknown in their amount and in their effect on the development of the particular culture of bacteria which we wish to study. 2. In a comparative study of the two media extending over some months, the results of which are out of place here, we have been able to get equally good reactions with either of the two media. 3. The preparation of the sugar-free broth is more complicated, and requires more time and skill than the preparation of the Dunham's solution, without any commensurate benefit in the results obtained.

Lactose Litmus Agar.

Besides the usual reading of the production of acid in the lactose litmus agar, as shown by the red colonies, we have made the additional reading as to whether the red colony was permanent, or was later turned blue. It is a well-known fact that some species of bacteria produce acid during the first part of their growth, and later produce alkali sufficient to more than neutralize the acid first formed. For cultures of the class which we are here reporting we consider this a valuable addition to the tests applied to the cultures.

Growth on Gelatin.

After a considerable study of the different growths on gelatin, both on the plate and in tube culture, we find that the various characteristic appearances which we have been accustomed to use in the descriptions of cultures are so variable that only slight reliance can be placed on them as factors in the differentiation of species, on the plate especially slight variations in the medium causing wide variations in the shape and structure of the liquefying colonies. In the gelatin tube we have recognized only three type forms of liquefaction, — saccate or cup, infundibuliform or funnel, and stratiform; and frequently these forms merge into one another, so that distinction is lost. Since this article was prepared, Whipple,[20] in his studies of gelatin as a culture medium, has found that even the above forms were entirely dependent on the character of the gelatin, which varied with the different brands of commercial gelatin used; and further, he finds that the character of the line and surface growth are widely variable, and even the liquefaction is rather erratic.

IV. — Proposed Classification of Bacteria.

Up to the present time the question of classification or grouping of bacteria has been rather a difficult one, and the number of systems proposed and in use, all having good and weak points, has made the writer somewhat diffident about offering any new system. The systems in use to-day may be divided into three general classes: (1) those in which the classification is based on morphology; (2) those in which it is based on biochemical and cultural reactions; and (3) those combining both morphological and biological features.

Of the first, the systems of Migula[14] and Fisher[15] are perhaps the best known; while of the second, that of Fuller and Johnson[7] is perhaps better known than many of the others.

Conn[16] has modified the method of Fuller and Johnson by including some morphological features, while Chester[17] has adapted a combination of Migula's and Fisher's systems, together with certain cultural features to suit the exigencies of the descriptive literature of the past. From what little we know about bacteria to-day, it seems that the future system must be based on a combination of morphology and biology, and must be sufficiently elastic to admit of such modifications as the future may show to be necessary, without disarranging the essential features of the system. Wyatt Johnston,[19] in a paper on the "Grouping of Water Bacteria," read at the Bacteriological Convention in 1895, suggested: "That all of the important characters of a given species might be recorded more compactly than at present, if a system were adopted by which the information furnished by the various tests could be represented by numbers, each stated in a definite order so as to form a code. In this the type of growth on different media, staining, fermentation, etc., would be recorded in a very condensed form, capable of being taken in at a glance, or so that a comparison of any one species, description with any other one, would be a rapid and easy affair, instead of a troublesome and tedious affair. This would differ from the existing keys, in that every leading characteristic would be given in the case of every species, and thus form a sort of cross-index to the species when grouped in natural manner."

In library work and in general business the numerical or decimal system has been found to be the only one which fulfilled all of the general requirements; and it would seem that some system of this kind could be well applied to descriptive bacteriology and bacteriological grouping, to considerable advantage.

In the decimal system, as applied to literature, the numbers are arbitrarily, though logically, assigned. Rickards[21] has assigned arbitrary numbers to certain species in his system of recording bacteria cultures genealogically. It is comparatively easy, however, to derive these numbers by having them represent certain characteristics of the species. Such a system, suggested by A. I. Kendall, has been modified and elaborated by the writer, and during the time which it has been used in this laboratory has proved very satisfactory.

In this system each group of bacteria becomes known by its characteristic number, this number showing the characteristics of the species which appear to be the ones essentially necessary to divide the species into definite and logical groups. Following a decimal point, more numbers may be added, showing further characters of the species, until we arrive at a group of numbers which effectively show the species, thus effectively fulfilling Wyatt Johnston's prediction.

It will thus become possible, when the distinction between species and variety is properly defined, to substitute numbers for names of new species, thus avoiding the confusion existing at present, where many practically identical descriptions are published under various names by different observers.

In the system which we have used in this work we have carried the scheme only through the grouping, with one subdivision of the groups. The group is indicated by four numbers, followed by a decimal point. Of these numbers, the first two signify the morphology, motility and flagellation, and are based on the accepted classification of Migula. The third figure of the group number shows the two principal biochemical features, the liquefaction of gelatin and the fermentation of dextrose, as suggested by groups IX to XIII of Fuller and Johnson. The fourth figure shows the fluorescence and chromogenesis on agar, and are similar to groups I to VIII of Fuller and Johnson. If future work shows that other features are important in the division into groups, these can be inserted in their proper place in the system without deranging what has already been done.

Following is the detailed system, as used in this paper, showing the derivation of the figures used in the classification and its subdivisions, which we have employed with the bacteria which are here described. The group is represented by four figures; the first two figures represent the morphology, motility and flagellation, as follows: —

1. Coccaceæ.
    11. Streptococcus, division in one plane.
    12. Micrococcus, division in two planes.
    13. Sarcina, division in three planes.
    14. Planococcus, motile coccus.
    15. Planosarcina, motile sarcina.

2. Bacteriaceæ.
    20.* Motile rods, flagella not determined.
    21. Bacterium, non-motile rods.
    22. Pseudomonas, α, motile rods, flagella monotrichic.
    23. Pseudomonas, β, motile rods, flagella lophotrichic.
    24. Bacillus, motile rods, flagella peritrichic.

3. Spirillaceæ.
    31. Spirosoma, cells rigid, without flagella.
    32. Microspira, cells rigid, 1 (rarely 2-3) polar flagellum.
    33. Spirillum, cells rigid, polar flagella tufts.
    34. Spirochæta, cells flexuous.

* 20 is a provisional group, and should disappear, its members falling into 22-23 or 24.

The third figure is a function of the liquefaction of gelatin and the fermentation of dextrose, as follows: —

Gelatin.	Dextrose Broth.
1. Non-liquefied,	No gas or acid produced.
2. Non-liquefied,	No gas, acid produced.
3. Non-liquefied,	Gas produced.
4. Liquefied,	No gas or acid produced.
5. Liquefied,	No gas, acid produced.
6. Liquefied,	Gas produced.
7.* Doubtful,	No gas or acid produced.
8.* Doubtful,	No gas, acid produced.
9.* Doubtful,	Gas produced.

* In groups 7, 8, 9, would be included the so-called thermophylic species, which do not grow at the temperature at which gelatin is solid.

The fourth figure shows the fluorescence or chromogenesis on agar, viz.: —

1. All fluorescent species, irrespective of their chromogenesis.
2. All red chromogenic species.
3. All orange chromogenic species.
4. All yellow chromogenic species.
5. All blue and violet species.
6. All green chromogenic species.
7. All brown chromogenic species.
8. - - -
9. All others not included in the above.

Following the decimal point, we have used a sub-classification based on the reaction on milk, nitrate broth and production of indol, as follows: —

	Milk coagulated.	Nitrates produced.	Indol produced.
1,	0	0	0
2,	0	0	+
3,	0	+	0
4,	0	+	+
5,	+	0	0
6,	+	0	+
7,	+	+	0
8,	+	+	+

.s an example of the above, B. coli falls in group 2439.8, being ıcillus which does not liquefy gelatin, produces gas in dextrose th, is neither fluorescent nor chromogenic on agar, and which co- lates milk, reduces nitrates to nitrites and produces indol.

—DESCRIPTION OF SPECIES OF BACTERIA ISOLATED DURING THE ROUTINE B. COLI STUDIES.

We have been able to include all of the descriptive matter rela- e to the different species which we have isolated during the studies rein described in tabular form, where it is readily accessible for mparison with other similar data. We have grouped the species cording to the system just described, and have arranged the groups numerical order. To such species as we have been able to identify ith previously described species we have given names; those of our vn work which do not agree with any descriptions to which we have ad access, and the majority of which are probably new species, we ave preferred to allow to remain unnamed, in the hopes that the ystem of numbering may find acceptance, and that, with a more omplete system of decimal figures for the species, these may form . nucleus for a numerical instead of a verbal nomenclature.

Some of the species which have been included in the table show ncomplete descriptive data. These are cultures which died out during the process of study, and, owing to the rapid change in the ideas concerning bacterial descriptions during the past two years, much of the data which we now consider essential was not completed during the earlier portion of the studies. These descriptions are included for what they may be worth, more to show the variety than as a final species description. The reactions as they stand, however, agree well with the earlier tests made when the culture was run through the routine tests for B. coli.

REFERENCES TO LITERATURE CITED IN THE TEXT.

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[2] Thirtieth annual report Massachusetts State Board of Health, 1898, page 533.

[3] The writer, Journal of Applied Microscopy, IV., 1901, page 1403.

[4] Houston, report to London County Council on Bacterial Treatment of Crude Sewage, III., May 24, 1900.

[5] Winslow and Hunnewell, Science, May 23, 1902, page 827.

[6] Journal of American Public Health Association, January, 1898.

[7] Fuller and Johnson, Journal of Experimental Medicine, IV., 1899, page 609; also Journal of American Public Health Association, 1899.

[8] Muir and Ritchie, Manual of Bacteriology, Edinburgh, 1899, page 116.

[9] Theobald Smith, American Journal of Medical Sciences, September, 1895.

[10] Grimbert, Annales de l'Institut Pasteur, XIII., 1898, page 67.

[11] Pammel and Bennett, Journal of American Chemical Society, XVIII., 1900, page 157.

[12] Wolff, Hygienische Rundschau, IX., 1899, page 1169.

[13] Theobald Smith, Journal of Experimental Medicine, II., 1897, page 543.

[14] Migula, System der Bakterien, Jena, 1900.

[15] Fischer, Structure and Functions of Bacteria, Oxford, 1900.

[16] Conn, 1899 report Storrs (Conn.) Agricultural Experiment Station.

[17] Chester, eleventh annual report Delaware College Agricultural Experiment Station, 1899; also, Manual of Determinative Bacteriology, New York, 1901.

[18] Russell, Journal of American Public Health Association, 1899.

[19] Wyatt Johnston, Journal of American Public Health Association, October, 1895, page 445.

[20] Whipple, Technology Quarterly, XV., 1902, page 127.

[21] Rickards, thirteenth annual report Boston Health Department, 1901, page 75.

LAWRENCE EXPERIMENT STATION, July 1, 1902.

FOOD AND DRUG INSPECTION.

FOOD AND DRUG INSPECTION.

The department of food and drug inspection as at present conducted by the State Board of Health has been in operation since and including the year 1883, under the provisions of a general statute of 1882, with such amendments as have been enacted since that date. This general act, with the amendments enacted previous to the present year, has now been embodied in the Revised Laws of 1902, together with the other laws relating to public health.

The following report deals with the work of the Board under the acts relating to food and drug inspection for the year ended Sept. 30, 1901.

By the terms of the food act, Revised Laws, chapter 75, section 7, the Board is required to "report annually to the Legislature the number of prosecutions made under the act, and an itemized account of all money expended in carrying out the provisions thereof."

This report was made to the Legislature in January, 1902, and is also embodied in the following detailed report of observations for the fiscal year ended Sept. 30, 1901.

The general supervision of the work has been carried out under the direction of the secretary, as in former years, including the collection of samples, their examination by the analysts, the prosecution of offenders, and other necessary work under these statutes, including the correspondence with such parties as may have a direct interest in these statutes, either in the State or out of it.

This correspondence in recent years has been unusually large, in consequence of the constant sale of articles of food in Massachusetts, which are prepared in other States, where different laws prevail, and on account of the enactment of new statutes relating to food inspection.

The following persons comprised the force employed by the Board during the year in this department of work: —

ALBERT E. LEACH,	*Analyst.*
C. A. GOESSMANN,	*Analyst.*
HERMANN C. LYTHGOE,	*Assistant Analyst.*
JOHN F. MCCAFFREY,	*Inspector.*
JOHN H. TERRY,	*Inspector.*
HORACE F. DAVIS,	*Inspector.*

The number of samples of food and drugs examined during the year is shown in the accompanying table, together with a condensed summary of the work done since and including the year 1883.

In the reports of previous years tables are presented giving the summary for each year in parallel columns. For the sake of brevity these columns of figures for single years are now omitted, except those of the two years 1900 and 1901.

Number of samples of milk examined,	6,247
Number of samples above standard,	4,490
Number of samples below standard,	1,757
Percentage of adulteration or deficiency,	28.1
Number of samples of other kinds of food examined (not milk),	3,120
Number of samples above standard,	2,530
Number of samples below standard,	590
Percentage of adulteration,	18.9
Number of samples of drugs examined,	958
Number of samples of good quality,	468
Number of samples adulterated (as defined by the statutes),	490
Percentage of adulteration,	51.3
Total number of samples of food and drugs examined,	10,325
Total number found to be of good quality,	7,488
Total number not conforming to the statutes,	2,837
Percentage of adulteration,	27.5

FOOD AND DRUG INSPECTION (1883-1901).

SUMMARY.	YEARS.		
	1900.	1901.	Total 1883-1901.
Number of samples of milk examined,	6,232	6,247	69,863
Number of samples above standard,	4,431	4,490	43,854
Number of samples below standard,	1,801	1,757	26,009
Percentage of adulteration,	28.9	28.1	37.2
Number of samples of other kinds of food examined (not milk),	3,132	3,120	45,845
Number of samples of good quality,	2,670	2,530	37,274
Number of samples adulterated, as defined by the statutes,	462	590	8,571
Percentage of adulteration,	14.2	18.9	18.7
Number of samples of drugs examined,	758	958	12,131
Number of samples of good quality,	377	468	7,484
Number of samples adulterated, as defined by the statutes,	381	490	4,647
Percentage of adulteration,	50.2	51.3	38.2
Total examinations of food and drugs,	10,122	10,325	127,839
Total examinations of good quality,	7,478	7,488	88,612
Total examinations not conforming to the statutes,	2,644	2,837	39,227
Percentage of adulteration,	26.1	27.5	30.7
Expense of collection, examination and prosecution,	$11,108 73	$12,341 38	$185,289 29
Expense of collection, examination and prosecution, per sample,	1 10	1 19	1 45

From the foregoing table it appears that the whole number of samples of food and drugs examined during the year ended Sept. 30, 1901, was 10,325, and the general ratio of adulteration found to exist was 27.5 per cent. Comment has usually been made in these reports upon the fact that this ratio of adulteration must not be taken to represent the actual condition of the food supply in this direction, since only those articles which are liable to adulteration are collected for examination. The actual ratio of adulteration of the general food supply constitutes but a small fraction or percentage of the whole. Certain selected articles, however, are specially liable to adulteration, and these are the kinds of food or drugs which are usually collected for examination. The principal reasons for this liability consist mainly in the high cost of the article in question, its scarcity, the question of supply and demand, and the ease with which adulteration is practised and concealed from ordinary detection.

The whole number of samples of food examined since the beginning of work in 1883 was 127,839, of which more than half, or 69,863, were samples of milk. The amount of money expended in the enforcement of the food and drug acts from the beginning of work has been $185,289.29 and the expense per sample was $1.45 for the whole time. This expense, however, has been reduced from $2.26 per sample in 1883 to $1.19 in 1901, or nearly one-half.

The routine work of the Board in the inspection of food and drugs during the past year has been very much like that of the years immediately preceding, the force employed was the same and the appropriation was the same. New forms of adulteration appear from time to time, and as often as they are detected they are made the object of careful study, and methods are devised for their detection. For example: the methods of coloring milk have undergone several changes since this practice was first introduced. For several years caramel or burnt sugar was the only substance employed for this purpose, then various preparations of annatto were used for a series of years, and now the most common coloring matter for milk is an orange aniline dye. All of these, however, are easy of detection.

The adulteration of cider vinegar has been increasing in recent years in consequence of a scarcity of apples in what are usually termed "off years," and this has led to the introduction of artificial imitations of the genuine product from other States at a low price.

Reference will also be found in the report of the analyst to the increase in the adulteration of certain food products sold under the names of preserves, jellies, jams, marmalades, etc. If the use of coloring matters in these products were forbidden by law, as is done in some States, very many of these products would disappear, since these artificial colors are employed for the purpose of concealing their fraudulent character.

The same comment may be made upon the various compounds which have been devised for use as flavoring extracts.

In the course of investigations which have been made with reference to the existence of arsenic in food and drugs during the past year, the examinations for arsenic in glycerine were continued, and in addition it was found that phosphate of soda, a drug in common use, occasionally contained considerable quantities of this poison. In one instance as much as 80 parts in 100,000 were found, a decidedly dangerous quantity. Complaints were entered in court in some cases where glycerine and phosphate of soda containing arsenic had been sold, and convictions were secured against the vendors, after which this dangerous adulteration was found to have diminished in frequency.

Cities and Towns to which Notices were sent on Account of Adulterated Milk in 1901.

Abington,	1	New Bedford,	1
Attleborough,	8	Newburyport,	1
Ayer,	2	Newton,	15
Bedford,	1	North Attleborough,	1
Beverly,	1	Peabody,	2
Boston,	17	Pepperell,	1
Brockton,	6	Plymouth,	1
Brookfield,	1	Provincetown,	2
Brookline,	3	Quincy,	5
Cambridge,	7	Rehoboth,	2
Chelmsford,	1	Revere,	9
Chelsea,	18	Salem,	13
Chicopee,	1	Somerville,	23
Dedham,	1	Stoneham,	1
Everett,	3	Taunton,	4
Fall River,	5	Waltham,	10
Fitchburg,	1	Wareham,	1
Gloucester,	11	Watertown,	7
Haverhill,	10	West Bridgewater,	1
Hyde Park,	4	West Brookfield,	1
Lawrence,	6	Westfield,	2
Leominster,	1	Woburn,	2
Lowell,	18	Worcester,	2
Malden,	3		
Medford,	2	Total,	239

Cities and Towns to which Notices were sent on Account of Adulterated Articles of Food other than Milk.

Amherst,	1	Lowell,	20
Attleborough,	2	Medford,	2
Boston,	72	Montague,	1
Brockton,	1	New Bedford,	6
Cambridge,	7	Newburyport,	1
Chelsea,	3	Newton,	2
Chicopee,	3	Pittsfield,	2
Clinton,	1	Salem,	2
Edgartown,	1	Somerville,	6
Everett,	2	Springfield,	14
Fall River,	3	Taunton,	2
Franklin,	1	Tisbury,	1
Gloucester,	1	Watertown,	1
Haverhill,	4	Westfield,	6
Hingham,	1	Worcester,	3
Holyoke,	19		
Hudson,	2	Total,	210
Lawrence,	17		

Cities and Towns to which Notices were sent on Account of Adulterated Drugs.

Arlington,	1	Montague,	3
Attleborough,	4	Nantucket,	2
Boston,	76	New Bedford,	1
Brookline,	1	Newton,	2
Cambridge,	7	North Attleborough,	2
Chelsea,	2	Provincetown,	1
Chicopee,	1	Rockland,	1
Cottage City,	3	Somerville,	4
Fall River,	1	Tisbury,	2
Fitchburg,	1	Vineyard Haven,	1
Greenfield,	1	Ware,	1
Hingham,	1	Warren,	5
Holyoke,	5	Watertown,	2
Lawrence,	7	Webster,	2
Lowell,	1	Westfield,	1
Malden,	3	Worcester,	2
Medford,	1		
Milton,	3	Total,	151

Summary.

Notices sent on account of adulterated milk,	239
Notices sent on account of other articles of food,	210
Notices sent on account of drugs,	151
	600

The following report was transmitted to the Legislature as required by the statutes, Jan. 7, 1902: —

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, Jan. 7, 1902.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The following summary is made in compliance with the provisions of chapter 289, section 2, of the Acts of 1884, requiring the State Board of Health to "report annually to the Legislature the number of prosecutions made under chapter 263 of the Acts of 1882, and an itemized account of all money expended in carrying out the provisions thereof."

The whole number of prosecutions made by authority of the Board against offenders, under the provisions of the food and drug acts, for the year ended Sept. 30, 1901, was 95.

The cities and towns in which the articles were sold, and in respect to which complaints were entered in court, the character of the articles found to be adulterated or fraudulently sold, the dates of the trials, and their results, are presented in the following list: —

MILK AND MILK PRODUCTS.

For Fraudulent Sales of Milk.

PLACE.	DATE.	RESULT.
Boston,	Sept. 10, 1901,	Convicted.
Boston,	Sept. 10, 1901,	Convicted.
Lowell,	Feb. 15, 1901,	Convicted.
Lowell,	Feb. 15, 1901,	Convicted.
Lowell,	Feb. 15, 1901,	Convicted.
Lowell,	Feb. 21, 1901,	Convicted.
Lowell,	Feb. 21, 1901,	Convicted.
Lowell,	Feb. 23, 1901,	Convicted.
Lowell,	Feb. 23, 1901,	Convicted.
Lowell,	Feb. 23, 1901,	Convicted.
Lowell,	Feb. 23, 1901,	Convicted.
Lowell,	March 2, 1901,	Convicted.
Lowell,	March 2, 1901,	Convicted.
Lowell,	March 2, 1901,	Convicted.
Lowell,	March 5, 1901,	Convicted.
Lowell,	March 6, 1901,	Convicted.
Lowell,	March 9, 1901,	Convicted.
Lowell,	March 9, 1901,	Convicted.
Lowell,	March 19, 1901,	Convicted.
Lowell,	June 22, 1901,	Convicted.
Lowell,	June 22, 1901,	Convicted.
Lowell,	June 22, 1901,	Convicted.
Lowell,	June 22, 1901,	Convicted.
Lowell,	June 22, 1901,	Convicted.

MILK AND MILK PRODUCTS — Concluded.

For Fraudulent Sales of Milk — Concluded.

PLACE.	DATE.	RESULT.
Lowell,	June 28, 1901,	Discharged.*
Lawrence,	Feb. 19, 1901,	Discharged.
Lawrence,	Feb. 19, 1901,	Discharged.
Fall River,	Sept. 26, 1901,	Convicted.
Gloucester,	Aug. 26, 1901,	Convicted.
Gloucester,	Sept. 17, 1901,	Convicted.
Gloucester,	Sept. 17, 1901,	Convicted.
Chelsea,	Aug. 31, 1901,	Discharged.†
Taunton,	April 16, 1901,	Convicted.
Waltham,	Oct. 15, 1900,	Convicted.
Waltham,	March 5, 1901,	Convicted.
Waltham,	March 5, 1901,	Convicted.
Waltham,	March 15, 1901,	Convicted.
Newton,	Nov. 17, 1900,	Convicted.
Newton,	Nov. 17, 1900,	Convicted.
Woburn,	Feb. 16, 1901,	Convicted.
Woburn,	Feb. 16, 1901,	Convicted.
Leominster,	Nov. 14, 1900,	Convicted.
Cottage City,	Oct. 11, 1900,	Convicted.
Cottage City,	Oct. 11, 1900,	Convicted.
Cottage City,	Oct. 11, 1900,	Convicted.
Hawley,	Dec. 6, 1900,	Convicted.
Westwood,	Dec. 24, 1900,	Convicted.
Walpole,	Dec. 3, 1900,	Convicted.
Whitman,	Dec. 5, 1900,	Convicted.
Whitman,	Aug. 3, 1901,	Convicted.
Whitman,	Aug. 3, 1901,	Convicted.
Oxford,	Jan. 30, 1901,	Convicted.
Littleton,	Jan. 16, 1901,	Convicted.
Littleton,	Sept. 18, 1901,	Convicted.
Medway,	Feb. 26, 1901,	Convicted.
Barre,	Feb. 27, 1901,	Convicted.
Barre,	Feb. 27, 1901,	Convicted.
Carlisle,	March 11, 1901,	Convicted.
Watertown,	March 22, 1901,	Convicted.
Concord,	May 23, 1901,	Convicted.
Harvard,	July 2, 1901,	Convicted.
Franklin,	July 30, 1901,	Convicted.
Bellingham,	Aug. 22, 1901,	Convicted.
Pepperell,	Sept. 11, 1901,	Convicted.
Wareham,	Sept. 27, 1901,	Convicted.

* The result of the analysis made by the defendant's chemist showed so wide a divergence from that of the State's chemist as to lead to the belief that another sample had been substituted.

† This defendant was discharged upon his plea that the milk taken by the inspector was not for sale. It had been watered and treated with formaldehyde.

Molasses.

Place.	Date.	Result.
Cottage City,	Oct. 11, 1900,	Convicted.
Fall River,	Dec. 7, 1900,	Convicted.

Syrup.

Fall River,	Jan. 10, 1901,	Convicted.

Maple Syrup.

Franklin,	April 25, 1901,	Discharged.

Lard.

Chelsea,	June 26, 1901,	Convicted.*

Cocoa.

Haverhill,	Dec. 22, 1900,	Nol. pros.†
Boston,	Dec. 22, 1900,	Convicted.
Boston,	March 2, 1901,	Convicted.

Coffee.

Fall River,	Dec. 28, 1900,	Convicted.
Springfield,	May 16, 1901,	Convicted.

Extract of Vanilla.

Boston,	March 1, 1901,	Convicted.
Lawrence,	May 21, 1901,	Convicted.
Springfield,	May 23, 1901,	Convicted.

Extract of Lemon.

Boston,	March 1, 1901,	Convicted.
Malden,	March 25, 1901,	Convicted.
Chelsea,	March 12, 1901,	Convicted.
Boston,	April 17, 1901,	Convicted.
New Bedford,	April 24, 1901,	Convicted.
Taunton,	May 8, 1901,	Convicted.
Springfield,	May 23, 1901,	Convicted.
Springfield,	May 23, 1901,	Convicted.
Fall River,	June 12, 1901,	Convicted.

* In this case the party who sold the lard was found guilty in the lower court, and appealed. He was tried in the superior court and again convicted, but his counsel filed exceptions, to the effect that the State had no jurisdiction, the lard having been sold at the Marine Hospital, upon property of the United States. The case was taken to the United States district court, and is not yet settled.

† In this case a fine was not imposed, since a new complaint was made against the wholesaler, who was convicted.

PEPPER.

PLACE.	DATE.	RESULT.
Fall River,*	Nov. 23, 1900,	Convicted.
Fall River,*	Nov. 23, 1900,	Convicted.
Fall River,*	Nov. 23, 1900,	Convicted.
Fall River,	Dec. 28, 1900,	Convicted.
Franklin,	April 25, 1901,	Convicted.

CAYENNE PEPPER.

Fall River,	Dec. 28, 1900,	Convicted.

MACE.

Worcester,	Jan. 22, 1901,	Convicted.

CREAM OF TARTAR.

Worcester,	Jan. 22, 1901,	Convicted.

The number of complaints entered in court under the provisions of the acts relating to milk was 65; other articles of food, 30; total, 95.

SUMMARY.

The whole number of complaints entered by the State Board of Health during the year ended Sept. 30, 1901, in the courts of the Commonwealth against parties for violation of the statutes relating to food and drug inspection, was 95. In 90, or 94.5 per cent. of these, the parties were convicted, and 5 were discharged.

Of the whole number, 65 were for violation of the statutes relating to the adulteration of milk, and of this number 61 resulted in conviction. The greater number of these were for violation of the statutes providing that milk offered for sale shall be of good standard quality. In 14 of the foregoing cases the complaints were for sales of milk containing coloring matter.

The other articles of food with reference to which complaints were made were as follows: molasses, 2 cases; syrup and maple sugar, 2 cases; lard, 1 case; cocoa, 3 cases; coffee, 2 cases; extract of vanilla, 3 cases; extract of lemon, 9 cases; spices, including pepper, cayenne and mace, 7 cases; cream of tartar, 1 case.

Among the most common adulterations met with during the past year have been the many imitations of flavoring extracts, many of which are of a worthless character; the various imitations of jams,

* These complaints were made against one individual for three sales of different articles, the wholesaler being a Philadelphia dealer.

jellies and preserves, containing scarcely any of the natural fruits which are called for by the consumer; and an unusual amount of an artificial product sold as cider vinegar. Nearly all of these preparations are artificially colored to represent genuine products, the use of coloring matter constituting a valuable aid to the professional adulterator.

Since frequent inquiries are made for the recently enacted statutes relating to food inspection, the following laws are herewith published for general information: —

[ACTS OF 1897, CHAPTER 344.]

AN ACT RELATIVE TO THE ADULTERATION OF FOOD.

SECTION 1. No person shall within this Commonwealth manufacture for sale, offer for sale, or sell any article of food which is adulterated within the meaning of this act.

SECTION 2. The term "food," as used herein, shall include all articles used in food or drink by man, whether simple, mixed or compound.

SECTION 3. An article shall be deemed to be adulterated within the meaning of this act in the case of food: 1. If any substance or substances have been mixed with it, so as to lower or to depreciate or injuriously affect its quality, strength or purity. 2. If any inferior or cheaper substance or substances have been substituted wholly or in part for it. 3. If any valuable or necessary constituents or ingredients have been wholly or in part taken from it. 4. If it is in imitation of or is sold under the name of another article. 5. If it consists wholly or in part of a diseased, decomposed, putrid, tainted or rotten animal or vegetable substance or article, whether manufactured or not, or, in the case of milk, if it is produced from a diseased animal. 6. If it is colored, coated, polished or powdered in such a manner as to conceal its damaged or inferior condition, or if by any means it is made to appear better, or of greater value, than it really is. 7. If it contains any added substance or ingredient which is poisonous or injurious to health.

Provided, that the provisions of this act shall not apply to mixtures or compounds recognized as ordinary articles or ingredients of articles of food, if every package sold or offered for sale is distinctly labelled as a mixture or compound, with the name and per cent. of each ingredient therein, and if such mixtures or compounds are not injurious to health.

SECTION 4. No person shall offer for sale any canned articles of food after the first day of January in the year eighteen hundred and ninety-eight except goods packed prior to the passage of this act, unless such articles bear a mark to indicate the grade or quality thereof, together with the name and address of the person, firm or corporation which packed the same, or of the dealer who sells the same.

SECTION 5. All canned articles of food prepared from dried products which have been soaked before canning shall be plainly marked by an adhesive label, having on its face the word "soaked," in letters not less in size than two-line pica, of legible type; and all cans, jugs and other packages containing maple syrup or molasses shall be plainly marked by an adhesive label, having on its face the name and address of the person, firm or corporation which made or prepared the same, together with the name and quality of the ingredients of the goods, in letters of the size and description above specified.

SECTION 6. Any person, firm or corporation falsely stamping or labelling any cans, jars or other packages, containing fruit, or food of any kind, or knowingly permitting such false stamping or labelling, and any person, firm or corporation violating any of the provisions of this act, shall be deemed guilty of a misdemeanor, and shall be punished by a fine of not less than ten dollars nor more than one hundred dollars in the case of vendors, and, in the case of manufacturers and those falsely or fraudulently stamping or labelling such cans, jars or other packages, by a fine of not less than one hundred dollars nor more than five hundred dollars.

SECTION 7. All acts and parts of acts inconsistent herewith are hereby repealed.

The following statute, as amended in 1899 (by chapter 223 of the Acts of that year), presents the standard of milk in Massachusetts at the date of publishing this report:—

[ACTS OF 1899, CHAPTER 223.]

In all prosecutions under this chapter, if the milk is shown upon analysis to contain less than thirteen per cent. of milk solids, or to contain less than nine and three-tenths per cent. of milk solids exclusive of fats, or to contain less than three and seven-tenths per cent. of fat, it shall be deemed for the purposes of this act to be not of good standard quality, except during the months of April, May, June, July, August and September, when milk containing less than twelve per cent. of milk solids, or less than nine per cent. of milk solids exclusive of fat, or less than three per cent. of fat, shall be deemed to be not of good standard quality.

The two following laws were enacted by the Legislature of 1901, and measures were taken by the Board, within sixty days after the passage of each act, which the Board deemed "sufficient to make the provisions of these two acts known to the persons who may be affected thereby." An edition of 15,000 copies was printed, and these were sent to the various manufacturers and dealers in the articles named in these acts.

[Acts of 1901, Chapter 341.]

An Act relative to the Sale of Articles of Food and Drink which contain Antiseptic or Preservative Substances.

Section 1. Every article sold as an article or ingredient of food or drink that contains any added antiseptic or preservative substance except common table salt, saltpetre, cane sugar, alcohol, vinegar, spices, and in smoked food the natural products of the smoking process, shall be deemed to be adulterated within the meaning of chapter three hundred and forty-four of the acts of the year eighteen hundred and ninety-seven, unless every package of such article sold or offered for sale bears a label on which are clearly indicated the presence and the percentage of every such antiseptic or preservative substance.

Section 2. The foregoing provision shall not apply to such portions of suitable preservative substances as are employed as a surface application for preserving dried fish or meat, or to such preservative substances as exist in animal or vegetable tissues as a natural component thereof, but shall apply to additional quantities.

Section 3. This act shall be construed as in addition to and not superseding or annulling any of the provisions of existing laws.

Section 4. Within sixty days after the passage of this act the state board of health shall take such measures as the board may deem sufficient to make the provisions of the act known to the persons who may be affected thereby.

Section 5. Goods held in stock by retail dealers prior to the date of the taking effect of this act, if proved to have been so held, shall be exempt therefrom during the first year of the operation of this act.

Section 6. Section four of this act shall take effect upon its passage, and the remainder of the act shall take effect on the first day of January in the year nineteen hundred and two. [*Approved May 1, 1901.*

[Acts of 1901, Chapter 396.]

An Act relative to the Labelling of Certain Articles of Food and Drink.

Section 1. In every case where a statement of any of the ingredients is required by law to be announced upon the label of an article of food or drink, or of an article entering into food or drink, such statement, and the name and address of the manufacturer or vendor of the article, shall be distinctly and conspicuously printed on the label, in straight, parallel lines of plain, uncondensed, legible type, well spaced on a plain ground. The statement of ingredients shall be clearly separated from and not interspersed or confused with other matter, shall specify every such ingredient by its ordinary name, and shall be in the English language. The letters of said type shall be not less than one-twelfth of an inch long, and shall be larger than those of any other printed matter on the label or package, except that the name of the compound or chief article enclosed therein may be in larger type. The required label shall be firmly attached to or printed on the exterior of the package or envelope of the said article, on the top or side thereof, in plain sight.

SECTION 2. The state board of health may in writing approve specific labels not strictly in accordance with the provisions of section one, if they deem that the information required by law is set forth thereon clearly enough for the reasonable protection of the purchaser.

SECTION 3. Except as otherwise provided in section two, goods labelled in violation of section one hereof shall be subject to the same provisions of the laws relative to adulteration of food which would apply to them if unlabelled.

SECTION 4. Within sixty days after the passage of this act the state board of health shall take such measures as the board may deem sufficient to make the provisions of the act known to the persons who may be affected thereby.

SECTION 5. Goods held in stock by retail dealers prior to the date of taking effect of this act, if proved to have been so held, shall be exempt therefrom during the first year of the operation of this act.

SECTION 6. This act shall be construed as in addition to and not as superseding or annulling any of the provisions of existing laws relative to the labelling of articles of food or drink.

SECTION 7. Section four of this act shall take effect upon its passage, and the remainder of the act shall take effect on the first day of January in the year nineteen hundred and two. [*Approved May 16, 1901.*

The whole number of samples of food and drugs examined in this department since the beginning of work in 1883 was 127,840, and the number of complaints entered in court was 1,571. The average cost per sample for collection, analysis and other work has been reduced from $2.26 in 1883 to $1.19 in 1901.

The following list presents the total solids in each of the samples of milk upon which complaints were founded, so far as records of the same were kept: —

8.03	10.20	10.87	11.11	11.70
8.45	10.30	10.88	11.20	11.70
8.80	10.40	10.90	11.24	11.71
9.07	10.64	10.92	11.25	11.71
9.40	10.64	11.00	11.30	11.76
9.60	10.65	11.05	11.44	11.80
9.70	10.80	11.08	11.50	11.84
9.71	10.80	11.08	11.60	11.90
9.92	10.80	11.09	11.60	11.90
9.99	10.84	11.10	11.69	

The total number of samples of food and drugs examined during the year was as follows: —

Milk,	6,247
Other articles of food,	3,120
Drugs,	958
Total,	10,325

Total expenses of collection, examination and prosecution,	$12,341 38
Average expense per sample collected,	1 19

Fines.

The amount of fines paid into the treasuries of counties, cities and towns, under the provisions of the general and special laws relative to the inspection of food and drugs, was as follows: —

Fines paid for the Violation of the Food and Drug Acts upon Cases entered for the Year ending Sept. 30, 1901.

Under the provisions of the laws relating to milk and milk products,	$1,445 00
Under the provisions of the laws relating to other articles of food,	429 70
Total,	$1,874 70

The total amount of fines imposed since the beginning of the enforcement of the general food acts to Sept. 30, 1901, was $37,003.84.

Expenditures

Under the Provisions of the Food and Drug Acts during the Year ending Sept. 30, 1901.

	For the Enforcement of the Statutes relating to Food and Drug Inspection.	
	Relative to Milk and Milk Products.	Relative to Other Kinds of Food and Drugs.
Salaries of analysts,	$2,895 00	$1,930 00
Salaries of inspectors,	2,675 00	1,777 53
Travelling expenses and purchase of samples,	1,140 00	755 11
Apparatus and chemicals,	578 18	375 00
Printing,	4 00	3 01
Special investigations,	–	23 00
Services (cleaning laboratory),	70 00	34 00
Express,	–	6 21
Sundry laboratory supplies,	30 00	14 85
Books,	–	9 24
Extra services (stenographer),	12 75	8 50
	$7,404 93	$4,936 45
		7,404 93
Total,		$12,341 38

SAMUEL W. ABBOTT, *Secretary.*

REPORT OF THE ANALYST.

By Albert E. Leach.

REPORT OF THE ANALYST.

By Albert E. Leach.

Dr. S. W. Abbott, *Secretary State Board of Health.*

Dear Sir: — I herewith submit my report on the analysis of food and drugs for the year ending Sept. 30, 1901.

Milk.

The number of samples of milk analyzed, as well as the ratio of adulteration, do not differ materially from the figures of the last three years. Additional experience has tended to confirm the views expressed in the analyst's report of 1899 relative to the difference in legal standard of milk solids during the summer and the winter, viz., that there would seem to be no good reason for a difference of 1 per cent. in the total solids for the two seasons of the year other than the question of demand and supply. No such difference, as a matter of fact, was found to exist in the large number of samples tabulated in the report for 1899, wherein all the samples of milk brought in during the months of December and June from the various cities and towns throughout the State were analyzed in full, and the averages of total solids, fat and solids not fat were summarized.*

It would seem as if the chief reason why milk is of a lower standard in summer than in winter is on account of the greater demand, rather than the difference in the quality of the feed. For example, at some of the summer resorts the demand for milk during the hot months of the year is much greater than that of the winter months, and in many localities the number of cows supplying milk for the summer guests is not materially increased. The lower quality of the milk supply under these conditions is very marked,

* Thirty-first Annual Report Massachusetts State Board of Health (1899), p. 615.

especially at the various crowded sea-shore resorts. It would seem as if a uniform standard of 12½ per cent. for total solids for the entire year would be more equitable.

The usual statistics follow, summarizing, in tabular form, the quality of the milk from cities, towns and suspected producers, analyzed during the year.

Milk from Cities.

CITIES.	Total Samples collected.	Number above Standard.	Number below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.	Number of Samples colored with Annatto.	Number of Samples colored with Aniline Orange.	Number of Preserved Samples.	Number of Samples preserved with Formaldehyde.	Number of Samples preserved with Boric Acid.
Boston,	375	243	120	32.1	8.80	-	7	7	-	2	2	-
Brockton,	163	125	38	22.6	11.30	-	-	-	-	-	-	-
Cambridge,	460	305	155	33.7	10.65	-	-	-	-	-	-	-
Chelsea,	190	120	70	36.8	10.20	-	-	-	-	-	-	-
Everett,	150	106	44	29.3	10.40	1	-	-	-	8	8	-
Fall River,	168	135	33	19.0	10.10	-	-	-	-	1	1	-
Fitchburg,	94	76	18	19.1	11.72	5	-	-	-	-	-	-
Gloucester,	118	91	27	22.9	11.28	-	7	5	2	-	-	-
Haverhill,	272	174	98	32.3	8.95	1	-	-	-	1	1	-
Lawrence,	141	98	43	30.5	8.90	2	2	-	2	-	-	-
Lowell,	257	161	96	37.4	8.80	4	23	-	23	-	-	-
Malden,	181	126	55	30.3	11.00	-	-	-	-	-	-	-
Marlborough,	49	44	5	10.2	9.73	2	-	-	-	-	-	-
Medford,	121	78	43	35.5	10.45	-	-	-	-	-	-	-
New Bedford,	26	18	8	30.8	11.26	-	-	-	-	-	-	-
Newburyport,	105	86	19	18.5	11.50	3	-	-	-	-	-	-
Newton,	217	165	52	24.4	8.99	4	3	3	-	10	10	-
Quincy,	105	80	25	23.8	10.30	4	-	-	-	-	-	-
Salem,	167	120	47	28.1	9.73	-	-	-	-	10	10	-
Somerville,	439	270	169	36.5	10.00	-	-	-	-	3	-	3
Taunton,	120	110	10	8.3	9.70	2	-	-	-	-	-	-
Waltham,	121	79	42	34.1	11.80	1	3	-	3	2	2	-
Woburn,	66	44	22	31.8	10.09	-	1	-	1	-	-	-
Worcester,	172	138	34	19.8	9.00	6	-	-	-	2	2	-
Summary,	4,275	2,992	1,283	30.0	8.80	35	46	15	31	39	36	3

Milk from Towns.

Towns.	Total Samples collected.	Number above Standard.	Number below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.	Number of Samples colored with Annatto.	Number of Samples colored with Aniline Orange.	Number of Preserved Samples.	Number of Samples preserved with Formaldehyde.	Number of Samples preserved with Boric Acid.
Attleborough, . .	137	111	26	18.9	10.00	4	-	-	-	9	-	9
Ayer, ...	7	5	2	28.5	10.30	-	-	-	-	-	-	-
Bedford, . . .	25	19	6	24.0	11.20	-	-	-	-	-	-	-
Beverly, ...	12	3	9	75.0	11.85	-	-	-	-	-	-	-
Billerica, . . .	6	6	-	0.0	12.00	-	-	-	-	-	-	-
Brookline, . . .	134	112	22	16.4	11.57	-	-	-	-	-	-	-
Canton, ...	30	29	1	3.3	12.80	1	-	-	-	-	-	-
Clinton, ...	50	41	9	18.0	9.40	8	-	-	-	-	-	-
Concord, . . .	2	-	2	100.0	10.30	-	-	-	-	-	-	-
Dedham, . . .	96	82	14	14.6	11.47	-	-	-	-	-	-	-
Easton, ...	11	9	2	18.1	12.80	-	-	-	-	-	-	-
Falmouth, . . .	4	4	-	0.0	13.20	-	-	-	-	-	-	-
Framingham, . .	23	21	2	8.7	12.00	-	-	-	-	-	-	-
Franklin, . . .	4	4	-	0.0	12.10	-	-	-	-	-	-	-
Hull, ...	10	9	1	10.0	11.70	-	-	-	-	-	-	-
Hyde Park, . . .	134	100	34	25.4	10.40	-	-	-	-	-	-	-
Leominster, . . .	35	23	12	34.3	8.45	-	-	-	-	-	-	-
Lexington, . . .	5	-	5	100.0	11.85	-	-	-	-	-	-	-
Milford, ...	37	32	5	13.5	10.20	1	-	-	-	-	-	-
Natick, ...	47	37	10	21.3	10.56	3	-	-	-	-	-	-
Nantucket, . . .	8	8	-	0.0	12.40	-	-	-	-	-	-	-
North Attleborough, .	8	7	1	12.5	11.30	-	-	-	-	-	-	-
Norwood, . . .	10	10	-	0.0	12.06	1	-	-	-	-	-	-
Peabody, . . .	31	21	10	32.2	10.20	-	-	-	-	1	1	-
Plymouth, . . .	54	47	7	12.9	11.45	2	-	-	-	-	-	-
Provincetown, . .	41	38	3	7.3	11.11	-	-	-	-	2	2	-
Revere, ...	119	87	32	26.9	8.60	-	-	-	-	1	1	-
Salisbury, . . .	30	26	4	13.3	11.40	-	-	-	-	-	-	-
Stoneham, . . .	45	36	9	20.0	6.80	-	-	-	-	-	-	-
Stoughton, . . .	71	64	7	9.8	12.12	-	-	-	-	-	-	-
Watertown, . . .	87	56	31	34.8	11.03	-	-	-	-	-	-	-
Webster, . . .	7	7	-	0.0	13.00	-	-	-	-	-	-	-
Wareham, . . .	19	12	7	36.9	10.64	-	-	-	-	-	-	-
Westborough, . .	18	17	1	5.6	11.23	1	-	-	-	-	-	-
Weymouth, . . .	32	31	1	3.1	11.84	-	-	-	-	-	-	-
Whitman, . . .	31	25	6	19.4	10.80	-	-	-	-	2	2	-
Winchester, . . .	58	35	23	39.7	9.60	-	-	-	-	-	-	-
Winthrop, . . .	58	45	13	22.4	12.20	-	-	-	-	-	-	-
Summary, . .	1,536	1,220	316	20.3	6.80	21	-	-	-	15	6	9

Milk from Suspected Producers.

Locality.	Total Samples collected.	Number above Standard.	Number below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.
Barre, ...	13	-	13	100.0	10.66
Bedford, ...	20	7	13	65.0	10.02
Bellingham, ...	13	5	8	61.6	9.99
Bolton, ...	9	9	-	0.0	12.10
Charlemont, ...	20	-	20	100.0	7.91
Franklin, ...	5	3	2	40.0	10.80
Harvard, ...	6	2	4	66.7	10.90
Littleton, ...	17	-	17	100.0	9.60
Medway, ...	15	4	11	73.3	10.87
Needham, ...	20	20	-	0.0	12.08
Pepperell, ...	12	6	6	50.0	10.80
Southborough, ...	24	13	11	45.0	9.67
Walpole, ...	8	1	7	85.0	11.10
Waltham, ...	10	10	-	0.0	12.50
Wayland, ...	10	10	-	0.0	12.40

Milk from Suspected Producers — Concluded.

Locality.	Total Samples collected.	Number above Standard.	Number below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.
Webster,	8	-	8	100.0	8.03
Westborough,	9	9	-	0.0	13.03
West Brookfield,	21	15	6	28.6	10.90
Weston,	17	17	-	0.0	12.21
Westwood,	10	3	7	70.0	11.73
Summary,	267	134	133	49.8	7.91

Summary.

	Total Samples collected.	Number above Standard.	Number below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.	Number of Samples colored with Annatto.	Number of Samples colored with Aniline Orange.	Number of Preserved Samples.	Number of Samples preserved with Formaldehyde.	Number of Samples preserved with Boric Acid.
Cities,	4,275	2,992	1,283	30.0	8.80	35	46	15	31	39	36	3
Towns,	1,536	1,220	816	20.3	6.80	21	-	-	-	15	6	9
Suspected producers,	267	134	133	49.8	7.91	-	-	-	-	-	-	-
Miscellaneous,	31	26	5	16.1	10.60	-	-	-	-	-	-	-
Summary,	6,109	4,372	1,737	27.6	6.80	56	46	15	31	54	42	12

Samples of colored milk were collected from the following cities: Boston, Gloucester, Lawrence, Lowell, Newton, Waltham and Woburn. No samples of artificially colored milk were this year collected from towns.

Milk containing added preservative was collected from Boston, Everett, Fall River, Haverhill, Newton, Salem, Somerville, Waltham, Worcester, Attleborough, Peabody, Provincetown, Revere and Whitman. As a rule, milk artificially colored is below the legal standard of solids as well; but this year 4 samples out of the 46 found colored were above the standard. Of the milk with added preservatives, 40 samples were above the standard, so that 44 samples of milk should be added to the number of those tabulated as adulterated by being below the standard. The last two annual reports of the analyst contained most of the methods used in the laboratory for the routine analysis of milk.

Method for determining Milk Sugar. — It is rarely necessary in our work to make this determination, excepting in cases of milk of known purity, in which it is customary to express in full the total solids, fat, ash, milk sugar and proteids. Milk sugar is determined by means of the polariscope, and 65.36 grams are taken for analysis. The volume corresponding to this weight varies, of course, with the specific gravity, but in practice it has been found sufficiently accurate to employ a pipette, graduated to deliver 64 cubic centimeters. This amount is measured into a 100 cubic centimeter graduated flask, 2 cubic centimeters of a concentrated solution of acid nitrate of mercury are added and the flask is then filled to the mark with water. Instead of the nitrate of mercury, 10 cubic centimeters of sub-acetate of lead solution (United States Pharmacopœia) may be employed before making up to the mark. If the Ventzke polariscope is used, 2.6 cubic centimeters of water are added by means of a pipette to compensate for the volume of precipitated proteids. The contents of the flask are very gently shaken and poured upon a dry filter. The filtrate, which should be perfectly clear, is polarized in a 200 millimeter tube, and the scale reading of the instrument will express the exact percentage of milk sugar.

The percentage of proteids, as expressed in analyses of samples of milk of known purity, is usually determined by difference.

Quick Approximate Methods of testing Milk. — It is no longer necessary for milkmen to depend on the very rough and by no means accurate results hitherto obtained by means of the lactometer or milk hydrometer alone for determining the quality of their milk. The widespread use of the Babcock machine among milk dealers and creamery men has brought the price of this useful apparatus within the means of most dealers, and by its use it is possible to determine the percentage of fat in milk with accuracy. The percentage of total solids is, however, a much more important factor than the percentage of fat from the point of view of the milk dealer, who wishes to know whether he can, with safety, sell his product. From the fixed ratio between the total solids, the fat and specific gravity, if any two of these constants are known, the third may be readily calculated by means of formulæ worked out for the purpose or by the use of tables. In addition to the Babcock fat apparatus, an accurate lactometer and a thermometer are necessary. The most convenient form of lactometer is the Quevenne, which combines both the hydrometer and thermometer scales in one instrument. In taking the specific gravity, or lactometer reading of milk, it is very important that the temperature should be exactly 60° Fahrenheit.

It is possible, however, to take the specific gravity at other temperatures, and make the proper correction by means of tables prepared for this purpose. The following table will serve to correct the lactometer reading according to temperature: —

For correcting the Specific Gravity of Milk according to Temperature (by Dr. Paul Vieth).

Degrees of Lactometer.	Degrees of Thermometer (Fahrenheit).															
	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
20, . .	19.0	19.0	19.1	19.1	19.2	19.2	19.3	19.4	19.4	19.5	19.6	19.7	19.8	19.9	19.9	–
21, . .	19.9	20.0	20.0	20.1	20.2	20.2	20.3	20.3	20.4	20.5	20.6	20.7	20.8	20.9	20.9	–
22, . .	20.9	21.0	21.0	21.1	21.2	21.2	21.3	21.3	21.4	21.5	21.6	21.7	21.8	21.9	21.9	–
23, . .	21.9	22.0	22.0	22.1	22.2	22.2	22.3	22.3	22.4	22.5	22.6	22.7	22.8	22.8	22.9	–
24, . .	22.9	22.9	23.0	23.1	23.2	23.2	23.3	23.3	23.4	23.5	23.6	23.6	23.7	23.8	23.9	–
25, . .	23.8	23.9	24.0	24.0	24.1	24.1	24.2	24.3	24.4	24.5	24.6	24.6	24.7	24.8	24.9	–
26, . .	24.8	24.9	24.9	25.0	25.1	25.1	25.2	25.2	25.3	25.4	25.5	25.6	25.7	25.8	25.9	–
27, . .	25.8	25.9	25.9	26.0	26.1	26.1	26.2	26.2	26.3	26.4	26.5	26.6	26.7	26.8	26.9	–
28, . .	26.7	26.8	26.8	26.9	27.0	27.0	27.1	27.2	27.3	27.4	27.5	27.6	27.7	27.8	27.9	–
29, . .	27.7	27.8	27.8	27.9	28.0	28.0	28.1	28.2	28.3	28.4	28.5	28.6	28.7	28.8	28.9	–
30, . .	28.6	28.7	28.7	28.8	28.9	29.0	29.1	29.1	29.2	29.3	29.4	29.6	29.7	29.8	29.9	–
31, . .	29.5	29.6	29.6	29.7	29.8	29.9	30.0	30.1	30.2	30.3	30.4	30.5	30.6	30.8	30.9	–
32, . .	30.4	30.5	30.5	30.6	30.7	30.9	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7	31.9	–
33, . .	31.3	31.4	31.4	31.5	31.6	31.8	31.9	32.0	32.1	32.3	32.4	32.5	32.6	32.7	32.9	–
34, . .	32.2	32.3	32.3	32.4	32.5	32.7	32.9	33.0	33.1	33.2	33.3	33.5	33.6	33.7	33.9	–
35, . .	33.0	33.1	33.2	33.4	33.5	33.6	33.8	33.9	34.0	34.2	34.3	34.5	34.6	34.7	34.9	–

For correcting the Specific Gravity of Milk according to Temperature (by Dr. Paul Vieth) — Concluded.

Degrees of Lactometer.	Degrees of Thermometer (Fahrenheit).														
	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
20, ...	20.1	20.2	20.2	20.3	20.4	20.5	20.6	20.7	20.9	21.0	21.1	21.2	21.3	21.5	21.6
21, ...	21.1	21.2	21.3	21.4	21.5	21.6	21.7	21.8	22.0	22.1	22.2	22.3	22.4	22.5	22.6
22, ...	22.1	22.2	22.3	22.4	22.5	22.6	22.7	22.8	23.0	23.1	23.2	23.3	23.4	23.5	23.7
23, ...	23.1	23.2	23.3	23.4	23.5	23.6	23.7	23.8	24.0	24.1	24.2	24.3	24.4	24.6	24.7
24, ...	24.1	24.2	24.3	24.4	24.5	24.6	24.7	24.9	25.0	25.1	25.2	25.3	25.5	25.6	25.7
25, ...	25.1	25.2	25.3	25.4	25.5	25.6	25.7	25.9	26.0	26.1	26.2	26.4	26.5	26.6	26.8
26, ...	26.1	26.2	26.3	26.5	26.6	26.7	26.8	27.0	27.1	27.2	27.3	27.4	27.5	27.7	27.8
27, ...	27.1	27.3	27.4	27.5	27.6	27.7	27.8	28.0	28.1	28.2	28.3	28.4	28.6	28.7	28.9
28, ...	28.1	28.3	28.4	28.5	28.6	28.7	28.8	29.0	29.1	29.2	29.4	29.5	29.7	29.8	29.9
29, ...	29.1	29.3	29.4	29.5	29.6	29.8	29.9	30.1	30.2	30.3	30.4	30.5	30.7	30.9	31.0
30, ...	30.1	30.3	30.4	30.5	30.7	30.8	30.9	31.1	31.2	31.3	31.5	31.6	31.8	31.9	32.1
31, ...	31.2	31.3	31.4	31.5	31.7	31.7	31.8	32.0	32.2	32.4	32.5	32.6	32.8	33.0	33.1
32, ...	32.2	32.3	32.5	32.6	32.7	32.9	33.0	33.2	33.3	33.4	33.6	33.7	33.9	34.0	34.2
33, ...	33.2	33.3	33.5	33.6	33.8	33.9	34.0	34.2	34.3	34.5	34.6	34.7	34.9	35.1	35.2
34, ...	34.2	34.3	34.5	34.6	34.8	34.9	35.0	35.2	35.3	35.5	35.6	35.8	36.0	36.1	36.3
35, ...	35.2	35.3	35.5	35.6	35.8	35.9	36.1	36.2	36.4	36.5	36.7	36.8	37.0	37.2	37.3

The following table is introduced, by means of which the total solids corresponding to any given lactometer * reading and percentage of fat may be readily ascertained. This table has been recom-

* The "lactometer reading" is expressed in whole numbers for convenience. The true specific gravity corresponding to a given lactometer reading is obtained by writing 1.0 before the lactometer reading. Thus, 1.026 is the specific gravity corresponding to lactometer reading 26, etc.

puted from the table of S. M. Babcock * so as to express results in total solids rather than solids not fat.

Table showing Per Cent. of Total Solids in Milk corresponding to Quevenne Lactometer Readings and Per Cent. of Fat.

Per Cent. of Fat.	Lactometer Reading at 60° Fahrenheit.														
	22	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
0.0	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	9.00
0.1	5.62	5.87	6.12	6.37	6.62	6.87	7.12	7.37	7.62	7.87	8.12	8.37	8.62	8.87	9.12
0.2	5.74	5.99	6.24	6.49	6.74	6.99	7.24	7.49	7.74	7.99	8.24	8.49	8.74	8.99	9.24
0.3	5.86	6.11	6.36	6.61	6.86	7.11	7.36	7.61	7.86	8.11	8.36	8.61	8.86	9.11	9.36
0.4	5.98	6.23	6.48	6.73	6.98	7.23	7.48	7.73	7.98	8.23	8.48	8.73	8.99	9.23	9.48
0.5	6.10	6.35	6.60	6.85	7.10	7.35	7.60	7.85	8.10	8.35	8.60	8.85	9.10	9.35	9.60
0.6	6.22	6.47	6.72	6.97	7.22	7.47	7.72	7.97	8.22	8.47	8.72	8.97	9.22	9.47	9.72
0.7	6.34	6.59	6.84	7.09	7.34	7.59	7.84	8.09	8.34	8.59	8.84	9.09	9.34	9.59	9.84
0.8	6.46	6.71	6.96	7.21	7.46	7.71	7.96	8.21	8.46	8.71	8.96	9.21	9.46	9.71	9.96
0.9	6.58	6.83	7.08	7.33	7.58	7.83	8.08	8.33	8.58	8.83	9.08	9.33	9.58	9.83	10.08
1.0	6.70	6.95	7.20	7.45	7.70	7.95	8.20	8.45	8.70	8.95	9.20	9.45	9.70	9.95	10.20
1.1	6.82	7.07	7.32	7.57	7.82	8.07	8.32	8.57	8.82	9.07	9.32	9.57	9.82	10.07	10.32
1.2	6.94	7.19	7.44	7.69	7.94	8.19	8.44	8.69	8.94	9.19	9.44	9.69	9.94	10.19	10.44
1.3	7.06	7.31	7.56	7.81	8.06	8.31	8.56	8.81	9.06	9.31	9.56	9.81	10.06	10.31	10.56
1.4	7.18	7.43	7.68	7.93	8.18	8.43	8.68	8.93	9.18	9.43	9.68	9.93	10.18	10.43	10.68
1.5	7.30	7.55	7.80	8.05	8.30	8.55	8.80	9.05	9.30	9.55	9.80	10.05	10.30	10.55	10.80
1.6	7.42	7.67	7.92	8.17	8.42	8.67	8.92	9.17	9.42	9.67	9.82	10.17	10.42	10.67	10.92
1.7	7.54	7.79	8.04	8.29	8.54	8.79	9.04	9.29	9.54	9.79	10.04	10.29	10.54	10.79	11.04
1.8	7.66	7.91	8.16	8.41	8.66	8.91	9.16	9.41	9.66	9.91	10.16	10.41	10.66	10.91	11.17
1.9	7.78	8.03	8.28	8.53	8.78	9.03	9.28	9.53	9.78	10.03	10.28	10.55	10.78	11.04	11.29
2.0	7.90	8.15	8.40	8.65	8.90	9.15	9.40	9.65	9.90	10.15	10.40	10.66	10.91	11.16	11.41
2.1	8.02	8.27	8.52	8.77	9.02	9.27	9.52	9.77	10.02	10.27	10.52	10.78	11.03	11.28	11.53
2.2	8.14	8.39	8.64	8.89	9.14	9.39	9.64	9.89	10.14	10.39	10.64	10.90	11.15	11.40	11.65
2.3	8.26	8.51	8.76	9.01	9.26	9.51	9.76	10.01	10.26	10.51	10.76	11.02	11.27	11.52	11.77
2.4	8.38	8.63	8.88	9.13	9.38	9.63	9.88	10.13	10.38	10.63	10.88	11.14	11.39	11.64	11.89
2.5	8.50	8.75	9.00	9.25	9.50	9.75	10.00	10.25	10.50	10.75	11.00	11.26	11.51	11.76	12.01
2.6	8.60	8.87	9.12	9.37	9.62	9.87	10.12	10.37	10.62	10.87	11.12	11.38	11.63	11.88	12.13
2.7	8.74	8.99	9.24	9.49	9.74	9.99	10.24	10.49	10.74	10.99	11.24	11.50	11.75	12.00	12.25
2.8	8.86	9.11	9.36	9.61	9.86	10.11	10.36	10.61	10.86	11.11	11.37	11.62	11.87	12.12	12.37
2.9	8.98	9.23	9.48	9.73	9.98	10.23	10.48	10.73	10.98	11.23	11.49	11.74	11.99	12.24	12.49
3.0	9.10	9.35	9.60	9.85	10.10	10.35	10.60	10.85	11.10	11.36	11.61	11.86	12.11	12.36	12.61
3.1	9.22	9.47	9.72	9.97	10.22	10.47	10.72	10.97	11.23	11.48	11.73	11.98	12.23	12.48	12.74
3.2	9.34	9.59	9.84	10.09	10.34	10.59	10.84	11.09	11.35	11.60	11.85	12.10	12.35	12.61	12.86
3.3	9.46	9.71	9.96	10.21	10.46	10.71	10.96	11.22	11.47	11.72	11.97	12.22	12.48	12.73	12.98
3.4	9.58	9.83	10.08	10.33	10.58	10.83	11.09	11.34	11.59	11.84	12.09	12.34	12.60	12.85	13.10
3.5	9.70	9.95	10.20	10.45	10.70	10.95	11.21	11.46	11.71	11.96	12.21	12.46	12.72	12.97	13.22
3.6	9.82	10.07	10.32	10.57	10.82	11.08	11.33	11.58	11.83	12.08	12.33	12.58	12.84	13.09	13.34
3.7	9.94	10.29	10.44	10.79	10.94	11.20	11.45	11.70	11.95	12.20	12.45	12.70	12.56	13.21	13.46
3.8	10.06	10.31	10.56	10.81	11.06	11.32	11.57	11.82	12.07	12.32	12.57	12.82	13.08	13.33	13.58
3.9	10.18	10.43	10.68	10.93	11.18	11.44	11.69	11.94	12.19	12.44	12.69	12.94	13.20	13.45	13.70
4.0	10.30	10.55	10.80	11.05	11.30	11.56	11.81	12.06	12.31	12.56	12.81	13.06	13.32	13.57	13.83
4.1	10.42	10.67	10.92	11.17	11.42	11.68	11.93	12.18	12.43	12.68	12.93	13.18	13.44	13.69	13.95
4.2	10.54	10.79	11.04	11.29	11.54	11.80	12.05	12.30	12.55	12.80	13.05	13.31	13.56	13.82	14.07
4.3	10.66	10.91	11.16	11.41	11.66	11.92	12.17	12.42	12.67	12.92	13.18	13.43	13.68	13.94	14.19
4.4	10.78	11.03	11.28	11.53	11.78	12.04	12.29	12.54	12.79	13.04	13.30	13.55	13.80	14.06	14.31
4.5	10.90	11.15	11.40	11.65	11.90	12.16	12.41	12.66	12.91	13.16	13.42	13.67	13.92	14.18	14.43
4.6	11.02	11.27	11.52	11.78	12.03	12.28	12.53	12.78	13.03	13.28	13.54	13.79	14.04	14.30	14.55
4.7	11.14	11.40	11.65	11.90	12.15	12.40	12.65	12.90	13.15	13.40	13.66	13.91	14.16	14.42	14.67
4.8	11.27	11.52	11.77	12.02	12.27	12.52	12.77	13.02	13.27	13.52	13.78	14.03	14.28	14.54	14.79
4.9	11.39	11.64	11.89	12.14	12.39	12.64	12.89	13.14	13.39	13.64	13.90	14.15	14.40	14.66	14.91
5.0	11.51	11.76	12.01	12.26	12.51	12.76	13.01	13.26	13.51	13.76	14.02	14.27	14.52	14.78	15.03
5.1	11.63	11.88	12.13	12.38	12.63	12.88	13.13	13.38	13.63	13.89	14.14	14.39	14.64	14.90	15.15
5.2	11.75	12.00	12.25	12.50	12.75	13.00	13.25	13.50	13.75	14.01	14.26	14.51	14.76	15.02	15.27
5.3	11.87	12.12	12.37	12.62	12.87	13.12	13.37	13.62	13.87	14.13	14.38	14.63	14.88	15.14	15.39
5.4	11.99	12.24	12.49	12.74	12.99	13.24	13.49	13.71	14.00	14.25	14.50	14.76	15.01	15.26	15.51
5.5	12.11	12.36	12.61	12.86	13.11	13.36	13.61	13.86	14.12	14.37	14.62	14.88	15.13	15.38	15.63
5.6	12.23	12.48	12.73	12.98	13.23	13.48	13.73	13.99	14.24	14.49	14.75	15.00	15.25	15.50	15.75
5.7	12.35	12.60	12.85	13.10	13.35	13.60	13.85	14.11	14.36	14.61	14.87	15.12	15.37	15.62	15.87
5.8	12.47	12.72	12.97	13.22	13.47	13.72	13.97	14.22	14.48	14.74	14.99	15.24	15.49	15.74	15.99
5.9	12.59	12.84	13.09	13.34	13.59	13.84	14.10	14.35	14.60	14.86	15.11	15.36	15.61	15.86	16.12
6.0	12.71	12.96	13.21	13.46	13.71	13.96	14.22	14.47	14.72	14.98	15.23	15.48	15.73	15.98	16.24

* United States Department of Agriculture, Division of Chemistry, Bulletin 47, p. 124.

Artificial Coloring Matter in Milk. — Where formerly annatto was the chief coloring matter employed, of late years aniline orange is being used more and more for this purpose, as being, on the whole, a better counterfeit of the cream color in a rich Jersey milk. The following table has been introduced showing the extent to which various artificial coloring matters have been discovered during the last eight years in Massachusetts: —

Artificial Color in Milk.

Year.	Number of Samples analyzed.	Number of Colored Samples.	Number containing Annatto.	Number containing Orange Aniline.	Number containing Caramel.
1894,	3,551	16	16	-	-
1895,	3,794	38	34	4	-
1896,	4,484	45	39	6	-
1897,	6,046	54	50	4	-
1898,	6,247	37	29	2	6
1899,	6,186	23	23	-	-
1900,	6,232	67	20	43	4
1901,	6,109	46	15	31	-
Totals,	42,649	326	226	90	10

Thus, out of 42,649 samples of milk analyzed during these years, 326, or .76 per cent., were found to be artificially colored.

Preservatives in Milk. — During the last four years, all the samples of milk collected during the summer months have been systematically examined for preservatives, and the results are summarized in the following table: —

Preservatives in Milk.

Year.	Samples examined.	Number containing Formaldehyde.	Per Cent. containing Formaldehyde.	Number containing Boric Acid.	Per Cent. containing Boric Acid.	Number containing Carbonate.	Total containing Preservative.
1898,	1,046	26	2.5	11	1.0	4	41
1899,	2,105	55	2.6	13	.6	3	71
1900,	2,018	61	3.0	6	.3	-	67
1901,	2,154	42	1.9	12	.5	-	54
Totals,	7,323	184	2.5	42	.6	7	233

In 1898, samples were examined for preservatives during July and August only, and in the three following years during June, July, August and September. Out of 7,323 samples of milk examined, 184, or 3.2 per cent., were found to contain added preservatives. Formaldehyde is still used more than any other preservative.

*Quick Routine Methods for detecting Preservatives in Milk.**

1. *Formaldehyde.* — After having been examined for total solids and fat, the milk samples are arranged in order in their original containers, and about 10 cubic centimeters of each sample are poured into a casserole and tested in succession by means of the hydrochloric acid and ferric-chloride test,† holding the casserole by the handle while heating nearly to the boiling point and giving it a rotary motion to break up the curd. The well-known violet coloration shows formaldehyde. A large stock-bottle is kept on hand, containing the reagent ready for use, consisting of commercial hydrochloric acid (Sp. Gr. 1.20) containing 1 cubic centimeter of 10 per cent. ferric chloride solution to each 500 cubic centimeters of acid. Less than one minute is required in making the formaldehyde test for each sample.

2. *Carbonate and Boric Acid.* — These tests have been so simplified as to be, as it were, a side issue in the process of cleaning the platinum dishes used for the determination of total solids. The various residues from the total solids are burnt to an ash in the original numbered dishes in succession, these dishes after incineration being arranged side by side on a flat tray. By means of a pipette, one or two drops of dilute hydrochloric acid are introduced into each dish in succession, noting at the time any effervescence that may ensue, which is in itself an indication of sodium carbonate. After every milk ash has been acidulated, a few cubic centimeters of water are added to each dish by means of a wash bottle, the dissolving of the ash being hastened by giving a rotary motion to the tray containing the dishes. A strip of turmeric paper is then allowed to soak for a minute or so in each dish, after which it is withdrawn from contact with the solution and allowed to adhere to the side of the dish above the liquid, where it remains until dry. If the paper when dry is of a deep cherry-red color, turning a dark olive when treated with dilute alkali, the presence of boric acid is assured. These methods are, of course, preliminary tests for quickly singling out the preserved samples. Such confirmatory tests as are desired may in all cases be employed.

The quality of the milk examined by months during the year is shown in the following table: —

* Leach, Analyst, XXVI. (1901), p. 289.

† Thirty-first annual report Massachusetts State Board of Health (1899), p. 606.

Quality of Milk by Months.

	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
Number having more than 15 per cent. of total solids.	17	14	36	19	14	18	16	16	21	18	23	19	231
Number having between 14 and 15 per cent. of total solids.	52	44	74	48	42	46	48	32	41	35	38	31	531
Number having between 13 and 14 per cent. of total solids.	191	210	223	212	130	208	164	164	182	118	151	133	2,082
Number having between 12 and 13 per cent. of total solids.	213	129	141	159	155	204	218	260	258	243	256	240	2,476
Number having between 11 and 12 per cent. of total solids.	31	34	25	59	29	34	36	40	42	70	74	58	532
Number having between 10 and 11 per cent. of total solids.	11	19	8	19	8	9	9	9	4	22	15	24	157
Number having between 9 and 10 per cent. of total solids	4	10	5	6	6	4	9	4	4	8	5	11	76
Number having between 8 and 9 per cent. of total solids.	2	-	1	2	2	-	-	-	6	6	1	-	20
Number having less than 8 per cent. of total solids.	-	2	-	-	-	1	-	-	1	-	-	-	4
Number of samples of skimmed milk above the standard.	5	4	1	1	3	4	6	3	3	3	1	6	43
Number of samples of skimmed milk below the standard.	1	2	1	2	1	1	-	1	1	1	1	1	13

Cream.

Nine samples of cream were examined, 2 of which were found to be preserved with formaldehyde.

Condensed Milk.

During the past seven years nearly 100 brands of condensed milk have been analyzed in full, many of them several times, and the results tabulated in the analyst's reports for these years. It would therefore be unnecessary to duplicate these analyses, and in the following table are given the analyses in full of the new brands examined during the year, as well as of such brands as have run abnormally low in fat, even though analyzed previously: —

Brand.	Total Solids.	Water.	Milk Solids.	Cane Sugar.	Milk Sugar.	Protein.	Fat.	Ash.	Fat in Original Milk.
Dixie,	77.73	22.27	28.82	48.91	10.47	8.41	9.22	1.72	4.17
Plume,	73.49	26.51	30.22	43.27	13.40	6.55	8.72	1.55	2.62
Silver Cord,	74.37	25.63	29.24	45.13	10.15	9.76	7.83	1.50	3.30
Defiance,	73.12	26.88	32.20	40.92	13.40	10.53	6.84	1.43	2.48
Stag,	74.66	25.34	30.69	43.97	12.50	10.35	6.12	1.62	2.31
Regent,	75.43	24.57	29.45	45.98	11.55	10.48	5.94	1.48	2.37
Dot,	72.86	27.14	29.03	43.78	11.17	10.60	5.85	1.46	2.34
Arrow,	71.32	28.68	23.45	47.87	9.75	6.74	5.40	1.69	2.78

In the case of brands of milk collected and brought in, which have been analyzed in full many times in previous reports, the determination of fat alone was made as follows: —

Brand.	Fat.	Brand.	Fat.
Grandmother's,	11.97	Rose,	8.73
Eclipse Junior,	10.98	Rustic,	8.64
Tip Top,	10.44	Gail Borden Eagle,	8.38
Dixie,	9.72	J. B. Smith,	8.37
Tip Top,	9.72	Moosehead,	8.37
Hires,	9.72	Silver Cord,	8.10
Thistle,	9.61	Pennant,	7.80
Dairy,	9.18	Gail Borden Eagle,	7.38
Dairy,	9.00	Grandmother's,	7.35
Jersey,	9.00	Lion,	7.30
Milk Maid,	9.00	Lion,	7.02
Pine Tree,	9.00	Rustic,	6.70
Champlain,	8.82	Lion,	6.12
Ensign,	8.82	Dirigo,	6.04
Hero,	8.82	Lion,	5.40

Food exclusive of Milk.

Artificial Coloring Matter in Food. — The use of artificial dye stuffs in food products has greatly increased of late, so that the time would seem to be at hand when a special law should be framed, dealing more specifically and stringently with the question of colors than does the present general food law. Artificial dye stuffs are added to foods in most cases to conceal inferiority or to make them more attractive in appearance, thus tending to deceive the purchaser as to the quality of the goods. It would seem to be desirable to directly prohibit the use of coloring matter in food, unless so marked, with the possible exception of confectionery, certain dessert mixtures and perhaps a few other specified articles, wherein the presence of color cannot possibly deceive.

Probably the general public has become so accustomed to the artificial coloring of butter as to prefer it to the uncolored variety, so that butter would almost of necessity have to be included under the exceptional foods wherein added color could be used unmarked. As to the question of allowing the sale of colored oleomargarine, it is hard to see why the large number of people who desire to use this article on account of its cheapness and uniformly wholesome quality should be obliged to submit to so much difficulty in obtaining it. If oleomargarine is honestly sold, not for butter but for what it really is, the argument is advanced, with considerable reason, that yellow coloring matter, if not injurious to health, should be just as permissible in oleomargarine as in butter, for, as a matter of fact, the reason for the use of foreign coloring matter in both cases is to make the product appear of better value than it really is.

In the food and drug laboratory of the Board there is a varied collection of strips of woollen nun's veiling or albatross cloth originally white, dyed in a variety of fast colors by boiling up the pieces of woollen cloth in solutions of various food products sold commonly on the market, illustrating in a striking manner the extent to which jellies, jams, ketchups, fruit syrups and cordials, especially of the cheaper variety, are so frequently colored. Reds, pinks and orange colors were dyed from preserved fruits and ketchups, a deep yellow from lime juice and a brilliant green from "creme de menthe." The latter "cordial" consisted of sugar syrup slightly flavored with peppermint and deeply colored with the aniline dye. It was completely decolorized by boiling with the wool for a few minutes. Various fruit syrups are also commonly found with artificial color, the coloring matters being in nearly all cases aniline dyes. The exact class to which the dye belongs may in most instances be identified by experiments with various reagents on the dyed fibre. Azo-eosin has been found in raspberry and strawberry preserve; primulin orange in preserved quince; Bismarck brown in apricot, pineapple, etc.; chrysamin in orange fruit syrup; malachite green in creme de menthe; dinitrocresol and tropæolin in lemon extracts, etc.

Method of determining the Presence of Coal-tar Dye in Jellies, Jams, etc. — A good quality of worsted or white woollen cloth should be selected, taking care that the color is pure white and not the more common yellow-white. Nun's veiling has been found admirable. It should be freed from grease by boiling first in a very dilute soda solution and finally in water.

Strips of the woollen cloth thus prepared are boiled in diluted solutions of the jam or jelly, slightly acidified with hydrochloric acid. Arata* recommends boiling the wool in a dilute solution of

* Ztschr. Anal. Chem., 28 (1889), 639.

the material, to which potassium bi-sulphate has been added. After removing the wool from the solution, it is boiled in water and dried. The natural colors from fruit will make very little impression on the wool under this treatment, the cloth being usually colored only a slight muddy or brownish hue. The azo-aniline colors, usually quite brilliant, are so firmly fixed on the wool that no amount of boiling or soaping will remove them. Tables of classified colors are given in various text books, notably Allen's "Commercial Organic Analysis," for the identification of the particular dyes by means of treatment of the dyed wool with various reagents, such as concentrated acids and alkalis.

Arsenic in Food. — The large amount of arsenic found last year in English beer, which caused such disastrous results in Manchester, England, has led to an investigation as to whether arsenic is present, accidentally or otherwise, not only in beer, but also in many articles of food sold in this part of the world. In the English cases referred to the arsenic was traced to sulphuric acid, which entered into the manufacture of commercial glucose used in the beer. Much of the acid found so highly arsenical was made from Swedish pyrites, which was found to be abnormally high in arsenic.

It is a well-known fact that arsenic is commonly present in commercial sulphuric acid, and would also naturally occur in any food product into the manufacture of which sulphuric acid had entered. For this reason various food products have been examined in this laboratory for arsenic, and a number of samples of commercial glucose have been found to contain it, but to a very slight extent only. Arsenic in small traces has also been found and would naturally be expected in food compounds wherein commercial glucose was an ingredient, such, for example, as honey, molasses and maple syrup of the compound or adulterated variety, as well as confectionery.

Traces of arsenic have also been found in saleratus and incidentally in baking-powder, both of the phosphate and tartrate variety. It should be said, however, that the arsenic found in all these cases was present in very minute traces only, so small as to occasion absolutely no concern as an element of danger.

Desiccated Foods. — Various brands of desiccated milk and eggs, as well as some other foods, are quite common in our markets.

Some of these are honestly labelled, but many have labels which, to say the least, are misleading. In past reports of the Board several entirely factitious egg substitutes have been described, which in most cases, though purporting to resemble pure eggs in chemical composition, were found, as a matter of fact, to resemble them in color and appearance only. One brand, typical of this variety, consisted almost wholly of starch. A brand of desiccated egg, known as "Egg Flake," appears to be really a form of desiccated whole egg.

Several forms of desiccated skimmed milk have been sold as substitutes for eggs, and these indeed do possess a nitrogenous value, which is not true of the starch substitutes above referred to, though the claim commonly made that they replace fresh eggs in cooking at a fraction of the cost is not warranted.

Many brands of desiccated milk or milk powder are found, most of which purport to contain all the ingredients of milk, excepting water, but no samples of desiccated *whole* milk have yet come under the notice of the writer. All the samples analyzed in this laboratory have proved to be pulverized, dried skimmed milk.

Various other forms of desiccated foods are found, such, for example, as "prepared pumpkin," which contains, in powdered form, all the necessary ingredients for making pumpkin pie by simply adding milk.

Butter.

Number of samples examined, 116; number found adulterated, 7. Two samples classed as adulterated were oleomargarine, and 5 were renovated or process butter. Both the oleomargarine and the renovated butter were sold fraudulently as genuine butter.

Methods of detecting Renovated Butter. — The most distinctive chemical constants of genuine butter, namely, — the Reichert number, — the percentage of soluble fat acids, the saponification equivalent and the refractometer reading, are so nearly the same for both the genuine and the renovated variety as to be of little service in distinguishing between the two. It is, however, as a rule, a very simple matter to distinguish renovated from fresh pure butter. One of the best preliminary tests to apply is the so-called "spoon" or "foam" test. A small lump of the sample, about the size of a filbert, is heated over a low Bunsen flame in a large spoon, while being stirred. Genuine butter under these conditions will boil quietly but with the production of considerable froth or foam, leaving comparatively clear fat after the boiling. Renovated butter or oleomargarine under this treatment will bump and sputter like hot grease containing water, but will not foam, and after removing the spoon from the flame, masses of curd will usually be found in the melted fat.

Having distinguished pure butter from oleomargarine or process butter, the two latter may readily be distinguished from each other by the usual chemical tests or by the refractometer.

Another physical difference between renovated and pure butter is the appearance of the melted sample. If beakers containing pure and renovated butter are melted on a water bath, the curd of the pure sample will settle at once or in a very few minutes to the bottom after melting, leaving a comparatively clear supernatant fat. The renovated sample will nearly always fail to settle out clear, even after standing on the water bath for half an hour or more, but will still be cloudy throughout the mass, due to particles of floating curd.

The microscope is the very best means of distinguishing between the two. When viewed by polarized light under a low magnification, pure butter not previously melted should show theoretically no crystalline structure, being uniformly bright throughout, and, if the selenite plate be used, should present an evenly colored field entirely devoid of fat crystals. With process butter or oleomargarine, both of which have been melted and subsequently cooled, the crystalline structure should be marked, showing with polarized light a mottled appearance and a play of colors with the selenite.

Various conditions enter in to affect the reliability of the polarized light test. It is nearly always possible in cold winter weather to obtain these tests in a sharp and striking manner, but in the summer time, when pure butter melts so easily at ordinary temperatures, the distinction is not so marked. A very characteristic difference under the microscope between the two consists in the relative opacity of the fields. The fat film in the case of genuine butter is much more transparent than that of renovated. Again, the curd is so finely divided throughout the mass of genuine butter that the field is much more even than that of the renovated, wherein often large and opaque masses of curd are frequently distributed throughout the field.

Identification of Foreign Coloring Matter in Butter and Oleomargarine. — Where formerly annatto was used almost universally for coloring these products, the azo dyes have now almost entirely displaced it. A ready method of detecting this azo color is that of Low.* A small amount of material to be tested is melted in a test tube, an equal volume of a mixture of 1 part of concentrated sulphuric acid and 4 parts of glacial acetic acid are added, and the tube is heated nearly to the boiling point, the contents being thoroughly mixed by shaking; the tubes are set aside, and after the acid solution has settled out it will have been colored wine-red in the presence of azo color, while with pure butter-fat comparatively no color will be produced.

Mitchell's method for the detection of annatto and azo colors in butter is very satisfactory.† The melted sample is first filtered. Two test tubes are taken and into each are poured about 2 grams of the filtered fat, which is dissolved in ether. Into one test tube are poured 1 or 2 cubic centimeters of dilute hydrochloric acid, and into the other about the same volume of dilute potassium hydroxide solution. Both tubes are well shaken and allowed to stand. In the presence of azo dye, the test tube to which the acid has been added will show a pink to wine-red coloration, while the potash solution in the other tube will show no color. If annatto has been used, on the other hand, the potash solution will be colored yellow, while no color will be apparent in the acid solution. Further confirmatory tests may be made in both cases, if desired.

Canned Goods.

Only 3 samples were examined under this heading, these being canned fruits or vegetables, one of which was classed as adulterated. This was a sample of canned pear, which had become badly decomposed.

Cheese.

One sample out of the 49 examined was found to contain boric acid. This was labelled, "Royal Lunch Cheese," Horton, Cato Manufacturing Company, Detroit, Mich.

Cocoa and Chocolate.

Seventy-three samples were examined, mainly cocoa. Of these, 34 were adulterated, the common adulterants being corn and wheat.

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* Journal American Chemical Society, 20, p. 889.

† United States Department of Agriculture, Bureau of Chemistry, Bulletin 65, p. 152.

One sample contained 50 per cent. of corn starch, another 40 per cent. of arrowroot and sugar. Still another sample, purporting to be pure breakfast cocoa, consisted almost entirely of cocoa shells. The following brands of cocoa have been found to contain foreign ingredients: —

Brand.	Adulterant.	Manufacturer.
A. A. Cooper & Co., New York,	Corn starch,	- -
Union Grocery Company,	Corn starch,	- -
Fanchon,	Corn starch,	C. H. Russell, Fall River.
Webb's Compound,	Corn starch,	- -
Shield,	Corn starch,	- -
Hooten's,	Corn starch,	- -
Ader's,	Corn starch,	- -
Elite,	Corn starch,	- -
Metropolitan,	Corn starch,	J. H. Folkins & Co., Chelsea.
Brewster's Royal,	Wheat starch,	- -
Scott & Co.,	Wheat starch,	- -
Champion,	Wheat starch,	- -
Sparrow,	Wheat starch,	- -
London,	Wheat starch,	- -
Justice,	Wheat starch,	W. H. Baker, Syracuse, N. Y.
Sovereign,	Wheat starch,	- -
Commonwealth,	Wheat starch,	Union Pacific Tea Company.
Compound Crown,	Wheat starch,	- -
Imperial,	Wheat starch,	- -
Admiral,	Sugar,	Hub Cocoa Works, Boston.
Phillips,	Sugar,	- -
Fry's,	Arrowroot and sugar,	- -
Epps',*	Arrowroot and sugar,	- -
Sterry & Sterry, N. Y.,	Cocoa shells,	- -

* Label on can plainly states admixture of arrowroot and sugar.

Coffee.

One hundred and forty-three samples were examined, 10 of which were adulterated. One sample contained 70 per cent. of added peas and pea hulls, another 75 per cent. of peas, pea hulls and chicory. A number of samples were found with chicory alone, and some with added wheat.

Confectionery.

Only 1 sample out of the 56 examined was classed as adulterated. This was a chocolate candy containing a large admixture of iron oxide.

Cream of Tartar.

Three hundred and forty-three samples were analyzed, 5 of which were found adulterated. The ratio of adulteration of cream of tartar this year is the lowest in the history of the examination of foods by the Board. The usual adulterants were found, namely, corn starch, alum, acid phosphate of lime and calcium sulphate. One sample was found with at least 80 per cent. of a mixture of these adulterants.

*Wolff's Test for Tartaric Acid both Free and Combined in Cream of Tartar.** (Applicable in presence of phosphates.) — About 5 grams of the sample are repeatedly shaken in a flask with about 250 cubic centimeters of cold water and the insoluble portion allowed to subside. The solution is decanted through a filter and the filtrate evaporated to dryness. To the dry powdered residue a few drops of a 1 per cent. solution of resorcin and about 3 cubic centimeters of strong sulphuric acid are added and the mixture is heated slowly. A rose-red indicates tartaric acid, the color being discharged on dilution with water.

Flavoring Extracts.

Lemon Extract. — Nearly all the brands of extract of lemon sold in the Massachusetts market were collected during the year and analyzed. One hundred and sixty-seven samples were examined, of which 139 were classed as adulterated. The samples collected represent about 100 brands. We have adopted as a standard of purity for lemon extract or essence of lemon the requirements of the United States Pharmacopœia, in accordance with which oil of lemon should be present to the amount of 5 per cent. An extract of lemon to contain 5 per cent. of lemon oil must contain at least 80 per cent. by weight of alcohol, lemon oil being insoluble in dilute alcohol.

A very large variety of ten-cent brands of lemon extract are in the market, most of which contain no oil of lemon. Many of these purport to be pure, others have formulæ with the name and per-

* Rev. Chim. anal. appl., 1899, 4, 263. United States Department Agriculture, Bureau of Chemistry Bulletin 65, p. 104.

centage of the ingredients, but in many cases these formulæ are entirely deceptive and misleading.

In making a cheap extract of lemon, the cost of the lemon oil is not so important an item as that of the alcohol. The manufacturer may and frequently does use sufficient oil of lemon to produce a good extract, but on account of the high price of alcohol he undertakes to get along with a very small amount of the latter. Having mixed his ingredients, namely lemon oil, dilute alcohol and, as a rule, coloring matter together, he usually percolates through magnesia, not realizing that all the oil stays behind on the filter, and that it is *absolutely necessary* to use strong alcohol in order to dissolve it. The resulting product is bottled as "Pure Extract of Lemon," but it contains none of the lemon oil. Time and again manufacturers have protested that the purest lemon oil was used by them, when notified that their brand contained no oil or when prosecuted in court, and were with difficulty convinced that the trouble with their goods was that on account of weak alcohol employed the lemon oil used failed to get into the final product. It is true that a certain taste or odor of the lemon is present, even in the cheap varieties wherein no oil is found, due to the fact that even dilute alcohol, when slowly percolating through the magnesia in which the oil is finely distributed, does abstract therefrom a suggestion of the flavor, which is, however, but a mere shadow of the substance and body possessed by a strong alcoholic solution of oil of lemon.

Method of determining Oil of Lemon. — If in adding a large excess of water to a little of the extract in a test tube no cloudiness occurs, the oil may fairly be inferred to be absent. The degree of cloudiness produced is proportional to the amount of lemon oil present.

If a polariscope is available, the most ready means of determining lemon oil is by its use. The extract is polarized, without being diluted, in a 200 millimeter tube and the reading on the cane sugar scale is noted. This reading divided by 3.4 gives directly the percentage of lemon oil in the sample. If one has no polariscope, but has at hand Babcock's milk apparatus, lemon oil may be determined by transferring 20 cubic centimeters of the extract into an ordinary Babcock milk bottle, to which is first added 1 cubic centimeter of dilute hydrochloric acid (1 : 1), and then from 25 to 28 cubic centimeters of warm water. The mixture is well shaken and allowed to stand in water at a temperature of 60° C. for five minutes. The bottle is then whirled in the centrifuge for about five minutes, and by the addition of warm water the oil is run into the neck of the bottle, where the percentage is read directly in the usual manner. The reading should be taken at 60°, for which purpose the bottle should be brought to that temperature by standing in warm water. A correction for solubility must be made, varying with the amount of oil. When the lemon oil is present to the extent of more than 2 per cent., .4 is added to the reading as a solubility correction, and in case less than two per cent. is present or more than 1 per cent., .3 per cent. is added. The Babcock centrifuge method last described is by no means as accurate as the former method, involving the use of the polariscope. Both methods are due to A. S. Mitchell.*

For examination as to the purity of lemon oil, the oil as separated by the Babcock process should be reserved for examination, as described under "oleum limonis" in the drug portion of the present report.

Determination of Alcohol. — Mitchell has pointed out that the difference in specific gravity between oil of lemon and stronger alcohol is not so great but that a very close approximation to the true percentage of alcohol in lemon extracts may be obtained from the specific gravity of the extract itself, assuming, of course, that foreign substances, such as sugar, glycerine, etc., are absent. By thus determining the specific gravity and ascertaining from the alcohol tables the per cent. of alcohol corresponding, the latter may be assumed to be at least within 1 per cent. of the true result, providing no more than 6 per cent. of lemon oil is present.

In the absence of oil of lemon, a measured portion of the original sample may be distilled and the percentage of alcohol determined from the distillate in the usual manner, but when lemon oil is present this should first be removed by diluting 50 cubic centimeters of the extract to 200 with water and shaking the mixture with 5 grams of magnesium carbonate in a flask, filtering through a dry filter and determining the alcohol by distillation in an aliquot part of the filtrate. The result is multiplied by 4 to correct for the dilution.

In the following table are given the results of the analyses of the

* Journal American Chemical Society, 21 (1899), p. 1132. United States Department Agriculture, Bureau Chemistry, Bulletin 65, pp. 73, 74.

various brands of lemon extract examined. In some cases formulæ have appeared on the bottles, but very often these formulæ have been misleading, or were not found to be in accordance with the result of the analysis.

Lemon Extracts.

Brand.	Address of Manufacturer.	Polarization 200 Millimeters.	Lemon Oil (Per Cent.).	Alcohol (Per Cent.).	Color.
A. & P.,	Great Atlantic and Pacific Tea Company, New York.	0.0	0.0	22.15	Dinitrocresol.
A. & P.,	Great Atlantic and Pacific Tea Company, New York.	2.0	0.6	68.82	- -
Acme,	Acme Extract Company, Binghamton, N. Y.	0.2	0.03	35.90	Dinitrocresol.
Advanced,	Advanced Grocer's Company, New York.	0.0	0.0	47.32	- -
Arlington Co-operative Association.	- -	0.0	0.0	26.93	Tropæolin.
Baker's Best Concentrated,	W. P. Baker, New York,	0.0	0.0	39.60	- -
Baker's Pure,	Baker Extract Company, Portland, Me.	14.0	4.1	75.50	Dinitrocresol.
Baker's Superior,	W. S. Baker, Springfield, Mass.,	2.0	0.6	38.94	- -
Baker's "William's Brand,"	W. P. Baker, New York,	0.0	0.0	21.92	- -
Bennett's,	Bennett & Co., Philadelphia, Pa.,	0.0	0.0	19.42	Dinitrocresol.
Boston, "Lemon Flavor,"	M. O'Keefe, Boston, Mass.,	0.8	0.2	58.77	- -
Burnett's,	Joseph Burnett & Co., Boston, Mass.	30.8	9.0	90.29	- -
Brunswick Concentrated "Double Strength"	Brunswick Manufacturing Company, New York.	0.4	0.1	45.14	Tropæolin.
Brunswick Concentrated,	Brunswick Manufacturing Company, New York.	0.0	0.0	45.27	Tropæolin.
Carter's,	No address,	9.9	2.9	74.45	- -
Celebrated Champion,	No address,	0.3	0.1	53.78	- -
Challenge,*	J. T. Connor, Boston,	5.0	0.9	56.50	Dinitrocresol.
Choice,	Bram & Co., New Haven,	0.0	0.0	25.29	Dinitrocresol.
Charlton's,	No address,	0.0	0.0	43.48	Tropæolin.
Collet's,	No address,	13.0	3.9	86.82	- -
Colton's,	J. W. Colton, New York,	18.0	5.3	88.44	- -
Concentrated,	F. L. Carter, Georgetown,	10.0	2.9	74.45	None.
Concentrated,	No address,	4.0	1.2	69.45	Tropæolin.
Concentrated,†	No address,	0.0	0.0	20.00	Dinitrocresol.
Concentrated,	L W. Gaving, North Reading, Mass.	20.0	5.9	85.65	- -
Concentrated,	Elms Extract Company, Somerville, Mass.	0.4	0.1	38.11	Uncolored.
Concentrated,	Slater Extract Company, Pawtucket, R. I.	0.0	0.0	19.00	Tropæolin.
Concentrated,	No address,	1.4	0.4	51.96	Nitro dyestuff.
Condell's Extra Fine,	H. W. Spurr Specialty Company, Boston.	—8.0	0.0	-	- -

* Formula: oil of lemon, .030; oil of lemon grass, .001; grain alcohol, .660; distilled water, .300; coloring, .009 = 1.000.

† Formula: oil of lemon, .35; aqua, 6.00; alcohol, 3.15; fruit acid, .55.

Lemon Extracts — Continued.

Brand.	Address of Manufacturer.	Polarization 200 Millimeters.	Lemon Oil (Per Cent.).	Alcohol (Per Cent.).	Color.
Connor's,*	J. T. Connor, Boston,	2.8	0.82	58.27	Dinitrocresol.
Connor's,†	J. T. Connor, Boston,	0.0	0.0	41.80	Dinitrocresol.
Crescent,	Crescent Extract Company, Philadelphia, Pa.	0.0	0.0	34.86	- -
Dalton's,	J. H. Dalton & Co., Boston, Mass.,	0.0	0.0	18.62	Dinitrocresol.
Delicious,	Hannan & Tierney, Boston,	2.2	0.6	60.62	Dinitrocresol.
Dr. Price's,	Price Flavoring Extract Company, New York.	21.0	6.2	82.31	- -
Edgerley's Pure Concentrated.	Edgerley Extract Company, Boston.	18.0	5.3	87.65	Uncolored.
Empress,	No address,	0.0	0.0	40.60	Uncolored.
Eureka,	Eureka Manufacturing Company, Hartford, Conn.	0.0	0.0	-	- -
Folkins',	J. H. Folkins & Co, Chelsea, Mass.	8.8	2.6	68.17	Tropæolin.
Folkins' Concentrated,	J. H. Folkins & Co., Chelsea, Mass.	5.0	1.5	65.33	Tropæolin.
Forest City,	Forest City Extract Company, Portland, Me.	8.0	2.3	78.08	Dinitrocresol.
Foss Pure,	Schlotterbeck & Foss, Portland, Me.	21.8	6.4	83.46	- -
French's Genuine,	R. T. French & Co., Rochester, N. Y.	0.3	0.1	39.40	Dinitrocresol.
Ferguson & Co.,	No address,	10.5	3.1	74.23	Orange dyestuff.
Gardner's Pure,	No address,	18.0	5.2	83.69	- -
Globe,	Potter & Wrightington, Boston,	22.0	6.4	79.64	- -
Ginter,	Ginter Grocery Company,	0.0	0.0	35.20	Dinitrocresol.
Ginter's High Proof Compound.	Ginter Grocery Company, Boston,	0.0	0.0	20.83	- -
Golden Rod,	Miami Manufacturing Company, New York.	0.0	0.0	4.00	Tropæolin.
Golden Cup,	Tremont Extract Company,	1.1	0.31	50.26	Tropæolin.
Good Value,	Good Value Extract Company, Binghamton, N. Y.	0.4	0.12	44.40	- -
Gray's High Proof,	E. E. Gray & Co., Boston,	4.3	1.3	69.08	- -
Grand Union Tea Company Concentrated.	Grand Union Tea Company, Brooklyn.	2.0	0.6	52.14	- -
Hadley's,	G. H. Hadley, Lawrence,	0.0	0.0	45.27	- -
Harris Pure,	F. E. Harris, Binghamton, N. Y.,	6.8	2.0	82.69	- -
Hamblen,	E. H. Hamblen & Co. (no address),	12.2	3.6	73.17	Dinitrocresol.
Harrison's Highly Concentrated.	R. Harrison, Glens Falls, N. Y.,	0.0	0.0	40.45	- -
Hartshorn,	E. Hartshorn & Sons, Boston,	23.5	6.9	85.19	Dinitrocresol.
Highly Concentrated,	E. P. Charlton, Fall River,	0.3	0.1	43.48	Tropæolin.
Irvine's Pure,	Wm. Irvine, New York,	0.0	0.0	32.87	Tropæolin.
Keen's,	Jos. Keen, Boston,	13.2	4.0	76.88	Dinitrocresol.
Kellog's Pure,	F. P. Adams & Co, Boston,	26.0	7.7	87.81	- -

* Formula: alcohol, 800; distilled water, 190; oil of lemon, 10.

† Formula: alcohol, 553; aqua, 450; oil of lemon, 15; naphthol color, very slight.

Lemon Extracts — Continued.

BRAND.	Address of Manufacturer.	Polarization 200 Millimeters.	Lemon Oil (Per Cent.).	Alcohol (Per Cent.).	Color.
Kidder's Concentrated,	Kidder & Co., Boston,	3.5	1.0	61.04	- -
Keystone,	No address,	0.0	0.0	6.21	Orange color.
Kline's,	Kline Extract Company, Plainfield, N. J.	21.0	6.2	81.44	- -
Leighton's Pure,	R. S. Leighton, Portland,	19.0	5.6	83.62	- -
Lion,*	Highland Extract Company, Boston.	27.0	0.0	22.50	Aniline.
Mrs. Bradford's,	Mrs. M. J. Bradford, Claremont, N. H.	26.0	7.6	83.23	- -
Maple Leaf,	Maple Leaf Chemical Company, New York.	0.0	0.0	3.59	Tropæolin.
Nickel Extract with a "Lemon Flavor."	N. S. Nickel Company, Philadelphia.	0.0	0.0	20.00	- -
Pansy,	Pansy Extract Company, Philadelphia.	0.0	0.0	31.56	Dinitrocresol.
Pure,	N. S. Nickel Company, Philadelphia.	0.0	0.0	19.92	Tropæolin.
Pure Concentrated,	Ferguson & Co., Haverhill,	11.0	3.1	74.28	Colored.
Pure Concentrated,	Royal Worcester Manufacturing Company, Boston.	0.0	0.0	20.00	Dinitrocresol.
Pure Concentrated,	No address,	0.0	0.0	22.85	Dinitrocresol.
Pure Concentrated,	S. M. Sargent, Worcester,	31.0	9.1	90.54	- -
Pure Concentrated Imperial,	Lowell Pharmacy, Lowell,	17.0	5.0	73.88	- -
Pure Concentrated Peerless,	No address,	2.0	0.6	52.14	Dinitrocresol.
Pure Concentrated,	Superior Extract Company, Detroit, Mich.	1.6	0.5	52.32	- -
Pure Sovereign,	Union Pacific Tea Company, New York.	15.0	4.4	89.73	Aniline.
Puritan,†	W. E. Farrington & Co., Boston,	4.5	1.3	64.84	- -
Parker's 10 Cent,	Parker Specialty Company, Melrose.	0.0	0.0	17.67	- -
Quinsigamond Mills,	No address,	1.4	0.4	44.64	Dinitrocresol.
Strictly Pure Red Cross,	Red Cross Extract and Baking Powder Company, Franklin.	2.5	0.7	65.17	Tropæolin.
Royal Worcester,	Royal Worcester Extract Company,	0.0	0.0	22.85	- -
Sargent's Pure Concentrated,	S. M. Sargent, Worcester,	30.0	9.1	90.50	- -
Sage Bro's,	Boston,	0.0	0.0	19.67	Tropæolin.
Standard,	Standard Bottling Company, Lowell, Mass.	0.0	0.0	33.41	- -
Standard,	Sam'l Stuart & Co., Hartford, Conn.	0.0	0.0	34.71	- -
Standard,	Standard Extract Company, New York.	0.3	0.1	44.77	- -
Special Concentrated,	No address,	0.0	0.0	10.38	- -
Stirling Pure Concentrated,	Stirling Extract Company, Cambridgeport, Mass.	0.0	0.0	-	Dinitrocresol.
St. John's,	No address,	0.0	0.0	26.40	Tropæolin.
Spurr's Absolutely Pure,	H. W. Spurr Specialty Company, Boston.	8.0	2.3	69.71	Dinitrocresol.
Superior Quality,	No address,	7.0	2.0	68.25	- -

* Containing cane sugar.

† Formula: oil of lemon, 1.50; alcohol (94 per cent.), 80.00; coloring, 9.50; water, 18.50 = 100.00.

Lemon Extracts — Concluded.

BRAND.	Address of Manufacturer.	Polarization 200 Millimeters.	Lemon Oil (Per Cent.).	Alcohol (Per Cent.).	Color.
Thorpe's,*	T. D. Thorpe Company, Chelsea, Mass.	0.0	0.0	40.00	- -
Van Duzer's Highly Concentrated.	Van Duzer & Co., New York,	14.0	4.1	84.72	Tropæolin.
Trumbull's,	Trumbull & Co., Hartford, Conn.,	0.0	0.0	34.67	Dinitrocresol.
Waldorf,	J. J. Egan, Holyoke,	0.0	0.0	11.08	Dinitrocresol.
Webb's XX,	Webb & Co.,	0.0	0.0	26.93	- -
William's Choice,	Williams & Charlton, Hartford, Conn.	20.0	5.9	87.81	Dinitrocresol.
Winner,	J. F. Nickerson Company, Boston,	0.4	Trace	39.80	Dinitrocresol.

* Containing oil other than lemon oil.

Vanilla Extract. — Seventy-three samples were examined, of which 54 were adulterated. In the adulterated class have been included (1) such extracts as were found to contain coumarin, (2) those which were found to contain less than .05 per cent. of vanillin and (3) those which, though containing sufficient vanillin, were entirely artificial and not true extracts of the vanilla bean. If they were found to conform strictly to an honestly printed formula, they were not classed as adulterated. Here, as in the case of lemon extracts, there have been many examples of deceptive formulæ, as, for instance, the following: —

In 10,000 parts: hydro-alcoholic solution, extract of Mexican vanilla beans, synthetically prepared, 7,000 parts; hydro-alcoholic solution angostura tonka beans, 2,000 parts; hydro-saccharated solution, 1,000 parts; caramel trace.

Much information may be gained as to the genuine character of an extract by an examination of the extracted matters. This is especially true of the resins and gums according to methods recommended by Hess.* If no precipitate is produced when a few drops of acetate of lead solution are added to a little of the extract in a test tube, the tincture may be pronounced entirely artificial. The presence of a precipitate, however, is by no means a guarantee of the purity. Methods for determining vanillin and coumarin were given in the analyst's report for 1899.†

* Journal American Chemical Society, 21 (1899), p. 719. Also United States Department of Agriculture, Bureau of Chemistry, Bulletin 65, p. 70.

† Thirty-first annual report of Massachusetts State Board of Health (1899), pp. 629, 630.

The various brands examined during the year and the results of analyses are given in the following table: —

Vanilla Extracts.

BRAND.	Address of Manufacturer.	Per Cent. of Vanillin.	Per Cent. of Coumarin.
A. & P.,*	Great Atlantic and Pacific Tea Company, New York.	.0125	Present.
Advanced,	Advanced Grocer's Company, New York,	.0375	Present.
Challenge,	J. T. Connor, Boston,	.0812	Present.
Choice,	- -	None.	Considerable.
Climax Vanilla Flavor,	New York,	.0125	Present.
Climax,	New York,	.0187	Considerable.
"Compound,"	Walker Chemical and Extract Company, Chelsea.	.1500	Present.
Concentrated Extra,	XLCR Extract Company, Chelsea,	.0500	-
Colton's,	J. W. Colton, New York,	.0375	-
Concentrated,†	- -	.0187	Present.
Condell's Extra Fine,	H. W. Spurr Specialty Company, Boston,	.0250	.1100
Connor,‡	J. T. Connor, Boston, Mass.,	None.	Present.
Connor's,§	J. T. Connor, Boston,	.0125	.0120
Dalton's Flavoring Extract with a Vanilla Flavor.	- -	.0250	Present.
Double Extract,	C. B. Woodworth Company, Rochester, N. Y.	.0375	-
Empire State,	- -	None.	Considerable.
Forest City,	Forest City Extract Company, Portland,	.0187	.0325
Folkins' Concentrated,‖	J. T. Folkins & Co., Chelsea,	.0625	Present.
French's Genuine,‖	R. T. French Company, Rochester, N. Y.,	.0250	-
Ginter,‖	Ginter Grocery Company, Boston,	.0750	.0200
Good Value,	Good Value Extract Company, New York,	.0125	.0500
Gray's,‖	- -	.0875	.0450
Harris Pure,	F. E. Harris, Binghamton, N. Y.,	.0500	-
Highly Concentrated,	E. P. Charlton, Fall River,	.1750	-
Holbrook's,	Holbrook & Co., Lynn,	.1750	-
Kidder's Concentrated,	Kidder & Co., Boston,	.0250	-
Lion,	Highland Extract Company, Boston,	.0500	Present.
Morse's Pure,	C. H. Morse Manufacturing Company, Providence.	.1250	-
Pansy,	Pansy Extract Company, Philadelphia,	Trace.	-
Parker's 10 Cent,	Parker Specialty Company, Melrose,	.1250	Considerable.
Perfection,	Perfection Extract Company, New York,	None.	Considerable.

* Formula: containing vanilla, tonka, spirits, aqua, sugar.

† Formula: compound vanilla, 1.00; aqua, 4.84; tonka, 2.72; sugar, 1.44.

‡ Formula: vanilla beans, 75; alcohol, 150; syrup, 200; cochineal, 15; aqua, 555.

§ Formula: vanilla beans, 75; alcohol, 150; syrup, 200; caramel, 15; tonka beans, 5; distilled water, 555 = 1,000.

‖ Package provided with a formula.

Vanilla Extracts — Concluded.

Brand.	Address of Manufacturer.	Per Cent. of Vanillin.	Per Cent. of Coumarin.
Pure,	Sage Bros., Portland,	.0750	-
Pure Concentrated,	Park Drug Store, Fall River,	.0750	Considerable.
Purity Preserving Company's,	Worcester,	.1750	-
Royal Compound Flavoring,	- -	.0125	.0250
Royal Worcester,	Royal Worcester Extract Company, Worcester.	.0750	Considerable.
Sage Bros' Pure,	Sage Bros., Portland,	.0500	Considerable.
Sargent's,	S. M. Sargent, Worcester,	.0750	Present.
Sovereign,	Union Pacific Tea Company, New York,	.0250	.0250
Special,	- -	None.	Considerable.
Standard Quality,	Sam'l Stuart & Co., Hartford, Conn.,	.1875	Considerable.
St. John's,	No address,	.0375	-
Taunton Cash Grocery,	Taunton Cash Grocery, Taunton, Mass.,	.0150	-
Waldorf,	John J. Eagan, Holyoke, Mass.,	.0250	Considerable.
Williams' Choice,	Williams & Carlton Co., Hartford, Conn.,	.2000	-

It should be said with reference to the above table that the quality of the extract should not be judged from the amount of vanillin alone, since it is possible to reinforce a true vanilla extract with artificial vanillin, or an extract may be high in vanillin and yet be entirely artificial and in no sense an extract of the vanilla bean, which, as is well known, depends nearly as much for its virtue as a flavor upon its various extractive matters as upon its vanillin.

Miscellaneous Flavoring Extracts. — One sample each of raspberry, checkerberry and Jamaica ginger extract was analyzed. The raspberry was a synthetic preparation made up of artificial fruit ethers, and the Jamaica ginger extract contained no oil of ginger.

Honey.

Fifty-three samples were analyzed, 17 of which were adulterated by the presence of commercial glucose, cane sugar or both. The most adulterated sample contained 80 per cent. of commercial glucose.

Method of determining Commercial Glucose in Honey. — Owing to the large amount of invert sugar which honey contains, the method of determining glucose in molasses and maple syrup as given in the analyst's report for 1900 * is not sufficiently accurate for honey. Much closer results may be attained by dissolving the normal weight of the sample (26.048 grams for the Schmidt & Haensch polariscope) in water in a 100 cubic centimeter graduated flask, adding alumina cream for the clarifier and making up to the mark with water. The solution is shaken, filtered and polarized in the usual manner in a 100 millimeter tube, the true direct reading being twice the scale reading. The filtered normal solution is then subjected to inversion (see thirty-second annual report, p. 658) and the polariscopic reading obtained at 87° in a hot-water jacketed tube, making the necessary correction due to any dilution of the sample by the addition of acid for the inversion. The true reading at 87° divided by 175 gives the approximate percentage of commercial glucose in the sample.

Lard.

Twenty-three samples were examined, 2 of which contained admixtures of cotton-seed oil. One sample was found with 50 per cent. of the foreign oil.

Halphen's Test for Cotton-seed Oil. — This test is very satisfactory and will detect at least 1 per cent. of the adulterant. A mixture is made of equal volumes of amyl alcohol and carbon bisulphide in which 1 per cent. of sulphur has been dissolved. From 3 to 5 cubic centimeters of melted fat is mixed with an equal volume of the above reagent in a test tube, loosely stoppered with cotton and heated in a bath of boiling water for fifteen minutes. If cotton-seed oil is present, a deep red or orange color is produced. If the lard is pure, little or no color is developed.

Maple Sugar.

Two samples out of the 20 collected and examined were found to contain brown or molasses sugar.

Maple Syrup.

Forty-one samples were analyzed, 5 of which contained commercial glucose, 1 sample being found with 95 per cent. of this adulterant.

Molasses.

Of 93 samples examined, 22 were found adulterated by the admixture of commercial glucose.

* Thirty-second annual report of State Board of Health (1900), p. 658.

Spices.

Allspice. — Six out of 151 samples analyzed were found to be adulterated. The worst specimen contained 60 per cent. of cocoanut shells. Other adulterants found were wheat and exhausted ginger.

Cassia. — Two hundred and three samples were analyzed, 6 of which were adulterated. One sample contained 20 per cent. of roasted wheat. Others were found with admixtures of wheat and exhausted ginger.

Cayenne. — Thirty-nine samples were examined, 9 of which were classed as adulterated. One sample was found to contain 25 per cent. of wheat.

Cloves. — One hundred and sixty-three samples were examined; 19 were found adulterated, containing allspice, clove stems, wheat, ginger and millet. The worst specimen contained 60 per cent. of clove stems and millet; another, 30 per cent. of roasted wheat.

Ginger. — Two hundred and fifty-three samples were examined, 20 of which were adulterated. One was found to contain 70 per cent. of wheat bran and turmeric; another, 70 per cent. of corn starch. Other adulterants found were millet, exhausted ginger and an aniline dye.

Mace. — Of 52 samples analyzed, 19 were adulterated, the adulterants found being corn starch and wild mace. One sample was found to contain 75 per cent. of corn starch.

Nutmeg. — Fifteen samples were examined, all of which were pure.

Mustard. — Eighty-four out of 297 samples examined were adulterated with such substances as mustard hulls, aniline dyes, turmeric and cayenne. The worst specimen contained 80 per cent. of wheat and turmeric. One sample, labelled "Sadtler's Celebrated Old English Mustard, Double Superfine," was found to contain 50 per cent. of roasted wheat, charcoal and turmeric.

Pepper. — Four hundred and nineteen samples were examined, of which 53 were poor. One sample contained 40 per cent. of olive stones, another, 20 per cent. of roasted wheat. Other adulterants met with were exhausted ginger, pepper shells and millet.

Syrup.

Under this heading are included samples of table syrup sold under the name "Golden" or "Golden Drip Syrup." Thirteen samples were examined, 7 of which are classed as adulterated by the addition of commercial glucose without being properly labelled, the label stating the name and percentage of the ingredients being either entirely lacking or containing statements which were not found to agree with the analysis.

Tea.

Forty-nine samples were analyzed, all of which were found to conform to the law as to purity, though in many instances inferior grades were evidently substituted for the higher priced varieties.

Vinegar.

Twenty-three of the 40 samples examined were found adulterated. In the following table, which summarizes the results of the samples

Cider Vinegar.

Acid (Per Cent.).	Solids. (Per Cent.).	Polarization in 200 Millimeter Tube.	Lead Acetate.	
5.00	2.39	—1.2	Precipitate, .	- -
5.00	**1.90**	—1.6	Precipitate, .	Low in solids.
4.98	2.13	+0.6	Precipitate, .	Adulterated.
4.98	**1.85**	—1.2	Precipitate, .	Low in solids.
4.96	2.00	—3.0	Precipitate, .	- -
4.88	**1.60**	+0.4	Precipitate, .	Adulterated.
4.80	**1.43**	—1.2	Precipitate, .	Low in solids.
4.76	2.61	+7.4	Precipitate, .	Entirely artificial.
4.74	**0.29**	+0.4	No precipitate,	Entirely artificial.
4.74	2.20	—1.8	Precipitate, .	- -
4.72	**1.80**	—2.6	Precipitate, .	Low in solids.
4.70	2.33	—3.0	Precipitate, .	- -
4.68	**1.85**	—2.6	Precipitate, .	Low in solids.
4.66	2.00	—0.8	Precipitate, .	- -
4.66	2.40	—3.8	Precipitate, .	- -
4.64	2.43	—1.2	Precipitate, .	- -
4.62	2.78	—1.2	Precipitate, .	- -
4.60	2.17	—2.2	Precipitate, .	- -
4.60	2.00	—1.6	Precipitate, .	- -
4.56	2.55	—3.0	Precipitate, .	- -
4.54	2.20	—2.4	Precipitate, .	- -
4.54	3.03	—3.6	Precipitate, .	- -
4.50	**1.46**	—1.4	Precipitate, .	Low in solids.
4.50	**1.60**	—0.2	Precipitate, .	Low in solids.
4.50	3.20	—4.2	Precipitate, .	- -
4.40	**2.32**	—1.0	Precipitate, .	Low in acid.
4.40	**1.99**	—1.6	Precipitate, .	Low in acid and solids.
4.36	**2.25**	—1.2	Precipitate, .	Low in acid.
4.20	**0.27**	+1.0	No precipitate,	Entirely artificial.
3.84	**2.53**	—0.8	Precipitate, .	Low in acid.
3.70	**2.76**	—2.6	Precipitate, .	Low in acid.
2.68	**2.60**	—1.4	Precipitate, .	Low in acid.
2.56	**2.17**	—3.3	Precipitate, .	Low in acid.
2.44	**4.46**	—0.5	Precipitate, .	Low in acid.
2.36	**2.17**	—3.5	Precipitate, .	Low in acid.

examined, it is seen that 19 of the samples (those printed in full-faced type) are adulterated by reason of being below the legal standard of solids or acidity or both. The rest were classed as adulterated, because, though being above the legal standard of solids and acidity, they proved on analysis not to be the exclusive product of pure cider, though sold for cider vinegar.

Recent strongly contested court cases have brought out the value of the polariscope as an index to the purity of cider vinegar. The chemical constants of an artificial cider vinegar may, by skilful manipulation, be made to come within the limits of the pure article in many cases, but it is very difficult to "doctor" a spurious cider vinegar in such a manner that its dishonest character will not be rendered apparent by means of the polariscope, taken in connection with a chemical analysis. The direct polarization alone will often be sufficient to indicate adulteration. It is a characteristic of pure apple juice that it *always* polarizes to the left, whether the sample be a freshly expressed juice, or a juice having undergone alcoholic fermentation so that it becomes cider, or after it has undergone acetic fermentation and formed vinegar. This being the case, it is readily seen that distinct right-handed polarization in a vinegar sample may be regarded as absolute evidence that it is not pure cider vinegar. Figures for polarization in the above table are given in terms of undiluted vinegar. Subacetate of lead solution was used to clarify, but correction was made for the dilution.

The lævo-rotation of apple juice and its products has been confirmed many times in this laboratory. C. A. Browne, Jr.,* has shown that the polarization of freshly expressed juice from 11 varieties of apple varies from 19.24 to 49.00, these figures expressing the rotation to the left of the clarified juice in a 400 millimeter tube on the Ventzke scale. He has further shown that the left-handed rotation under the same conditions of fermented cider varies from 1.76 to 5.28, and in the case of cider vinegar the left-handed rotation varies from .96 to 2.94.

Approximate Determination of Vinegar Acidity by Lime Water. — It has generally been considered difficult for vinegar dealers and others who desire to estimate the acidity of their vinegar to do this themselves, in that it has been necessary to obtain for the purpose a

* Pennsylvania Department of Agriculture, Bulletin 58.

carefully standardized alkaline solution, the exact strength of which it is impossible for them to determine.

It has been found that very satisfactory, though of course not absolutely accurate, results may be obtained by the use of ordinary lime water, which any one may easily prepare by making a saturated solution of ordinary air-slaked lime. The strength of such a solution is very nearly constant, and has been found to be about $\frac{1}{21.4}$ of the normal. If, therefore, it is not easy to obtain exactly normal or tenth normal alkali, approximate figures may be obtained by employing such a saturated lime water. If 2.75 cubic centimeters of vinegar are titrated with lime water contained in a burette, using phenol phthalein as an indicator, the number of cubic centimeters of the lime water necessary to neutralize the vinegar, divided by 10, gives the percentage of acetic acid in the vinegar. To make sure that the lime water is saturated, an excess of lime should always be present in the reagent bottle.

The acidity of cider vinegar is by no means an indication of the age of the sample. Six samples of cider vinegar of known purity of the same age have been examined in this laboratory and found to vary from .7 per cent. to 5 per cent. in acetic acid.

Miscellaneous Foods.

Under this heading are included samples of the following foods which were examined and found pure: apple jelly, baking powder, cake frosting, celery salt, cider jelly, "cocoa-coffee," cocoanut (shredded), cod fish, corn meal, gelatine, ginger ale, glucose, grape nuts, "konut," "lemonine" (a lemonade mixture), poultry seasoning, "prune coffee," saleratus, sweet pepper or "pepper dulce," "tryphosa" (a quick jelly preparation) and yellow sugar.

"*Antifermentine*,"—for preserving all kinds of fruits, ciders, etc. This preparation, put up by W. W. Chase of Newburg, N. Y., was in the form of tablets and consisted of salicylic acid and salt.

Beer and Ale.—Thirty-one samples of various brands of beer and ale on sale in Massachusetts have been examined, principally for arsenic and incidentally for preservatives. Arsenic has been found only in very minute traces, so that no danger from this source is to be apprehended. Salicylic acid has been found in the following brands of beer and ale as well as in several unbranded samples:

Standard Lager, Providence Brewing Company; McCormick's Stock Ale, Boston; Sterling Ale, Rueter & Co., Boston; P. B. Stock Ale, A. G. Van Nostrand, Boston; XXX India Pale Ale, Burke, Marlborough; W. E. B. Co., Boston.

Jams and Jellies. — A large number of samples of these preparations have been examined during the year, especially of the cheaper variety. In this, as in other similar classes of goods, which from their character would be classed as adulterated but for the use of the formula stipulating the name and percentage of ingredients employed, the use of such a label is on the increase. Where formerly such a label was looked at askance by the average manufacturer and dealer, it is encouraging to note that the formula, especially when an honest one, is growing to be regarded not only as a safeguard to the manufacturer himself, but is actually getting to be demanded by the trade, especially since the enactment of the new law regarding such formulæ. The local dealer who handles the cheaper varieties of jellies and jams knows full well that the low price indicates in most cases the admixture of cheaper or inferior substances, which, in the absence of a formula, would be regarded as adulterants, and views with suspicion the cheap brands offered which do not contain such a formula, fearing he may get into trouble by selling the unmarked goods. Preservatives in jellies and jams of the cheaper variety are almost always found, in some cases salicylic, in others benzoic, and sometimes sulphurous acid or salts of these acids. In view of the conflict of authority regarding the wholesomeness of these antiseptic substances, it is no more than right that the public should know, by a plainly printed label, just what is being purchased.

Ketchup. — What was said in the previous paragraph as regards the employment of formulæ in the cheaper jellies and jams applies with equal force to the many brands of tomato and other ketchups now in the market that contain not only preservative but also coloring matter, and the manufacturers of these goods should realize the importance of having an honest label thereon in compliance with the new law.

Lime Juice. — Nine samples of this preparation were examined, representing 8 different brands, and the results as to percentage of citric acid and character of the preservative used are given below: —

Lime Juice.

Brand.	Citric Acid (Per Cent.).	Preservative.
Montego,	3.01	Sulphurous and salicylic acids.
Sovereign,	3.20	Sulphurous and salicylic acids.
Princess,	2.87	Salicylic acid.
London,	2.62	Sulphurous acid.
Superior,	2.58	Sulphurous and salicylic acids.
Ashmont,	2.57	Salicylic acid.
Geer's,	1.76	Sulphurous acid.
Princess,	1.53	Sulphurous and salicylic acids.

Pickles. — Five samples were examined, all of which were found to be put up in a vinegar preparation which contained added sulphuric acid.

The usual summary of foods examined follows.

Summary of Statistics of Food, exclusive of Milk.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Allspice,	145	6	151	3.9
Butter,	109	7	116	6.0
Canned goods,	3	1	4	25.0
Cassia,	197	6	203	2.9
Cayenne,	30	9	39	23.1
Cheese,	48	1	49	2.0
Chocolate,	39	34	73	46.6
Cloves,	144	19	163	11.6
Coffee,	133	10	143	6.9
Condensed milk,	28	12	40	30.0
Confectionery,	55	1	56	1.8
Cream of tartar,	338	5	343	1.5
Flavoring extracts:				
Lemon,	28	139	167	83.2
Vanilla,	19	54	73	74.0
Miscellaneous,	1	2	3	66.6
Ginger,	233	20	253	7.9
Honey,	36	17	53	32.1
Lard,	21	2	23	8.7
Mace,	33	19	52	26.5
Maple sugar,	18	2	20	10.0
Maple syrup,	36	5	41	12.2
Miscellaneous,	100	30	130	23.1
Molasses,	71	22	93	23.7
Mustard,	213	84	297	28.3
Nutmeg,	15	-	15	-
Pepper,	366	53	419	12.6
Syrup,	6	7	13	53.8
Tea,	49	-	49	-
Vinegar,	17	23	40	57.5
Summary,	2,530	590	3,120	18.9

Drugs.

Nine hundred and fifty-eight samples of drugs have been examined during the year, or 200 more than for any previous year. The ratio of adulteration, which was 51.3 per cent., is the highest on record, with one exception. The regular summary of drug statistics at the end of this report shows in detail the general character of the samples examined, and such individual drugs only as are especially liable to adulteration are referred to in the following comments.

Acidum Tannicum. — More than half the samples of tannic acid collected have been classed as adulterated on account of the presence of gums and resins. An additional recrystallization would in most instances have sufficiently purified these samples.

Aqua Destillata. — The following figures express in terms of parts per 100,000 the residues of the 8 samples of distilled water that were not pure: 0.6, 2.0, 2.2, 6.8, 7.8, 8.2 and 26.0. Only one sample was absolutely pure. When distilled water is so easily prepared there is no excuse for furnishing in drug stores such impure samples as the above.

Calx Chlorata. — Only 3 samples, all far below the standard, were examined, 2 of which were of the "Acme" brand, containing, respectively, 0.1 and 6.4 per cent. of available chlorine. The third sample, put out by the Walker Chemical Company, contained 21.2 per cent. of available chlorine. The standard of the Pharmacopœia is 35 per cent.

Caryophyllus. — Four samples of powdered cloves were this year collected from drug stores, 1 of which was found to contain 50 per cent. of corn starch.

Capsicum. — Forty-nine samples were examined, 12 of which were adulterated. The fact that the ratio of adulteration of capsicum purchased in the drug stores is so much higher than that of the grocery store samples is one which should be carefully pondered by druggists. Twenty-eight per cent. of the samples of capsicum purchased as drugs were found to be adulterated, as against 23 per cent. purchased from grocery stores. According to the preceding analyst's report (for 1900), drug-store capsicum showed a ratio of adulteration of over 30 per cent., as compared with 14 per cent. as the adulteration of the samples bought from grocers in 1900. There would seem to be no good reason why a druggist, especially when charging a higher price than the grocer, should not furnish at least as pure an article, especially when this spice is in most cases wanted for medicinal purposes. Drug-store capsicums examined this year have been found adulterated with millet, exhausted ginger, wheat, corn, redwood, turmeric and aniline dye stuffs. One sample was found containing over 60 per cent. of corn starch, turmeric and ground redwood. Aside from actually containing foreign adulterants, a number of samples showed evidence of having been kept on hand for a long period, by their lack of strength and pungency. These, however, were not included in the adulterated class.

Cera Alba and Cera Flava. — Considerably more than half of the samples of both white and yellow wax analyzed were found to be adulterated with paraffin. Three constants that differ the most widely from each other in pure beeswax and paraffin are the specific gravity, the saponification value and the refractometer reading. These three determinations are therefore of most value in judging the purity of the wax, and the correct constants for both beeswax and paraffin are as follows: —

	Specific Gravity at 15° C.	Saponification Value.	Butyro-Refractometer Reading at 65°.
Beeswax, ...	0.964–0.970	90–98	30–31.5
Paraffin, ...	0.868–0.915	0	11–14.5

The Use of the Butyro-Refractometer for Beeswax. — If this instrument is available, it furnishes a most ready preliminary means of judging the purity of beeswax. Much care should be taken, however, in using it for this purpose, since it is necessary to employ as high a temperature as 65° C. to be well above the melting point of the beeswax, and, as a matter of fact, the instrument, primarily intended as it is for use with butter and lard, was not made with a view to being heated to this high temperature. A letter from Zeiss of Jena, the manufacturer of the instrument, has assured us, in response to an inquiry, that while its use at so high a temperature was not intended, if great care is taken to raise the temperature in the water jacket to the required point (65° C.) very slowly, and to exercise as great care in cooling gradually, the instrument could safely be used. Otherwise, by sudden changes of temperature the cement used in securing the prisms in place would be in danger of being loosened, if often heated so high. Experience in the laboratory has shown that with this precaution, and by taking care that the temperature does not exceed 65°, no material injury to the refractometer is apparent.

Extractum Glycyrrhizæ. — Ten samples out of the 16 examined were found to be adulterated with corn or wheat. One sample contained 25 per cent. of corn starch.

Glycerinum. — The presence of arsenic in glycerine is distinctly less prevalent now than formerly. Less than half the samples examined during the year were found to be arsenical. One sample was found with 3.9 parts of arsenic per 100,000. Nearly all the samples classed as adulterated were so regarded by reason of being distinctly arsenical, but a few were found below the standard on account of containing carbonizable impurities.

Iodoformum. — The single sample of this drug found to be adulterated contained 38 per cent. of borax.

Liquor Calcis. — Only 2 samples of the 9 examined were found to be pure. The rest were weak in strength, being unsaturated solutions. The weakest sample was found to be 67 per cent. of the strength required.

Oleum Limonis. — Seven samples out of 17 analyzed were classed as adulterated by reason of the presence of foreign oil or alcohol, or because they had undergone decomposition. The Zeiss refractometer is very useful in determining the purity of lemon oil, but when used with ordinary white light, the dispersion is considerable. It is therefore preferable to employ the sodium light, with which a clear sharp reading may be obtained. The following table shows the refractometer reading of pure lemon oil at various temperatures, using the sodium light: —

Readings on Zeiss Butyro-Refractometer of Lemon Oil.

Temperature, Centigrade.	Scale Reading.	Temperature, Centigrade.	Scale Reading.
40.0, ...	59.4	29.5, ...	66.6
39.5, ...	59.7	29.0, ...	67.0
39.0, ...	60.1	28.5, ...	67.3
38.5, ...	60.4	28.0, ...	67.7
38.0, ...	60.8	27.5, ...	68.0
37.5, ...	61.0	27.0, ...	68.4
37.0, ...	61.5	26.5, ...	68.7
36.5, ...	61.8	26.0, ...	69.0
36.0, ...	62.1	25.5, ...	69.3
35.5, ...	62.4	25.0, ...	69.7
35.0, ...	62.8	24.5, ...	70.0
34.5, ...	63.1	24.0, ...	70.4
34.0, ...	63.5	23.5, ...	70.7
33.5, ...	63.8	23.0, ...	71.1
33.0, ...	64.2	22.5, ...	71.4
32.5, ...	64.5	22.0, ...	71.8
32.0, ...	64.9	21.5, ...	72.1
31.5, ...	65.1	21.0, ...	72.5
31.0, ...	65.6	20.5, ...	72.8
30.5, ...	65.9	20.0, ...	73.2
30.0, ...	66.3		

The polariscope is useful for the examination of lemon oil. The right-handed rotation of undiluted oil of lemon on the cane sugar scale, corresponding to a tube-length of 100 millimeters, varies from 173 to 184.5°. For the purpose of examining essential oils on the polariscope we have found it convenient in this laboratory to employ a tube 50 millimeters in length, thus enabling us to get readings well within the limits of the scale in the case of many oils, the readings of which it would be otherwise impossible to obtain without dilution.

In the following table are shown the refractometer reading, rotation and specific gravity of oil of lemon, as well as of various oils used as adulterants of lemon oil. The same constants are incidentally given for a few other essential oils.

Constants of Some Essential Oils.

Oil.	Butyro-Refractometer (Sodium Light) at— 25.0°.	Butyro-Refractometer (Sodium Light) at— 40.0°.	Rotation in 100 Millimeter Tube, Ventzke Scale.	Specific Gravity at 15° C.
Oil of lemon (lowest),	69.5	57.5	173.0	0.8580
Oil of lemon (highest),	71.2	61.0	184.5	0.8610
Oil of lemon grass (A. Giese),	95.4	86.4	—10.8	0.9309
Oil of citronella (A. Giese),	85.6	76.6	—10.2	0.9437
Terpeneless oil of lemon (Hansel's),	86.7	77.7	—22.0	0.9463
Terpeneless oil of lemon grass (Hansel's),	89.8	80.8	—5.6	0.9232
Citral (A. Giese),	93.5	84.5	—3.6	0.9296
Oil of bergamot (Schimmel & Co.),	56.7	46.6	49.9	0.8817
Oil of lavender (Schimmel & Co.),	61.1	51.0	—17.3	0.8919
Oil of cloves,	-	146.1*	—2.9	1.0470

* Calculated by dilution.

One sample of lemon oil was found with 50 per cent. of added alcohol. On account of the presence of a little water the character of the adulteration in this case was rendered apparent from the mere appearance of the sample.

Determination of Alcohol in Oil of Lemon and Other Essential Oils. — The presence of alcohol in an essential oil is best detected by adding a drop of fuchsine to a few cubic centimeters of oil in a test tube. A deep red coloration indicates alcohol. To determine the amount, 2 cubic centimeters of oil are measured into a Babcock milk bottle, from 30 to 40 cubic centimeters of water are added and the mixture is vigorously shaken. Then by the addition of more water the liquid is run up into the graduated neck of the bottle, which is then whirled in the centrifuge for about five minutes. The reading is then taken, which, multiplied by 10, gives the percentage of oil in the mixture. The difference between this and 100 corresponds to the percentage of alcohol.

Oleum Olivæ. — Eighteen samples of olive oil out of 61 collected and examined were found to consist entirely of, or to contain, cotton-seed oil. Here, as in lard, the Halphen test for cotton-seed oil is useful (see page 465).

Potassii et Sodii Tartras. — Two samples of Rochelle salts were found to consist entirely of borax.

Piper. — Only one sample of pepper was this year purchased from a druggist, and this proved to contain 60 per cent. of ground olive stones.

Sodii Boras. — One hundred and sixty-nine samples were analyzed, 100 of which were found to contain sodium bicarbonate. The amount of adulterant found varied from 15 to 73 per cent.

Spiritus Frumenti. — Nine samples were purchased from drug stores, all of which were below the standard of the Pharmacopœia, though 2 of them were nearly up to that standard. All had residues insoluble in the amount of water specified in the Pharmacopœia. The solids and alcohol content were as follows: —

Spiritus Frumenti.

Solids (Per Cent.).	Alcohol (Per Cent.).	Solids (Per Cent.).	Alcohol (Per Cent.).	Solids (Per Cent.).	Alcohol (Per Cent.).
0.17	43.86	0.35	40.20	0.40	37.39
0.20	43.76	0.60	39.00	0.74	36.22
0.90	41.86	0.45	37.64	0.43	34.90

Sodii Phosphas. — Twenty-one samples out of the 66 analyzed were found to be distinctly arsenical. One sample was found to contain 49.4 parts of arsenic per 100,000.

Tinctura Opii. — Of 11 samples examined, only 1 was found to be of standard strength. The others varied from 0.3 per cent. to 1.0 per cent. of morphine.

Tinctura Iodi. — One hundred and thirty-four samples were examined, 123 of which were below strength. It is our custom to record the results of tincture of iodin in terms of percentage of the strength required by the Pharmacopœia, which calls for 7 grams of iodin in 100 cubic centimeters. One sample contained much more iodin than the required amount, being 113 per cent., United States Pharmacopœia strength. Eleven samples were of the exact strength required, those below the standard were as follows: —

7 samples were between 90 and 95 per cent. of the U. S. Pharmacopœia strength.
37 samples were between 80 and 90 per cent. of the U. S. Pharmacopœia strength.
39 samples were between 70 and 80 per cent. of the U. S. Pharmacopœia strength.
16 samples were between 60 and 70 per cent. of the U. S. Pharmacopœia strength.
10 samples were between 50 and 60 per cent. of the U. S. Pharmacopœia strength.

The lowest sample contained 35 per cent. of the strength called for.

Summary of Drug Statistics.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Acidum tannicum,	13	17	30	56.6
Æther,	1	2	3	66.6
Alcohol,	1	–	1	–
Aqua ammoniæ,	1	1	2	50.0
Aqua destillata,	1	8	9	88.8
Calx chlorata,	–	3	3	100.0
Capsicum,	36	13	49	28.3
Caryophyllus,	3	1	4	25.0
Cera alba,	2	4	6	66.6
Cera flava,	6	10	16	62.5
Chloroformum,	3	2	5	40.0
Cinnamomum cassia,	3	–	3	–
Extractum glycyrrhizæ,	6	10	16	62.5
Extractum glycyrrhizæ fluidum,	3	–	3	–
Extractum zingiberis fluidum,	–	1	1	–
Ferri et quininæ citras,	7	1	8	12.5
Ferri et strychninæ citras,	2	–	2	–
Glycerinum,	78	69	147	47.0
Iodoformum,	1	1	2	50.0
Liquor calcis,	2	7	9	77.8
Maranta,	29	–	29	–
Miscellaneous,	3	2	5	40.0
Oleum limonis,	10	7	17	41.2
Oleum olivæ,	43	18	61	29.5
Oleum menthæ piperitæ,	–	1	1	–
Opii pulvis,	3	1	4	25.0
Piper,	–	1	1	–
Potassii bitartras,	13	–	13	–
Potassii et sodii tartras,	–	2	2	–
Pulvis glycyrrhizæ compositus,	9	–	9	–

Summary of Drug Statistics — Concluded.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Quinina,	–	1	1	–
Quininæ sulphas,	21	–	21	–
Sapo,	1	–	–	–
Sodii boras,	67	102	169	60.4
Sodii phosphas,	45	21	66	31.8
Spiritus ætheris nitrosi,	3	23	26	88.4
Spiritus frumenti,	–	9	9	100.0
Spiritus myrciæ,	–	2	3	66.6
Spiritus vini gallici,	–	1	1	100.0
Sulphur lotum,	3	4	7	57.1
Sulphur præcipitatum,	2	16	18	88.8
Syrupus,	2	2	4	50.0
Syrupus acidi hydriodici,	2	–	2	–
Tinctura capsici,	2	–	2	–
Tinctura ferri chloridi,	2	1	3	33.3
Tinctura iodi,	11	123	134	91.8
Tinctura opii,	1	10	11	90.9
Zingiber,	18	1	19	5.2
Summary,	468	490	958	51.3

General Summary.

	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Milk,	4,372	1,737	6,109	28.4
Foods not milk,	2,530	590	3,120	18.9
Drugs,	468	490	958	51.3
Totals,	7,370	2,817	10,187	27.6

Respectfully submitted,

ALBERT E. LEACH,
Analyst.

REPORT

UPON THE

PRODUCTION, DISTRIBUTION AND USE OF DIPHTHERIA ANTITOXIN

FOR THE

YEAR ENDED MARCH 31, 1902.

REPORT

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PRODUCTION, DISTRIBUTION AND USE OF DIPHTHERIA ANTITOXIN

FOR THE

YEAR ENDED MARCH 31, 1902.

The work of producing diphtheria antitoxin was undertaken by the State Board of Health in the fall of 1894, but the distribution of the product for general use in the State was not begun until the last week of March, 1895, and for this reason the different annual reports pertaining to this work have, as a matter of convenience, ended with the month of March in each year, and embraced the previous twelve months in each instance. During the first two years of this period the city of Boston produced its own supply of antitoxin. A favorable opportunity is now offered of reviewing the seven years' work of the Board in this direction, in producing a gratuitous supply of antitoxin for a State of nearly three million inhabitants, with reference to the general results obtained, whether of success or of failure.

Fortunately, we now have in Massachusetts the proper data from which conclusions may be drawn with reference to the character of the work in question. These data consist of the records of deaths from diphtheria, covering a period of over forty years. This disease first appears in the registration reports of the State in 1858, in which year 18 deaths were recorded as having been due to this cause. Undoubtedly the disease had existed previously under different names.*

In addition to the data relating to deaths, records have also been kept by local boards of health during the past eleven years of all

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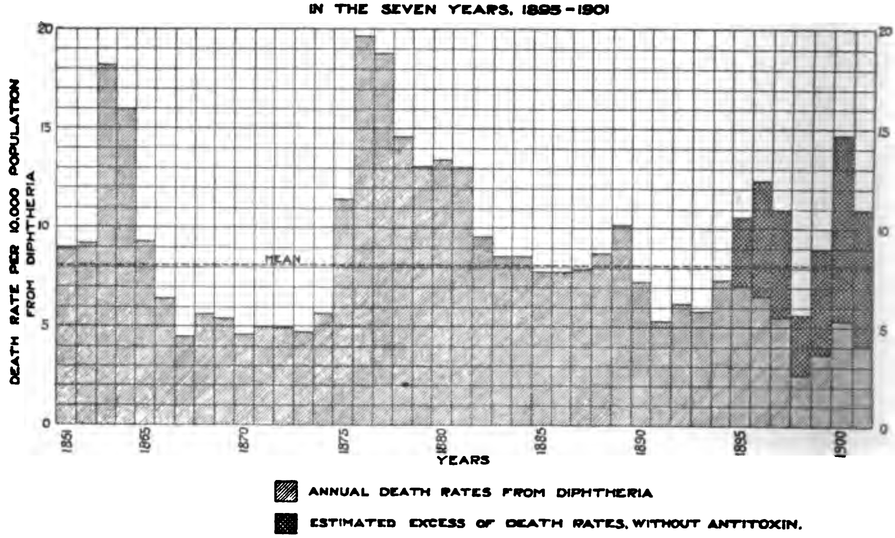
* For the purposes of this report all cases of membranous croup are considered under the title of diphtheria.

the cases of diphtheria which have been reported to such boards by practising physicians in the cities and towns. Since the statute requiring such reports is compulsory, and since, by an additional statute of 1893, it was also required that these reports should be transmitted to the State Board of Health as well as to the local board, we may reasonably regard these two sources of information as a reliable basis from which to draw conclusions as to the fatality of diphtheria.

The records relating to the reporting of contagious diseases embrace a period of eleven years (1891–1901). The following table and diagram show the course of diphtheria during the period of

DIAGRAM ILLUSTRATING THE MORTALITY FROM DIPHTHERIA IN MASSACHUSETTS DURING THE FORTY ONE YEARS, 1861 – 1901 AND THE ESTIMATED SAVING OF LIFE BY THE FREE DISTRIBUTION OF ANTITOXIN IN THE SEVEN YEARS, 1895 – 1901

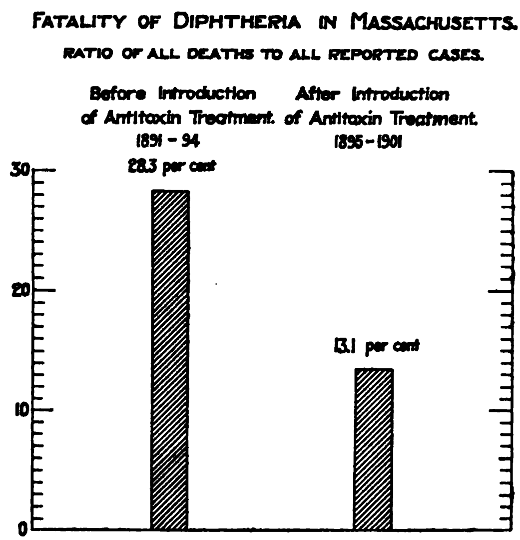


forty-one years (1861–1901). The whole number of deaths from this disease which were registered during this period was 63,038, and the mean death-rate from diphtheria per 10,000 of the population for the whole time was 8.1. Certain prominent points in this table and diagram are worthy of notice. Two epidemics appear during the first half of the period, in which the death-rate from diphtheria rose to 18.2 per 10,000 in 1863 and to 19.6 in 1876. In one of these epidemics the death-rate also remained above the mean for a period of seven years.

Death-rate from Diphtheria in Massachusetts, Forty-one Years (1861-1901).

YEARS.	Death-rate from Diphtheria per 10,000 Population.	YEARS.	Death-rate from Diphtheria per 10,000 Population.	YEARS.	Death-rate from Diphtheria per 10,000 Population.	YEARS.	Death-rate from Diphtheria per 10,000 Population.	Estimated Death-rate without use of Antitoxin.
1861, . .	8.9	1872, . .	4.9	1882, . .	9.6	1892, . .	6.2	-
1862, . .	9.2	1873, . .	4.7	1883, . .	8.6	1893, . .	5.8	-
1863, . .	18.2	1874, . .	5.7	1884, . .	8.6	1894, . .	7.4	-
1864, . .	15.9	1875, . .	11.4	1885, . .	7.8	1895, . .	7.1	10.6
1865, . .	9.3	1876, . .	19.6	1886, . .	7.8	1896, . .	6.6	12.4
1866, . .	6.4	1877, . .	18.7	1887, . .	7.9	1897, . .	5.5	11.0
1867, . .	4.5	1878, . .	14.6	1888, . .	8.7	1898, . .	2.6	5.6
1868, . .	5.7	1879, . .	13.1	1889, . .	10.2	1899, . .	3.7	9.0
1869, . .	5.4	1880, . .	13.4	1890, . .	7.3	1900, . .	5.3	14.7
1870, . .	4.6	1881, . .	13.1	1891, . .	5.3	1901, . .	4.1	10.9
1871, . .	5.0	- -	-	- -	-	- -	-	-

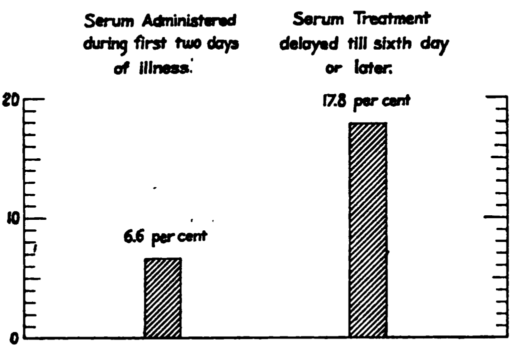
In the latter half of the period, however, no epidemics have occurred in which the death-rate from this cause attained a higher rate than 10.2 per 10,000. Unfortunately, for the first thirty years of this period there are no definite existing records in the possession of the State which show the fatality of diphtheria (ratio of deaths to cases). From such hospital records as exist, and from the recorded experience of a few physicians, it appears that the fatality was as high as 30 per cent.



Beginning with 1891, however, the records of cases and deaths may be regarded as fairly complete, and for the four years 1891 to 1894 inclusive the fatality was 28.3, this being the mean or average of the four years, since there were in this time 13,332 reported cases of diphtheria and 3,768 registered deaths in those cities and towns from which full reports of cases were received.

But beginning with 1895, the year in which antitoxin treatment was introduced throughout the State, the fatality fell at once to 18.9 per cent. of all reported cases, and thereafter continued to fall as its use became more general, the fatality of the next six years being successively 15.1, 14.1, 13.2, 11.6, 10.2 and 10.5, and if it were practicable to treat every reported case at the outset, on the first day of illness, the fatality would undoubtedly have been diminished still further, since the records in the possession of the Board show that the deaths of those among whom antitoxin treatment was begun during the first three days of illness were, relatively, but little more than half as many as were those of the several thousand among whom antitoxin treatment was delayed until the fourth day or later. If the experience shown by treatment on the first two days of illness be compared with that in which it is delayed till the sixth day or later, the distinction is still more sharply defined, the fatality of the former group being only 6.6 per cent. and that of the latter 17.8 per cent.

FATALITY OF DIPHTHERIA IN MASSACHUSETTS
AS RELATED TO THE PROMPTNESS OF TREATMENT WITH ANTITOXIN



We may now inquire what these figures mean in absolute numbers. An approximate answer may be obtained by applying the mean fatality-rate observed in the period of four years, 1891–94, in the reporting cities and towns, to the actual number of registered deaths in the succeeding periods 1895–1901, in the whole State, or, still more accurately, by applying this mean fatality-rate of the earlier period to each successive year of the later period. The difference between the sum thus obtained and the actual number of deaths would represent the saving of life in absolute numbers.

The actual number of registered deaths from diphtheria in Massachusetts in the seven years 1895–1901 was 9,281. But the estimated number obtained by applying the mean fatality-rate of the four years 1891–94, which was 28.3, to the actual fatality-rate of each successive year of the later period, 1895–1901, makes a total of 19,978 deaths in the seven years. The difference between the actual number which occurred and the estimated number which would have occurred had no antitoxin been used is 10,697, which represents the saving of life in these seven years.*

These estimated results of the gratuitous distribution of antitoxin throughout the entire State for a period of seven years are subject to certain indeterminate limitations and possible errors in the method of computation, which are due to the variability, both in the death-rate and the fatality from diphtheria from year to year, as well as to the fact that both the death-rate and the fatality of infectious diseases generally have diminished perceptibly, comparing early periods with later. Added to this is the probability that in 1891 and 1892 a small proportion of the cases of diphtheria were not reported to the local boards of health in the cities and towns embraced in the report from which this conclusion is formed relative to the pre-antitoxin fatality of diphtheria. (See thirty-second annual report of the Board, 1900, p. 768.) There has also been a constant improvement in the ratio of the reporting population, as the laws relating to the reporting of disease and mortality have become operative in cities and towns. But even if these indeterminate limitations and sources

* The method of estimation is as follows:—

Let x equal the estimated number of deaths for any given year, provided that no antitoxin is used in the treatment of diphtheria.

Then x = approximately,

$$\frac{\text{Actual deaths from diphtheria in a given year} \times \text{the mean fatality-rate for the pre-antitoxin period.}}{\text{The observed fatality-rate of the year in question.}}$$

So, for the year 1895, $x = \frac{1784 \times 28.3}{18.9} = 2,671$, the estimated number of deaths in 1895, if no antitoxin had been used.

By treating each separate year's deaths in the same manner we have the following table:—

Years.	Actual or Registered Deaths from Diphtheria.	Estimated Deaths from Diphtheria without Antitoxin.
1895,	1,784	2,671
1896,	1,677	3,143
1897,	1,426	2,862
1898,	706	1,518
1899,	1,047	2,554
1900,	1,475	4,093
1901,	1,166	3,142
Total,	9,281	19,978
		9,281
		10,697 = Lives saved.

of error were to cut down the estimated saving of life by one-half, the result would still be more than 5,000 lives saved by the use of antitoxin in the course of the past seven years. This satisfactory result has been made possible by the production of antitoxin by the State Board of Health, and its free distribution through the agency of local boards of health throughout the State.

Another point worthy of consideration is the economy of production, as well as the great saving to the people of the State, and especially to the poor, who can ill afford to purchase antitoxin at the retail price which is charged for it. This is especially true in severe cases, where several packages are required before favorable results are secured.

During the past two years the number of bottles of antitoxin issued by the Board for use in the State was 93,600, and the actual cost of these, if the people had been obliged to buy them at the retail price, would have been, at the least calculation, $1.50 per bottle, or $140,000 for the two years' supply. The actual cost of producing this amount of antitoxin, of the highest degree of strength and purity, was not over $14,000 for the two years, so that the saving to the consumers or users of the product was at least $126,000.

Another interesting question which presents itself is that of the effect of gratuitous supply of antitoxin as compared with a supply which is furnished only by private sale. It is manifestly impossible to arrive at conclusions upon this point with mathematical exactness, since they must be derived from the varied observations of a considerable number of distributers of antitoxin in different parts of the State, who furnish the supply to persons living under widely different social conditions. In order to obtain an approximate answer to this question, copies of the following circular were sent to the principal parties in the State who were charged with the duty of issuing the antitoxin furnished by the Board: —

OFFICE OF THE STATE BOARD OF HEALTH, August, 1902.

To______________________________

Will you kindly answer the following question and oblige,

Yours respectfully,

SAMUEL W. ABBOTT, *Secretary.*

In your opinion, what proportion of the cases of diphtheria which have received antitoxin treatment by means of serum obtained through your board (and furnished by the State Board of Health) would have been compelled to go without antitoxin if the antitoxin had not been gratuitously furnished by the State?

Circulars of this description were sent to the fifty distributers issuing antitoxin in the largest quantities throughout the State, including the local boards of health and proprietors of drug stores where deposits had been made. Replies were made by nearly all the parties to whom the circulars were sent, and in most instances were stated in the most convincing language. In the majority of instances the authorities answering the circulars replied that a very large proportion of the cases treated (in some cities as high as 90 or 95 per cent.) would, in the opinion of the authorities making the replies, have been deprived of the use of antitoxin if the families in which it was administered had been compelled to purchase it.

Extracts from Replies to the Foregoing Circular.

From the board of health of a small city: "In my opinion, after carefully looking over the names of those to whom it was furnished by our board, I would say fully 90 per cent. would have been compelled to go without it."

From the superintendent of a large hospital: "About 70 per cent., and in cases of immigration, 100 per cent."

From the health officer of a large town: "I regret that you do not give us space enough on the enclosed sheet to express our convictions as to the wise and most beneficent action of the State Board of Health in providing the citizens of Massachusetts free and reliable and pure antitoxin; not only are the citizens saved many thousands of dollars annually by State production, but the fact that it is prepared by a State Board in which we have the fullest confidence is a guarantee that removes all doubt from the minds of physicians and parents as to perfect safety and success in its use. . . . The State Board has saved the cities and towns thousands of dollars, and what is more important, thousands of lives by its free, pure and effective antitoxin."

From the board of health of a large city: "I think that 25 per cent. would have received none, and that 50 per cent. more would have received an amount inadequate to accomplish the results which can be accomplished by sufficient doses. This opinion is based on the supposition that the patients will be treated at home."

From the board of health of a large city: "I do not think 75 per cent. an excessive estimate."

From the board of health of a large city: "Practically all the cases. . . . Nearly all the persons here who have had the benefit of it were very poor."

From the board of health of a large city: "About one-third."

From the board of health of a large manufacturing city: "I think 75 per cent."

From the board of health of another large manufacturing city: "In my opinion from 60 to 80 per cent."

From another large city: "Fifty per cent."

From a small city: "Eighty to eighty-five per cent. would have to go without or call on the city."

From a large manufacturing city: "In my opinion a little over one-half."

From a small city: "All of them."

From a residential city: "I think it is safe to say that between 50 and 60 per cent. of our cases which have received antitoxin would have found it a great hardship to have had to purchase antitoxin. Fully that proportion of cases were from the laboring classes."

From a manufacturing city: "My opinion, reinforced by those of leading practitioners in our city, is that to 50 to 90 per cent. of diphtheria patients the commercial price of diphtheria antitoxin would be prohibitive."

From a large city: "I am of opinion that at least 50 per cent. would be a low estimate."

From the board of health of a large city: "I doubt if 10 per cent. of the cases would have had antitoxin, and those only one dose. Consequently, many would have died and the whole history of antitoxin treatment would have been changed."

From druggists in large cities, who distribute antitoxin furnished by the State Board of Health: —

"In our opinion 90 per cent. would have been compelled to go without it."

"More than 75 per cent."

"About 50 per cent."

"Fifty per cent."

"I feel quite sure that fully 90 per cent. of the cases supplied by us would have had to do without antitoxin if they had to pay for it. In my opinion free antitoxin is a Godsend, and one of the best things the State does."

"Practically all the antitoxin which I distribute goes to people who cannot afford to pay for it."

"Taking as a basis the experience of the physicians having the largest practice here, we should say, in answer to your question, about 90 per cent."

"I think at least one-half."

"According to the statement of physicians, I should judge about 75 per cent."

"We think that in a very large majority of the cases the patient would be sent to the hospital for serum treatment, thereby causing delay and additional expense to the city if not to the State. In many other cases an insufficient amount would be used."

"I learn from physicians that about 60 per cent. of the cases would have had to go without. The rest was furnished to poor people who *could* have paid, but with great sacrifice."

The following summary relates to the operations of the Board regarding the production, distribution and use of diphtheria antitoxin for the twelve months ended March 31, 1902. The work of the Board in this direction has rapidly increased from the time when it was begun in the spring of 1895. As a condition of the use of antitoxin by boards of health, physicians, hospitals and others, it was required that a return should be made in each case where antitoxin was used upon blank forms furnished by the Board, upon which the details of each case were to be recorded. Since returns have not been made in all cases, the report must be deemed to be incomplete so far as the use of antitoxin is concerned.

The returns contributed from the Boston City Hospital and the Worcester, Cambridge, Waltham, Lynn and Lowell isolation hospitals form a large share of the report, since these are more complete than those received from other parts of the State.

The supervision of antitoxin production has been carried on, as in former years, under the charge of Dr. Theobald Smith, at the Bussey Institute, near the Forest Hills Station of the New York, New Haven & Hartford Railroad in Roxbury. The distribution has been conducted at the State House, from the office of the Board.

The strength of the serum employed has varied from 300 to 450 units per cubic centimeter, and the serum has usually been issued in a 5 cubic centimeter vial, containing 1,500 units. For convenience, a vial containing 20 cubic centimeters has also been employed for use where several patients are to be treated at once, or where unusually large doses are used. The serum has been distributed throughout the whole State, wherever it has been called for, to local boards of health, to contagious disease hospitals and to physicians in private practice, the latter being usually supplied through the local boards of health. In many instances the local board of health has placed it in charge of a druggist, where it could be obtained at any time during the day or night.

The confidence which has been expressed quite generally by physicians with reference to the value of antitoxin in diminishing the fatality from diphtheria has become so firmly established that few practitioners would be willing to undertake the treatment of the disease without this important remedy. Expressions of doubt as to its efficacy are now rarely heard and among the few physicians who decidedly opposed its use in 1895 and 1896 are now to be found some of the enthusiastic advocates of serum treatment.

The total number of packages issued by the Board during the seven years ending with March 31, 1902, was as follows:—

In 1895-1896 (year ending March 31),	1,724 bottles.
In 1896-1897 (year ending March 31),	3,219 bottles.
In 1897-1898 (year ending March 31),	4,668 bottles.
In 1898-1899 (year ending March 31),	12,491 bottles.
In 1899-1900 (year ending March 31),	31,997 bottles.*
In 1900-1901 (year ending March 31),	53,389 bottles.*
In 1901-1902 (year ending March 31),	40,211 bottles.
Total,	147,699 bottles.

In consequence of the variable strength of the product, it would be difficult to present an exact numerical statement, in units, of the antitoxin issued in these packages, the tendency having been to increase its strength from year to year. The total amount thus far issued is probably about 200,000,000 units.

An account was kept during the year of the amount of antitoxin employed in each case, with few exceptions, the result of which is shown in the following table:—

Amount of Antitoxin Used.	Number of Cases.	Deaths.	Amount of Antitoxin Used.	Number of Cases.	Deaths.
Less than 1,000 units,	37	5	5,000 to 10,000 units,	504	49
1,000 to 1,500 units,	387	17	10,000 to 15,000 units,	202	24
1,500 to 2,000 units,	121	9	15,000 to 20,000 units,	228	35
2,000 to 3,000 units,	514	35	20,000 and more units,	330	82
3,000 to 4,000 units,	410	18	Unknown,	15	2
4,000 to 5,000 units,	185	20			

* These numbers have reference to the actual number of bottles issued in packages of about 1,500 units each. In order to make this comparable with the figures of the first three years (1895-98), a package of 1,000 units should be employed as a standard, so that the 125,597 bottles distributed during the last three years would be equivalent to about 188,000 of the strength at first employed.

There were 2,158 cases in which the amount of antitoxin administered did not exceed 10,000 units in each case, and there were 760 cases in which the dose exceeded 10,000 units, and of these latter there were 330 in which the dose exceeded 20,000 units in each case.

The whole number of cities and towns to which antitoxin was distributed was 158, or 14 more than those which were published in the report of 1900. Among these are included 31 public and private institutions to which distribution of antitoxin was made. The actual number in each year was probably somewhat larger than these figures, since a few of the more distant cities acted as distributing centres for small towns in their neighborhood, and in some instances no returns were made from these towns. This serum was distributed to local boards of health and to physicians in the following cities and towns: —

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1901, to March 31, 1902.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Boston:		Salem,	604
City Hospital,	15,957	Brookline,	596
Children's Hospital,	600	Lynn,	530
St. Mary's Hospital,	287	Waltham,	477
Massachusetts Charitable Eye and Ear Infirmary.	208	Chelsea,	412
West End Nursery,	84	Newton,	400
Massachusetts General Hospital,	60	Lawrence,	337
Long Island Hospital,	31	Milford,	336
Massachusetts Homœopathic Hospital,	26	Holyoke,	321
Parental School,	25	Hyde Park,	319
Deer Island Hospital,	23	Springfield,	312
Gwynne Home for Children,	19	Haverhill,	311
Little Wanderers' Home,	12	Leominster,	272
New England Hospital,	6	Quincy,	261
General supply,	4,225	Everett,	246
Lowell,	2,908	Brockton,	245
Cambridge,	1,687	New Bedford,	222
Cambridge Hospital,	300	Fitchburg,	184
Worcester,	1,150	Fall River,	177
Somerville,	824	Reading,	172
Marlborough,	749	Malden,	170

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1901, to March 31, 1902 — Continued.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Pittsfield,	149	Taunton,	44
Weymouth,	138	Adams,	42
Peabody,	132	West Springfield,	42
Amesbury,	128	Belmont,	40
Medford,	127	Westborough,	2
Danvers,	126	Lyman School,	37
Insane Hospital,	14	Concord,	32
Easton,	121	Massachusetts Reformatory,	6
Melrose,	107	Mansfield,	38
Wakefield,	98	Attleborough,	36
Gloucester,	94	Dedham,	36
Scituate,	92	Medway,	34
Arlington,	90	Wellesley,	32
Bellingham,	78	Maynard,	30
Plymouth,	78	Merrimac,	30
Winchester,	78	Natick,	30
Woburn,	78	South Hadley,	30
Medfield,	46	Swampscott,	30
Insane Hospital,	22	Foxborough,	26
Milton,	66	State Hospital,	2
Stoneham,	66	Randolph,	28
Chicopee,	60	Rockland,	26
Marblehead,	60	Acton,	25
North Adams,	60	East Bridgewater,	25
Hopedale,	54	Framingham,	24
Revere,	54	Greenfield,	24
Watertown,	54	Needham,	24
Clinton,	48	Palmer,	18
Cohasset,	48	Massachusetts Hospital for Epileptics,	6
Lexington,	48	Templeton,	24
Middleborough,	48	Wilbraham,	24
Groton,	46	Hudson,	22
Winthrop,	43	Ayer,	21
Fort Banks,	2	Whitman,	21
Dighton,	44	Methuen,	20

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1901, to March 31, 1902 — Concluded.

City or Town.	Number of Bottles.	City or Town.	Number of Bottles.
Newburyport,	19	Barnstable,	6
Ashby,	18	Bridgewater,	6
Bedford,	18	Cheshire,	6
Lenox,	18	Gardner,	6
Ludlow,	18	Holliston,	6
Monson,	18	Ipswich,	6
Tewksbury:		Marshfield,	6
State Hospital,	18	Nantucket,	6
Princeton,	16	Northampton,	6
Beverly,	15	Norwell,	6
Saugus,	15	Provincetown,	6
Shirley,	15	Southborough,	6
Townsend,	15	Southampton,	6
Canton,	14	Ware,	6
Agawam,	12	Wareham,	6
Athol,	12	Warren,	6
Falmouth,	12	Wayland,	6
Hingham,	12	West Medway,	6
Kingston,	12	Braintree,	4
Millbury,	12	Georgetown,	4
Millis,	12	Lincoln,	4
North Attleborough,	12	Southbridge,	4
North Brookfield,	12	Walpole,	4
Norwood,	12	West Bridgewater,	4
Stoughton,	12	Blandford,	3
Williamstown,	12	Cummington,	3
Hanover,	11	North Reading,	3
Westford,	11	Norton,	3
Avon,	10	Pepperell,	3
North Andover,	10	Hull,	2
Leicester,	9	Marion,	2
North Abington,	8	Wales,	2
Sharon,	8	Wrentham,	2
West Brookfield,	8	Littleton,	1
Andover,	6	Total,	40,211

SUMMARY OBSERVATIONS UPON THE USE OF DIPHTHERIA ANTITOXIN IN MASSACHUSETTS DURING THE YEAR ENDED MARCH 31, 1902.

The whole number of returns of cases treated with diphtheria antitoxin furnished by the State Board of Health during the year ended March 31, 1902, to hospitals and to local boards of health for use in general practice was 3,033. Of this number, 2,933 were returns of cases of diphtheria treated with antitoxin, and 100 were returns of well persons who had been exposed to infection and were treated for the purpose of immunization. These cases constitute only a fraction of those which were treated during the year in the State with antitoxin furnished by the Board, since very many physicians failed to make returns to the Board.

Cases in which a Bacterial Examination was made.

The same methods of classification are continued in this report as were adopted in the reports of the previous six years. The cases in which cultures were made are classified into positive and negative cases. Diagnostic examinations were made in 2,482 cases reported to the Board as having been treated with antitoxin, and of these, 2,278 proved to be genuine cases of diphtheria and 204 gave a negative result.

Positive Cases.

Of the 2,278 positive cases, or those in which a diagnosis of diphtheria was made by bacterial cultures from the throat of the patient, there were 2,047 recoveries and 231 deaths, or 10.1 per cent., the results of the previous years having been, respectively, 13.7, 11.6, 8.2, 7.9, 11.4 and 9.4 per cent.

Sex. — The number of males was 1,052, and the deaths of these were 110, or 10.5 per cent. The females were 1,220, and the deaths of these were 120, or 9.8 per cent. The sex of 6 was not stated; of these there was 1 death.

Ages. — The following table shows the cases and deaths by ages : —

Year ended March 31, 1902.

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.). 1901.	Fatality (Per Cent.). 1900.
From 0 to 2 years,	263	53	20.2	21.7
From 2 to 5 years,	673	94	14.0	12.4
From 5 to 10 years,	637	55	8.6	5.3
Over 10 years,	599	16	2.7	4.6
Age unknown,	106	13	12.3	11.7
	2,278	231	10.1	9.4

Day of Illness when Antitoxin was first administered. — The following table presents the fatality, according to the day of illness on which the antitoxin was first administered: —

Day.	Cases.	Deaths.	Fatality (Per Cent.).						
			1901.	1900.	1899.	1898.	1897.	1896.	1895.
First,	263	25	9.5	6.4	9.8	8.2	8.0	0.0	0.0
Second,	653	44	6.7	6.0	5.6	1.8	8.9	9.5	9.7
Third,	520	49	9.4	7.7	12.8	6.2	7.0	8.3	8.7
Fourth,	304	38	12.5	11.3	14.1	13.2	3.0	22.7	15.4
Fifth,	147	25	17.0	14.8	15.6	11.8	11.8	0.0	22.2
Sixth,	75	12	16.0	21.1	17.9	20.0	0.0	14.3	20.0
Seventh,	38	7	18.4	13.7	27.1	9.5	30.0	25.0	33.3*
Eighth and later,	81	15	18.5	16.8	14.7	10.4	13.6	16.6	–
Unknown,	197	16	–	–	–	–	–	–	–

* Seventh day and later.

The value of the foregoing table consists mainly in the definite statement of the fatality of cases according to the day of illness at which antitoxin treatment was begun. In general, it shows that the ratio of success in treatment depends largely upon the early date at which antitoxin is first administered. A fuller and more conclusive summary embracing the whole period of seven years and containing greater numbers, may be found on a later page.

The cases in which antitoxin treatment was begun either upon the first, second or third days of illness constituted 63 per cent. of the whole number of positive cases reported to the Board to which antitoxin was administered during the year under consideration.

Hospitals and Private Practice.

	Cases.	Deaths.	Fatality (Per Cent.).
In hospitals,	1,412	160	11.3*
In private practice,	866	71	8.2*

* This apparent difference in the fatality of hospital and of general or outside treatment with antitoxin is accounted for by the fact that a considerable number of severe and fatal cases of diphtheria, which were treated by physicians in general practice, were transferred to a hospital after one or more days of home treatment and died at the hospital.

Seasons of the Year. — The cases embraced in the foregoing enumeration occurred in the following order: —

Months.	Cases.	Deaths.	Months.	Cases.	Deaths.
1901.			1901.		
April,	255	37	October,	189	14
May,	260	25	November,	251	24
June,	211	22	December,	206	26
July,	167	13	1902.		
August,	131	7	January,	231	25
September,	133	16	February,	134	12
			March,	106	9
Total six months,	1,157	120	Total six months,	1,117	110

By the foregoing table it appears that there were 1,157 positive cases reported in the warmer months, with 120 deaths, and 1,117 cases in the colder months, with 110 deaths. In 4 cases and 1 death the date was not given.

Negative Cases.

The reported cases in which a negative result was obtained were 204; and the deaths of these were 18, or 8.8 per cent.

Sex. — The males were 104, with 10 deaths, or 9.6 per cent., and the females 98, with 8 deaths, or 8.2 per cent.; and there were 2 cases in which the sex was not stated.

Age. — The percentage of fatality by ages was as follows: 0 to 2 years, 7.3 per cent.; 2 to 5 years, 22.0 per cent.; 5 to 10 years, 2.3 per cent.; and none over 10 years.

Summary of the Seven Years ended March 31, 1902.

Positive Cases treated with Antitoxin.

Whole number of cases for the seven years, 10,154; deaths, 1,010; fatality, 9.9 per cent.

Sex. — The fatality by sexes was as follows: —

Sex.	Cases.	Deaths.	Fatality (Per Cent.).
Males,	4,774	508	10.6
Females,	5,290	486	9.2

The sex of 90 was not stated; 16 deaths.

Ages. — The fatality by ages was as follows: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
0 to 2 years,	1,169	254	21.7
2 to 5 years,	3,315	423	12.8
5 to 10 years,	2,963	209	7.1
Over 10 years,	2,396	84	3.5
Age unknown,	311	40	-

Hospitals and Private Practice.

	Cases.	Deaths.	Fatality (Per Cent.).
In hospitals,	7,128	781	11.0
In private practice,	3,026	229	7.6

Cases in which no Bacteriological Examination was made during the Year ended March 31, 1902.

Reports were received of 451 cases where antitoxin was employed in which no cultures were taken. Of this number, 432, or nearly 96 per cent., occurred in general practice and the remainder were reported from hospitals. Of the whole number, 47 proved fatal, or 10.4 per cent.

Sex. — The number of males in this class was 193, and the deaths of these were 19, or 9.8 per cent. The number of females was 256, and the deaths of these were 28, or 10.9 per cent. The number of those whose sex was unknown or not stated was 2, none of whom died.

Age. — The following table presents the cases and fatality by ages among this class: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
From 0 to 2 years,	53	12	22.6
From 2 to 5 years,	134	12	9.0
From 5 to 10 years,	125	15	12.0
Over 10 years,	127	7	5.5
Age unknown,	12	1	–

Sequelæ.

Temporary skin eruptions, usually of brief duration, are of very common occurrence after the administration of antitoxin. Frequently these eruptions are quite mild and confined to a small area adjoining the place of injection, while occasional instances occur in which the eruption spreads throughout the entire surface of the body, or at least a portion of its area.

During the year under consideration such eruptions or rashes are reported as occurring in 864 instances, or 29.5 per cent. of the whole number reported upon. Of this number, 91 per cent. were mild in character and the remainder severe or extensive.

Albuminuria was reported in 338 instances, of which 91.7 per cent. were slight, or consisted of a trace only. The presence of albuminuria, however, has no significance as relating to the administration of antitoxin, since albuminuria is present according to good authorities in the majority of severe cases of diphtheria.*

Operations.

Tracheotomy, an operation which was once quite commonly resorted to in severe cases of laryngeal diphtheria, appears to have been almost entirely supplanted by the more safe and simple operation of intubation. It is reported as having been performed twice during the year, with 1 death.

Intubation is reported as having been performed 169 times during the year, with 37 deaths, or 21.9 per cent., a much smaller fatality than that of the previous year (30.7 per cent.).

* Osler's "Practice of Medicine," 2d edition, p. 115.

The complications of diphtheria which were met with among the patients treated with antitoxin were much the same as those of the preceding year, and consisted mainly of instances in which scarlet-fever or measles occurred simultaneously with diphtheria. Other infectious diseases also occasionally appeared as complications, but so far as can be learned these complications were no more common than they were before the introduction of antitoxin as a therapeutic or preventive remedy. Pneumonia was of rarer occurrence as a complication than scarlet-fever or measles.

By far the most important lesson to be learned from the returns which have been received since the introduction of antitoxin treatment is the necessity of *early administration of antitoxin in each and every case.*

Immunization.

Returns of cases in which antitoxin was used for the purpose of immunizing persons who had been exposed to the infection of diphtheria were received in only 100 cases, although quantities of antitoxin were issued for this purpose which would indicate a much larger number of persons thus treated. The average dose employed for this purpose was a little more than 900 units.

General Summary, 1895–1901.

Positive cases treated in the seven years ending March 31, 1902, and reported to the State Board of Health,	10,154
Cases in which no bacteriological examination was made,	2,576
Total,	12,730*
Deaths of these,	1,329
Fatality (per cent.),	10.4

Sexes.

The number of males who were treated was,†	5,933
The number of females who were treated was,†	6,635
The number whose sex was not stated was,†	162
Total,	12,730*
Deaths of males,	660
Fatality of males (per cent.),	11.1
Deaths of females,	644
Fatality of females (per cent.),	9.7
Deaths, sex not stated,	25

* In this number (12,730) 1,239 cases in which a bacterial diagnosis showed negative results are not included, so that the whole number treated with antitoxin of which returns were made to the Board was 13,969.

† Except cases determined to be "negative."

The following table contains the results of those cases only which had been determined by a culture examination to be positive, with reference to the fatality of the disease in each group of cases, considered in relation to the stage of the disease when antitoxin was first administered.

Nothing can be more conclusive than the cumulative testimony of these figures, supported as they are by similar experience elsewhere, as to the importance of the earliest possible administration of antitoxin in the treatment of diphtheria. Each day's delay renders the liability to a fatal result greater.

The fatality of the cases which were treated with antitoxin very early in the course of the disease (that is, before the termination of forty-eight hours from its onset) was only 6.6* per cent., or 277 deaths in 4,181 cases, while that of the cases which were not thus treated until the sixth day or later was as high as 17.8 per cent., or nearly three times as great.

Day of Administration.

Day.	Cases.	Deaths.	Fatality (Per Cent.).
First,	1,289	100	7.8
Second,	2,892	177	6.1
Third,	2,290	219	9.6
Fourth,	1,505	195	13.0
Fifth,	784	122	15.6
Sixth and later,	1,080	192	17.8

And there were 1,506 cases in which the day on which antitoxin was first administered was not stated, and of these there were 169 deaths.

* The sum of the experience of the first two days is expressed in this figure.

DIPHTHERIA CULTURES EXAMINED DURING THE YEAR ENDED MARCH 31, 1902.

During the year ended March 31, 1902, 4,119 cultures have been received from 118 towns and cities in the State. Of these cultures, 1,633 were made for the purpose of diagnosis and 2,486 for release from quarantine. The following table gives the number of cultures received from the different towns and cities and the results of the examinations: —

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.
		Positive.	Negative.	Doubtful.	
Adams,	1	1	–	–	–
Andover,	12	3	7	1	1
Arlington,	69	7	9	–	53
Ashby,	18	3	1	–	14
Attleborough,	14	10	4	–	–
Ayer,	2	1	–	–	1
Barnstable,	1	–	1	–	–
Bedford,	8	1	3	–	4
Belmont,	32	3	5	–	24
Beverly,	11	1	8	–	2
Boston,	3	–	2	–	1
Bolton,	1	–	1	–	–
Bourne,	1	–	1	–	–
Braintree,	4	2	2	–	–
Bridgewater,	18	2	3	–	13
Cambridge,	1	–	1	–	–
Chelsea,	154	43	32	2	77
Concord,	14	3	9	–	2
Cohasset,	78	11	7	2	58
Clinton,	17	3	11	–	3
Danvers,	70	13	12	3	42
Dartmouth,	1	–	1	–	–
Dedham,	7	1	2	–	4
Duxbury,	4	1	1	–	2
East Bridgewater,	24	2	11	–	11
Easton,	133	12	13	–	108
Everett,	525	68	47	3	407
Falmouth,	9	1	1	–	7

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.
		Positive.	Negative.	Doubtful.	
Framingham,	31	8	4	-	19
Foxborough,	27	6	15	-	6
Gloucester,	18	6	12	-	-
Greenfield,	28	6	5	-	17
Great Barrington,	3	1	2	-	-
Groton,	9	4	1	-	4
Hamilton,	3	-	-	-	3
Hanover,	2	-	1	-	1
Haverhill,	17	8	8	1	-
Hingham,	24	2	13	-	9
Holbrook,	1	1	-	-	-
Hopedale,	11	4	7	-	-
Hopkinton,	1	-	1	-	-
Hull,	3	1	1	-	1
Hyde Park,	234	32	21	2	179
Ipswich,	2	-	1	-	1
Kingston,	15	7	3	-	5
Lawrence,	28	4	17	1	6
Lexington,	39	6	7	-	26
Leominster,	33	11	13	1	8
Lincoln,	15	-	3	-	12
Ludlow,	5	1	1	-	3
Lynn,	1	1	-	-	-
Malden,	249	25	39	7	178
Mansfield,	3	3	-	-	-
Marblehead,	61	13	20	-	28
Marion,	2	1	1	-	-
Marlborough,	423	96	40	4	283
Marshfield,	2	-	2	-	-
Medfield,	46	11	12	-	23
Medford,	93	19	40	1	33
Medway,	7	2	4	-	1
Melrose,	133	18	29	3	83
Mendon,	2	-	2	-	-
Methuen,	2	-	2	-	-
Middleborough,	11	5	2	1	3
Millis,	2	2	-	-	-
Milton,	57	8	12	1	36
Natick,	11	4	3	1	3
Needham,	4	1	1	1	1
New Bedford,	89	11	21	3	54
Newburyport,	20	1	19	-	-
North Adams,	46	12	11	-	23
North Attleborough,	7	2	4	-	1
North Brookfield,	3	1	2	-	-
Northborough,	5	1	-	-	4
Norton,	1	1	-	-	-
Norwell,	9	1	5	-	3
Norwood,	7	1	3	-	3
Peabody,	99	10	11	2	76
Pittsburg,	74	6	10	-	58
Plymouth,	15	7	6	-	2

City or Town.	Whole Number of Cultures examined.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.
		Positive.	Negative.	Doubtful.	
Princeton,	6	-	-	-	6
Quincy,	81	23	31	1	26
Randolph,	7	3	3	-	1
Reading,	94	18	41	-	35
Revere,	10	2	6	-	2
Rockland,	5	1	3	-	1
Salem,	214	24	29	2	159
Saugus,	16	4	2	-	10
Scituate,	31	3	2	-	26
Sharon,	5	1	3	-	1
Somerville,	14	1	-	2	11
Southborough,	5	-	1	-	4
Spencer,	2	-	1	-	1
Sterling,	4	-	2	-	2
Stoneham,	7	1	5	-	1
Stoughton,	3	-	3	-	-
Swampscott,	20	6	7	-	7
Taunton,	3	-	3	-	-
Templeton,	2	1	1	-	-
Tewksbury,	1	-	1	-	-
Wakefield,	15	4	4	1	6
Walpole,	7	2	3	-	2
Ware,	2	-	1	1	-
Wareham,	4	-	3	-	1
Warren,	7	1	2	-	4
Watertown,	6	2	1	-	3
Wellesley,	40	2	6	-	32
Westborough,	52	8	8	-	36
West Boylston,	1	1	-	-	-
West Brookfield,	2	-	2	-	-
Westford,	7	4	-	-	3
Weymouth,	6	2	1	-	3
Whitman,	4	2	2	-	-
Williamstown,	3	3	-	-	-
Wilmington,	6	-	5	1	-
Winchester,	95	12	38	1	44
Winthrop,	52	5	20	-	27
Woburn,	15	2	11	-	2
Total,	4,119	701	883	49	2,486

Persistence of Diphtheria Bacilli in the Throats of Patients Convalescent from Diphtheria.

Among these cases are included only those in which frequent cultures were made until the throat was free from the bacilli. The time of persistence is given from the date of the earliest symptoms to when the bacilli were last found in cultures from the throat.

Time of Persistence.	Number of Cases.	Time of Persistence.	Number of Cases.
1 week or less,	3	8 to 9 weeks,	4
1 to 2 weeks,	55	9 to 10 weeks,	3
2 to 3 weeks,	78	10 to 11 weeks,	2
3 to 4 weeks,	86	87 days,	1
4 to 5 weeks,	46	96 days,	1
5 to 6 weeks,	15		
6 to 7 weeks,	11	Average, 25.1 days,	310
7 to 8 weeks,	5		

Relation of Clinical to Bacteriological Diagnosis.

Clinical Diagnosis.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
Positive in 620 cases,	390	212	18
Negative in 311 cases,	65	237	9
Doubtful in 448 cases,	153	282	13
Not given in 254 cases,	94	151	9

Relation of Bacteriological Diagnosis to the Day of Taking the Culture.

Day of Disease on which Culture was Taken.	Bacteriological Diagnosis.			Percentage of Positive Cases.
	Positive.	Negative.	Doubtful.	
First day,	56	57	3	48.3
Second day,	241	313	16	42.3
Third day,	176	250	12	40.2
Fourth day,	83	92	5	46.1
Fifth day,	52	61	3	44.8
Sixth day,	20	26	2	41.7
Seventh day,	28	33	2	44.4
Over seven days,	22	20	2	50.0
Not stated,	23	31	4	39.7

SUMMARY OF THE SIX YEARS ENDED MARCH 31, 1901.

The whole number of cultures examined during the six years is as follows: —

In 1896-97 (year ended March 31, 1897),	1,469
In 1897-98 (year ended March 31, 1898),	2,204
In 1898-99 (year ended March 31, 1899),	1,591
In 1899-1900 (year ended March 31, 1900),	3,258
In 1900-1901 (year ended March 31, 1901),	5,173
In 1901-1902 (year ended March 31, 1902),	4,119
Total,	17,814

Of these 17,814 cultures, 8,301 were made for the purpose of diagnosis and 9,513 for release from quarantine. Of the cultures made for diagnosis, 3,560 were positive, 4,600 were negative and 141 were doubtful.

In 1,430 cases, in which frequent cultures were made until the throat was free from the bacilli of diphtheria, the average time of persistence of the bacilli from the date of earliest symptoms was 26.2 days.

In 8,301 cultures examined for diagnosis the relation of clinical to bacteriological diagnosis was as follows: —

Clinical Diagnosis.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
Positive in 3,081 cases,	1,970	1,071	40
Negative in 1,657 cases,	332	1,295	30
Doubtful in 2,079 cases,	710	1,335	34
Not given in 1,484 cases,	552	898	34

EXAMINATION OF SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

During the year ended March 31, 1902, microscopical examination has been made of 797 specimens of sputum and other material suspected of containing the bacilli of tuberculosis. This material was received from 119 different towns and cities in the State. The following table gives the places from which the material was received and the results of the examinations: —

City or Town.	Number of Cases examined.	Males.			Females.			Sex not stated.		
		Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.
Abington,	4	1	1	-	2	-	-	-	-	-
Adams,	5	1	1	-	1	2	-	-	-	-
Andover,	3	1	1	-	-	1	-	-	-	-
Arlington,	8	-	-	-	3	4	-	-	1	-
Ashland,	1	-	1	-	-	-	-	-	-	-
Attleborough,	6	2	-	-	1	2	-	-	1	-
Ayer,	2	-	-	-	1	1	-	-	-	-
Barnstable,	3	-	2	-	-	1	-	-	-	-
Beverly,	2	-	1	-	-	1	-	-	-	-
Blackstone,	6	2	3	-	1	-	-	-	-	-
Boston,	14	5	2	1	1	4	-	1	-	-
Bourne,	1	1	-	-	-	-	-	-	-	-
Braintree,	3	1	2	-	-	-	-	-	-	-
Bridgewater,	4	-	1	-	1	2	-	-	-	-
Brockton,	36	7	10	1	3	13	2	-	-	-
Brookfield,	5	1	3	-	-	1	-	-	-	-
Brookline,	2	1	-	-	1	-	-	-	-	-
Canton,	1	-	-	-	-	1	-	-	-	-
Chelsea,	19	4	4	-	3	7	1	-	-	-
Clinton,	8	-	4	1	-	2	-	1	-	-
Cohasset,	2	-	1	-	-	1	-	-	-	-
Colrain,	1	-	-	-	1	-	-	-	-	-
Concord,	4	1	3	-	-	-	-	-	-	-
Cottage City,	1	-	-	-	-	1	-	-	-	-
Danvers,	8	2	2	-	3	1	-	-	-	-
Dedham,	5	-	3	-	-	1	1	-	-	-

City or Town.	Number of Cases examined.	Males.			Females.			Sex not stated.		
		Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.
Douglas,	2	1	-	-	-	1	-	-	-	-
East Bridgewater,	5	-	3	-	-	2	-	-	-	-
Edgartown,	4	1	-	-	2	1	-	-	-	-
Everett,	30	11	6	1	3	9	-	-	-	-
Fairhaven,	1	-	-	-	-	1	-	-	-	-
Fall River,	78	18	16	3	15	23	3	-	-	-
Falmouth,	2	-	1	-	1	-	-	-	-	-
Foxborough,	13	2	4	-	1	6	-	-	-	-
Framingham,	10	4	1	-	2	2	-	1	-	-
Franklin,	3	-	-	-	1	2	-	-	-	-
Georgetown,	2	-	-	-	1	1	-	-	-	-
Gloucester,	3	-	2	-	-	1	-	-	-	-
Great Barrington,	2	-	1	-	-	-	-	1	-	-
Greenfield,	2	-	2	-	-	-	-	-	-	-
Hanover,	1	-	1	-	-	-	-	-	-	-
Halifax,	1	1	-	-	-	-	-	-	-	-
Haverhill,	8	3	-	-	1	4	-	-	-	-
Heath,	1	-	-	-	-	1	-	-	-	-
Hingham,	9	-	4	-	2	2	1	-	-	-
Holbrook,	1	-	-	-	1	-	-	-	-	-
Hull,	1	-	-	-	-	-	-	-	1	-
Hyde Park,	1	-	-	-	-	1	-	-	-	-
Lawrence,	8	-	2	-	3	3	-	-	-	-
Lexington,	3	-	-	1	-	2	-	-	-	-
Littleton,	2	1	1	-	-	-	-	-	-	-
Lynnfield,	1	-	1	-	-	-	-	-	-	-
Malden,	18	4	3	-	4	6	-	-	1	-
Mansfield,	7	1	5	-	1	-	-	-	-	-
Marblehead,	1	1	-	-	-	-	-	-	-	-
Marlborough,	6	2	3	-	-	1	-	-	-	-
Marshfield,	1	-	-	-	-	1	-	-	-	-
Maynard,	2	-	-	-	1	-	-	-	1	-
Medford,	16	1	4	-	3	8	-	-	-	-
Medway,	2	-	-	-	1	1	-	-	-	-
Melrose,	25	3	12	-	4	6	-	-	-	-
Methuen,	7	1	2	-	2	2	-	-	-	-
Middleborough,	4	1	1	-	-	2	-	-	-	-
Milford,	1	1	-	-	-	-	-	-	-	-
Milton,	8	1	2	-	1	3	1	-	-	-
Natick,	3	-	1	-	1	1	-	-	-	-
Needham,	6	-	-	1	2	3	-	-	-	-
New Bedford,	13	1	4	-	4	4	-	-	-	-
Newburyport,	3	-	2	-	-	-	-	-	1	-
Newton,	1	-	-	-	-	1	-	-	-	-
Norfolk,	1	-	-	-	-	1	-	-	-	-
North Adams,	54	12	8	-	9	22	1	1	1	-
North Andover,	1	-	-	-	1	-	-	-	-	-
North Attleborough,	18	7	7	-	3	1	-	-	-	-
Northborough,	1	1	-	-	-	-	-	-	-	-
North Brookfield,	1	-	-	-	-	-	1	-	-	-

City or Town.	Number of Cases examined.	Males.			Females.			Sex not stated.		
		Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.	Positive.	Negative.	Doubtful.
Norwood,	3	1	2	-	-	-	-	-	-	-
Oxford,	2	-	2	-	-	-	-	-	-	-
Palmer,	1	-	-	-	1	-	-	-	-	-
Peabody,	15	3	2	-	6	3	-	-	1	-
Pittsfield,	3	-	1	-	-	2	-	-	-	-
Provincetown,	1	1	-	-	-	-	-	-	-	-
Quincy,	19	4	5	-	2	8	-	-	-	-
Randolph,	7	-	4	-	1	-	-	-	2	-
Reading,	17	1	8	1	2	4	1	-	-	-
Revere,	4	1	2	-	-	1	-	-	-	-
Rockland,	15	5	6	-	-	4	-	-	-	-
Rutland,	2	2	-	-	-	-	-	-	-	-
Salem,	19	5	2	-	8	4	-	-	-	-
Scituate,	1	-	-	-	1	-	-	-	-	-
Sheffield,	1	-	-	-	-	-	-	-	1	-
Shelburne,	1	-	-	-	-	-	-	-	1	-
Somerville,	15	1	1	-	3	6	-	2	2	-
Somerset,	1	1	-	-	-	-	-	-	-	-
Spencer,	10	2	5	-	1	1	1	-	-	-
Springfield,	3	-	1	-	-	2	-	-	-	-
Stoughton,	1	-	-	-	1	-	-	-	-	-
Taunton,	10	3	1	-	2	4	-	-	-	-
Topsfield,	1	-	1	-	-	-	-	-	-	-
Wakefield,	4	-	1	-	3	-	-	-	-	-
Waltham,	2	-	-	-	-	2	-	-	-	-
Ware,	1	-	1	-	-	-	-	-	-	-
Wareham,	2	-	1	-	-	1	-	-	-	-
Warren,	2	-	1	-	1	-	-	-	-	-
Watertown,	3	-	2	-	-	-	-	-	1	-
Wellesley,	1	1	-	-	-	-	-	-	-	-
Westborough,	3	-	2	-	-	1	-	-	-	-
West Bridgewater,	1	-	1	-	-	-	-	-	-	-
Westford,	11	-	3	1	1	5	-	-	1	-
Westport,	1	-	-	-	-	1	-	-	-	-
Weymouth,	5	1	3	-	1	-	-	-	-	-
Whitman,	12	2	5	-	1	3	-	-	1	-
Williamstown,	2	-	-	-	-	2	-	-	-	-
Winchendon,	3	-	-	-	2	1	-	-	-	-
Winchester,	13	1	4	-	-	6	-	2	-	-
Winthrop,	2	-	-	-	-	2	-	-	-	-
Worcester,	20	2	5	1	5	7	-	-	-	-
Worthington,	7	1	1	-	3	1	-	1	-	-
Not stated,	2	-	1	-	-	1	-	-	-	-
Total,	797	147	218	12	137	243	13	10	17	-

Ages. — The relation of bacteriological diagnosis to age is shown in the following table: —

Age Periods.	Number of Cases examined.	Positive.	Negative.	Doubtful.
From 0 to 10 years,	24	2	19	3
From 10 to 20 years,	110	41	66	3
From 20 to 30 years,	249	122	119	8
From 30 to 40 years,	175	63	107	5
From 40 to 50 years,	77	30	46	1
From 50 to 60 years,	57	15	40	2
From 60 to 70 years,	21	2	19	–
From 70 to 80 years,	10	–	10	–
From 80 to 90 years,	1	–	1	–
Not stated,	73	19	51	3
Total,	797	294	478	25

Sex. — The relation of bacteriological diagnosis to sex is shown in the following table: —

Bacteriological Diagnosis.	Total.	Males.	Females.	Sex not stated.
Positive cases,	294	144	135	15
Negative cases,	478	216	243	19
Doubtful cases,	25	13	12	–
Total,	797	373	390	34

Clinical Diagnosis. — The relation of clinical diagnosis to bacteriological diagnosis is as follows: —

Clinical Diagnosis.	Bacteriological Diagnosis.		
	Positive.	Negative.	Doubtful.
Positive in 311 cases,	148	153	10
Negative in 120 cases,	29	84	7
Doubtful in 175 cases,	48	119	8
Not given in 191 cases,	69	122	–
Total, 797 cases,	294	478	25

Duration of the Disease. — The relation of bacteriological diagnosis to the duration of the disease is shown below: —

Duration of Disease to the Time of Examination of the Sputum.	Bacteriological Diagnosis.			Percentage of Positive Cases.
	Positive.	Negative.	Doubtful.	
1 month or less,	16	62	5	19.3
1 to 2 months,	35	72	3	31.8
2 to 3 months,	35	48	2	41.2
3 to 6 months,	49	49	8	46.2
6 to 9 months,	19	11	1	61.3
9 to 12 months,	35	25	-	58.3
1 to 2 years,	18	15	1	52.9
Over 2 years,	16	33	1	32.0
Not given,	71	163	4	-
	294	478	25	36.9

Summary of the Six Years ended March 31, 1902.

The number of specimens of sputum and other material examined for the bacilli of tuberculosis during the six years ended March 31, 1902, is as follows: —

In 1896-1897 (year ended March 31, 1897),	124
In 1897-1898 (year ended March 31, 1898),	236
In 1898-1899 (year ended March 31, 1899),	414
In 1899-1900 (year ended March 31, 1900),	571
In 1900-1901 (year ended March 31, 1901),	746
In 1901-1902 (year ended March 31, 1902),	797
Total,	2,888

Of these 2,888 specimens, 1,233, or 42.7 per cent., contained the bacilli of tuberculosis, in 1,609 specimens the bacilli were not found and in 46 specimens the bacteriological diagnosis was doubtful.

Ages. — Of 434 specimens from persons who were under twenty years of age, 38.7 per cent. were positive; of the 1,835 specimens from persons who were between the ages of twenty and fifty years, 46.2 per cent. were positive; and of the 322 specimens from persons who were over fifty years of age, 24.5 per cent. were positive. The age was not given in 307 cases. Of the *positive cases*, 166, or 13.4 per cent. were under 20 years of age, 851, or 69 per cent., were between the ages of twenty and fifty years, 79, or 6.4 per cent., were over fifty years of age, and in 137 the age was not given.

Sex. — Of the 2,888 cases from which material was examined, 1,338 were males, 1,389 were females, and the sex was not stated in 161. Of the male cases 43.5 per cent. and of the female cases 42.3 per cent. were positive.

TYPHOID FEVER.

WIDAL, AGGLUTINATIVE OR SERUM TEST.

During the year the method of collecting blood for the Widal test described in the preceding report was in operation. A number of physicians, however, sent to the laboratory blood dried on glass and various kinds of paper. They were evidently not aware of the fact that suitable outfits were procurable from the office of the Board on application.

The cases examined are given in the two following tables. In the first they are tabulated according to towns, in the second according to the day of the disease as estimated by the physician or other person sending the blood. It will be noticed that of the 108 specimens examined only 22, or about 20 per cent., responded positively to the test. Since the Board possesses no further information concerning these cases no statement of the relative accuracy of the test can be made. It is also impossible to state how far the success of the test in these cases depended on the length of time elapsing from the beginnings of the disease to the collection of the blood. It should furthermore be borne in mind, both in this mode of diagnosis and in malaria, that physicians not infrequently make use of the test to confirm a negative clinical diagnosis, and thus relieve themselves of any doubt.

Typhoid Fever (Widal Test).

City or Town.	Number of Cases.	Positive.	Negative.	City or Town.	Number of Cases.	Positive.	Negative.
Adams,	1	1	-	Cottage City,	1	-	1
Andover,	2	-	2	Danvers,	1	-	1
Arlington,	1	-	1	Dedham,	3	-	3
Attleborough,	3	-	3	Everett,	5	1	4
Chelsea,	9	3	6	Foxborough,	1	-	1
Clinton,	3	-	3	Highlandville,	4	-	4
Concord,	2	-	2	Hingham,	1	1	-

Typhoid Fever (Widal Test) — Concluded.

City or Town.	Number of Cases.	Positive.	Negative.	City or Town.	Number of Cases.	Positive.	Negative.
Hyde Park,	1	-	1	Reading,	9	2	7
Lynn,	6	1	5	Saugus,	4	1	3
Marlborough,	8	3	5	Somerville,	1	-	1
Medway,	1	1	-	Southborough,	1	1	-
Melrose,	9	1	8	Swampscott,	1	-	1
Millis,	1	-	1	Waltham,	1	-	1
Needham,	2	-	2	Wellesley,	1	-	1
Newburyport,	12	4	8	Wollaston,	1	1	-
Newton,	3	1	2	Wilmington,	1	-	1
North Easton,	1	-	1	Winchester,	4	-	4
Norwood,	1	-	1	Total,	108	22	86
Quincy,	2	-	2				

Widal Test, according to Stage of Disease.

Approximate Number of Days from Beginning of Disease to Collection of Blood.	Number of Cases.		Approximate Number of Days from Beginning of Disease to Collection of Blood.	Number of Cases.	
	Positive.	Negative.		Positive.	Negative.
3,	-	3	19,	1	3
4,	-	2	20,	2	2
5,	1	4	22,	2	5
6,	-	5	24,	-	2
7,	-	7	28,	-	1
8,	2	7	30,	-	1
9,	1	1	34,	-	2
10,	4	14	37,	1	1
14,	1	6	42,	-	1
15,	4	6	Unknown,	1	9
16,	1	3	Total,	22	86
17,	1	1			

MALARIA.

The number of preparations of dried blood examined for malaria parasites is given in the table below. It shows little difference, either in total number of blood films received or in the percentage of positive cases, from the figures of the preceding year. In 22, or about 24 per cent., the tertian malaria parasites were found. It is not to be understood, however, that those cases in which parasites are not detected with the microscope are necessarily not malaria. The parasites may be very scarce, as in old or chronic cases, or the films may have been made after the administration of quinine or late in the attack.

Malaria.

City or Town.	Number of Cases.	Positive.	Negative.	Doubtful owing to Imperfect Preparation of Films.
Attleborough,	1	-	1	-
Bridgewater,	1	-	1	-
Brockton,	3	-	3	-
Cambridge,	3	1	2	-
Clinton,	3	-	3	-
Concord,	3	-	3	-
Hyde Park,	2	-	2	-
Melrose,	7	-	7	-
Needham,	1	-	1	-
Newton,	10	4	5	1
Quincy,	1	-	1	-
Southborough,	5	3	2	-
Uxbridge,	1	-	1	-
Waltham,	5	1	4	-
Westford,	2	-	2	-
West Roxbury (Boston),	6	5	1	-
Winchester,	37	8	27	2
Total,	91	22	66	3

STATISTICAL SUMMARIES

OF

DISEASE AND MORTALITY.

STATISTICAL SUMMARIES OF DISEASE AND MORTALITY.

The statistical information relating to disease and mortality which has been received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the last seven reports of the Board, been presented under four different heads or groups, which are summarized and defined as follows: —

I. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They are voluntary, and serve principally to show the seasonal prevalence of each of the chief infectious diseases, and the mortality of children under five years old in weekly periods. This series of statistics has been continued by the Board for more than twenty-five years, and has been published as a summary for seventeen years.

II. *The Reports of Certain Infectious Diseases, — Diphtheria and Croup, Scarlet Fever, Typhoid Fever and Measles.* — These are obtained from the annual reports of local boards of health for the year 1901, which are forwarded to the State Board from cities and towns. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy.

III. *Reports of Cities and Towns, made under the Provisions of Chapter 75, Section 52, of the Revised Laws.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in Summary No. III.

IV. *Annual Reports made under the Provisions of Chapter 75, Section 12, of the Revised Laws.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. These reports are made under the requirements of the following statute: —

In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the State Board of Health. The form of such reports shall be prescribed and furnished by the State Board of Health.

NOTE. — A supply of the postal cards, necessary for the reporting of voluntary mortality returns such as are required for the data presented in section I. of the following summary, will be forwarded to the registration officers of any city or town who are willing to contribute the necessary information.

Postal cards are also sent to all boards of health in the State, for the purpose of aiding them to comply with the provisions of chapter 75, section 52, of the Revised Laws, relative to the reporting of diseases dangerous to the public health to the State Board immediately after reports of the same are received by the local board.

Annual blank forms are also sent to each local board of health in cities and towns having over 5,000 inhabitants, for the return of such information as is called for by the provisions of chapter 75, section 12, of the Revised Laws.

I.

The Weekly Mortality Returns.

In the following summary, the voluntary reports of deaths received at the close of each week from the city registrars, town clerks and boards of health of the cities and towns are epitomized for the year 1901. The chief value of this abstract consists in the fact that it presents a continuous history of the mortality from certain specified diseases from week to week throughout the year.

This weekly report has been published in the Boston Medical and Surgical Journal every week for a period of twenty years or more, and also as a publication of the Board, in a weekly bulletin, since and including 1883.

These returns are necessarily incomplete, since they are voluntary and consequently embrace the statistics of a portion only of the population, the reporting places being chiefly the cities and large towns.

The estimated population of the cities and towns contributing to these returns in 1901 was 1,829,594, or about two-thirds of the total population.

The following items are embraced in this summary: —

Average height of barometer for each week.
Mean maximum temperature.
Mean minimum temperature.
Rainfall, expressed in inches.
Total deaths reported for each week.
Deaths of children under five years.
Deaths from infectious diseases.
Deaths from consumption.
Deaths from acute lung diseases.
Deaths from typhoid fever.
Deaths from diarrhœal diseases.
Deaths from scarlet fever.
Deaths from measles.
Deaths from diphtheria and croup.
Deaths from puerperal fever.
Deaths from whooping-cough.
Deaths from malarial fever.
Deaths from erysipelas.
Deaths from cerebro-spinal meningitis.

The following table contains a summary of the statistics compiled from these weekly returns of mortality: —

Summary for 1901.

1901.	Barometer.	Maximum Mean Thermometer for Each Week.	Minimum Mean Thermometer for Each Week.	Humidity.	Rainfall, in Inches.*	Total Deaths.	Deaths under Five Years of Age.	Consumption.	Acute Lung Diseases.	Typhoid Fever.	Diphtheria and Croup.	Scarlet Fever.	Measles.	Diarrhoeal Diseases.	Whooping-cough.	Puerperal Fever.	Malarial Fever.	Erysipelas.	Cerebro-spinal Meningitis.
Jan. 5,	30.22	35	20	59	-	559	148	59	87	9	41	5	-	5	5	-	-	-	4
12,	30.08	38	24	75	-	545	156	58	106	9	27	8	8	7	4	-	-	3	2
19,	29.86	33	21	75	-	641	180	72	107	4	39	4	2	3	4	1	-	1	8
26,	30.05	38	22	80	2.02	635	171	61	99	12	40	12	4	8	4	1	-	1	7
Feb. 2,	29.65	30	19	66	-	708	193	80	135	10	29	13	1	11	5	-	-	8	9
9,	29.77	28	15	63	-	652	151	77	130	6	20	11	-	5	4	8	-	4	1
16,	29.64	30	16	56	-	697	187	73	149	6	22	12	-	9	5	-	-	5	6
23,	29.69	34	22	63	.88	706	191	51	158	5	28	11	4	7	8	-	-	2	12
March 2,	29.98	37	20	57	-	646	168	67	116	-	17	9	1	2	10	1	-	8	4
9,	30.01	40	24	66	-	685	194	71	131	3	26	8	2	10	3	1	-	-	5
16,	29.88	40	31	78	-	646	200	46	140	4	20	6	8	1	6	1	-	2	10
23,	30.08	48	33	67	-	640	188	73	121	2	26	8	-	5	6	1	-	8	8
30,	29.73	43	33	73	5.95	636	183	68	132	6	19	10	8	8	2	3	-	8	8
April 6,	29.73	46	36	87	-	534	162	62	109	4	15	17	2	8	4	1	-	4	1
13,	29.83	48	39	71	-	588	153	75	98	4	11	13	3	7	4	1	1	2	6
20,	30.15	45	38	83	-	610	167	70	109	3	18	10	5	13	9	3	-	5	8
27,	30.10	46	41	87	7.45	629	181	62	101	7	24	9	3	7	8	-	-	2	13
May 4,	30.01	59	41	60	-	544	149	74	67	5	13	11	3	4	2	2	-	4	6
11,	29.89	61	46	67	-	608	162	69	92	2	9	3	8	10	1	1	-	1	4
18,	29.97	66	51	65	-	557	156	61	73	5	10	8	5	13	1	-	-	-	6
25,	29.99	63	49	86	7.00	556	146	70	56	4	16	6	5	15	8	2	-	2	4
June 1,	29.84	56	48	91	-	520	138	69	68	6	10	7	4	10	1	2	-	2	8
8,	29.87	76	57	67	-	560	156	83	62	4	12	8	3	8	4	-	-	3	6
15,	30.06	75	56	62	-	456	113	56	44	6	15	7	4	10	3	-	-	2	8
22,	30.05	74	57	66	-	485	125	67	37	2	19	5	5	6	2	-	-	2	8
29,	29.89	85	67	76	1.49	598	174	57	38	3	14	2	2	23	3	1	-	1	4
July 6,	29.88	84	70	68	-	676	177	52	28	4	18	6	10	45	5	1	-	4	5
13,	30.06	78	62	82	-	543	182	66	24	2	8	14	3	56	4	2	-	-	5
20,	29.90	87	69	78	-	579	215	48	26	3	13	6	4	86	8	-	-	-	7
27,	29.96	81	64	67	4.44	622	277	51	25	5	7	4	1	144	2	1	-	2	3
Aug. 3,	29.87	78	63	77	-	634	310	54	19	7	8	5	1	168	2	1	-	-	3
10,	30.03	78	64	76	-	640	319	47	17	4	7	-	1	165	1	-	-	-	6
17,	30.01	80	65	80	-	726	332	57	22	8	9	6	1	146	8	-	-	1	9
24,	30.13	75	63	84	-	645	320	44	24	7	8	7	-	132	2	-	-	-	4
31,	30.08	76	64	71	4.17	716	331	61	34	8	12	8	2	170	2	-	-	-	7

Sept. 7,	30.04	77	64	82	-	658	285	83	23	18	8	1	-	133	7	-	-	-	12
14,	29.88	75	59	76	-	627	277	67	33	13	8	-	1	102	3	-	-	-	6
21,	30.03	71	55	82	-	661	282	68	34	11	7	1	1	134	-	-	-	2	8
28,	30.33	71	50	72	3.23	665	262	59	32	12	15	2	2	84	5	-	1	-	7
Oct. 5,	29.92	69	51	75	-	598	229	59	44	12	12	6	1	58	3	1	-	-	6
12,	30.26	64	49	81	-	609	178	56	37	27	16	8	1	48	3	-	-	-	7
19,	29.97	66	48	79	-	537	190	55	41	8	14	2	-	34	-	-	-	1	3
26,	30.08	61	42	69	2.92	566	166	70	62	12	19	2	1	28	4	-	-	-	2
Nov. 2,	30.31	60	43	78	-	568	189	60	54	10	21	4	3	25	-	-	-	2	4
9,	30.06	51	36	73	-	577	157	74	54	6	23	1	3	17	4	-	-	1	8
16,	29.71	42	30	70	-	580	155	66	63	12	22	5	1	24	-	2	-	-	10
23,	30.12	43	31	77	-	573	164	54	89	9	14	1	4	13	2	-	-	3	7
30,	29.80	35	23	79	2.19	589	164	45	93	6	22	1	1	5	1	1	-	-	2
Dec. 7,	30.12	37	20	75	-	615	173	52	88	9	25	4	8	13	1	1	-	3	5
14,	30.20	50	36	80	-	565	149	40	89	11	27	5	10	6	2	1	-	-	2
21,	30.09	28	14	75	-	622	162	61	98	10	16	3	4	4	1	1	-	3	4
28,	30.01	39	29	75	8.24	582	170	55	71	14	13	4	3	5	1	-	-	-	10
Totals,	-	-	-	-	49.98	31,614	10,107	3,235	3,789	379	902	319	142	2,060	167	37	2	82	283
Weekly average,	-	-	-	-	-	608	194	62	73	7.3	17.3	6.1	2.7	39.6	3.2	.07	.04	1.6	5.4
Rate per 1,000 deaths,	-	-	-	-	-	-	319.7	101.3	119.8	12.0	28.5	10.1	4.5	65.2	5.3	1.11	.06	2.59	8.95
Rate per 1,000 population,	-	-	-	-	-	17.28	5.52	1.76	2.07	.21	.49	.17	.08	1.13	.09	.02	.001	.044	.15

Average reporting population, . . . 1,829,594

* Rainfall in inches. The figures in this column are given by months instead of weeks.

Condensed Statistics relative to the Total Deaths, Deaths under Five Years and Deaths from Certain Causes in Reporting Cities and Towns of Massachusetts in 1901.

	Deaths.	Average Number of Deaths in Each Week.	Percentage of Total Mortality.	Death-rate per 1,000 of Reporting Population.
Total deaths,	31,614	608	100.0	17.28
Deaths under five years,	10,107	194	31.9	5.52
Deaths from consumption,	3,235	62	10.1	1.76
Deaths from acute lung diseases,	3,789	73	12.0	2.07
Deaths from diarrhœal diseases,	2,060	40	6.5	1.13
Deaths from typhoid fever,	379	7	1.2	.21
Deaths from diphtheria and croup,	902	17	2.8	.49
Deaths from scarlet fever,	319	6	1.0	.17
Deaths from measles,	142	2.7	.4	.08
Deaths from cerebro-spinal meningitis,	283	5.4	.9	.15
Deaths from whooping-cough,	167	3.2	.5	.09
Deaths from puerperal fever,	37	.7	.11	.02
Deaths from erysipelas,	82	1.6	.26	.04
Deaths from malarial fever,	2	-	-	-

The usual observations upon the weekly mortality statistics are omitted, and the foregoing short table containing the essential statistics supplies their place. The omission is made because information of the same character is presented in a different form in Section IV. of these summaries. The chief difference consists in the fact that the information given in this section (I.) is entirely voluntary and is detailed by weeks, while that of Section IV. is required by statute, the data not being forwarded to the Board until after the close of the year. The population which furnishes the statistics presented in Section IV. is considerably larger than that embraced in Section I., but both populations consist of the more densely settled parts of the State.

METEOROLOGY.

The principal points of sanitary interest in the meteorology of Massachusetts for the year 1901 were the following:—

The mean temperature for the year in Massachusetts was 47.8 or slightly below the normal.

That of each of the summer months and September was considerably above the normal, these months having temperatures respectively of 67°, 72.9°, 70.5° and 63.8°.

The annual rainfall was 49.12, or a little above the normal of a series of years.

II.

Fatality of Certain Diseases.

The following tabular statement has been published annually since and including 1891. It consists of the statistics presented relative to the principal notifiable diseases in those cities and towns from which annual reports have been sent by the local boards of health to the State Board.

By comparing the deaths from each one of the four diseases enumerated in the table with the reported cases, a fairly accurate estimate may be obtained of the fatality of these diseases. It should be borne in mind, however, that the system of reporting cases is probably not quite so thoroughly carried out as the registration of deaths, the latter having been in force for more than a half century. Hence it is quite probable that the general fatality percentage is a little too high for each disease.

Cases of Certain Infectious Diseases and Deaths from the Same as reported to Local Boards of Health, Massachusetts, 1901.

City or Town.	Diphtheria and Croup.		Scarlet Fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Amherst,	2	-	4	-	5	-	2	-
Arlington,	3	2	2	-	-	-	6	-
Attleborough,	13	2	5	-	15	2	3	-
BEVERLY,	9	2	54	6	17	1	33	-
BOSTON,	3,319	358	1,398	210	713	142	4,442	103
BROCKTON,	78	11	78	9	32	18	40	-
Brookline,	158	6	27	2	26	-	165	2
CAMBRIDGE,	615	59	101	8	96	10	562	10
CHELSEA,	207	18	57	3	36	7	21	3
Clinton,	14	3	17	-	9	4	6	1
Easthampton,	14	2	14	-	-	-	-	-
EVERETT,	232	12	41	1	28	3	81	1
FALL RIVER,	79	23	166	2	101	21	-	-

Cases of Certain Infectious Diseases and Deaths from the Same as reported to Local Boards of Health, Massachusetts, 1901 — Continued.

City or Town.	Diphtheria and Croup.		Scarlet Fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
FITCHBURG,	66	12	15	-	48	7	-	-
Franklin,	2	-	-	-	7	-	2	-
Gardner,	12	1	67	-	19	5	-	-
GLOUCESTER,	40	5	32	1	22	4	-	-
Great Barrington,	9	2	4	-	-	-	-	-
HAVERHILL,	107	14	41	2	88	10	10	-
Hingham,	16	-	4	-	-	-	-	-
HOLYOKE,	282	45	98	2	23	7	129	1
Hopedale,	10	2	8	-	-	-	-	-
Hudson,	4	1	3	-	6	-	1	-
Leominster,	131	8	6	-	9	2	10	-
LOWELL,	803	117	65	3	70	18	356	17
LYNN,	383	34	81	7	61	10	-	-
MALDEN,	129	9	167	1	52	9	544	1
Marblehead,	23	3	10	-	2	-	6	-
MARLBOROUGH,	129	18	41	1	10	-	-	-
MEDFORD,	57	7	188	5	22	1	481	2
Milford,	114	11	27	-	14	1	5	-
Milton,	11	1	6	-	11	1	17	-
Natick,	8	1	2	-	2	-	35	-
NEW BEDFORD,	49	14	112	10	99	19	-	-
NEWTON,	123	9	60	1	43	6	72	-
NORTH ADAMS,	33	8	45	1	36	5	45	-
NORTHAMPTON,	35	1	29	-	27	3	112	-
North Andover,	7	1	-	-	5	1	39	-
North Attleborough,	7	2	9	-	2	1	1	-
North Brookfield,	2	-	8	-	-	-	-	-
Orange,	-	-	24	1	-	-	151	-
Palmer,	9	-	32	1	11	-	7	-
Peabody,	54	5	40	7	2	-	22	2
Plymouth,	20	3	13	-	11	1	3	-
QUINCY,	104	9	24	-	47	2	40	-
Reading,	18	1	28	-	4	-	17	-
Rockland,	-	-	8	-	5	1	43	-
SALEM,	141	12	77	15	32	4	13	1

Cases of Certain Infectious Diseases and Deaths from the Same as reported to Local Boards of Health, Massachusetts, 1901 — Concluded.

City or Town.	Diphtheria and Croup.		Scarlet Fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Sharon,	2	-	-	-	4	-	1	-
SOMERVILLE,	340	29	130	5	78	12	-	-
SPRINGFIELD,	187	13	70	2	87	16	49	1
Stoneham,	27	1	2	-	7	-	57	-
Stoughton,	3	1	-	-	2	2	3	-
Swampscott,	12	-	6	-	1	1	4	-
TAUNTON,	20	5	42	4	1	-	-	-
Wakefield,	41	1	6	-	18	2	251	-
WALTHAM,	101	8	25	1	41	5	-	-
Ware,	5	-	2	-	20	1	4	-
Watertown,	48	2	7	-	11	3	90	1
Westborough,	37	-	-	-	9	-	4	-
Westfield,	80	17	22	-	6	1	7	-
Whitman,	4	-	3	-	-	-	10	-
WOBURN,	72	-	-	-	15	-	187	-
WORCESTER,	266	17	218	13	110	26	68	2
Total,	8,921	938	3,871	324	2,278	395	8,257	148
Fatality (per cent.),	10.5		8.4		17.3		1.8	

The summary of the foregoing figures for 1901 is as follows: —

Reported cases of diphtheria and croup,	8,921
Registered deaths from diphtheria and croup in the same cities and towns,	938
Fatality (per cent.),	10.5
Reported cases of scarlet fever,	3,871
Registered deaths from scarlet fever in the same cities and towns,	324
Fatality (per cent.),	8.4
Reported cases of typhoid fever,	2,278
Registered deaths from typhoid fever in the same cities and towns,	395
Fatality (per cent.),	17.3
Reported cases of measles,	8,257
Registered deaths from measles in the same cities and towns,	148
Fatality (per cent.),	1.8

The number of cities and towns contributing to this table in 1901 was 64. Most of the large cities are included, and the estimated number of their population was about 70 per cent. of the entire population of the State.

The reported cases of diphtheria and croup were less by 3,607 than those of 1900, and the number of deaths was 336 less. The fatality (10.5) was but slightly in excess of that of 1900. These figures compare very favorably with the pre-antitoxin period, 1891–94, when the fatality was 28.3 per cent.

The reported cases of scarlet fever were 2,092 less than those of the previous year, but the fatality (8.4 per cent.) was considerably greater, and was also greater than the mean fatality of the previous ten years (5.3).

The reported cases of typhoid fever were 495 less than those of 1900, but the fatality (17.3) was slightly greater, but was also less than the mean fatality of the ten years 1891–1900, which was 18.6.

The reported cases of measles were less than those of 1900; but the fatality (1.8 per cent.) was greater than the mean fatality of the previous ten years (1.2).

The following table presents the summary of these statistics for the eleven years 1891–1901: —

Reported Cases of Infectious Diseases in Massachusetts.

Diphtheria and Croup.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,033	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Diphtheria and Croup.

[Antitoxin Period.]

	1895.	1896.	1897.	1898.	1899.	1900.	1901.	Total 1895-1901.
Reported cases,	7,856	8,915	7,856	3,843	6,540	12,578	8,921	56,459
Deaths,	1,484	1,348	1,107	507	758	1,274	938	7,416
Fatality (per cent.),	18.9	15.1	14.1	13.2	11.6	10.2	10.5	13.1

Scarlet Fever.

	1900.	1901.	Total 1891-1901.
Reported cases,	5,963	3,871	59,267
Deaths,	319	324	3,303
Fatality (per cent.),	5.3	8.4	5.6

Typhoid Fever.

	1900.	1901.	Total 1891-1901.
Reported cases,	2,773	2,278	27,036
Deaths,	458	395	5,005
Fatality (per cent.),	16.5	17.3	18.5

Measles.

	1900.	1901.	Total 1891-1901.
Reported cases,	9,954	8,257	77,892
Deaths,	167	148	962
Fatality (per cent.),	1.7	1.8	1.2

In the foregoing tables the statistics relating to diphtheria and croup have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. The mean fatality in the former period (1891–94) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–1901) it was 13.1 per cent., or less than half as large.

In England, where systematic records have been kept in regard to the fatality of these diseases, the percentage of deaths to cases in diphtheria, as determined from 243,269 cases and 50,483 cases which occurred in the period of eleven years (1890-1900) was 20.7. There was, however, a uniform diminution in this percentage, after the introduction of antitoxin treatment, from 25.1 in 1894 to 16.4 in 1900.

The fatality of scarlet fever showed quite similar figures to those of Massachusetts, the maximum being 8 per cent. in 1890 and the minimum 3.1 per cent. in 1899.

In typhoid fever the fatality varied also from 20.8 in 1891 to 16.8 in 1897 and 1898.

III.

Official Returns of Notified Diseases Dangerous to the Public Health, 1901.

The figures presented in the following summary are those of the official returns of diseases "dangerous to the public health," made to the State Board of Health during the year 1901, under the provisions of chapter 75 of the Revised Laws. In this act no disease is specified as being "dangerous to the public health" except small-pox. Hence the State Board deemed it necessary to indicate the diseases which should be included in the meaning of the term "dangerous to the public health." They are the following: small-pox, scarlet fever, measles, typhoid fever, diphtheria, membranous croup, cholera, yellow fever, typhus fever, cerebro-spinal meningitis, hydrophobia, malignant pustule, leprosy and trichinosis.

The whole number of cases of infectious diseases reported to the Board in 1901, under the provisions of this act, was 27,009, which were divided as follows: —

Reported cases of small-pox,	773
Reported cases of diphtheria and croup,	9,793
Reported cases of scarlet fever,	4,356
Reported cases of typhoid fever,	2,689
Reported cases of measles,	9,398
Total,	27,009

The summary for the eight years 1893–1901 is as follows: —

	Reported Cases of					Total.
	Small-pox.	Diphtheria and Croup.	Scarlet Fever.	Typhoid Fever.	Measles.	
1893 (four months only),	35	1,109	2,914	1,525	1,503	7,086
1894,	181	4,178	6,731	2,372	2,133	15,595
1895,	1	7,806	6,194	2,438	4,868	21,307
1896,	5	8,515	3,801	2,637	6,362	21,320
1897,	18	7,613	5,495	2,104	12,695	27,925
1898,	10	3,980	3,667	2,196	4,478	14,331
1899,	105	7,134	5,349	2,776	12,355	27,719
1900,	104	12,641	6,396	2,967	10,507	32,615
1901,	773	9,793	4,356	2,689	9,398	27,009
Total,	1,232	62,769	44,903	21,704	64,299	194,907

By months these diseases were reported as follows: —

Cases of Infectious Diseases reported to the State Board of Health by Months in 1901.

Months.	Small-pox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.	Months.	Small-pox.	Scarlet Fever.	Diphtheria.	Typhoid Fever.	Measles.
January, .	7	620	1,484	202	476	August, .	14	242	492	330	194
February, .	4	422	1,012	88	442	September,	35	206	495	491	138
March, .	6	489	983	108	722	October, .	59	302	853	502	418
April, .	8	398	741	116	1,031	November, .	229	345	1,096	284	1,139
May, .	43	361	672	92	1,326	December, .	278	421	785	263	1,343
June, .	65	302	728	118	1,414						
July, .	25	248	452	100	755	Total, .	773	4,356	9,793	2,689	9,398

The significance of the foregoing figures may be more clearly understood and compared with those of the previous years by consulting the following table: —

Certain Infectious Diseases.

Intensity of Prevalence.

Months.	Diphtheria and Croup.			Scarlet Fever.			Typhoid Fever.			Measles.		
	1901.		1900.	1901.		1900.	1901.		1900.	1901.		1900.
	A	B	B	A	B	B	A	B	B	A	B	B
	Mean Daily Number of Reported Cases in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Reported Cases in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Reported Cases in Each Month.	Decimal Ratio.	Decimal Ratio.	Mean Daily Number of Reported Cases in Each Month.	Decimal Ratio.	Decimal Ratio.
January, .	47.9	17.9	9.9	20.0	16.8	14.8	6.5	8.9	5.6	15.4	6.0	13.0
February, .	36.1	13.5	9.1	15.1	12.7	15.7	3.1	4.2	3.7	15.8	6.1	12.2
March, .	31.7	11.8	8.8	15.8	13.2	13.8	3.3	4.5	5.0	23.3	9.0	15.9
April, .	24.7	9.2	6.8	13.3	11.1	11.3	3.9	5.8	3.4	34.4	13.4	17.5
May, .	21.7	8.1	6.9	11.6	9.7	10.3	3.0	4.1	4.7	42.8	16.6	23.9
June, .	24.3	9.1	7.8	10.1	8.5	8.0	3.9	5.3	6.9	47.1	18.3	21.1
July, .	14.6	5.4	5.1	8.0	6.7	4.6	3.2	4.4	6.0	24.4	9.5	7.6
August, .	15.9	5.9	5.9	7.8	6.5	4.3	10.6	14.5	9.8	6.3	2.4	2.0
September,	16.5	6.1	9.2	6.9	5.8	5.7	16.4	22.4	23.5	4.6	1.8	1.1
October, .	27.5	10.2	15.0	9.7	8.1	9.9	16.2	22.1	24.9	13.5	5.2	1.3
November,	36.5	13.6	18.0	11.5	9.6	10.6	9.5	13.0	14.4	38.0	14.8	1.9
December,	25.3	9.4	17.3	13.6	11.4	11.1	8.5	11.6	13.0	43.3	16.8	2.7
Mean, .	26.8	10.0	10.0	11.9	10.0	10.0	7.3	10.0	10.0	25.7	10.0	10.0

The object of the foregoing table is to present the figures for each month upon a uniform basis of comparison, month by month, so that the relative intensity of prevalence of each disease is shown for each month. The method also has the advantage of eliminating the apparent errors of computation arising from the unequal length of the months.

The figures may be read as follows: For example, the mean daily number of reported cases of diphtheria and croup in January, 1901, was 47.9; of scarlet fever, 20.0; of typhoid fever, 6.5; and of measles, 15.4 (see columns marked A); and the mean daily number of reported cases of the same diseases for the whole year 1901 was, respectively, 26.8, 11.9, 7.3 and 25.7. Assuming a standard of 10 as a daily mean of each disease for the year, the ratios for January were as follows: diphtheria and croup, 17.9; scarlet fever, 16.8; typhoid fever, 8.9; and measles, 6.0. (See columns marked B.) That is to say, for each 10 cases of diphtheria and croup reported daily throughout the year 1901, as a mean, there were 17.9 in January, 13.5 in February, 11.8 in March, etc.

From the foregoing table it appears that the maximum prevalence of diphtheria in 1901 was in January and the minimum in July. There was then a rapid rise until November, as also in the preceding year, with a decided decrease in December, to a point below the yearly mean, while the December decrease in 1900 was but slight. This decrease in December has been nearly constant for the last seven years, the only exception being that of December, 1899, in which there was an increase beyond that of the preceding month.

Scarlet fever was at its maximum prevalence in January, decreasing to a minimum in September, the minimum of 1900 occurring in August. Its prevalence was above the mean in the first four months and in December, and below it in the remaining months.

Typhoid fever was below the mean in the intensity of its prevalence in the first seven months of 1901, rising to a maximum in September, the maximum of 1900 occurring in October.

The course of measles was quite irregular, and resembled that of 1898, since in each of these years there were two periods of intensity and two of depression. The maximum occurred in June, while its prevalence in December was nearly as great as that of June. The prevalence of the disease in January, February, March, July, August, September and October was below the mean, and above it in the remaining months. The whole number of reported cases was less by 1,109 than that of 1900.

The figures relating to small-pox are not sufficient in number to assume comparative value in a table of this sort. They will therefore be presented in a succeeding report in a summary for a series of years.

The following table presents the number of cases of infectious diseases reported to the Board from each city and town in 1901. The whole number of cases was less by 5,606 than that of 1900, but the number of reporting cities and towns was 256 or only seven less than those of 1900.

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Fifty-six Cities and Towns during 1901.

	Small-pox.	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.		Small-pox.	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.
Abington,	1	-	-	-	-	BOSTON,	505	8,390	1,422	714	4,442
Acton,	-	1	5	-	28	Boylston,	-	4	-	-	-
Acushnet,	-	1	3	1	17	Braintree,	4	28	37	6	15
Adams,	5	9	17	18	-	Brewster,	-	-	-	2	16
Agawam,	-	7	1	-	-	Bridgewater,	-	12	-	2	-
Alford,	-	-	2	-	-	BROCKTON,	2	57	57	15	18
Amesbury,	-	26	2	7	1	Brookline,	2	146	27	25	189
Andover,	-	8	-	9	-	Burlington,	-	1	1	1	-
Arlington,	-	33	15	11	44	CAMBRIDGE,	15	615	98	96	557
Ashby,	-	6	-	-	-	Canton,	-	3	-	-	1
Ashland,	-	2	-	-	2	Carver,	-	8	1	-	-
Athol,	1	21	7	-	4	Charlton,	-	-	9	5	-
Attleborough,	1	14	4	13	1	Chelmsford,	-	5	3	-	-
Auburn,	-	1	-	-	-	CHELSEA,	4	183	50	37	18
Avon,	1	-	1	-	1	Cheshire,	-	1	-	-	-
Ayer,	-	1	-	-	1	Chester,	-	2	4	-	-
Barnstable,	-	2	-	1	11	CHICOPEE,	-	75	13	38	15
Barre,	-	-	3	-	-	Clinton,	-	15	16	9	6
Becket,	-	1	-	-	-	Cohasset,	-	20	1	1	6
Bedford,	-	7	4	-	2	Colrain,	-	-	2	-	-
Belchertown,	-	-	-	2	-	Concord,	1	4	3	-	44
Bellingham,	-	9	4	2	-	Cottage City,	1	2	9	-	5
Belmont,	2	12	2	2	5	Dalton,	1	7	-	-	-
Berkley,	-	1	26	-	-	Danvers,	-	26	-	3	112
Berlin,	-	-	1	-	-	Dedham,	3	9	6	3	4
BEVERLY,	-	9	52	16	33	Dighton,	3	16	5	-	-
Billerica,	-	-	-	11	52	Douglas,	-	-	27	1	1

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Fifty-six Cities and Towns during 1901 — Continued.

	Small-pox.	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.		Small-pox.	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.
Dracut,	-	20	2	-	5	Harvard,	-	-	2	-	-
Dudley,	-	1	10	-	-	Harwich,	-	-	2	-	-
Dunstable,	-	3	1	-	-	Hatfield,	-	1	11	3	-
Duxbury,	-	2	2	2	1	HAVERHILL,	-	107	41	90	10
East Bridgewater,	-	2	-	-	-	Hingham,	-	15	1	1	-
Easthampton,	2	-	-	-	-	Hinsdale,	-	1	-	-	-
East Longmeadow,	-	1	-	-	-	Holden,	-	-	-	1	-
Easton,	-	35	-	1	-	Holliston,	-	5	5	-	-
Edgartown,	-	-	-	2	-	HOLYOKE,	3	255	88	25	109
Enfield,	1	-	-	-	-	Hopedale,	-	11	12	-	-
Erving,	-	-	2	-	1	Hopkinton,	-	1	-	2	-
Essex,	-	1	2	1	-	Hubbardston,	-	3	1	-	-
EVERETT,	1	220	38	24	70	Hudson,	-	4	3	6	-
Fairhaven,	-	3	5	4	4	Hull,	-	3	-	1	4
FALL RIVER,	22	68	138	88	-	Huntington,	1	1	-	1	-
Falmouth,	-	5	10	-	23	Hyde Park,	6	45	12	2	-
FITCHBURG,	9	59	18	45	78	Ipswich,	-	6	6	15	1
Foxborough,	-	10	-	5	11	Kingston,	-	8	-	-	-
Framingham,	1	18	6	22	166	Lancaster,	-	3	2	-	1
Franklin,	1	7	4	10	1	LAWRENCE,	4	106	45	99	33
Freetown,	-	-	1	-	-	Lee,	1	-	-	-	-
Gardner,	7	5	7	7	-	Leicester,	-	1	13	-	-
Georgetown,	-	-	1	-	1	Lenox,	-	6	1	-	-
Gill,	-	1	2	-	2	Leominster,	13	117	5	5	3
GLOUCESTER,	4	37	32	24	3	Lexington,	-	13	2	2	20
Grafton,	-	4	-	-	-	Lincoln,	-	5	1	1	-
Great Barrington,	-	11	4	1	-	Littleton,	-	-	1	-	-
Greenfield,	-	10	17	7	48	LOWELL,	9	789	65	69	333
Groton,	-	13	1	2	-	Ludlow,	-	6	-	7	-
Groveland,	-	6	10	3	-	LYNN,	7	359	71	65	46
Hadley,	-	-	7	1	-	MALDEN,	3	126	167	50	130
Halifax,	-	-	1	2	-	Manchester,	1	-	1	-	-
Hampden,	-	-	1	-	-	Mansfield,	-	12	3	2	1
Hanson,	-	1	-	-	-	Marblehead,	-	18	8	2	3
Hardwick,	-	2	3	7	-	Marion,	-	-	1	-	-

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Fifty-six Cities and Towns during 1901 — Continued.

	Small-pox.	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.		Small-pox.	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.
MARLBOROUGH, .	2	117	37	10	2	Orleans, . . .	-	-	2	-	-
Marshfield, . .	2	-	1	1	1	Otis, . . .	-	-	1	-	-
Maynard, . .	-	38	2	-	-	Oxford, . . .	1	1	1	-	-
Medfield, . .	-	2	-	-	1	Palmer, . . .	4	9	31	8	5
MEDFORD, . .	5	44	157	19	401	Peabody, . .	-	55	38	2	26
Medway, . . .	-	7	22	1	2	Pepperell, . .	1	1	19	5	-
MELROSE, . .	-	24	19	13	448	Petersham, . .	-	1	1	1	4
Merrimac, . .	-	8	1	4	-	PITTSFIELD, . .	-	52	8	17	10
Methuen, . .	2	-	-	-	-	Plymouth, . .	1	24	13	12	3
Middleborough, .	-	46	10	2	8	Princeton, . .	-	8	-	-	7
Milford, . . .	-	110	40	14	4	Provincetown, .	-	-	-	12	-
Millbury, . .	-	8	8	6	2	QUINCY, . . .	6	95	26	44	37
Millis, . . .	-	1	-	1	-	Randolph, . .	-	33	-	-	-
Milton, . . .	1	10	6	10	15	Raynham, . .	6	-	-	-	-
Monson, . . .	-	7	3	7	-	Reading, . . .	-	19	28	4	19
Montague, . .	-	1	2	-	-	Rehoboth, . .	-	-	2	2	3
Nahant, . . .	-	-	-	8	-	Revere, . . .	-	36	13	1	1
Natick, . . .	-	5	-	-	-	Rochester, . .	-	1	-	-	-
Needham, . .	-	1	-	1	-	Rockland, . .	-	-	8	5	44
NEW BEDFORD, .	37	44	103	98	68	Rockport, . .	-	3	12	21	-
NEWBURYPORT, .	-	6	11	33	1	Rowley, . . .	-	-	17	1	-
NEWTON, . .	5	117	60	41	78	Royalston, . .	-	3	-	-	-
NORTH ADAMS, .	-	32	38	37	76	Russell, . . .	1	-	-	-	-
NORTHAMPTON, .	-	23	18	24	70	SALEM, . . .	1	111	74	32	12
North Andover, .	-	10	-	6	26	Sandisfield, . .	-	-	2	2	-
No. Attleborough, .	-	7	8	1	-	Sandwich, . .	-	2	-	1	-
Northborough, .	-	-	1	4	-	Saugus, . . .	-	20	1	-	-
North Brookfield, .	3	4	10	-	-	Scituate, . . .	3	-	2	-	-
Northfield, . .	-	-	5	2	-	Seekonk, . .	-	-	1	-	-
North Reading, .	-	3	-	-	-	Sharon, . . .	-	2	-	4	1
Norton, . . .	-	1	1	1	-	Sheffield, . .	-	-	7	-	-
Norwell, . . .	-	6	1	5	-	Shelburne, . .	-	-	2	-	-
Norwood, . .	-	5	-	3	73	Sherborn, . .	-	1	-	-	-
Oakham, . . .	-	-	2	-	12	Shirley, . . .	-	1	3	-	1
Orange, . . .	-	-	24	-	151	Shrewsbury, . .	-	1	1	-	-

Cases of Infectious Diseases reported to the State Board of Health from Two Hundred and Fifty-six Cities and Towns during 1901 — Concluded.

	Small-pox.	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.		Small-pox.	Diphtheria.	Scarlet Fever.	Typhoid Fever.	Measles.
Shutesbury,	-	1	-	-	-	Wareham,	-	3	2	-	-
Somerset,	-	-	1	-	-	Warren,	-	-	1	5	-
SOMERVILLE,	7	341	132	73	128	Watertown,	-	40	6	11	96
Southampton,	-	-	-	3	-	Wayland,	-	1	2	-	3
Southborough,	-	7	-	3	-	Webster,	-	6	23	3	14
Southbridge,	3	15	1	2	-	Wellesley,	-	9	1	10	5
South Hadley,	-	34	3	1	-	Wenham,	-	1	-	-	3
SPRINGFIELD,	3	124	53	61	37	Westborough,	-	31	-	11	2
Sterling,	-	1	-	1	-	West Boylston,	3	3	3	-	1
Stockbridge,	-	-	1	-	-	West Brookfield,	-	-	-	-	2
Stoneham,	-	23	2	5	29	Westfield,	4	24	2	1	1
Stoughton,	-	8	-	2	-	Westford,	-	7	1	-	1
Stow,	-	1	1	-	-	Westminster,	1	-	-	-	4
Sturbridge,	-	1	6	-	-	West Newbury,	-	-	5	-	-
Sudbury,	-	-	-	1	-	Weston,	-	4	-	1	2
Sutton,	-	-	2	1	43	Westport,	-	-	8	-	-
Swampscott,	-	12	5	2	1	West Springfield,	-	7	10	-	-
Swansea,	-	-	1	-	-	Westwood,	-	-	2	-	-
TAUNTON,	-	21	34	2	-	Weymouth,	-	26	8	-	1
Templeton,	-	10	8	-	-	Whitman,	-	4	2	-	3
Tewksbury,	4	-	-	12	-	Wilbraham,	-	5	5	1	-
Tisbury,	-	-	-	-	1	Williamsburg,	-	1	2	-	-
Tolland,	-	-	-	-	1	Williamstown,	-	12	3	12	1
Topsfield,	-	-	2	-	-	Winchendon,	-	12	3	4	262
Townsend,	2	1	-	-	1	Winchester,	-	16	17	13	17
Tyringham,	-	-	2	-	-	Winthrop,	-	12	31	5	1
Upton,	-	-	4	-	-	WOBURN,	1	30	13	7	73
Uxbridge,	-	-	-	1	2	WORCESTER,	10	229	175	96	65
Wakefield,	5	55	5	13	185	Worthington,	-	-	-	-	3
Walpole,	-	3	-	1	21	Wrentham,	-	1	6	-	-
WALTHAM,	1	116	22	31	21	Total,	773	9,793	4,356	2,689	9,398
Ware,	-	7	12	20	2						

The following list comprises the cities and towns which failed to report (under the provisions of the statute) to the State Board of Health.

It is but just to state that in many of the towns named in group IV. and in some of those in group III. it is quite probable that no cases of infectious diseases occurred during the year.

A considerable number, however, are known to have occurred in Amherst and in Blackstone which were not reported to the State Board of Health at any time during the year.

List of Cities and Towns from which no Reports were received.

I. Cities.

None.

II. Towns having a Population of More than 5,000.

Amherst,	Northbridge,	Spencer. — 4.
Blackstone,		

III. Towns having a Population of More than 1,000 but Less than 5,000 in Each.

Ashburnham,	Dennis,	Nantucket,
Bourne,	Granville,	Newbury,
Buckland,	Hamilton,	Rutland,
Charlemont,	Hanover,	Southwick,
Conway,	Holbrook,	West Bridgewater,
Dartmouth,	Lunenburg,	West Stockbridge,
Deerfield,	Mattapoisett,	Wilmington. — 21.

IV. Towns having Less than 1,000 Inhabitants.

Ashfield,	Hancock,	Paxton,
Bernardston,	Hawley,	Pelham,
Blandford,	Heath,	Peru,
Bolton,	Holland,	Phillipston,
Boxborough,	Lakeville,	Plainfield,
Boxford,	Lanesborough,	Plympton,
Brimfield,.	Leverett,	Prescott,
Carlisle,	Leyden,	Richmond,
Chesterfield,	Longmeadow,	Rowe,
Chilmark,	Lynnfield,	Savoy,
Clarksburg,	Mashpee,	Sunderland,
Cummington,	Mendon,	Truro,
Dana,	Middlefield,	Tyngsborough,
Dover,	Middleton,	Wales,
Eastham,	Monroe,	Warwick,
Egremont,	Monterey,	Washington,
Florida,	Montgomery,	Wellfleet,
Gay Head,	Mt. Washington,	Wendell,
Goshen,	New Ashford,	Westhampton,
Gosnold,	New Braintree,	West Tisbury,
Granby,	New Salem,	Whately,
Greenwich,	Norfolk,	Windsor. — 66.

The following towns sent notices to the Board that no infectious diseases had been reported within their limits during the year 1901: —

Brookfield,	New Marlborough,	Salisbury,
Chatham,	Pembroke,	Yarmouth. — 6.

A supply of postal cards for the purpose of reporting infectious diseases to the State Board of Health, as required by statute, will be forwarded to any local board of health on application to the Secretary of the State Board, Room 141, State House, Boston.

IV.

Official Returns of Deaths in Cities and Large Towns (Revised Laws, Chapter 75, Section 12).

The following summary comprises the results obtained from the tabulation of the returns required by chapter 75, section 12, of the Revised Laws, whereby the board of health of each city and populous town is directed to send to the State Board of Health an annual statement of the deaths in such city or town upon a blank form furnished by the State Board.

The towns of Amherst, Greenfield, Natick and Winchendon, each of which had a population of more than 5,000, according to the latest census, failed to furnish the reports required by law. The town of Saugus, which sent no report for 1900, has furnished its returns for the year 1901.

The towns of Grafton, Reading and North Brookfield voluntarily contributed returns for 1900, although not required to do so by law. Two of these towns, Grafton and Reading, have also contributed returns for 1901.

With these changes, the list for 1901 embraces 90 cities and towns, including all of the 33 cities, and all of the towns having a population of more than 5,000 in each, except the four towns above named.

The estimated population of these cities and towns in 1901 was 2,402,080, or 37,307 more than the actual reporting population of 1900.

The whole number of deaths registered in these towns in 1901 was 40,494, and the death-rate as calculated from the census population of the reporting cities and towns was 16.86 per 1,000 of the living population, that of the preceding year having been 18.26 per 1,000. This was the lowest death-rate observed in this reporting population during the period of eight years since the enactment of the law requiring these returns. The mean death-rate of the State for the fifty years ended Dec. 31, 1900, was 19.22.

Sexes. — The number of deaths of males was 20,758, or 51.2 per cent. of the whole number of those whose sex was known; and the deaths of females were 19,718, or 48.8 per cent. There were 18 in which the sex was not stated in the returns.

Ages. — The deaths by four groups of ages were as follows: —

Ages.	Deaths. 1901.	Percentages of All Deaths.		Ages.	Deaths. 1901.	Percentages of All Deaths.	
		1901.	1900.			1901.	1900.
Under 1 year,	8,753	21.64	23.02	20 to 50 years,	10,214	25.25	24.18
1 to 20 years,	6,307	15.59	17.00	50 and over,	15,179	37.52	35.80

The deaths of infants under one year old were 8,753, or 21.6 per cent. of the total mortality, as compared with 23 per cent. in the previous year; and those of children under five years old were 12,160, or 30.1 per cent. of the total mortality, as compared with 33.3 per cent. in 1900.

All of the percentages in this table are estimated upon the number of deaths of those whose ages were specified in the returns. The total number of deaths in which the age was not specified was 41.

The infant mortality for the six years 1896–1901 respectively constituted 24.9, 23.5, 24.8, 22.8, 23 and 21.6 per cent. of the total mortality, that of 1901 being the lowest infant mortality of the period.

The change in the mortality at different ages, as compared with that of the previous year, is quite striking, since the decrease in the number of deaths of all persons under twenty years of age amounted to 2,210, while that of all persons over twenty years of age was only 492.

Still-births. — The number of still-births was 2,450.

The still-birth mortality, when compared with the total mortality (still-births included), was 5.7 per cent. of the total deaths and still-births combined.

Months and Quarters. — The number of deaths in each quarter of the year is shown in the following table: —

	Deaths. 1901.	Percentages.	
		1901.	1900.
First quarter,	11,091	27.39	26.58
Second quarter,	9,355	23.10	24.05
Third quarter,	10,447	25.80	27.43
Fourth quarter,	9,601	23.71	21.94
Totals,	40,494	100.00	100.00

These percentages differ slightly from the mean of several years, which usually shows the highest mortality in the third quarter of the year. In 1901 and in 1899 the highest mortality was in the first quarter.

During the forty-year period (1856–95) the mortality was generally above the mean in the third quarters of the years and below it in the other three quarters.

The intensity of the seasonal death-rate is more accurately shown in the following table, the method employed being explained on page 532 in Section III. of these summaries, relating to disease notification. By this method the errors which are due to differences in the length of the months are eliminated.

	Deaths in Each Month.	Mean Daily Deaths per Month. 1901.	Centesimal Ratio.			Deaths in Each Month.	Mean Daily Deaths per Month. 1901.	Centesimal Ratio.	
			1901.	1900.				1901.	1900.
January,	3,742	120.7	108.8	95.8	August,	3,683	118.8	107.1	116.2
February,	3,517	125.6	113.2	97.6	September,	3,514	117.1	105.6	101.2
March,	3,832	123.6	111.4	129.0	October,	3,178	102.5	92.4	87.2
April,	3,406	113.5	102.3	114.4	November,	3,127	104.2	94.0	85.2
May,	3,063	98.8	89.1	91.8	December,	3,296	106.3	95.9	88.8
June,	2,886	96.2	86.7	83.4	Annual mean,	-	110.9	100.0	100.0
July,	3,250	104.8	94.5	108.9					

The figures in the foregoing table indicate a departure in excess of the mean death-rate in January, February, March, April, August and September, while that of the remaining months was low.

The mean maximum departure from the death-rate for each month for the period of twenty years, 1856–75, was 32.9 per cent. in August, and in the twenty-year period 1876–95 it was 20 per cent. in August, while that of August, 1901, was only 7.1 per cent., and that of February, 1901, was 13.2 per cent.

In the two years having the highest death-rates in Massachusetts in the past half-century or more (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872. That of January, 1890, the month in which the epidemic of influenza was at its maximum, was 43.4 per cent. above the mean.

CAUSES OF DEATH.

Table III. presents the mortality of the cities and towns embraced in this summary, classified by causes of death for the year 1901. The same figures are again presented in a condensed form in Table IV., wherein the comparative mortality from different diseases and groups of diseases for the past five years may be examined.

An examination of Table IV., on page 554, shows that the death-rate of these reporting cities and towns was not only less than that of the corresponding population of the previous year, but also less than that of any year since these reports were first made, in 1895, and was also less than the general death-rate of the State in any year of the last half-century.

This decline in the general death-rate is chiefly due to a decrease in the number of deaths from infectious diseases. The death-rate from each of the following causes was less than that of 1901: consumption, typhoid fever, cholera infantum, dysentery, malarial fever, bronchitis, measles, scarlet fever, diphtheria, whooping-cough, cerebro-spinal meningitis, erysipelas, puerperal fever, influenza, diarrhœa, pneumonia, heart diseases and cancer. The death-rates from the first six causes in the foregoing list were also less than those of any year in the last five-year period.

The following table, first published in the report of 1899, presents the combined death-rate from eight of the principal infectious diseases, and also shows that this combined death-rate in 1901 was less than that of any of the years embraced in this series of reports.

The diseases referred to are consumption, measles, scarlet fever, diphtheria, whooping-cough, typhoid fever, puerperal fever and cholera infantum.

The combined death-rate per 10,000 of the population from these eight causes for the seven years (1895–1901) in the cities and towns included in this report (about five-sixths of the total population of the State) was as follows: —

Combined Death-rate from Eight Principal Infectious Diseases.

YEAR.	Combined Death-rate per 10,000.	YEAR.	Combined Death-rate per 10,000.
1895,	46.4	1899,	35.2
1896,	46.8	1900,	40.7
1897,	39.7	1901,	33.5
1898,	36.3		

The seasonal table which appeared in the earlier reports, presenting the deaths by months for each city and town and for the whole State, is omitted in the present report, since the details presented in this table are not of essential value. Its chief value consisted in the column of total figures for the State, which is retained essentially in the table on page 541.

The table of percentages of total mortality shown in Table IV. acts in a measure as a check or control in case of erroneous estimates of population; and, while such errors are not to be found in the figures of a census year, it seems best, as a matter of uniformity, to publish the table in the same form as in previous intercensal years.

The changes in the death-rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) were quite fully treated in the report of 1896. To these may be added the later comments on the changes in the death-rate from diphtheria, which appear in the figures of the past seven years.

The following preventable causes of death, consumption, measles, scarlet fever, diphtheria, whooping-cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off to 24.2, 24.2, 21.9, 21.1, 20.4, 22.3 and 19.9 in the seven succeeding years; while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9, 38.5, 39.2, 40.2, 38.6 and 40.1 per cent. in the same years.

This decrease of 2.4 per cent. in the former group over the figures of 1900 more than compensates for an increase of 1.5 in the latter group.

These all combined constituted the greater part of the total mortality in each of the eight years 1894–1901, and of the diseases specified in the table entitled the "Balance of Mortality," in the annual report of 1896, page 812.

TABLE I.

Population of Cities and Large Towns estimated for 1901.

Reporting Cities and Towns.	Estimated Population for 1901.	Reporting Cities and Towns.	Estimated Population for 1901.
Adams,	11,944	LAWRENCE,	64,874
Amesbury,	9,473	Leominster,	13,149
Andover,	6,947	LOWELL,	97,244
Arlington,	9,021	LYNN,	69,816
Athol,	7,061	MALDEN,	34,510
Attleborough,	12,067	Marblehead,	7,582
BEVERLY,	14,342	MARLBOROUGH,	13,609
Blackstone,	5,721	MEDFORD,	19,108
BOSTON,	574,642	MELROSE,	13,171
Braintree,	6,115	Methuen,	7,876
Bridgewater,	6,030	Middleborough,	6,924
BROCKTON,	41,606	Milford,	11,933
Brookline,	20,789	Milton,	6,790
CAMBRIDGE,	94,084	NEW BEDFORD,	63,989
CHELSEA,	34,663	NEWBURYPORT,	14,478
CHICOPEE,	19,769	NEWTON,	34,934
Clinton,	14,148	NORTH ADAMS,	25,364
Concord,	5,747	NORTHAMPTON,	19,047
Danvers,	8,614	North Attleborough,	7,388
Dedham,	7,506	Northbridge,	7,386
Easthampton,	5,766	Norwood,	5,661
EVERETT,	25,688	Orange,	5,552
FALL RIVER,	108,811	Palmer,	7,990
FITCHBURG,	32,669	Peabody,	11,738
Framingham,	11,699	PITTSFIELD,	22,037
Franklin,	5,017	Plymouth,	9,957
Gardner,	11,172	QUINCY,	24,593
GLOUCESTER,	26,121	Reading,	5,019
Grafton,	4,869	Revere,	11,119
Great Barrington,	6,066	Rockland,	5,327
HAVERHILL,	38,750	SALEM,	36,260
Hingham,	5,107	Saugus,	5,201
HOLYOKE,	46,873	SOMERVILLE,	63,727
Hudson,	5,483	Southbridge,	10,423
Hyde Park,	13,547	Spencer,	7,630

TABLE I.— *Concluded.*

Reporting Cities and Towns.	Estimated Population for 1901.	Reporting Cities and Towns.	Estimated Population for 1901.
SPRINGFIELD,	64,412	Westfield,	12,669
Stoneham,	6,197	West Springfield,	7,301
Stoughton,	5,476	Weymouth,	11,331
TAUNTON,	31,886	Whitman,	6,237
Wakefield,	9,487	Williamstown,	5,038
WALTHAM,	24,040	Winchester,	7,468
Ware,	8,385	Winthrop,	6,431
Watertown,	10,143	WOBURN,	14,269
Webster,	9,005	WORCESTER,	122,798
Wellesley,	5,241	Total,	2,402,080
Westborough,	5,433		

The death-rate in the following cities and towns was based on the figures given in the United States census of 1900, these towns having decreased in population in the five years which elapsed between the State decennial census of 1895 and the United States census of 1900: Amesbury, Athol, Blackstone, Franklin, Gloucester, Grafton, Marblehead, Marlborough, Newburyport, Rockland and Stoneham.

TABLE II.

Total Deaths, Deaths by Sexes and Age Periods, and Still-births in Cities and Towns having over 5,000 Inhabitants in Each, with General Death-rates estimated for 1901.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Adams,	186	101	85	-	13	54	8	6	5	4	2	4	9	13	12	15	19	18	16	6	-	15.58
Amesbury,	166	74	92	-	13	24	4	3	1	-	11	4	3	8	13	20	17	22	18	18	-	17.53
Andover,	91	39	52	-	2	11	3	2	-	1	1	-	2	4	6	5	8	21	14	13	-	13.11
Arlington,	131	79	52	-	8	29	5	1	-	1	4	4	2	13	10	19	5	13	11	14	-	14.52
Athol,	108	44	59	5	2	18	2	1	-	-	3	1	4	5	8	10	8	19	11	18	-	15.30
Attleborough,	122	73	49	-	5	21	7	1	-	2	1	6	1	11	14	9	14	19	11	5	-	10.10
BEVERLY,	217	109	108	-	7	28	5	1	1	-	5	2	2	14	20	17	18	38	32	34	-	15.13
Blackstone,	113	69	44	-	6	20	8	4	5	-	6	1	2	12	10	8	8	9	18	4	-	19.76
BOSTON,	11,300	5,895	5,405	-	576	2,287	568	285	186	143	329	150	237	1,079	1,254	1,061	1,136	1,187	917	481	-	19.67
Braintree,	81	44	37	-	6	13	-	-	1	-	2	2	2	7	10	7	5	14	12	6	-	13.24
Bridgewater,	75	47	28	-	-	10	2	3	-	2	1	-	4	3	3	4	4	14	14	11	-	12.44
BROCKTON,	523	260	263	-	46	87	20	16	4	6	24	5	20	48	54	44	48	55	53	39	-	12.57
Brookline,	273	138	135	-	6	40	8	6	2	7	7	3	2	19	17	26	31	32	43	30	-	13.13
CAMBRIDGE,	1,574	787	787	-	111	336	100	29	29	17	45	26	33	118	122	120	163	169	165	102	-	16.73
CHELSEA,	577	320	257	-	39	105	20	7	8	4	10	7	6	47	42	44	59	97	73	46	2	16.64
CHICOPEE,	340	159	181	-	12	120	24	10	5	5	12	4	9	21	20	11	26	26	30	17	-	17.20
Clinton,	223	120	103	-	15	52	6	6	3	1	3	3	10	24	15	20	20	25	23	12	-	15.76
Concord,	61	39	22	-	1	10	3	1	-	1	-	1	-	5	4	7	2	10	9	8	-	10.61
Danvers,	112	54	58	-	-	20	3	-	1	1	1	2	4	9	4	5	14	12	22	14	-	13.01
Dedham,	112	63	49	-	3	25	3	2	1	-	2	1	1	6	7	7	8	16	18	14	1	14.91
Easthampton,	95	44	51	-	4	18	2	1	1	1	4	1	-	6	4	7	11	20	14	10	-	16.46
EVERETT,	382	201	181	-	30	98	18	12	6	3	12	7	13	28	27	29	27	39	36	26	1	14.87

FALL RIVER,	2,143	1,107	1,036	-	193	799	-*	-*	-*	-*	86	-*	-*	159	132	152	120	148	97	36	-	19.79
FITCHBURG,	469	252	217	-	29	120	21	8	11	5	11	3	12	36	24	25	46	51	57	39	-	14.36
Framingham,	174	91	83	-	6	25	6	6	4	-	2	1	2	11	16	15	15	21	28	20	2	14.87
Franklin,	64	34	29	1	4	9	2	-	-	2	4	1	1	4	3	4	11	6	11	6	-	12.75
Gardner,	210	102	108	-	23	45	9	4	2	-	3	10	9	16	15	20	16	24	26	11	-	18.80
GLOUCESTER,	339	177	162	-	38	60	13	5	2	7	10	6	5	22	24	27	39	38	49	32	-	12.98
Grafton,	92	45	47	-	7	16	2	-	1	-	2	2	1	5	8	6	15	10	11	13	-	18.89
Great Barrington,	88	47	41	-	5	18	2	1	-	-	5	1	1	4	8	9	9	15	15	5	-	14.50
HAVERHILL,	547	273	274	-	55	78	21	6	8	4	6	9	6	46	55	61	63	70	73	41	-	14.12
Hingham,	101	59	42	-	2	11	-	1	3	2	2	1	-	6	5	3	12	21	25	9	-	19.77
HOLYOKE,	856	435	421	-	56	278	56	25	10	8	19	8	19	74	69	75	83	55	53	21	3	18.26
Hudson,	59	33	26	-	8	10	2	2	-	-	1	1	1	6	-	3	4	10	11	8	-	10.77
Hyde Park,	198	101	97	-	17	38	8	2	3	3	6	1	2	28	15	16	23	21	18	14	-	14.61
LAWRENCE,	1,118	560	558	-	70	350	56	20	7	10	28	12	15	88	78	100	121	114	84	35	-	17.23
Leominster,	168	96	72	-	8	34	5	4	5	3	3	5	5	11	7	16	17	18	19	16	-	12.78
LOWELL,	2,038	1,010	1,028	-	142	539	118	69	41	32	73	36	52	151	166	149	181	203	139	88	1	20.96
LYNN,	1,020	504	516	-	58	195	29	22	12	11	24	11	20	81	87	101	94	136	127	70	-	14.61
MALDEN,	486	260	226	-	31	113	17	8	9	6	18	9	11	25	36	42	49	56	52	35	-	14.09
Marblehead,	141	73	68	-	-	18	6	1	2	1	4	1	-	6	6	9	9	26	26	26	-	18.60
MARLBOROUGH,	213	110	103	-	8	27	9	4	3	2	14	8	5	21	16	16	18	27	28	13	2	15.65
MEDFORD,	247	121	126	-	18	43	6	8	6	-	14	8	4	20	12	14	19	31	33	28	1	12.93
MELROSE,	175	79	96	-	11	31	4	1	3	-	3	2	3	7	14	16	13	28	24	26	-	13.29
Methuen,	123	63	60	-	8	29	3	2	-	2	1	-	1	6	5	16	8	28	14	6	2	15.61
Middleborough,	101	51	50	-	4	10	3	2	-	2	1	2	2	3	7	4	13	12	18	19	3	14.59
Milford,	194	96	98	-	5	24	3	6	5	2	2	1	5	10	18	20	12	30	29	27	-	16.26
Milton,	100	44	56	-	6	16	1	-	3	3	-	1	2	8	11	8	9	11	19	8	-	14.73
NEW BEDFORD,	1,236	599	637	-	74	361	63	29	19	17	35	14	23	92	89	91	95	121	113	74	-	19.32
NEWBURYPORT,	275	113	162	-	21	39	10	4	6	1	6	6	4	16	23	17	34	33	45	31	-	19.02
NEWTON,	434	218	216	-	33	87	9	5	3	4	12	6	10	31	34	32	39	52	64	45	1	12.42
NORTH ADAMS,	381	201	180	-	28	94	23	14	3	7	8	4	22	35	26	28	33	40	26	18	-	15.02
NORTHAMPTON,	324	169	155	-	13	47	6	4	2	2	3	5	5	27	32	31	40	41	54	24	1	17.01

* Two hundred and ninety-three from one to five years; one hundred and twenty-six from ten to twenty years.

TABLE II. — *Concluded.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
North Attleborough, . .	118	55	63	-	5	17	3	-	1	-	1	3	6	9	4	9	16	27	12	10	-	15.97
Northbridge, ...	121	67	54	-	11	37	7	3	1	1	4	2	4	9	9	11	5	12	8	8	-	16.37
Norwood, ...	73	39	34	-	5	10	4	2	3	-	1	1	1	4	9	9	6	12	9	2	-	12.90
Orange, ...	75	30	45	-	3	9	-	1	1	-	2	-	1	8	5	6	10	15	9	8	-	13.51
Palmer, ...	121	73	48	-	10	36	6	3	2	1	1	3	2	11	6	6	7	15	15	6	1	15.14
Peabody, ...	199	107	92	-	9	34	7	2	3	6	10	5	6	9	15	21	20	18	26	17	-	16.95
PITTSFIELD, ...	415	210	194	11	25	61	9	3	5	-	19	4	6	31	34	26	50	61	68	33	5	18.88
Plymouth, ...	199	101	98	-	3	26	5	2	-	-	5	2	2	12	11	16	19	29	37	33	-	19.98
QUINCY, ...	318	169	149	-	23	58	13	5	5	1	3	9	4	21	26	32	25	37	42	36	1	12.93
Reading, ...	67	32	35	-	3	10	3	1	-	-	-	1	3	3	6	5	2	9	11	13	-	13.35
Revere, ...	134	70	64	-	12	34	5	3	1	3	3	3	2	12	7	11	16	9	20	5	-	12.05
Rockland, ...	102	57	44	1	5	14	1	1	-	-	-	1	-	7	8	10	8	15	25	12	-	19.14
SALEM, ...	630	318	312	-	32	145	18	15	7	8	18	3	10	28	49	47	61	78	85	49	9	17.37
Saugus, ...	69	32	37	-	6	14	5	1	-	-	3	-	1	1	9	7	5	7	11	5	-	13.27
SOMERVILLE, ...	831	409	422	-	62	174	19	13	9	10	17	16	17	55	55	67	68	129	115	67	-	13.04
Southbridge, ...	154	86	68	-	11	39	6	2	4	2	1	3	4	11	12	16	15	14	16	9	-	14.78
Spencer, ...	94	53	41	-	7	16	1	1	1	-	2	2	5	5	8	6	8	9	20	10	-	12.82
SPRINGFIELD, ...	933	464	469	-	49	163	24	19	19	2	22	15	25	92	94	86	89	100	114	69	-	14.49
Stoneham, ...	93	47	46	-	4	11	4	1	-	-	-	1	1	7	13	7	12	13	14	9	-	15.00
Stoughton, ...	96	53	43	-	4	27	1	1	-	1	3	1	-	9	2	8	3	7	17	16	-	17.52
TAUNTON,*	562	305	257	-	29	102	11	2	2	5	7	6	12	48	49	58	55	76	81	47	1	14.02
Wakefield, ...	132	60	72	-	13	17	-	3	2	2	3	2	1	8	14	10	15	17	30	8	-	13.91
WALTHAM, ...	351	182	169	-	14	56	7	6	5	4	9	8	15	36	29	26	23	49	45	32	1	14.60
Ware, ...	146	69	77	-	11	40	6	2	5	4	3	4	4	11	10	8	9	12	20	8	-	17.40
Watertown, ...	148	85	63	-	6	33	4	3	1	1	3	1	2	12	18	14	10	24	13	9	-	14.60

Webster, ...	137	73	64	-	8	44	12	3	4	2	3	2	2	4	4	5	9	17	9	14	3	15.21
Wellesley, ...	52	22	30	-	2	8	-	2	1	2	-	-	-	3	2	4	5	4	15	6	-	9.92
Westborough,† . . .	147	75	72	-	4	5	-	-	-	1	1	1	1	7	12	19	20	28	28	24	-	14.00
Westfield, ...	232	125	107	-	14	37	11	7	3	4	8	8	2	22	8	17	19	22	36	28	-	18.31
West Springfield, . .	105	43	62	-	3	25	4	4	2	2	3	2	3	9	5	10	5	10	10	11	-	14.38
Weymouth, ...	174	89	85	-	8	19	3	1	2	-	5	8	4	12	9	19	13	25	26	28	-	15.36
Whitman, ...	73	47	26	-	5	13	2	-	1	-	2	-	1	9	3	5	7	10	8	12	-	11.70
Williamstown, . . .	57	22	35	-	4	9	2	1	-	-	1	1	2	3	7	6	5	8	7	5	-	11.31
Winchester, ...	90	37	53	-	5	15	1	3	1	1	2	2	2	9	8	5	8	10	9	14	-	12.05
Winthrop, ...	62	39	23	-	4	7	3	1	2	-	1	3	1	5	4	7	8	8	7	5	-	9.64
WOBURN, ...	211	109	102	-	9	41	9	5	2	2	1	3	5	23	16	17	21	22	23	21	-	14.79
WORCESTER,‡ . . .	1,997	1,022	975	-	136	367	82	35	19	14	41	31	45	156	191	195	216	238	240	127	-	14.90
Totals, ...	40,494	20,758	19,718	18	2,450	8,753	1,630	817	546	414	1,099	566	816	3,276	3,488	3,450	3,804	4,558	4,229	2,588	41	16.86

* Includes 115 deaths at Taunton Insane Asylum.
† Includes 71 deaths at Westborough Insane Hospital.
‡ Includes 167 deaths at Worcester Insane Asylum.

These deaths are not included in estimating the death-rate of the town.

TABLE III.

Deaths from Specified Causes in Cities and Towns having more than 5,000 Inhabitants in Each.

	Consumption.	Small-pox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Adams,	19	-	-	3	7	-	5	5	-	-	-	-	6	1	1	12	8	21	6	9	6	1	6	17	58
Amesbury,	16	-	1	2	3	1	1	7	-	-	6	-	4	8	2	34	1	24	5	11	8	-	5	-	32
Andover,	4	-	-	-	2	-	1	1	-	-	-	-	2	3	-	11	6	14	10	-	3	-	4	-	30
Arlington,	15	-	-	-	2	-	3	-	1	-	-	-	3	1	-	10	5	11	8	4	6	-	8	-	53
Athol,	10	-	-	-	7	1	-	1	-	-	-	-	2	1	-	10	4	12	-	5	4	3	3	-	45
Attleborough,	16	-	-	-	2	-	2	-	-	2	2	-	3	1	5	14	8	10	6	9	6	1	6	-	33
BEVERLY,	29	-	-	6	3	-	1	4	-	-	5	-	6	-	-	20	2	30	17	10	12	1	8	2	61
Blackstone,	9	-	-	8	5	-	-	3	-	4	-	-	9	5	3	21	5	8	1	7	2	-	5	-	23
BOSTON,	1,346	74	108	210	353	65	142	54	51	81	166	1	210	28	488	1,099	301	963	644	534	368	87	566	117	3,280
Braintree,	8	-	-	-	-	-	1	5	-	-	1	1	1	-	-	7	1	17	7	7	7	-	8	-	15
Bridgewater,	10	-	-	-	1	-	-	6	-	-	1	-	-	-	3	7	-	3	5	3	5	-	4	14	13
BROCKTON,	59	-	1	9	11	-	6	25	-	-	1	-	22	2	1	68	4	53	13	10	21	8	6	-	203
Brookline,	21	-	2	2	8	-	-	3	-	-	-	-	2	-	-	29	1	40	22	21	15	2	16	1	88
CAMBRIDGE,	188	3	10	8	59	11	10	6	8	1	17	1	38	2	52	174	37	148	171	71	92	10	59	98	304
CHELSEA,	25	-	3	3	18	3	7	5	2	-	-	-	14	1	5	22	13	69	4	1	18	2	10	-	352
CHICOPEE,	25	-	-	-	10	8	5	-	1	-	5	-	18	2	3	29	11	31	54	18	8	-	8	4	100
Clinton,	18	-	1	-	8	-	4	-	-	-	-	2	7	1	9	15	3	28	2	7	3	8	10	-	107
Concord,	7	-	-	-	-	-	-	-	-	-	3	-	2	-	1	7	1	9	7	6	1	1	3	-	13
Danvers,	13	-	1	-	1	-	-	2	2	-	2	2	-	1	3	12	-	11	20	10	4	1	2	-	25
Dedham,	7	-	-	-	-	-	1	1	-	-	-	1	2	-	4	11	2	8	2	5	2	-	1	1	64
Easthampton,	9	-	-	1	4	1	-	-	-	-	-	-	4	1	-	5	4	13	2	9	4	-	-	-	38
EVERETT,	38	-	1	1	12	2	2	1	1	-	12	-	11	1	-	27	12	30	6	12	15	2	10	1	185
FALL RIVER,	182	1	7	2	23	9	21	4	7	-	8	3	189	-	25	225	112	79	282	102	50	1	49	23	739

FITCHBURG,	38	1	-	-	12	3	7	2	2	1	4	-	23	-	4	47	11	55	3	14	24	2	15	-	201
Framingham,	18	-	-	-	-	-	-	4	-	-	5	-	4	-	4	23	4	17	19	13	11	2	5	-	45
Franklin,	11	-	-	-	1	-	-	1	-	-	1	-	-	-	2	5	1	10	1	2	2	1	1	-	25
Gardner,	23	-	-	-	1	-	5	14	1	-	10	-	7	3	3	12	3	11	14	18	9	1	6	-	69
GLOUCESTER,	17	-	-	1	7	2	4	5	1	1	-	2	2	1	1	24	7	28	-	1	20	3	3	-	209
Grafton,	6	-	-	-	-	1	4	-	-	1	5	-	4	-	2	13	1	14	-	4	-	-	1	-	36
Great Barrington,	7	-	-	-	4	-	1	-	-	-	3	-	2	-	-	13	1	13	11	4	3	2	2	1	20
HAVERHILL,	74	-	-	2	14	2	10	2	1	2	19	-	12	-	3	44	5	36	29	34	28	9	26	4	191
Hingham,	9	-	-	-	2	-	3	3	1	-	2	-	-	3	-	10	2	13	14	5	10	1	3	1	19
HOLYOKE,	91	-	-	8	38	17	7	-	-	1	14	1	57	2	37	75	29	51	93	38	28	6	36	1	230
Hudson,	8	-	-	-	1	-	-	2	1	-	-	-	2	1	-	1	1	6	-	-	4	-	1	-	31
Hyde Park,	26	1	-	2	7	-	3	-	-	-	2	-	4	-	4	23	6	8	-	7	-	2	7	-	96
Lawrence,	110	-	1	-	16	2	12	3	1	2	7	-	103	2	6	116	31	104	96	43	40	12	13	23	375
Leominster,	13	-	-	-	8	-	1	4	-	1	-	-	2	4	-	20	2	24	3	5	6	-	5	-	70
LOWELL,	170	-	17	3	117	17	18	6	6	-	26	3	99	4	17	248	59	197	49	82	49	7	50	-	799
LYNN,	94	-	-	7	37	-	10	32	1	-	8	1	23	3	7	110	17	89	1	19	51	2	9	-	499
MALDEN,	45	1	1	1	9	7	9	3	1	-	2	-	17	2	-	59	11	50	47	28	21	3	8	1	160
Marblehead,	10	-	-	-	4	-	-	2	1	-	2	-	2	1	-	7	3	25	10	5	6	-	1	-	62
MARLBOROUGH,	30	-	-	1	13	-	-	10	-	-	-	-	2	1	-	21	4	19	-	11	3	1	7	-	90
MEDFORD,	14	-	2	5	7	-	1	-	1	-	2	-	8	-	1	40	9	23	-	11	19	1	2	-	101
MELROSE,	9	-	2	-	2	-	3	2	-	-	4	-	3	2	-	7	5	23	19	3	6	-	5	4	76
Methuen,	15	-	-	-	1	1	2	4	-	-	-	-	12	1	1	7	6	14	4	3	6	2	-	-	44
Middleborough,	6	-	1	1	1	-	1	1	1	-	1	-	1	-	1	6	-	18	9	1	6	2	3	-	41
Milford,	25	-	-	-	11	-	1	3	1	2	-	4	7	2	1	29	4	29	16	10	4	-	4	16	25
Milton,	13	-	-	-	1	-	1	1	-	-	-	1	2	-	2	9	2	13	1	1	7	-	-	-	46
NEW BEDFORD,	125	6	2	10	14	-	19	4	1	2	6	-	95	7	3	99	54	112	66	64	49	5	-	-	493
NEWBURYPORT,	14	-	-	-	-	2	6	1	-	-	1	-	8	11	-	18	4	26	9	17	15	-	8	-	135
NEWTON,	40	1	-	1	11	-	6	1	-	1	-	1	20	3	1	37	9	39	39	-	20	1	8	-	195
NORTH ADAMS,	46	-	-	1	6	-	5	3	-	-	-	-	17	2	5	33	6	26	-	10	10	2	21	-	187
NORTHAMPTON,	34	-	-	-	3	-	5	-	-	-	-	-	12	-	8	22	8	39	46	17	15	-	21	6	88
North Attleborough,	16	-	-	-	2	-	1	-	-	-	3	2	1	-	-	10	3	9	13	12	6	2	2	1	35
Northbridge,	8	-	-	-	2	1	2	4	-	-	-	-	5	1	1	27	2	13	4	5	5	2	4	-	35

TABLE III. — *Concluded.*

	Consumption.	Small-pox.	Measles.	Scarlet Fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Norwood, . . .	6	-	1	-	1	-	-	-	-	-	4	-	3	-	-	5	1	8	10	6	1	2	1	-	23
Orange, . . .	5	-	-	1	-	-	-	3	-	-	2	-	1	-	-	7	5	10	9	5	4	2	1	-	20
Palmer, . . .	14	-	-	1	2	-	1	1	-	1	2	1	6	1	5	11	2	11	12	5	7	-	8	-	30
Peabody, . . .	23	-	2	7	5	1	-	5	1	-	1	-	9	4	-	13	10	28	21	11-	6	1	3	-	48
PITTSFIELD, . .	31	-	-	-	14	8	8	12	-	1	1	-	8	9	1	42	2	57	31	22	17	2	13	1	128
Plymouth, . . .	9	1	-	-	4	-	1	-	1	-	5	1	3	-	-	17	8	33	26	12	11	1	7	27	31
QUINCY, . . .	38	-	-	-	9	6	2	-	2	1	6	-	10	1	14	23	8	41	36	16	18	6	14	-	72
Reading, . . .	5	-	1	-	2	-	-	1	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	54
Revere, . . .	11	-	-	5	3	2	1	-	-	-	-	-	7	-	-	14	4	10	8	7	6	-	7	-	54
Rockland, . . .	14	-	-	-	-	-	1	3	-	-	-	-	4	1	1	19	4	16	-	9	6	-	4	4	16
SALEM, . . .	60	-	-	16	12	1	9	-	2	-	13	-	40	7	11	46	14	60	7	38	24	2	13	-	255
Saugus, . . .	5	-	-	-	2	-	-	2	-	-	-	2	1	-	-	5	3	6	1	3	4	-	2	-	33
SOMERVILLE, . .	92	-	3	5	28	6	12	22	3	-	14	-	18	5	7	85	35	74	8	46	39	5	15	-	309
Southbridge, . .	9	-	-	-	4	-	1	11	1	3	-	-	13	-	-	19	2	14	11	12	1	1	2	-	50
Spencer, . . .	14	-	1	-	-	-	2	-	-	-	-	-	4	2	4	8	1	15	11	1	4	-	2	-	25
SPRINGFIELD, . .	101	-	1	2	13	5	16	4	1	9	13	4	20	-	28	78	16	105	28	87	40	4	50	17	291
Stoneham, . . .	13	-	-	-	1	-	-	1	-	-	-	-	1	-	-	12	-	13	21	6	3	-	3	3	16
Stoughton, . . .	6	-	-	-	1	-	1	4	-	-	2	-	4	1	-	2	1	10	1	-	1	-	1	-	61
TAUNTON, . . .	60	-	-	4	5	1	6	-	3	1	4	2	17	3	25	50	12	37	9	23	10	6	3	-	281
Wakefield, . . .	15	-	-	-	1	-	2	3	-	-	1	-	1	2	-	7	2	15	17	-	14	1	4	-	47
WALTHAM, . . .	56	-	-	1	8	1	5	4	-	1	7	-	6	9	18	34	8	48	15	12	13	1	4	8	102
Ware, ...	16	-	5	-	3	1	1	1	-	1	2	1	10	2	4	19	2	10	10	5	2	2	3	4	42
Watertown, . .	17	-	1	-	2	-	3	6	2	-	2	-	4	1	1	16	3	17	8	9	3	2	10	-	41
Webster, . . .	8	-	2	1	4	1	1	4	-	-	-	2	10	1	1	11	5	9	1	-	-	-	4	1	71

Wellesley,	2	-	-	-	3	-	-	-	-	1	1	-	1	1	-	4	4	7	4	8	4	-	2	-	15
Westborough,	11	-	-	-	2	-	-	1	1	1	-	-	1	-	1	12	2	25	47	8	9	8	2	-	21
Westfield,	19	-	-	-	17	-	1	6	1	-	6	-	11	-	-	28	7	37	25	7	11	1	9	-	46
West Springfield,	18	-	-	2	1	-	2	3	-	1	-	2	3	-	-	11	-	5	3	7	2	-	5	-	45
Weymouth,	22	-	1	2	4	-	4	2	-	-	2	2	3	-	2	7	6	20	22	13	6	1	3	24	28
Whitman,	8	-	-	-	2	-	-	3	-	1	-	-	8	-	-	4	2	10	2	8	7	-	2	-	26
Williamstown,	9	-	-	-	-	-	1	-	-	-	-	-	2	-	-	2	6	10	8	7	1	-	-	-	11
Winchester,	5	-	-	-	2	1	4	-	-	-	-	-	2	-	-	11	6	10	12	8	2	-	-	-	32
Winthrop,	9	-	-	2	-	-	-	-	-	-	-	-	1	1	-	4	-	10	9	2	6	-	1	1	16
WOBURN,	30	-	-	-	-	-	-	-	-	-	-	-	8	1	-	23	1	18	1	7	8	-	4	-	110
WORCESTER,	240	4	2	18	17	12	26	-	6	7	18	8	119	10	13	274	43	191	162	110	60	15	23	-	632
Totals,	4,235	93	176	350	1,058	202	470	352	113	81	457	46	1,469	172	850	4,002	1,073	3,771	2,501	1,863	1,488	252	1,294	426	13,671

	Homicide.
Arlington,	1
BOSTON,	18
CAMBRIDGE,	1
Great Barrington,	1
HOLYOKE,	1
North Adams,	1
Norwood,	1
Plymouth,	1
WORCESTER,	2

	Tetanus.
Attleborough,	1

	Malignant pustule.
BOSTON,	1

Table IV.

Deaths from Specified Causes, 1901, in Cities and Towns required to report to the State Board of Health, Death-rates per 10,000 (1897-1901), Deaths per 1,000 from All Causes, 1897-1901.

Causes of Death.	Deaths. 1901.	Mortality per 10,000 of the Population.					Deaths per 1,000 from all Causes.				
		1901.	1900.	1899.	1898.	1897.	1901.	1900.	1899.	1898.	1897.
Consumption,	4,235	17.63	18.56	17.91	18.41	19.01	104.58	101.60	103.70	107.01	105.00
Small-pox,	93	0.39	0.008	0.06	-	0.018	2.30	0.046	0.33	-	0.10
Measles,	176	0.73	0.99	0.66	0.34	0.57	4.35	5.44	3.80	1.99	3.13
Scarlet fever,	350	1.46	1.51	0.84	0.53	1.32	8.64	8.29	4.85	3.09	7.27
Diphtheria and croup,	1,058	4.40	5.87	3.99	2.74	5.75	26.13	32.12	23.08	15.94	31.78
Whooping-cough,	202	0.84	1.27	1.11	1.43	0.72	4.99	6.85	6.41	8.28	3.98
Typhoid fever,	470	1.96	2.25	2.31	2.49	2.37	11.61	12.34	13.40	14.50	13.08
Cerebro-spinal meningitis,	352	1.46	1.63	1.73	2.12	2.59	8.69	8.91	10.03	12.35	14.31
Erysipelas,	113	0.47	0.66	0.50	0.33	0.44	2.79	3.66	2.88	1.94	2.44
Puerperal fever,	81	0.34	0.37	0.20	0.23	0.27	2.00	2.01	1.17	1.36	1.52
Influenza,	457	1.90	2.28	1.57	0.68	1.10	11.29	12.44	9.09	3.93	6.09
Malarial fever,	46	0.19	0.22	0.21	0.30	0.23	1.14	1.23	1.20	1.76	1.28
Cholera infantum,	1,469	6.11	9.87	8.20	10.18	9.69	36.28	54.10	47.45	59.14	53.55
Dysentery,	172	0.72	0.75	1.00	0.94	0.79	4.25	4.12	5.79	5.45	4.39
Diarrhœa and cholera morbus.	850	3.54	3.84	1.84	2.44	2.00	20.99	21.00	10.67	14.16	11.02
Pneumonia,	4,002	16.66	18.40	17.89	15.08	17.18	98.83	100.70	103.60	87.66	94.92
Bronchitis,	1,073	4.47	5.09	5.18	5.60	5.81	26.50	27.88	30.00	32.56	32.07
Diseases of the heart,	3,771	15.70	16.16	14.85	14.84	14.81	93.12	88.45	86.00	86.22	81.84
Diseases of the brain and spinal cord.	2,501	10.41	10.80	11.99	12.50	13.23	61.76	59.00	69.42	72.61	73.08
Diseases of the kidneys,	1,863	7.75	7.32	7.13	6.57	6.42	46.01	40.05	41.30	38.17	35.43
Cancer,	1,488	6.19	6.53	6.06	6.32	6.04	36.75	35.75	35.07	36.70	33.35
Suicide,	252	1.05	0.99	1.07	1.06	0.98	6.22	5.39	6.18	6.16	5.40
Accident,	1,294	5.39	5.20	5.20	5.56	5.21	31.95	28.50	30.12	32.30	28.80
Unknown or ill-defined causes.	426	1.77	2.63	2.56	2.26	2.77	10.52	14.38	14.80	13.10	15.30
All causes,	40,494	168.58	182.60	172.70	172.10	181.00	-	-	-	-	-

HEALTH OF TOWNS.

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HEALTH OF TOWNS.

The following digest consists mainly of extracts from the annual reports of the boards of health of cities and towns, showing the character and amount of the sanitary work performed by local boards of health.

One of the principal points of interest in these reports is the unusual prevalence of small-pox. This disease invaded 62 cities and towns during the year, and may, for the first time since 1873, be said to have become epidemic in the State. Other infectious diseases were generally less prevalent than usual, so that the general death-rate was considerably below the average of the past fifty years.

An increasing number of cities are now provided with laboratories furnished with the means of examining the different products brought to them by local physicians for the purpose of determining the character of different diseases. The management and control of infectious diseases constitute the most important function of local boards of health, and the laboratory furnishes a valuable aid in this work. Small towns which cannot reasonably be expected to fit up such laboratories can make use of the means provided by the State Board of Health for such purposes, or, if the time and distance from Boston be too great, may make such arrangements with the local boards of health of neighboring cities as may be satisfactory.

Reports of inspections made by Dr. F. L. Morse, medical inspector of the State Board of Health, may also be found in this section of the report, together with a table showing the visits and inspections made for the purpose of aiding cities and towns in controlling the spread of small-pox.

The following numerical statement of bacteriological work and of vaccinations performed by local boards of health is also taken from the annual reports of those boards for the year 1901 : —

Summary of Bacteriological Work in Massachusetts Cities and Towns in 1901, and by the State Board of Health.

	Throat Cultures for Diphtheria.	Examinations for Tuberculosis.	Examinations for Typhoid Fever.	Examinations for Malaria.	Packages of Diphtheria Antitoxin produced, of 1,500 Units each.
Boston,*	11,304	1,957	1,049	-	-
Brockton,	268	-	-	-	-
Brookline,	1,463	100	68	-	-
Cambridge,	2,552	229	178	-	-
Fall River,	52	-	-	-	-
Fitchburg,	171	77	68	-	-
Holyoke,	544	-	-	-	-
Lowell,	2,411	170	90	9	-
Lynn,	1,516	-	-	-	-
Newton,	470	-	33	-	-
New Bedford,	108	-	-	-	-
Somerville,	441	49	23	-	-
Springfield,	948	-	-	-	-
Waltham,	840	18	-	-	-
Watertown,	101	-	-	-	-
Worcester,	1,700	-	-	-	-
State Board of Health,	4,119	797	108	91	40,211

* Boston, 156 tests for Glanders.

*Vaccinations performed at Public Cost, 1901.**

City or Town.	Number of Vaccinations.	City or Town.	Number of Vaccinations.
Arlington,	1,250	Milton,	1,223
Boston,†	185,000	New Bedford,	425
Brookline,‡	-	North Adams,	Over 1,000
Cambridge,	5,793	Salem,¶	1,738
Chelsea,	1,771	Springfield,	2,145
Chicopee,	593	Stoneham,	410
Clinton,§	-	Westborough,	146
Fall River,‖	2,080	Weymouth,	549
Marblehead,	Over 600	Worcester,	8,116
Medford,	1,982		

* The figures presented in this table were taken from the published reports of cities and towns. It may be assumed, however, that the actual number of vaccinations performed, both at public cost and by private practitioners, was very much larger than the numbers here stated.

† The number vaccinated by private physicians and other agencies is estimated at 300,000.

‡ More than half the population.

§ Nearly half the population.

‖ In 1899, 60,455; in 1900, 2,755.

¶ Also many adults.

Adams.

The following report of medical inspector Morse relates to an unusual prevalence of typhoid fever, which occurred in December, 1901: —

During the early part of December, from reports of infectious diseases received from the board of health of the town of Adams, it was apparent that an unusual number of cases of typhoid fever existed in the town, and as the board of health had not made an investigation it was decided to ascertain, if possible, the source of the disease. A visit was made to the town on December 10, the board of health interviewed, and it was at once apparent that all cases of the disease had not been reported to the board, as required by the statutes. It was necessary, therefore, that each physician in the town be interviewed in order to obtain the correct number of cases present, and in this way it was ascertained that since the 15th of November there had been 28 cases of the disease present in the town, while in the preceding three months only seven cases had been reported to the board. Suspicion having been attached to the water supply by the board of health, a visit was made to the superintendent of the water works to obtain, if possible, any information which would point to the possible pollution of the supply, but, so far as was known, no such condition existed. It was also known that during the preceding month a freshet occurred upon the river which runs through the town, and that many of the cellars to the houses in which these patients lived were overflowed, and it was stated at the time of my visit that water was still present in the cellars. Upon further investigation, however, it was found that all of these patients had obtained milk from one dealer, and a visit was made to his house, which was located quite near the centre of the town. He obtained his milk, amounting to twenty-seven cans daily, from two farms in Cheshire, the next town adjoining Adams, it being brought to the dealer's home in Adams each afternoon and distributed by him personally early the next day. On November 5 he began to feel poorly, but still continued to work until November 11, when, on account of lack of strength, he gave up work and remained at home. He felt chilly, had some headache, was feverish, and had an uncomfortable feeling in his stomach. He was attended by his family physician, who saw him only two or three times, and from his symptoms made a diagnosis of influenza. He was sufficiently sick, however, to remain at home until December 2, when he again went to work on his milk route; but on December 8, still feeling ill, he gave up work for the second time. During his illness it is stated that he lost some weight and considerable strength.

On account of the probable source of infection existing upon this milk route, and the sickness of the one who distributed the milk himself, although a diagnosis of influenza had been made by the attending physician, it was deemed of sufficient importance to obtain a specimen of blood from him for examination. This specimen was examined for the Widal reaction at the laboratory of the board, with the result of a positive reaction, indicating, that his sickness was undoubtedly typhoid fever and not influenza, and the subsequent development of the cases among his customers would indicate that such was the fact, for he began to be ill on November 5, and it was not until November 15, ten days later, that any of his customers became ill with the disease.

The board of health of the town, through their chairman, were informed of the results of this investigation and advised to take measures to prevent further spread of the disease.

Arlington.

During the past year the medical inspector of schools has made daily visits to each school (with the exception of the high school), and has examined 626 children. Of this number, 86 were sent home. From a total of 86, 31 were throat cases. Subsequently, 3 developed diphtheria, 2 scarlet fever, 8 ring worm, 3 mumps, 6 measles, 12 whooping-cough and 8 chicken-pox. In the school-rooms from which the cases of diphtheria and scarlet fever were removed no other pupils were infected. Any pupil in school thought to be ill by the teacher is reported to the principal. The inspector examines the pupil, and, if he considers it necessary, sends the pupil home with a note to parent or guardian to summon the family physician in case of need, and not to return the child to school until well. Most of the pupils thus examined would have remained in school for the day at least, and one with scarlet fever would have remained indefinitely (as she was desquamating when she first came to school), had there not been in operation this system of daily medical inspection. The great importance of the removal of a pupil from school as soon as the first symptoms of disease are manifested, and while the danger of infecting others is least, cannot be overestimated.

We feel that the work done by the medical inspector for the past year fully justifies the establishment of this office, and we advise that it be continued as a permanent feature of this board.

The cost of free vaccination was $370.

Considering the great importance to all of an early diagnosis of diphtheria, an agreement has been made with Dr. Darling of Cambridge whereby he will examine and report within twelve hours the result of a culture.

Athol.

Early in the year the town was visited with an outbreak of diphtheria, which proved the most fatal that the town has undergone for years, and which in the space of a few weeks resulted in 6 deaths.

In the spring, the board of health purchased a formaldehyde gas apparatus for disinfecting, which has been used during the year in the disinfecting of all premises where contagious diseases have occurred, and which has proved much more convenient and effective than the old methods that were pursued.

Beverly.

The general health of the community depends largely upon the action of the people, and unless the people will voluntarily comply with the regulations of the board of health unsatisfactory work will be the result. If each property owner would see to it that his tenements and their surroundings are kept in a clean condition it would greatly aid the board in a very important work.

We are of the opinion that the time is not far distant when the city will have to provide a hospital, or some suitable place, for the care and treatment of contagious diseases.

The following report of Medical Inspector Morse relates to an epidemic of scarlet fever which occurred at Beverly, Salem and Baker's Island in Salem Harbor in July, 1901: —

On July 8 my attention was called to a number of cases of scarlet fever which had occurred in the cities of Salem and Beverly, and a visit was made to the city of Beverly on that date, to ascertain, if possible, the cause of the infection. Up to this date 21 cases of the disease had been reported to the board of health of the city since the first of the month, and upon obtaining a history of each case it was found that 19 of them were using milk supplied by one dealer. As this dealer during the preceding year had had an epidemic of typhoid fever upon his route, the methods of carrying on his business were familiar to us, and a visit was made immediately to his farm. It was ascertained that he produced five cans of milk daily himself and he obtained fourteen other cans from three neighbors. Visits were made to these three farms to obtain a history of any sickness, and at one it was discovered that three children had been sick during the preceding month. The first one ill was a girl sixteen years of age, who had been to Boston temporarily and had been at home only a few days when she was taken ill with sore throat. Three days later another sister, twelve years of age, and five days later still a brother, fourteen years of age, had sore throat, swelling of the glands of the neck, felt tired all over, went to bed temporarily, and it is stated that one of them had a very slight rash which lasted only twenty-four hours. The boy, fourteen years of age, after his recovery from the acute symptoms, assisted in the handling of the milk. The dealer himself collected the supply from these farms late in the afternoon of each day, keeping it in his ice chest over night and distributing it in the cities of Salem and Beverly the following day. An additional supply of five cans also went to a summer hotel and a few summer residents who lived on Baker's Island, and upon July 15 information was received at this office that a number of cases of the disease had developed among the people residing there. The next day a visit was made to this island and all of the cases investigated. It was found that 10 persons had been taken ill with undoubted scarlet fever between the 2d and 7th of July, and 2 others, who had lived at the island, had been removed in the early part of their illness to their homes at Peabody. Upon further investigation it was found that every one of those 12 patients had used milk supplied by this milkman, while others who lived on the island, and had obtained milk from other sources, had not been taken ill.

Attention was then directed to cases which had occurred in the city of Salem during the month of July, and it was found that the first case was reported on the fifth day of the month, and from then to the 15th 24 cases had occurred. During the remaining two weeks of the month only 3 cases were reported, and in Beverly there was a total of 31 cases for the month, only 2 of which were reported in the last two weeks.

Upon the first suspicion that the milk supply was the probable source of infection both city boards of health ordered the dealer to discontinue distributing milk in these cities. This was upon the 8th of July, and allowing a week for patients already infected to become ill with the disease, we find only 5 cases of the 60 developing at a time subsequent to the incubation period of the disease and after the infection had been stopped.

In summing up this epidemic we find that the probable source of infection was a mild, unrecognized case of scarlet fever in a person who subsequently handled milk which became infected and undoubtedly produced 60 cases of the disease. The sudden outbreak of the disease, and the almost as sudden stopping of it after the source had been determined, would confirm the probability of this infection. Another important fact was the high fatality, there being 11 deaths from scarlet fever reported in the cities of Salem and Beverly during the month, — a fatality of 18.33 per cent., while that of the State for the year was 8.4.

Blackstone.

We have ordered free public vaccination on three different occasions, not having had any in the town for twenty years or more. We wish to extend our thanks to the local mills for their kind assistance in requiring their help to be vaccinated.

Boston.

The total number of deaths in 1901 was 11,300, a decrease from the previous year of 378 deaths, and the death-rate as estimated was 19.7 per 1,000. This death-rate was less by 1.12 than that of the previous year, and was the lowest on record.

Nuisances. — The number of nuisances abated during the year was 22,110.

Disinfection. — Number of rooms disinfected after the occurrence of infectious diseases, 11,747. Number of streets, yards, passageways, vaults, sinks, cesspools and other places and objects disinfected, 92,942. For these purposes 2,075 gallons of formaldehyde, 56,750 pounds of chloride of lime, and 1,000 pounds of bichloride of mercury were used.

Regulations. — During the past year the board found it necessary to adopt the following regulations: —

In consequence of the occasional occurrence of glanders, as a result of infection contracted in horseshoeing shops, it was ordered: —

That the walls, hitching-bars, chains and ropes, or other apparatus in horseshoeing shops, to or by which horses may at any time be secured, shall be thoroughly disinfected by the proprietor of such shops with a five per cent. solution of chloride of lime at the close of each day's business.

The board of health hereby adjudges that the deposit of sputum in public places is a nuisance, source of filth and cause of sickness, and hereby orders, that spitting upon the floor, platform or steps of any railroad or railway station or car, or from any electric car while said car is in the subway or elevated above the surface of the ground, or upon the floor, platform or steps of any public building, hall, church, theatre, market, or any sidewalk immediately connected with said public places, be, and hereby is prohibited.

The board of health hereby forbids the exercise of the trades or employments of slaughtering animals, rendering animal matter (except fresh tallow), manufacturing fertilizers, mixing or storing refuse, animal or vegetable substances, smoking fish or meat, or the keeping, sorting or breaking or otherwise handling of rotten or offensive eggs, refining oils, making varnish, asphaltum, glue, gasoline, or any burning fluid within the limits of the city of Boston, except at such place or places as may be assigned by said board; such trades or employments being nuisances, hurtful to the inhabitants of said city, dangerous to the public health, attended by noisome and injurious odors, and otherwise injurious to the estates of said inhabitants.

No substance in any way liable to be distributed or blown about by wind or air currents shall be sieved, screened, agitated or otherwise handled or exposed in any street or public place, nor elsewhere in such a manner that particles or portions of such substances are scattered, blown or otherwise pass into or upon any such street or public place, or into or upon any inhabited buildings. This shall not apply to the delivery of coal, provided suitable precautions for dampening are taken.

No carpets, rugs, mats or similar articles shall be beaten in any street or public place, and no carpets, rugs, mats, old garments or similar articles shall be beaten or cleaned upon or near inhabited buildings, unless reasonable precaution is taken to prevent dust particles or portions of said articles from being blown, scattered or otherwise passing from the place where such beating or cleaning is carried on.

No work shall be done upon any building or other structure while in course of erection, alteration or demolition, unless every reasonable precaution is taken to prevent dust or fragments of lime, mortar or other similar material from being blown or carried into or upon any street, public place or inhabited buildings.

It was unanimously voted to pass the following regulation respecting vaccination: —

Whereas, Small-pox has been prevalent to some extent in the city of Boston, and still continues to exist, although the number of cases has much decreased, owing largely to the voluntary vaccination of the great majority of the inhabitants; and

Whereas, It is necessary for the speedy extirpation of the disease, that all persons not protected by vaccination should be vaccinated; and

Whereas, In the opinion of this board, the public health and safety require the vaccination or re-vaccination of all the inhabitants of Boston;

Be it ordered, That all the inhabitants of the city who have not been successfully vaccinated since Jan. 1, 1897, be vaccinated or re-vaccinated forthwith.

*Tenement-houses.** — During the year 1901 a most thorough and systematic inspection of the tenement-houses was made, and there is now on file in the office of the board a complete record of every tenement-house in Boston.

* A "tenement-house" means a building which, or any portion of which, is occupied, or intended to be occupied, as a dwelling by more than three families living independently of one another and doing their cooking upon the premises, or by more than two families above the first story so living and cooking, and includes apartment houses, family hotels and flat houses, where families are so living and cooking.

The inspection has been thorough, and the board of health will endeavor with renewed energy to diminish the unsanitary and unhealthful conditions found to exist as a result of this inspection. In our report of 1900 we called attention to bad features in old private houses which had been altered over into tenement-houses. In making this inspection the fact has been very forcibly brought to our attention of unsanitary conditions existing in a large number of the recently erected tenement-houses. These defects are largely want of light and air. The tendency is almost entirely towards the construction of fireproof buildings, with almost no attention given to light or ventilation. The board is of opinion that some change in the existing building law should be made, so that good light and ventilation shall be provided for all halls, stairways, bedrooms and water-closets in every tenement-house hereafter constructed.

Small-pox. — This disease appeared in a very mild form in a large factory in May. It was not recognized until several severe cases had resulted. It was then reported to the board of health, and within forty-eight hours 12 cases were found and removed to the hospital. This outbreak was soon ended, but another and another occurred in different parts of the city. All known cases were quickly picked up and cared for in the hospital and all necessary precautions put in use. In spite of the measures taken, cases increased to 12 in August, to 30 in September, to 49 in October, to 195 in November, to 201 in December, and to 177 in January.

In October it became evident that more hospital accommodations would be required, and the board hastily equipped extra buildings at Gallop's Island, to which a portion of the patients have been sent since November 16.

Vaccination. — The office for public vaccination has been open daily, Sundays and July 1 to September 1 excepted, throughout the year, where 12,180 persons have been vaccinated by the city. Beginning November 13, temporary offices for free vaccination were opened from six to eight o'clock in the evening for a few weeks at a time in several sections of the city where the largest number of cases of small-pox were found. Letters were sent to railroad companies, mercantile and other establishments recommending the free vaccination of all employees. The people in general were advised through the daily papers to protect themselves from small-pox by vaccination. Under these several methods of suggestion by the board of health a ready and generous response was made by the people, and a very large percentage of the inhabitants secured vaccination. There were then left a few who, for one reason or another, neglected or refused to be vaccinated, and on December 26 the board issued its order for the vaccination of all the inhabitants of the city. On January 2 the board began sending physicians into portions of the city where most needed, to give free vaccination in the homes and places of business, and to take the names of those who refused to be vaccinated, and who were within the provisions of the order. The number prosecuted was 19.

Hospital for Consumptives. — The board of health regrets to say that it has not been able to accomplish as much in the way of diminishing the prevalence of or suffering from consumption during the past year as it could have done had it possessed the advantage of a convenient and sufficient hospital for cases in the advanced stages of the disease.

Stables. — Since March 8, 1889, no new stables have been occupied, nor increase of animals allowed in any stables, without a written permit from the board of health. It has been the constant effort of the board to lessen the objections to stables by improving the drainage and ventilation, and particularly by changing the old method of storing manure, which has been one of the chief objections to stables. In the opinion of the board, storing manure in pits is a nuisance, its removal an unwarrantable annoyance to the neighborhood and an unnecessary expense to the owner.

Medical Inspection of Schools.

Summary.

Specific infectious diseases,	379
Oral and respiratory diseases,	2,293
Diseases of the ear,	137
Diseases of the eye,	531
Diseases of the skin,	2,883

Examined for Vaccination Marks.

Satisfactory marks found,	34,319
No marks found,	2,282
Total,	36,601

Number of pupils examined in the schools,	55,409
Number recommended to be sent home,	3,647
Number of consultations with teachers (about pupils returning to school, etc.),	4,289

Report of the Director of the Bacteriological Laboratory.

The report of the director of the bacteriological laboratory demonstrates very conclusively the importance of this department as an adjunct of the local board.

The laboratory routine and methods are first described, together with notes on the application and interpretation of the laboratory results in practice, and the outline of a system for genealogical record of cultures.

Thereafter are given the results of certain investigations conducted under general instructions from the board of health, or under special instructions in particular cases. These investigations related to (1) the morphology of *B. diphtheriæ*, (2) the sanitary condition of the Boston ice supply, (3) public laundries, (4) clam digging in the Mystic River, (5) the possibility of typhoid infection through cooked oysters and clams, (6) a case of ptomaine poisoning, (7) candy-making, (8) arsenic in paint used for public school blackboards, (9) other matters, such as diphtheria bacilli in well persons, the brown-tail moth, malarial and other mosquitoes, etc. An appendix follows, summarizing the routine work.

The work of the laboratory is fully detailed, and embraces the examination of suspected tubercular sputum, diphtheria cultures, examinations for typhoid and malarial fevers, glanders, rabies, influenza and other diseases. An elaborate system of recording cultures genealogically is also detailed.

The investigation of the Boston ice supply was begun in a previous year, and continued in 1901. The ice supply is derived at present from both natural and artificial sources. The former consists of four ponds in New Hampshire and about twenty-four ponds and the Charles River in Massachusetts. The Massachusetts ponds are nearly all within thirty miles of Boston. Two ice ponds and the Charles River are partly, or wholly, within its limits.

A list of these supplies, giving certain particulars, is shown in the following table:—

Sources of Natural Ice in 1901.

Supply.	Nearest Town.	Area. Acres.	Number of Tons cut.
MASSACHUSETTS SUPPLIES.			
Charles River,	Boston,	-	40,000*
Strong's Pond,	Boston,	10-15*	12,000
Kibler's Pond,	Boston,	10*	1,000
Pope's Pond,	Milton,	20*	12,000
Turner's Pond,	Milton,	20*	12,000
Hammond's Pond,	Newton,	28	8,000
Morse's Pond,	Wellesley,	38	20,000
Wigwam Pond,	Dedham,	32	10,000
Morey's Pond,	Walpole,	10-20*	2,000
Washakum Pond,	South Framingham,	93	20,000
Lake Quannapowitt,	Wakefield,	264	70,000
Horn Pond,	Woburn,	91	25,000
Great Pond,	South Weymouth,	288	25,000
Warren's Pond,	Littleton,	40	30,000
Sandy Pond,	Ayer,	80	30,000
Silver Pond,	Plympton,	728	20,000
Silver Pond,	Wilmington,	38	40,000†
Mirror Pond,	Hudson,	46	40,000
Rock Pond,	Georgetown,	43	10,000*
Chebacco Lake,	Hamilton,	260	15,000
Wenham Lake,	Beverly,	255	15,000
Maple Spring Pond,	Jefferson,	25	10,000
Great Pond,	North Andover,	621	10,000*
Massapoag Lake,	Sharon Heights,	460	30,000
Flint's Pond,	North Grafton,	?	25,000
NEW HAMPSHIRE SUPPLIES.			
Country Pond,	Newton Junction,	60*	25,000
Lake Paugus,	Lakeport,	2,000*	18,000
Lovell's Pond,	Sanbornville,	1,000*	70,000
Milton, 3 Ponds,	Milton, 3 Ponds,	60*	30,000†

* Estimated.

† Said to be retailed for preserving fish exclusively.

NOTE.—While this list may be considered reasonably accurate as representing the sources of this year's supply of ice, it must be remembered that minor changes occur from year to year, although as a whole the sources of supply remain fairly constant.

Two places listed as ponds in the above (Kibler's and Pope's) are not permanent ponds, but merely hollows which are flooded each year in the autumn.

Outline of Natural Ice Business in Boston.—The natural ice shipped into Boston from a distance is loaded, for retail purposes, into ice wagons directly from the cars. From the few ice houses in Boston the ice is generally taken directly into wagons.

Eight ice companies cut, store and sell their own ice at retail for domestic purposes. Another company cuts its own ice for the fish trade. Four or five buy their ice from outside sources, and three others cut ice for wholesale purposes chiefly. Some of the retail ice dealers sell also wholesale to small companies who retail it. The various dealers buy or borrow from each other more or less freely, as they require ice to meet an emergency shortage.

The total amount of ice sold in Boston annually is estimated at 300,000 to 400,000 tons, representing about 75,000,000 to 100,000,000 gallons of water. Only a small portion is actually consumed in food or drink.

Other topics treated in the ice report are the pollution of natural ice, the danger from polluted water supplies, typhoid bacilli in relation to ice, opportunities for infection of ice, artificial ice, dangers from artificial ice, and dirt in ice.

Laundries.—An inspection of the methods pursued in various laundries led to the following conclusions: For the present it would seem proper to continue the advice given heretofore by the board of health that in all cases of infectious diseases, clothing of every description should be boiled before being washed, and that such infected material should not go to public laundries at all, but be washed at home. Uninfected material can of course do no harm.

Animals killed at the Abattoir.—There were 76,917 animals killed at the abattoir. Of this number 120 were condemned, weighing 62,682 pounds, mostly cows. Of these, 114 were condemned on account of tuberculosis. Twenty cases of actinomycosis were found. Out of the whole number of cattle, tuberculosis was found in .98 per cent. (less than 1 per cent.). There were reported 235 horses suspected of having glanders, and of these 163 were found to have this disease.

BROCKTON.

During the past year the death-rate in the city has been very low, as compared with other years, which is one of the greatest reasons for congratulation. The public generally has seconded the efforts of the board in a most gratifying manner, respecting all its rules and regulations, and the board is pleased to report the city, as a whole, in a very good condition.

The number of cases of contagious diseases that the board has had to contend with has been most gratifyingly small, although the anxiety on account of several cases of small-pox was correspondingly great.

Factory sanitation in a city like Brockton is a most important thing, and the board has found that those in charge of the factories of Brockton fully recognize the fact, and are generally careful as to the health of their employees. This argues well for the good of the entire community.

Recognizing the vital importance of having none but pure milk sold in the city, the board believes that all persons bringing or selling milk in the city should be compelled to have their milk subjected to chemical analysis, under the direction of the board, at least once a month. The present system of determining the purity or impurity of milk sold in Brockton is most unsatisfactory for the welfare of the public.

In its last annual report the board devoted considerable attention to a recommendation which was not new, calling for a daily inspection of the schools, for the purpose of detecting incipient cases of contagious diseases, and arresting them by precautionary measures. The methods to be followed in carrying out such a system are now generally well known, and it is not necessary to give them in detail here. It should suffice to say that the plan is in operation in many cities. It is generally recommended, and should receive the attention of the city council. As the cost of maintaining such a system is comparatively small, the pecuniary side of the matter should not be a factor in influencing opinion against it.

The board has decided to establish, at the filter beds of the sewerage department, a laboratory for bacteriological work. Such a laboratory will be the means of saving the city considerable money. It will also save much valuable time in the work of the department, and greatly lessen the danger of the spread of contagion.

The need of a hospital for infectious diseases could not have been more strikingly shown than during the past summer, when eight children in one family were sick, and three died with scarlet fever. This instance alone convinces us that we should have a suitable place where such cases can be cared for, which cannot be treated in their own homes without danger to others.

Brookline.

The amount expended for maintaining the public health has been $28,133.58.

In addition to a general authority to employ necessary officers, agents and assistants to execute the health laws, the board of health appoints an agent to act for it in cases of emergency, or if it cannot be conveniently assembled. This agent possesses by statute all the authority of the board itself, but is directly responsible to it, and under its supervision and control. With the growth of population and the increased importance of matters pertaining to the public health the agent, once the occasional adviser of the board, is developing into its executive officer, and ought soon to become the head of a department, charged with financial as well as professional responsibility, just as the superintendent of streets or schools is. His present duties are to exercise a general oversight over all the other employees of the board, to see that the board of health hospitals are properly conducted when open, and when they are closed to have everything in readiness for opening them at short notice, to find out what patients ought to be sent to the hospitals, and to see that they are sent, to organize the corps of doctors for inspection of schools when contagious diseases are sufficiently prevalent to make school inspection desirable, to inform, advise and assist the board in every way in performing its statutory duty of using all possible care to prevent the spread of infection when a disease dangerous to the public health exists in the town, and, in general, to bring to the attention of the board all matters requiring its action, and to be prepared to furnish it with such medical advice as it needs.

The laboratory, conveniently situated in the police station building, is in charge of the bacteriologist and director of the laboratory. Here free daily examinations and tests are made, to assist the physicians practising in the town in determining the presence of diphtheria, consumption and typhoid fever. Outfits for taking cultures are provided by the town and kept at centrally located drug stores, where physicians can readily obtain them. Numerous cultures taken by direction of the board in the course of a search for the cause of cases of diphtheria, and those taken in the public schools, are also examined. Other more elaborate microscopical and chemical examinations described in a circular issued to physicians are made for a small fee, of which the town receives one-fifth and the bacteriologist four-fifths.

During the last four months more than half the population of Brookline has been vaccinated or revaccinated, but there are still several thousand not recently vaccinated, and some, chiefly domestic servants from the provinces, who have never been vaccinated at all.

At the last annual meeting the town authorized the construction of new contagious disease hospital buildings, at an estimated cost of $86,500, on the site of the old board of health hospitals, erected in 1894. The work on the new buildings is well advanced, and will be finished in the course of the spring.

The town furnishes the apparatus and material for disinfection, the estimated value of which for an ordinary room is one dollar. The disinfector sends his bill directly to the householder and pays over to the town all the money he receives. The town pays for his labor and five per cent. of the amount collected by him from householders and paid over to the town. The disinfector has the use of the apparatus free, for any out-of-town disinfecting which he may do, when it is not needed in town.

The collection of ashes and rubbish is the most expensive work paid for from the health appropriation, because it is both universal and continuous. The number of loads increases every year, and the average length of haul also constantly increases, as available dumps become scarcer. Combustible rubbish is separately collected and much of it is burned. The work is done by the street department.

Among the unusual and more prominent features of the health department's work during 1901 have been the building of a hospital for diphtheria and scarlet fever patients; more systematic sanitary inspection; a beginning of efforts directed against the mosquito nuisance, the same measures also tending to abate malaria; the checking of an outbreak of diphtheria, probably due to infected milk; and finally, the precautions taken against small-pox by prompt and thorough isolation of every patient, and most unusual facilities for free vaccination.

In August, the writer made a special report to the board on the mosquito nuisance, with recommendations. A brief circular of information on the subject, with suggestions as to co-operation with the board in measures to abate the nuisance, was sent to every family in the town. The laboratory assistant inspected almost every pond, pool and ditch in the town, and "petrolized" many found to be the breeding places of mosquitoes. He also treated in the same way nearly 250 catch-basins, found infested with mosquitoes. Malarial and other mosquitoes in every stage were also cultivated in the board of health laboratory, and experiments made with various oils to determine the best for the destruction of mosquito larvæ (wrigglers). In certain parts of the town, draining and filling-in should be done to permanently remove breeding places of mosquitoes. This work, now just begun, will be continued throughout the season.

Cambridge.

Complaints investigated and nuisances abated during the year,	1,559
Number of inspections,	9,509
Number of subsequent inspections,	12,409

Medical Inspection of Schools.

The diseases discovered in the schools and the number of cases were as follows: —

Chicken-pox,	17
Diphtheria,	6
Measles,	28
Mumps,	30
Influenza,	12
Pediculosis,	252
Whooping-cough,	18
Diseases of ear,	25
Diseases of eye,	150
Diseases of heart,	2
Diseases of nervous system,	28
Diseases of respiratory system,	20
Diseases of skin,	153
All other diseases,	329
Total,	1,070

Temporary Hospital. Diphtheria.

The hospital was reopened Oct. 29, 1900, from which date to Dec. 31, 1901, inclusive, there were admitted 211 cases, in each of which the clinical diagnosis was confirmed by a positive culture.

Bacteriological Laboratory.

The total number of examinations made was 2,959, distributed as follows: —

Throat cultures for diphtheria,	2,552
Sputum examinations for tuberculosis,	229
Blood examinations for typhoid fever,	178
Total,	2,959

The mean annual death-rate for the ten years 1892 to 1901, inclusive, was 18.35. In calculating death-rates, the deaths of non-residents occurring in the city were excluded, and the deaths of residents wherever they occurred were included.

In November four stations were opened for free vaccination, at which the following number of persons were vaccinated: —

East Cambridge,	2,258
Cambridgeport,	2,054
Old Cambridge,	843
North Cambridge,	638
Total,	5,793

Chelsea.

The death-rate for the year is about 14 + per thousand of the population. In computing this death-rate the deaths at the Soldiers' Home, Marine and Naval hospitals, of non-residents at the Frost Hospital and still-births are deducted from the total.

Chicopee.

During the past year there have been no serious epidemics of contagious disease, and the mortality from the cases reported to the board was small.

During the early months of the year a number of cases of typhoid fever, which occurred at Chicopee Falls, were investigated, and in 14 cases the cause was found to arise from the drinking of water from the Chicopee River and from a spring which was fed by percolation from the canal. An analysis by the State Board of Health showed the water from the spring so polluted as to be unfit for use, and the spring was condemned and its further use ordered discontinued. Steps were also taken to prevent use of the river water for domestic purposes, since which time no more cases of the disease have occurred in that neighborhood.

On request of the board of health the board of aldermen passed the following ordinance: —

SECTION 1. The board of health shall have the power to inspect from time to time, as said board may deem necessary, all ice kept by, or in the possession of, any person with the intent to sell the same, or offered for sale by any person, and to enter upon any premises where such ice is kept or stored or offered for sale for the purpose of making such inspection.

SECTION 2. If the board of health, after such inspection, shall determine that any ice so kept for sale is impure or unfit for use, the said board shall forbid the sale, or offering for sale, or keeping with intent to sell said impure or unfit ice, by an order in writing which shall be served upon the person so keeping or offering for sale, or selling said ice, and a copy of said order shall be posted in a conspicuous place upon the premises where said impure or unfit ice is kept or stored, and after the service of said notice no person shall keep in his possession for the purpose of sale, or offer for sale, or sell any portion of said ice so determined to be impure or unfit within the limits of the city.

SECTION 3. No person shall bring into the city, or have in his possession, with intent to sell, or offer for sale, or sell any ice until the source of supply of the same shall have been approved in writing by the board of health.

SECTION 4. Whoever shall violate any of the provisions of this ordinance shall be liable to a fine not exceeding twenty dollars for each offence.

Pursuant to this the board of health caused inspection to be made of all sources of ice supply sold within the city, and granted certificates of approval to seven persons, also two conditional certificates subject to further investigation, while one application was refused.

CLINTON.

This board should be non-partisan, and consist of intelligent, public-spirited citizens, without reference to party affiliation. The present members hope that fitness for office will be the only consideration actuating the selection of candidates in the future.

Nearly half the population were vaccinated.

Formaldehyde gas has been used for the disinfecting of 74 rooms in dwelling-houses, besides 14 large school-rooms and 5 corridors which had been exposed to infection as a result of the forty-six cases of contagious and infectious diseases which have occurred during the year.

Total number of nuisances investigated, 358.

Each spring the whole town is examined, and cellars, yards and alleyways where rubbish and filth have collected, are required to be cleaned.

EVERETT.

The board has investigated 118 complaints, issued 80 orders to abate nuisances and ordered 290 sewer connections. There have been 250 fumigations, including 6 school-rooms. The death-rate on an estimated population of 25,000 has been 15.28, as compared with a rate of 14.97 in 1900 and 15.21 in 1899.

Of the 12 deaths from diphtheria, 5 died without being treated with antitoxin, and in 4 of the other cases the patient died within twenty-four hours after the disease was recognized by the physician, the patient being treated by the family, and in 1 of the other 3 cases the patient died from a heart complication, not having been especially sick with the diphtheria.

At present there is no place in our city where the usual forms of contagious diseases can be treated except in the dwellings where the disease happens to occur. The care of many of these cases has been inadequate and has imposed a great hardship either on the patient or upon others. Every community rightfully should provide for the care of its inhabitants, and until a contagious hospital is provided the public must suffer.

Fall River.

A contagious hospital is a pressing need. If an appropriation to enable the board to rent or lease a building for this purpose cannot be granted, the city should erect a wooden building on some of its land at the city farm, or elsewhere, which might answer the purpose until a properly equipped hospital, where contagious diseases, such as scarlet fever and diphtheria, that cannot be cared for at home, could be removed for isolation and treatment, can be provided.

In 61 of the 79 cases of diphtheria reported, antitoxin was administered to the patients, and of this number only 3 died; of the remaining 18, in which antitoxin was not used, all died. That we did not have many more cases of diphtheria reported we are satisfied is due to the fact that antitoxin, in immunizing quantities, was administered by the attending physician to all the children in the family not affected with the disease just as soon as he was satisfied that the first patient he was called to attend had diphtheria.

Fitchburg.

The saving in time now obtained from the so-called rapid diagnosis from the swab culture proves to be of material assistance, both to the attending physician and to this board, in securing an early quarantine of the case.

The health of the city has been unusually good the past year. Two hundred and forty-six cases of contagious diseases were reported to the board, as against 402 the previous year. The board has continued to enforce its regulations regarding quarantine of contagious diseases, as in previous years. In all these cases the wage earner has been considered and preference given him or her, as the case may be. So long as this city has no hospital for contagious diseases it will be necessary for this board to restrict the liberty of some people by reason of quarantine regulations. Modern houses should have one room so isolated from the rest of the living portion of the house that in the event of an inmate being sick with a disease contagious to the public, such person could readily be quarantined without the other members of the family being kept from their respective occupations. Blocks and tenements should be so constructed that the various families living in them could have access to the outside world other than through a single door for the entire building. Sanitary arrangements, water supply and fuel accommodations should be furnished each family independent of all others in the block, so that when necessary all communication could be cut off from every other family occupying the building.

Fumigation of rooms occupied by persons sick with consumption, or after their decease, still continues to be the policy of the board, and the public are now beginning to realize its value.

The causative relation of poor plumbing in houses to disease is shown in the following data.

Fifty-two cases of diphtheria were reported during the year. The plumbing, as shown by house inspection, was in good condition in 65.4 per cent., in fair condition in 19.2 per cent., and in poor condition in 15.4 per cent.

In the 14 cases of membranous croup, in 64.3 per cent. of the houses the plumbing was in good condition, 21.4 per cent. in fair condition and 14.3 per cent. in poor condition.

The plumbing was in good condition in 61.4 per cent. of the houses in which typhoid fever occurred during the year, in fair condition in 27.1 per cent. and in poor condition in 11.5 per cent. The total number of cases was 48.

Only 15 cases of scarlet fever were reported during the year, and in none of these were the surroundings dirty. There were but 2 cases in which the plumbing was poor; the houses in the remaining 86.7 per cent. were in good condition as far as the plumbing was concerned.

In all these cases the plumbing referred to included anything by or through which waste water or sewage was conveyed.

Gloucester.

The following report of Dr. Morse, medical inspector, relates to an unusual prevalence of typhoid fever at Gloucester in October, 1901: —

During the month of October frequent reports of cases of typhoid fever were received at this office from the city of Gloucester, and on October 24, as the cases did not seem to be abating, an investigation was made. It was found that the locality infected was in the village of Lanesville, a part of the city on the north side of Cape Ann. As a result of the investigation it was found that 19 cases of the disease had appeared in this locality, most of them occurring in the early part of the month, but a few later ones appearing in families where previous cases already existed.

From a history obtained from each patient, it was apparent that no common source of infection existed, the patients not having the same milkman, and, as far as could be learned, no common dealer in any article of food. The village has no public water supply and each family has in the yard a well which is used for domestic purposes. Samples of water were obtained from wells at six different houses, and upon analysis all of them were found to be most seriously polluted. The board of health of the city were informed of the results of these analyses, and although it could not be definitely stated that the well waters were the specific sources of infection, they were certainly of such a suspicious character that they could be pointed to as the probable sources, and the board were advised to take measures to prevent further use of these well waters.

Great Barrington.

There is evidently a growing appreciation on the part of the inhabitants of the importance of a thorough quarantine in all cases of contagious or infectious diseases, and the maintaining of good sanitary conditions about their homes.

We earnestly desire the assistance of every resident of our town in the maintenance of such conditions as will make it more cleanly, more healthful and desirable for a home.

Hingham.

It is the opinion of the board that if a case of small-pox should occur in Hingham it would be best to quarantine the person in his own home, if possible, but as it might happen that it would be safer to remove the person infected with the disease, the board has had three rooms in a house on the town farm thoroughly cleansed and painted and put in proper shape for use as a hospital if necessary.

Holyoke.

During the past year the board has continued the system of bacteriological examinations in all cases of diphtheria or of throat trouble of a suspicious nature. Dr. H. C. Emerson of Springfield was again elected bacteriologist of the board.

Such yearly inspections of bakeries and their surroundings, as is prescribed by law, have been made. Taken as a whole, these important places, where so much of our food product is manufactured, were found to be in good general condition. Twenty-six bakeries are at present in operation in the city. The board endeavors to use its influence against the establishment of cellar bakeries, and such advice is being favorably taken in all new establishments.

Vital Statistics. — In this branch of the work the board is constantly endeavoring to bring the standard of its office up to that of the boards of statistics in the larger cities. This year, in addition to a gradual extension of the system, we have purchased a "card index system," upon which all of the statistics of the department will be placed, and which, when completed, will place them in practical form for ready use.

Leominster.

The great question which will soon confront this town is, what will be done with the sewage? Already some signs have appeared which point significantly to the fact that it is but a matter of time when the sewage must not be emptied into the Nashua River.

The use of antitoxin, we are glad to note, has become almost universal here, nearly every physician using it freely and early in the treatment of diphtheria; and to this undoubtedly is due the fact that the death-rate was so low. This board obtained from the State Board of Health every few days, a supply of fresh antitoxin, which was furnished free to the physicians, so that all that was needed could be readily obtained.

Lowell.

We maintain a house to house inspection and keep a card index, which shows at all times the condition at the last inspection.

Bacteriological Laboratory. — Whole number of examinations, 2,411. In addition to the regular work in diphtheria this laboratory took part in the investigations proposed by the committee on diphtheria in well persons, of the Massachusetts Association of Boards of Health, to settle the vexed question about the frequency of the presence of diphtheria bacilli in healthy throats. During April and May, through the courtesy of the agents of the various mills, the bacteriologist was permitted to enter the mills during hours, and with the kindly and willing co-operation of the operatives, 500 cultures were made, one each from nose and throat of 250 individuals. It seems a waste of time and energy to attempt to discuss the value of the culture to detect and the antitoxin to relieve and probably cure diphtheria.

Every health report for the last six years has made a request, and set forth clearly the reasons why Lowell should have a hospital, ample to meet the needs of its citizens and located where there could be plenty of air, sunshine and a plentiful water supply.

The collection and disposal of garbage in a thorough and sanitary manner are questions of ample appropriations; a good equipment of covered metal carts, subjected to daily cleansing and disinfection; suitable and well-kept horses and equipments, sober and efficient men, and a business-like administration that will give to the houses as prompt and regular service as possible, taking care of the product in such a way as to cause the least annoyance and odor in its final disposal.

Lynn.

The regulation relating to gathering of ashes and rubbish was on May 13 modified to read as follows: —

All owners and occupants of any and all premises are hereby required to place their ashes and rubbish in barrels or other suitable receptacles on the outside edge of the sidewalk in front of their premises not later than 7 A.M. of the day that the board of health will collect the ashes and rubbish of the owners and occupants of said premises. Dry combustible waste, such as paper, paper boxes, excelsior, straw, hay and sawdust must be put in a separate receptacle from that or those containing ashes or other rubbish, except as hereinafter provided. Paper and paper boxes will be taken, if securely tied up into bundles and placed on the outside edge of the sidewalk. No barrel or other receptacle, together with its contents of ashes and rubbish, and no bundle or bale of paper or paper boxes, shall exceed 150 pounds in weight. The use of dry goods boxes or cases as said receptacles is forbidden, likewise any other receptacle of such shape, size, design or bulk that it cannot be ordinarily handled by one man with contents. Stones, gravel, loam, manure, waste building materials, furniture, junk, trimming of trees, vines and leaves will not be removed. No team having passed through the street will be sent back to collect ashes or rubbish not put out before 7 A.M. All persons are forbidden overhauling said bundles, bales or the contents of any barrel or receptacle for waste material set upon the sidewalk to be removed by the board of health.

There has been collected during the year 39,856 loads of ashes and rubbish.

During the year a convalescent ward has been added to our hospital plant. It is an exact counterpart of the diphtheria ward, and is connected with the same by means of a corridor. Our reason for this arrangement is in case the capacity of the hospital is overtaxed with diphtheria patients this could be used as a sick ward. When, on the other hand, there is an excessive number of convalescents it can be completely isolated by shutting off the corridor and entering from the outside. The city is fortunate in having so well an equipped hospital in treatment of small-pox, but unfortunate in that it is far too small. There can be at present only 8 cases treated with ease. In the present emergency we came within one patient in filling the hospital. Had the disease spread, we should have been obliged to fit up another house, at great expense. The capacity of the hospital can be doubled at small expense by building one large ward, of twice the capacity of the existing wards, to the rear of the building.

Malden.

The health and sanitary condition of the city through the year has been generally satisfactory.

We have been comparatively free from epidemics and contagious diseases, except for an outbreak of measles at the close of the year, which was largely due to gross carelessness on the part of parents and children, — a carelessness which was beyond the power of the board of health to avert.

Four cases of small-pox occurred during November and December, one of which proved fatal. These cases were all treated under strict quarantine in residences in the city, and it is gratifying to be able to state that there was no spread of the disease from any one of them after they came under our care. This occurrence, however, has had one salutary effect in awakening the citizens and the city government to a sense of the necessity and duty of providing a suitable hospital for the treatment of this disease and for the better protection of the community against it, and after long years of urgent pleading the board of health has at last been provided with the required funds, and will proceed at its earliest opportunity to build such a hospital.

Free vaccination was furnished and largely availed of and urged strenuously upon all the citizens.

MARBLEHEAD.

As a precautionary measure the school committee were ordered to enforce the law regarding the admission of children to school who had not been vaccinated, and all who had not been thus vaccinated within five years were required to be before admission.

Free vaccination stations were opened, at which over 600 persons were vaccinated.

MARLBOROUGH.

For the first time since 1894 small-pox appeared in Marlborough. At the time we were absolutely unprepared for handling any case of this kind, there being no building available for the purpose.

On the day the disease was pronounced small-pox by Dr. Morse, the inspector of the State Board of Health, work was immediately commenced on a wooden structure on land of the city farm, and the building was completed on the following day, and the patient was removed there that night. A second case developed in the person of the nurse of the first patient, but in a very mild form. Both cases recovered.

MEDFORD.

One thousand nine hundred and eighty-two persons have been vaccinated at the expense of the city.

The board again emphasizes its statement in regard to the urgent need of early and carefully made microscopical examination in cases suspected to be diphtheria, and would also add that it is now necessary for the physician to procure one or more negative cultures before asking for a release of the patient from quarantine.

In response to the request of the board of health, the mayor and city council ordered "that the sum of $1,000 be and the same hereby is appropriated for the purpose of free vaccination or for any other needs that may be deemed wise by the board of health and his honor the mayor, for the suppression of small-pox in the city of Medford, said amount so appropriated to be taken from any available unexpended balance."

The city is to be congratulated upon having excellent accommodations for the care of small-pox patients. The hospital is distant from the populous portions of the city, and is well supplied with water and proper sanitary and heating apparatus.

MIDDLEBOROUGH.

The work of the year has been a busy one. Early in the year the board adopted an order forbidding spitting upon our sidewalks and public places, which has been very well complied with.

The keeping of fowl has become a serious and vexed question.

MILTON.

At the meeting of November 20 it was "*Voted*, That the school committee concurring, all teachers and scholars in the public schools be required to either produce a certificate showing that they had been vaccinated within four years, to give evidence of recent vaccination, or to present themselves for vaccination to one of the physicians selected by this board." The principals of the private schools of the town were notified of the above action, and urged to see that every scholar in their schools was vaccinated.

On the same date the following notice to the citizens was adopted: —

> Owing to the prevalence of small-pox in Boston and the neighboring towns, the board of health considers it imperative that all inhabitants of the town who have not been vaccinated within the past four years should be vaccinated, or re-vaccinated, at once.
>
> Beside the danger to the individual, the board of health calls the attention of all citizens to the inconvenience that would arise, both in the home and in business, from the rigorous quarantine regulations which would be immediately enforced should any member of a household contract the disease.
>
> Those who cannot afford to pay for vaccination will find a physician at the time and places stated below, who will perform the service without charge.

Public vaccinations were performed four times a week for two weeks in four of the school-houses, and 500 persons availed themselves of the opportunity to be vaccinated. In addition to this, 723 vaccinations were done in the public schools.

We think that a suitable hospital for the use of the board of health for the isolation of cases dangerous to the public, sufficient to accommodate 8 patients, could be built and equipped for $5,000 to $5,500 at the town farm, where it could be so placed as to be sufficiently remote from all other buildings. We have accordingly caused an article to be inserted in the warrant, in order that the citizens being informed as to the facts, the town may take such action as it sees fit.

Nahant.

The following report of Medical Inspector Morse relates to an unusual prevalence of typhoid fever at Nahant in September, 1901: —

On September 26 my attention was called by the board of health of the town of Nahant to the existence of a number of cases of typhoid fever which had been present in the town during the latter part of September. A visit was, accordingly, made to the town, the conditions investigated, and, as a result, it was found that 12 cases of the disease had been present since the 16th of the month. On further study it was found that another case had existed previous to this time, the patient being a young man who had been on a pleasure trip to Maine and had returned ill with the disease on August 15. Of these 12 cases 3 had been removed to the Lynn Hospital for treatment, 4 to the Massachusetts General Hospital and 1 to the Waltham Hospital, and upon investigation it was found that all of them had a common milk supply.

A visit was then made to the farm where the milk was produced and it was found that the supply was obtained from twenty cows kept upon the premises. As an additional supply one or two cans daily were obtained from a Lynn dealer when necessary. The conditions existing at this farm were inadequate for carrying on such a large business. The barn was not capable of accommodating the number of cattle kept at the farm, and the appliances for washing the milking utensils were extremely unsatisfactory. The water for the cattle was obtained from the public supply, but for washing the milking utensils the supply was obtained from a well in front of the house, located only fifteen feet distant from the cesspool and fifty feet from the barn, with the drainage of both towards it. These utensils were cleaned in an ordinary wash-tub with ten gallons of water, five of which were said to have been heated and subsequently cooled with five other gallons obtained from this well supply. There was no history of any case of typhoid fever occurring upon the premises, but the analysis of the sample of water obtained from the well showed that it was dangerously polluted and not safe to use for domestic purposes. The board of health of the town were informed of the results of the investigation and were advised to order the sale of milk from this farm stopped until the methods of carrying on the business were made satisfactory to the board.

Natick.

We have escaped almost entirely any of the contagious or infectious diseases that the warm months or the colder season is apt to engender, and while our death-rate is slightly increased from the preceding year, it is largely due to the number of persons who died at the advanced age of seventy and over.

New Bedford.

During the year just ended there has been a very perceptible falling off in the number of cases of scarlet fever, which disease has usually interfered with the work of the school department.

In our opinion the efficacy of fumigation in buildings so much frequented as school-houses is apparent, and if, during each vacation of the long period, our school buildings should be treated as thoroughly as was done in 1900, the number of cases of contagion and infection would be very materially reduced.

That there is need for a contagious disease hospital for this fast growing mill city is apparent to any one who has given the subject the least thought. In tenements where are several families it is as essential to remove a person afflicted with scarlet fever to a hospital for treatment as in cases of smallpox.

Realizing that a daily inspection both of public and parochial schools is essential in the effort to prevent the spread of contagion and infection, the board has carried on the work during the year successfully, employing two physicians in that department. During the year 3,300 pupils were examined, and 54 were recommended to be sent home for different causes.

The number of vaccinations for the year which has drawn to a close is 425.

Newton.

The general health of the city has continued exceptionally good during the year 1901. There were no epidemics of contagious disease during the year, and no outbreaks of sufficient importance to deserve mention.

Early in the year the diphtheria ward and the administration building of the contagious hospital plant were completed, and put in use. The scarlet fever ward is now in process of completion and will be ready for occupancy early in 1902.

The advantages of being provided with a suspect or detention room, an institution which was lacking in the old hospital, have been amply demonstrated during the year. Frequently it is found advisable to remove a suspect from a crowded home or boarding-house before the diagnosis of the disease is positive. By the use of the suspect room it has been possible in several instances to early relieve the inmates of the patient's home from risk of possible contagion, and at the same time safeguard the interests of the patient, who might otherwise be exposed to the danger of contracting diphtheria in the ward, while suffering from some one of the minor throat troubles. The advantages of the suspect room attached to the scarlet fever ward are likely to be still more marked, on account of the frequency of cases which closely simulate scarlet fever in its early stages.

The use of antitoxin has become so general, and the success of this method of treatment is so commonly recognized, that instances of its successful use need not be recited.

Free vaccination was offered daily at the office of the board. Vaccine was supplied free to physicians for non-paying patients, and several calls for free vaccination from large employers of labor were responded to.

No recurrent cases of contagious disease have occurred after disinfection, and the board sees no reason to change its belief in the efficiency of formaldehyde gas as a disinfecting agent. The superiority, as regards cost, efficiency and speed, of present methods of disinfection as compared with those previously in use continues to be demonstrated.

The close of the year 1901 finds the city with practically all houses on the line of public sewers connected with the sewer. It is probable that hereafter it will be possible to have the work of house connection keep pace with that of street sewer construction.

Street waste barrels for the reception of rubbish, paper, etc., have been placed at convenient points in all sections of the city, and have been of great value in keeping the streets free from offensive rubbish.

North Adams.

Early in the year the prevalence of small-pox in this vicinity seemed to demand our attention, and we endeavored to take such measures as would prevent an epidemic of this disease in our midst. Compulsory vaccination was ordered by this board and was cheerfully complied with by our citizens. Over 1,000 people were vaccinated at the expense of the city, and every manufacturing corporation in our city had its help vaccinated. The attention of the school authorities was called to the enforcement of the statutes relating to vaccination of school children, and no child is now admitted unless compliance is had with the provisions of this law.

During the year ninety tenements and buildings have been fumigated for contagious diseases. Formaldehyde vapor was used and gave general satisfaction.

Northampton.

In no way can the public health be more endangered than by lax or improper garbage collection. This board proposes to ask for a large increase of appropriation for this collection of garbage, and is of the opinion that it would be safer to discontinue public garbage collection entirely rather than to keep up the present pretence of sanitary work in this line.

We would call attention to chapter 171 of the Acts of 1901, requiring all cities in the Commonwealth to establish one or more hospitals for infectious diseases. There is at present no provision for a pest house, and this law requires one.

North Attleborough.

It would be well for the present and prospective owners of pigs to acquaint themselves with the rule that "No swine can be kept in the thickly settled part of the town, whenever such keeping may constitute a nuisance."

Malaria has prevailed quite extensively, and the general character of the disease has been quite severe.

Orange.

From Dec. 7, 1901, to Jan. 1, 1902, there were reported to the board of health 147 cases of measles. The town was entirely free from diphtheria, typhoid fever and small-pox.

A number of legal notices were served and several houses were ordered to be connected with the sewer, and the time will eventually come when all houses upon streets where there are sewers will have to be connected with those sewers, for the public health demands that such measures be taken.

Palmer.

The cases of contagious and infectious diseases reported to the board during the past twelve months have been less than half the number reported the previous year.

Pittsfield.

The following report of Medical Inspector Morse relates to an unusual prevalence of diphtheria at Pittsfield in the winter of 1900–1901: —

On April 5, 1901, my attention was called by the board of health of the city of Pittsfield to the appearance of a large number of cases of diphtheria which had occurred in the city during the preceding fall and winter, and upon investigation it was found that since Aug. 15, 1900, 71 cases of the disease had appeared in the city. Previous to August 15 there had been no cases of the disease reported since Jan. 26, 1900. On August 15 and 16 two children, seven and eight years of age, who had recently come from New York, were taken ill with the disease, and these were the only cases reported in the month of August. On September 20 another case was reported, followed by 3 others in the same month. Five were reported in October and 16 in November, 18 in December, 8 in January, 5 in February, 11 in March, and 2 in the first four days of April, making a total of 71 cases. Upon plotting these cases upon a map it was found that 37 of them were in the district known as Morningside, the greater majority of these cases being among children attending the Wm. B. Rice school, and the remainder were in the scattered parts of the city. Attention had been previously directed to this school by the board of health and the school committee, and at times during the winter it had been temporarily closed and fumigated, but on the reopening of the school other cases developed, which led them to believe that the cause existed either in the school building itself or in the sanitary arrangement of the heating and ventilating apparatus. The board of health and the school committee, being assured that such conditions would not probably propagate the disease, were advised to insist upon the children who were ill with the disease having two negative culture reports from their throats before being allowed to return to school, this never having been the custom previously. The number of cases of the disease continued to a limited extent during the remainder of the month and also during May and June, following which time there was a notable decrease in the number reported.

Plymouth.

It has been repeatedly brought to the attention of the board that the small brook running in the vicinity of Samoset Street and Depot Avenue and thence to the harbor is a nuisance during the summer months, because it is used for the disposal of a large and constantly increasing amount of sewage for which its limited capacity and central location render it absolutely unfit. The board has accordingly taken measures which will lead, as soon as satisfactory arrangements can be made, to the removal of objectionable matter from the brook, leaving it to its legitimate work, the disposal of surface water.

During the summer the flats near the outlet of Eel River became a source of annoyance at low water. As the river now empties directly into the bay, each severe north-east storm carries large quantities of marine vegetation of various sorts up to a point where the stream becomes broad and shallow, depositing it there, where it decomposes, giving off at times a horrible stench, and affording a breeding place for clouds of insects, making the locality an extremely uncomfortable one for residents or even for the passer-by.

Taking advantage of a low condition of water in the river the Board caused the channel below the flats to be cleared of obstructing rocks and sand bars, thus getting a swifter current and draining the objectionable flats, from which the decomposing mass was scraped as far as possible. By these means the matter was greatly helped.

Quincy.

Early in the year bids were advertised for, to contract for scavenger work in the city, for a term of three years; two bids were submitted, and the contract let to the lowest bidder at the following rates: cleaning cesspools, per tank load, $1.65; cleaning single vaults, $1.20; cleaning double vaults, $1.70; all work to be done under the supervision of the board; apparatus, tanks, etc., to be approved by us, and a bond of $1,000 to be given by contractor. It is to be noted that the rates established by the above contract are considerably lower than the previous rates.

The collection of garbage has been done, as in the past, by two teams and four men, and has given general satisfaction.

The bake-houses in the city were inspected early in the year, and the sanitary inspector reported favorably in all but one instance.

Reading.

But 1 out of the 67 cases of contagious diseases reported during the year proved fatal.

The board would respectfully recommend a method of school inspection which has been adopted in other places with very satisfactory results. The plan is to divide the town into districts, with a medical inspector for each district, whose duty it shall be to visit the schools at regular intervals and examine any pupil whom the teacher thinks is ailing or needs medical attention from any cause whatever. If the physician thinks the ailment of sufficient importance, he recommends to the teacher that the pupil be sent home, with a statement of the cause. The importance and value of this method of inspection in preventing the spread of contagious diseases of all kinds has been demonstrated so satisfactorily by the experience of other towns and cities that we feel it our duty to recommend that it be adopted here.

Salem.

It is still the opinion of the board that the city should be provided with a hospital for the proper care of contagious diseases, as contemplated by statute law. During the year a site has been designated at Salem Neck for this purpose. One hundred dollars having been placed in the hands of the board of health by the city council for the purpose of securing plans and specifications for said hospital, the board had presented to them nine plans and specifications, as called for by advertisement. After giving these plans and specifications careful examination, and securing such information as was possible regarding requirements of the building necessary, the board were obliged to return all of them. This action was taken by the board because, in its opinion, it was shown to be impossible to secure a proper building except for a sum much in excess of that which, in the judgment of the board, would have met the approval of the city council, and for the further reason that the appropriation available was not sufficient to enable the board to purchase such plans as were in part satisfactory. In addition to the cost of erecting the building comes the additional expense of its maintenance and occupancy during the entire year, of not less than $1,000. Yet, notwithstanding this expenditure of money and expense following, the board are strongly of the opinion that the city council should, at the earliest day, take measures to provide the city with a building of this character to meet any emergency that may arise.

Sharon.

The board recommended that all persons be vaccinated, and arranged for free vaccination for those who desired to avail themselves of the same.

Regulation.

Section 1. Pulmonary tuberculosis is hereby declared to be a disease dangerous to the public health. Every physician shall report in writing to the board of health the name, age and sex of every person under his care or treatment having such disease.

Section 2. A room or apartment that has been occupied by a person suffering from tuberculosis shall not again be used or occupied after the death or removal of the patient until the same shall have been disinfected by or under the supervision of the board of health.

Section 7. Any person who owns, controls or has charge of a room or apartment that has been occupied by such tuberculous patient and allows the same again to be used or occupied before being disinfected according to section two, shall forfeit a sum not exceeding fifty dollars.

SOMERVILLE.

Number of nuisances abated,	906
Number of nuisances referred to board of 1902,	76
Number of nuisances complained of,	982
Number of complaints (many covering more than one nuisance),	476
Number of notices mailed,	594
Number of notices served by constables,	3

In addition to the above, 235 dead animals have been removed from the public streets and many nuisances have been abated on verbal notice from the agent, without action by the board, of which no record has been made. Each spring the whole city is examined, and cellars, yards and alleyways where rubbish and filth have collected are required to be cleaned.

Glanders. — Twenty-nine cases of glanders have been reported during the year. Prompt action was taken in every case, and 26 of the horses were killed, 3 being released from quarantine by order of the Cattle Commissioners.

During the past year the ashes have been removed by this department with teams owned and men hired by the city, under a competent superintendent, who also superintends the collection of house offal. The number of loads collected during the year was 29,112. The number of loads of offal during the year was 6,345.

Warning cards are used in dealing with scarlet fever and with diphtheria, and the premises are fumigated by the use of the formaldehyde gas generator immediately after the termination of the case. An inspection is made by the agent of the board of the premises where diphtheria is reported, and all sanitary defects discovered are required to be remedied as soon as possible.

Promptly with the entrance of the first of the autumn small-pox patients to the hospital, the board authorized the three physicians that were associated with the board to perform free vaccinations to such as might apply to them therefor at their respective offices during the remainder of the year. An appeal to the public through the press was authorized, and the co-operation of other city departments was asked in getting their employees vaccinated.

We renew our earnest recommendation of the last two years for the speedy inauguration of a system of daily medical inspection of the public and private schools of the city.

The system of free bacteriological examinations tentatively inaugurated last year by this board to facilitate the early diagnosis of diphtheria, tuberculosis and typhoid fever has been an unqualified success from the start, and now it has become a necessity.

Southborough.

The following report of Dr. Morse, medical inspector, relates to an inspection made relative to a few cases of typhoid fever which occurred in Southborough in October, 1901 : —

On October 11 my attention was called to 3 cases of typhoid fever which existed in the town of Southborough, and the board of health of the town requested that an investigation be made relative to the origin of the disease. On the following day I made a visit to the town and found that two brothers had been taken ill, one on the first day of October and the other on the 10th. As far as could be ascertained they had not been exposed to infection outside of the town, they being of the school age, going to school daily. Their water supply at home was obtained from a well situated in the back yard and only a short distance from a cesspool. At school the water supply was obtained from a driven well located on the premises.

The other case was a girl nine years of age, who went to bed ill on October 3. The water at her house was obtained from a spring located some distance back of the house and only ten feet from a large pig-pen. Samples of water were collected from these different sources, and the water from the well at the schoolhouse was found to be seriously polluted. The water from the well at the first house and from the spring at the second, although not showing by the chemical analyses to be seriously polluted, must be considered, on account of their location, quite suspicious.

At the first house the father of the two boys ill with the disease worked for a large creamery located in the town and he handled practically all of the milk there. At the second place twenty-four cows were kept, the milk being sold to this same creamery, and it was important that all measures should be taken to prevent possible infection of the milk, most of which was sent to Boston, Cambridge and Brookline. Accordingly, the superintendent of the creamery was advised to dispense with his foreman's services temporarily and that milk from the second farm be discontinued until complete recovery of the patients had taken place. These suggestions seemed to be effective, for, so far as could be ascertained, no cases of typhoid fever developed among the customers using this milk supply.

As a result of the analyses of the sample of water taken at the high school building, and found to be seriously polluted, the board of health and the school committee of the town were advised to discontinue this supply and secure one which would be free from pollution.

Springfield.

Springfield is a sanitary city. The hygienic conditions which prevail here are those of a well-ordered and well-regulated community of people residing in homes, as contrasted with cities having a large foreign population living in tenement houses. The duties of the board of health, therefore, are largely those of supervision and prevention, as far as possible, of all causes that contribute to unhealthfulness and unsanitary conditions, and not so much the difficult enforcement of the ordinary rules of hygienic living.

Early in the year a rule was passed forbidding expectoration in any public place.

Taunton.

There has been no unusal amount of contagious diseases during the year. While diphtheria and scarlet fever have been more or less prevalent, as always in a city of this size, the number of cases at any one time has not been sufficient to cause alarm. In December it was deemed judicious to close one grade in the School Street school owing to the appearance of three cases of scarlet fever in one week in one room in that school.

The existence of small-pox all around us was a source of anxiety during the closing months of the year. We are very fortunate in having escaped it so far.

We have continued the custom, inaugurated last year, of having medical inspections of school children and believe it to be a valuable aid in the detection and prevention of contagious diseases.

Waltham.

The board deemed it necessary to urge upon the people of Waltham immediate vaccination, and later ordered the various corporations to vaccinate all their employees who had not already been successfully vaccinated within the prescribed limit of time. To the prompt compliance with these suggestions may, we think, be credited the comparative freedom of the city from this dread disease.

Early in the year an unusually large number of cases of diphtheria occurred among the pupils of the Plympton school, so that it was deemed expedient to close this school, to enable the agent and assistants to thoroughly fumigate and disinfect the premises. The floors, ceilings, and all the furniture were thoroughly cleansed, and quite a number of the books which had been handled by the affected pupils were burned. The means adopted evidently attained the end desired, for the condition of the pupils of the district has since remained normal.

The school inspection system has been very satisfactory, and was of great value in preventing infected children from attending school and thereby lessening the spread of contagious diseases.

Three hundred and eighty-four rooms in dwelling houses have been disinfected with formaldehyde gas and many rooms have been washed with a solution of corrosive sublimate. Much bedding and wearing apparel has been sterilized by immersion in a similar solution.

Wakefield.

Your board would recommend that a permanent small-pox hospital be erected, to provide for future emergencies.

Ware.

Twenty cases of typhoid fever is an unusually large number of cases for this town in one year; for several years past there has not been more than one or two cases in a year, consequently the community was somewhat stirred at the proportions of this epidemic. Fortunately the source of the contagion was traced to an infected milk supply, and as soon as this was cut off the spread of the disease began rapidly to abate. A single case, contracted in Berkshire county, came to this farm, an old well became infected, and this water was used temporarily to wash the cans, and in this way the germs reached the milk. To this supply nearly every case could be traced.

There is no suitable house at present for isolation in case of small-pox. The town owns an old house, with a few acres of surrounding land, on the hill just above the race track, but the house is so dilapidated and filthy that it would hardly be a fit habitation for swine. We have been prepared, therefore, with plans, etc., to construct a temporary building for this purpose should such an emergency arise.

Watertown.

The general health of the town has been excellent during the past year. It has fortunately been free from a general epidemic of any contagious disease. Timely precautions were taken against threatening small-pox by instituting free public vaccination, of which about 900 persons took advantage.

With small-pox threatening upon all sides the town took a very inopportune time to delay the much-needed rebuilding of its quarantine hospital, which was burned down after having been located upon the town farm during the past thirty years. There is no other place known to the board in town more free from all reasonable objections for its re-erection than upon this ten-acre piece of town property. Especially so if it be placed about two-thirds of the distance back from the front towards the rear of the lot. As such institutions are now conducted none but sentimental or theoretical objections can be urged against them. Unless the town very shortly provides itself with the proper accommodations for a case of emergency, it is likely to find itself in a very embarrassing and probably very costly situation, if it should suddenly find a case of small-pox upon its hands. Under the present circumstance it cannot reasonably expect to continue wholly free from it.

The medical inspection of the schools, as recommended in our last annual report, has now been in successful operation since the opening of the schools in September last, and has worked to the great satisfaction of the health and school boards. The schools have been grouped into three districts, requiring, so near as may be, equal amounts of service.

During the past year the board, to facilitate its control of and for the prevention of the spread of diphtheria, malaria, typhoid fever and tuberculosis, has maintained a small bacteriological laboratory under charge of one of its medical inspectors. Returns upon cultures have thus been much more promptly obtainable than when they have had to be sent out of town. The results of cultures have been immediately reported to the attending physician by telephone whenever possible.

Westborough.

It was deemed advisable, in view of the prevalence of small-pox throughout the country, to provide the means and make arrangements for free vaccination, since which time 146 persons have availed themselves of the opportunity, and been vaccinated at the expense of the town.

Weymouth.

When it became apparent, late in the fall, that small-pox was prevailing extensively in Boston, and scattering cases were reported in several of the neighboring towns, the board invited the physicians of the town to meet them for the purpose of consulting upon measures which might be taken for the prevention of the spread of the disease in our town. This meeting was held on December 3, and as one result thereof free vaccination was offered to all who would avail themselves of the same. It was also practically agreed at this meeting — the physicians unanimously favoring the plan — that, should occasion require the establishment of a small-pox hospital, the town house should be used for that purpose. It became apparent, also, that the physicians of the town were unwilling to treat the disease, and outside medical aid will need to be called in for attendance upon any case which may occur.

Under the offer of free vaccination 549 have been vaccinated or revaccinated.

Whitman.

We have so far been free from small-pox, and we attribute it to the fact that Whitman has for years employed the vaccination law in the schools. We have also attended promptly to all suspected cases, and all of those known to have been exposed were quarantined until such time as they were found to be free from infection.

Worcester.

Number of complaints for the year ending Dec. 31, 1901, 854.

The number of deaths during the year was 1,997, a mortality of 16.49.

Bacteriological Department.

The work of this department continues to give the satisfaction of previous years. Seven hundred cultures were examined in all.

The bath houses were opened for use June 10 and closed September 21. Thirty thousand four hundred and forty-nine men and boys used the men's house during the season.

On June 4, small-pox was reported to this board. A total of 10 cases were reported between June 4 and July 3, with 4 deaths, a heavy mortality, showing the extreme virulence of the disease. It is significant that none of these patients who died had ever been vaccinated, with the possible exception of Dr. Campbell, who was said to have been vaccinated in childhood but who showed no scar. This would indicate that his vaccination was not successful, or had lost its power to protect him.

Fewer cases of diphtheria were reported this year than in any year since 1895; 266 cases were reported. Seventeen deaths occurred, making the mortality 6.39, the lowest of which we have any record. This very low rate is due, in our opinion, to the more general and prompter use of anti-toxin, which is furnished free by this department to the medical profession from the supply given us by the State Board of Health, and also to the good work of the isolation hospital, where most of the severest cases are sent for treatment.

We again renew our recommendation that an appropriation be made for medical inspection in the schools of this city.

The isolation hospital has continued the excellent work of previous years. This hospital should be credited largely, in our opinion, with the decrease in the number of contagious diseases in the city, for by its aid we are enabled to remove promptly any case of disease which occurs in the crowded tenements before it has a chance to spread.

We again renew our recommendation that the additions contemplated two years ago be constructed so that we may be able to care properly for those mixed cases of infection which are always a source of care and anxiety.

One hundred and fifty-seven cases were treated during the year.

Record of Visits made to 75 Cities and Towns by the Medical Inspector, for the purpose of Investigating 107 Cases suspected of being Small-pox, during 1901.

Case No.	City or Town.	Date.	Sex.	Age.	Character.	Successfully Vaccinated.	Remarks.
1	Attleborough,	Jan. 14,	F.	33	Discrete,	No,	Was at Central Falls, R. I., December 24 to January 5, caring for husband ill with fractured ribs who was attended by physician who had a case of unrecognized small-pox. Ill January 9.
2	Lawrence,	Jan. 17,	M.	24	Discrete,	No,	Visited by brother from Manchester, N. H. (small-pox prevalent there), December 25. January 7 taken ill, and no physician called. Mild case of small-pox.
3	Lawrence,	Jan. 17,	F.	22	Discrete,	No,	Visited by brother from Manchester, N. H. (small-pox prevalent there), December 25. January 7 taken ill. Physician called January 16. Eruption in pustular stage.
4	Lawrence,	Jan. 23,	M.	2	-	No,	Diagnosis, impetigo contagiosa.
5	Dighton,	Jan. 24,	M.	52	Confluent,	Childhood, fifteen years ago.	Quartermaster of boat between New York and Fall River. Ill January 11. Eruption January 15.
6	Lawrence,	Jan. 26,	F.	21	-	Infancy, three years ago,	Diagnosis, acne.
7	Methuen,	Jan. 31,	M.	21	Discrete,	No,	Exposed at Lawrence January 10, by cases Nos. 2 and 3. Taken ill January 23. Eruption January 25.
8	Methuen,	Jan. 31,	F.	19	Discrete,	No,	Exposed at Lawrence January 10, by cases Nos. 2 and 3.
9	Lawrence,	Jan. 31,	M.	7	Discrete,	No,	Exposed by cases Nos. 2 and 3 in same house.
10	Concord Junction,	Feb. 2,	M.	15	-	Fifteen months ago,	Diagnosis, chicken-pox.
11	Dighton,	Feb. 23,	F.	45	Discrete,	Infancy,	Wife of case No 5. Ill February 2.
12	Dighton,	Feb. 23,	M.	49	Discrete,	Infancy,	Lived in house with case No. 5. Ill February 7.
13	Huntington,	Mar. 25,	M.	44	Discrete,	Seventeen years ago,	Duster in rag room of paper mill. Ill March 15. Eruption March 18. Dusted rags March 5 to 8 (incubation period) from Newark, N. J. Small-pox prevalent there.
14	Russell,	Mar. 25,	M.	4	Discrete,	No,	Aunt works in dressing room of same paper mill. Ill March 14. Eruption March 17.
15	Springfield,	Mar. 26,	M.	24	Discrete,	No,	Works in saloon. No history of exposure. Ill March 14. Eruption March 18.
16	Lawrence,	Apr. 6,	M.	7 weeks.	-	No,	Diagnosis, eczema.
17	Fitchburg,	Apr. 10,	M.	21	Hemorrhagic,	No,	Ill April 2. Eruption April 8. Died April 10.
18-22	Fitchburg,	Apr. 23,	1 M., 4 F.,	3, 4, 5, 8, 23	Discrete,	Twelve days ago,	Ill April 19 or 20. Exposed by case No. 17. These cases had never been vaccinated before exposure. Six others in same family previously vaccinated and none taken ill.

23	Leominster, .	May 10,	M.	30	Discrete,	No,	Ill May 1. Eruption May 4.
24	Leominster, .	May 10,	M.	20	Discrete,	No,	Ill from April 5. Mild case. No attending physician.
25	Leominster, .	May 10,	M.	24	Confluent,	No,	Ill from April 10. Unrecognized case. Said to be dog-wood poisoning. Patient pitted badly.
26	Leominster, .	May 10,	M.	20	Discrete,	Infancy,	Ill from April 1. Unrecognized case.
27	Leominster, .	May 10,	M.	24	Discrete,	No,	Ill from April 20. Unrecognized case.
28	Braintree,	May 11,	M.	18	-	Eight years ago,	Diagnosis, chicken pox.
29	Leominster, .	May 14,	F.	25	Discrete,	No,	Ill May 2. Eruption May 4.
30	Southbridge,	May 15,	M.	26	Discrete,	No,	Exposed at Manville, R. I. April 28. Ill May 7. Eruption May 10.
31	Southbridge,	May 15,	M.	20	Discrete,	Fifteen years ago,	Works in lunch room. No history of exposure. Eruption May 10.
32	Marlborough,	May 20,	F.	28	Confluent,	No,	Unrecognized case in house, in the early part of the month. Ill May 16. Eruption May 19. Another visitor at house ill at New York. They were the only two unvaccinated in the house and the only two that had the disease.
33	Middleborough,	May 25,	F.	42	-	-	Diagnosis, syphilis.
34	Dedham,	May 25,	F.	28	Confluent,	No,	Ill on May 19. Eruption May 22. Works in Boston. No history of exposure.
35-37	Braintree,	May 27,	2 M., 1 F.,	15, 4, 3,	-	Yes,	Diagnosis, chicken-pox.
38	Leominster, .	May 29,	M.	40	Discrete,	No,	Exposed to case No. 29, May 9 and 11. Ill May 23. Eruption May 25.
39	Quincy,	May 31,	M.	29	Discrete,	No,	Arrived from British Columbia May 16, via Montreal. Ill May 25. Eruption May 26.
40	Townsend, .	June 11,	M.	21	Discrete,	No,	From Fitchburg May 28. Ill June 5. Eruption June 8.
41	Sutton, .	June 13,	M.	19	-	-	Diagnosis, measles.
42	Oakdale,	June 15,	F.	16	Discrete,	No,	Ill for ten days. Pustular at present time.
43-47	Fitchburg, .	June 18,	Children.		-	-	Diagnosis, chicken-pox.
48	Northborough,	June 25,	F.	55	-	Yes,	Diagnosis, acne.
49	Westborough,	June 26,	M.	35	-	Yes,	Diagnosis, dermatitis herpetiforme.
50	Townsend, .	June 28,	F.	16	-	No,	Diagnosis, chicken-pox.
51	Waltham,	June 29,	F.	16	Discrete,	Twenty-three days ago,	Ill June 23. Eruption June 27. Modified by vaccination.
52	North Brookfield,	July 2,	M.	28	Discrete,	Sixteen years ago,	Ill June 24. Eruption June 26. Exposed by unrecognized cases Nos. 53 and 54.

Record of Visits made to 75 Cities and Towns by the Medical Inspector, for the Purpose of investigating 107 Cases suspected of being Small-pox, during 1901 — Concluded.

Case No.	City or Town.	Date.	Sex.	Age.	Character.	Successfully Vaccinated.	Remarks.
53, 54	North Brookfield,	July 2,	M.	13, 15	Discrete, .	No, ...	Ill four or five weeks ago. Infected by a pedler who stayed at house over night, with an eruption on body.
55	North Brookfield,	July 3,	M.	5	-	No, ...	Diagnosis, chicken-pox.
56-59	Dudley, . .	July 5,	Children.		-	No, ...	Diagnosis, chicken-pox.
60	Blackstone, . .	July 6,	M.	1	Discrete, .	No, ...	Ill for three weeks. Unrecognized case.
61	East Douglas, .	July 6,	F.	8	-	- -	Diagnosis, measles.
62	Princeton, . .	July 10,	F.	22	-	No, ...	Diagnosis, chicken-pox.
63	Southborough, .	July 12,	F.	40	-	Yes, ...	Diagnosis, malaria. Quinine eruption.
64	Franklin, . .	July 17,	M.	21	Confluent, .	No, ...	Ill July 10. Eruption July 13. At Woonsocket, July 4. Small-pox present there.
65, 66	Palmer, . .	July 22,	M.	11, 7	Discrete, .	No, ...	Exposed at Pawtucket, R. I., by brother ill with disease. Not quarantined there and came to Palmer to visit.
67	Westfield, . .	Sept. 6,	F.	23	Confluent, .	No, ...	Exposed on steamer "Prince Arthur," from Yarmouth, N. S., August 21. Two unrecognized cases in same apartment on boat. Ill August 31. Eruption September 3.
68	Quincy, . .	Sept. 9,	F.	31	-	Yes, ...	Diagnosis, acne.
69	Wakefield, . .	Oct. 8,	F.	25	Confluent, .	No, ...	From New York City, October 2. Sick on boat. Eruption October 4.
70, 71	Newton, . .	Oct. 23,	M., F.	21, 19	Discrete, .	Nineteen days ago, .	Brother ill with small-pox and removed to Boston October 4. Ill on October 16. Eruption October 20.
72	Concord, . .	Oct. 31,	M.	23	Discrete, .	Childhood, . . .	At Boston, October 14. Ill October 25. Eruption October 28.
73	Concord, . .	Nov. 6,	M.	4	-	Seven months ago, .	Diagnosis, chicken-pox.
74	Palmer, . .	Nov. 13,	F.	21	Confluent, .	No, ...	From St. Jude, Canada, October 25. Ill November 6. Eruption November 8.
75	Lynn, . . .	Nov. 15,	F.	19	Confluent, .	No, ...	Ill November 10. Eruption November 13. No history of exposure.
76	Raynham, . .	Nov. 16,	F.	23	Confluent, .	Thirteen years ago, .	At Boston, October 28. Ill November 9. Eruption November 11.
77	Lynn, . . .	Nov 17,	M.	24	Confluent, .	No, ...	At Jamaica Plain, from November 5 to November 8. Ill November 14. Eruption November 16.
78, 79	Palmer, . .	Nov. 22,	F.	14, 1½	-	No, ...	Diagnosis, chicken-pox.

80	Lynn,	Nov. 27,	M.	34	Discrete,	Infancy,	Returned from Chicago, November 19. Ill November 21. Eruption November 24.
81	Palmer,	Nov. 29,	M.	26	Discrete,	No,	From Morristown, Pa., November 22. Small-pox present there. Ill November 25. Eruption November 29.
82	Lynn,	Dec. 2,	M.	38	-	-	Vaccinated eight days ago. Diagnosis, vaccinal rash.
83	Wakefield,	Dec. 3,	F.	35	Discrete,	Infancy,	At Boston, November 21. Ill November 28. Eruption November 30.
84	Avon,	Dec. 3,	F.	30	Discrete,	Infancy,	Did washing at a house where child was ill with disease unrecognized. Ill November 29. Eruption December 1.
85	Brockton,	Dec. 4,	F.	2	Discrete,	No,	Visited by Boston people November 24. Ill December 1. Eruption December 3.
86	Dedham,	Dec. 5,	M.	37	Discrete,	Infancy,	From New York city November 27. Ill November 29. Eruption December 2.
87	Wakefield,	Dec. 5,	M.	8 months,	-	No,	Diagnosis, measles.
88	Brockton,	Dec. 6,	M.	3 weeks,	Discrete,	No,	Brother of case No. 85.
89-92	Hanover,	Dec. 9,	M., F.	10, 10, 17, 32	-	Yes,	Diagnosis, chicken-pox.
93	Hanover,	Dec. 9,	M.	10	-	No,	Diagnosis, urticaria.
94, 95	Duxbury,	Dec. 13,	M.	13, 9	-	-	Diagnosis, chicken-pox.
96, 97	Waverley,	Dec. 14,	F., M.	35, 5	-	Infancy, 2 weeks ago,	Ill December 9. Eruption December 11. Husband works at stone quarry near small-pox hospital, Boston. He was taken ill about November 25 and gave up work. He had no doctor and diagnosis uncertain but suspicious of small-pox.
98	Lynn,	Dec. 16,	M.	31	Discrete,	Twenty-five years ago,	At Boston November 29. Ill December 13. Eruption December 16.
99	Reading,	Dec. 18,	M.	23	-	-	Diagnosis, pneumonia.
100	Lynn,	Dec. 18,	M.	30	Discrete,	Twenty years ago,	Ill December 12. Eruption December 14. No history of exposure.
101	Plymouth,	Dec. 19,	F.	25	Confluent,	December 7,	Came from Boston (case of small-pox in house) December 9. Ill December 12. Eruption December 16.
102	Winchester,	Dec. 20,	M.	5	-	-	Diagnosis, chicken-pox.
103	Framingham,	Dec. 20,	M.	27	-	-	Diagnosis, measles.
104	Hingham,	Dec. 23,	M.	44	-	-	Diagnosis, pneumonia.
105	Medford,	Dec. 28,	M.	4	Confluent,	No,	Ill December 25. Eruption December 27.
106	Westminster,	Dec. 30,	M.	30	Discrete,	Four years ago,	Ill December 20. Eruption December 25.
107	Holbrook,	Dec. 31,	F.	23	-	-	Diagnosis, chicken-pox.

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