THESIS.

ON

AN EFFICIENCY TEST.

of the

ALBANY FILTRATION PLANT.

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AN EFFICIENCY TEST OF THE ALBANY WATER FILTRATION PLANT.

The Filtration Plant that furnishes water to the city of Albany, Oregon, a town of about 5000 population, is located in the south western part of the town. It is owned and operated by the Oregon Power Company in conjunction with the electric power and light enterprises, an arrangement which is both very efficient and economical. The surplus water is used to generate power, part of which in turn operates the motors and pumps in the filtration plant. The water filtration plant is a very substantial building of red brick and concrete construction, and modern in every respect. It was completed during the year 1912 at a cost of $86,000. and built according to the plans and specifications of Engineer J. L. Linke of Chicago; although many of the patented devises and ideas of the "Jewell Filter Company" are incorporated in the plant. The design of the plant is characterized by its compactness, its completeness, and its convenience, which reduce the cost of operation to the minimum and make high efficiency possible. The coagulation basins with a capacity of 450,000. gallons occupy the east side of the plant, while the "clear well" with a capacity of 230,000

gallons is located under the filters and the operating room. The filter beds with their operating devises, and most of the machinery are immediately above the clear well giving absolutely direct connections in every case.

The plant is operated largely by the gravity system, although pumps are used to force the water from the canal up to the coagulation basins and also to wash the filters.

The source of the water supply is the Santiam River, which rises some fifty miles away in the Cascade Mountains. The water is taken from the river just above the town of Lebanon, eleven miles east, and conducted by open canal to the filter plant at Albany. This canal is about four feet in depth and twelve feet in width, but a small part only of this is used for the water supply; the remainder being used to generate power.

The water of the Santiam River at the place where the water is obtained is quite free from sewage contamination, owing to the sparsely populated condition of the drainage basin and the lack of any settlements of size along the river banks. Periodical tests of the water at Albany showed very infrequent pollution in the open canal, a quite possible source of danger which

has not proved to be a menace thus far.

The canal is patrolled by the company and a watch maintained to keep the canal and the head gates at Lebanon in good condition, and also to prevent any misuse of the canal for drainage purposes or sewage disposal. The country through which the canal flows is very level agricultural land, mostly meadows which furnish not uninviting grassy banks of a permanent nature to the canal. Bridges and culverts protect the canal at the intersection of the roads, so the pollution may be considered as negligible. Naturally the ordinary soil bacteria are present in the water constantly, and in rather high numbers during flood conditions of the river at which times "B. coli" is usually present also. As would be expected, the worst conditions prevail during the first heavy rains in the fall, when the soil, thoroughly saturated with water for the first time in months, gives up a part of its season's accumulation of bacteria to such extent that the water shows at times a count as high as 10,000 bacteria per cc. with "B. coli" in every 1/10 cc. At such times of flood condition the turbidity becomes very high and the water takes on a dirty muddy yellow color that settles out but partially in the cogulation basins and makes necessary

frequent washing of the filters. During settled weather conditions, the water goes to the other extreme becomes a clear blue color in the canal with a turbidity of less than ten parts per million, and a total count of bacteria as low as 30 per cc. Under these conditions the water would be fit for domestic uses without filtering except for the ever present danger of contamination.

The amount of water used per capita in Albany is inexcusably high and is explained by the fact that the "flat rate" is so largely used instead of the meter system. The amount of water used per day varies from 1,000,000 gallons to 3,500,000 gallons for the 6000 people using the city water. In contrast to this, the per capita consumption in Corvallis, Oregon, a town similar in many respects but possessing a supply of mountain water, very largely metered, is on the average 115 gallons per day.

The canal passes by the east side of the filter plant. The water is taken through a properly screened intake which removes all the debris and is pumped to a surge well at the corner of the coagulation basins. At this point the aluminum sulphate solution and, if necessary, the soda ash solution are added, and the treated water allowed to pass out into the coagulation

basins. Water enters the first basin at about mid depth, then by means of baffle walls and the dividing wall between the two basins, this water is forced to circulate considerably before passing through the weir in the far end of the second basin into the pipe leading to the filters. By this method the water has ample time to become thoroughly mixed with the aluminum sulphate and soda ash solutions, to precipitate the aluminum completely and to undergo a certain amount of sedimentation, this sedimentation being especially important during periods of high turbidity.

The water after leaving the coagulation basins flows to the filters through an 18" pipe from which an 8" lateral leads to each separate filter. At present there are four filters in operation, three of which are usually filtering at one time, thus making it possible to wash, overhaul, or repair one filter without risk of falling below the required capacity of the plant. The water enters the filter through the center channel, flows on to the filterbed on each side and continues to rise in the filter until there are five and one-half feet of water on top of the sand. The water is then kept automatically at this level. By the pressure from its own head the water passes down through the filter bed, through the collecting system, then through the ventura or controlling valve to the clear well below.

An ingenious arrangement of valves, connections, etc. makes possible the diversion of wash water to the sewer, the forcing of the wash water through the filter in the opposite way, or the passing of air under pressure through the collecting system at the bottom of the filters in order to wash thoroughly and to stir up the sand. Upon the proper construction of the filter bed depends in a large measure the efficiency of the plant, for a slight defect renders useless all the precautions of filtration.

The process of filtration is entirely mechanical with the exception of the formation of the floc and the addition of the alkali to insure complete precipitation of the aluminum hydroxide. The principle involved is this: A solution of aluminum sulphate when added in certain small quantities to water of an alkaline reaction due to the presence of carbonates, undergoes a chemical change in which the aluminum sulphate is broken up, the aluminum combines with the oxygen and hydrogen to form aluminum hydroxide while the sulphate combines with the calcium or magnesium to form the corresponding salt. The aluminum hydroxide precipitates out in more or less finely formed particles of a flocculent nature and it is the mechanical action of the formation of the precipitate which causes clarification and aids sedimentation in the

coagulation basins. Complete precipitation and partial sedimentation should be accomplished in the coagulation basins; then the water is ready to be admitted into the filters. During filtration the water must pass through a bed of sand especially adapted to this purpose, being graded from a very fine sand on top to coarse gravel at the bottom. The layer of sand is about 2 feet 6 inches, the fine gravel about two inches and the coarse gravel about four inches deep. The rapid method of filtration necessary for economical operation would be very inefficient were the arresting of all turbidity and bacteria dependent upon the sand alone; hence the formation of the alumunium hydroxide particles which, being larger than the grains of fine sand, are retained in the upper strata of the filter-bed and form there a colloidal-like film over and between the sand particles among which the water must pass. This film is formed by a coagulant, by which is meant the salt of any metal that is used for the formation of an artificial "floc." The most important metalsused are aluminum iron and copper. By allowing the treated water to pass through the same, this film is formed sufficiently in fifteen minutes to give the maximum efficiency. Thus after this length of time the filtered water may be turned again into the clear water well with no decrease in efficiency. The percentage of water wasted

by filters and the waste necessary after the washing varies from 1% to 5% according to the turbidity of the water, which in turn regulates the frequency of washing. The necessity of keeping the percentage of waste water as low as possible is very apparent since filtered water is used for this purpose. Therefore this factor adds to the cost of maintenance and decreases the capacity of the filter plant. Turbid water causes more rapid loss of head in the filter, thus necessitating washing at more frequent intervals. Imperfect setting of the straining cups in the receiving pipes causes lack of uniformity in washing. This requires an excess of wash water to insure thorough cleaning throughout.

At the time the series of tests was commenced the filtration plant had been thoroughly overhauled, re-adjusted, and placed in the best possible condition by Mr. Gillespie of Berkeley, California, an expert in this line of engineering. He determined the amount of aluminum sulphate necessary, adjusted the automatic regulating devices, plotted curves and devised charts to simplify the adjustment of the different valves to the varying conditions, besides instructing the local force in the management of the Plant. Defects in Filters 1 and 3 were found which

were caused by carelessness in installing the strainer system, which resulted in uneven washing when the air from the blower was introduced. As these laterals are imbedded in concrete, the correction can be made only at some little expense, and so far has not been done.

Scope of the Test.

To obtain an adequate idea of just what results were being obtained by the method of filtration, a series of weekly bacteriological tests were made commencing Nov. 9, 1912 and continuing until June 1, 1913. In conjunction with this a sanitary chemical analysis was made about once a month to determine if possible any correlation between the chemical and the bacterial results. These bacterial tests, although conducted in general about once a week, were timed so as to embrace all the varying conditions possible, including weather, temperature, alkalinity of water, amount of coagulant, turbidity, etc. Tests were made also at different periods during the run of the filter to determine whether a clean or dirty condition influenced the bacterial efficiency of the filter. Tests were made just before and just after washing the filter, also a test of an entire run of the filter. For the last named test samples were taken at two hour intervals

during a period of thirty hours; at such intervals plates of the raw and filtered water were poured and the efficiency determined during the entire run of the filter from immediately after washing until 9 feet loss of head had been reached, the time at which the filter is washed again.

Tests were made when a filter had been allowed to run by, or in other words, until the loss of head had reached eleven feet and the filtered water was beginning to appear turbid.

The texture of floc best adapted for removing the bacteria during filtration was determined, also the least amount of aluminum sulphate necessary to produce such floc under the different conditions of the raw water. The effect of the alkalinity of the water upon the formation of the floc was studied, also the change in alkalinity during high water. The necessity for the addition of alkali was worked out and the minimum amount necessary for the highest efficiency determined.

From a chemical standpoint, an ordinary sanitary analysis was made about once a month. This included the determination of total solids, suspended matter, chlorine, nitrates, nitrites, free and albuminoid ammonia, total alkalinity, carbonates, bicarbonates, etc. Quantitative tests were made of various samples

of coagulant to determine the amount of aluminum and iron present; the latter being an impurity that was thought to be det rimental in increasing the amount of ferric oxide in the mains and pumps.

Chemical analyses were made of the reddish deposit in blind-end mains, also tests of soda ash and aluminum sulphate solutions as they passed through the orifice and into the raw water.

THE PROBLEM.

In starting the series of tests, the problem was first to determine the maximum efficiency of the filter plant and then to maintain that efficiency during all the changing adverse weather conditions of the season, and to do this with the minimum expenditure of time and material, while producing at all times water absolutely above criticism. The most difficult condition with which to contend is the extreme softness of the water which makes the complete precipitation of the aluminum at all times somewhat difficult. With the total alkalinity ranging from 22 to 15 p. p. m., and the amount of coagulant necessary varying from 0.65 gn. to 2 gn. per gallon it is apparent that there is danger of a part of the aluminum remaining in solution, or during times of sudden changes due to heavy rains in the mountains, of it all remaining so. Under normal weather conditions

the alkalinity of the raw water remains fairly constant at 18 - 22 p. p. m. while the amount of aluminum sulphate remains at about 0.7 gn. per gallon, thus giving the maximum alkalinity for precipitating the minimum amount of coagulant. On the other hand, with the increase of the turbidity of the water during rainy weather, the alkalinity of water drops, while at the same time more aluminum sulphate is necessary to take care of the additional turbidity. As the reaction of the aluminum sulphate is acid, the low alkalinity is soon neutralized with the resultant lack of precipitation, or disappearance of the floc, unless the alkalinity is augmented by an alkaline substance such as soda ash. This is added in quantity sufficient to maintain an alkalinity in the filtered water of 12 - 15 p.p.m.; anything below that having been found inadequate.

It was found necessary to add soda ash when the first heavy autumn rains commenced, and its use has been continued ever since, although during the settled weather in the spring and winter only 0.1 gn. per gallon was necessary. During stormy or unsettled weather both coagulant and soda ash were increased, as the turbidity in the raw water often rose very rapidly and unless there was an excess of aluminum and alkali the floc might completely disappear. As the whole process of filtration

is dependent upon these small particles of flocculent aluminum hydroxide, the efficiency drops immediately and the water is unsafe for domestic use, especially since at such times the raw water is most likely to contain sewage bacteria.

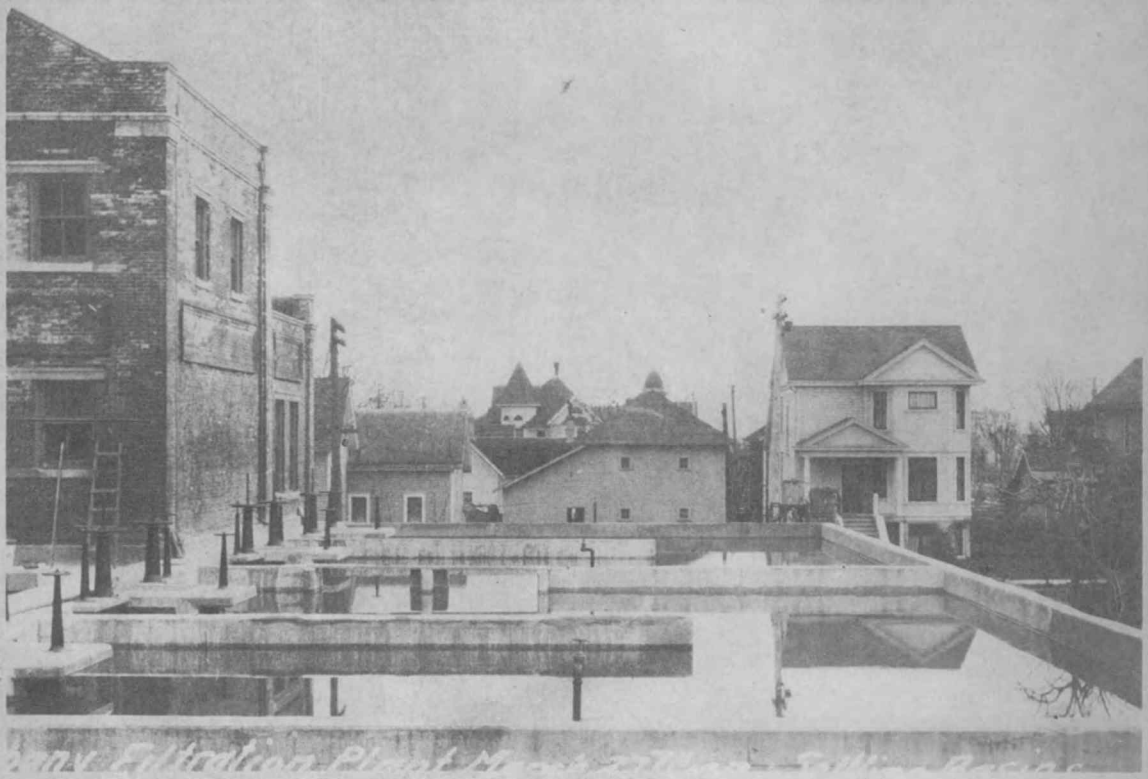
The tests were made on the average of once a week and usually on Saturday morning. All precautions possible were taken to insure a fair, accurate test of the filter plant. The apparatus, media, etc. were taken to the filter plant where an improvised laboratory was fitted up and the plates poured immediately after the sample was taken. Fermentation tubes were also inoculated at the same time and then all were brought back to the laboratory immediately and incubated; the plates at 30° C. and the fermentation tubes at 37.5° C.

Standard methods as recommended by the American Public Health Association were used in general. Liebig's Beef Extract was substituted for the meat infusion, but the reaction, concentration, and ingredients used were standard. Observations of the fermentation tubes were made at the end of twenty-four and forty-eight hours and those showing gas-formation were plated out on lactose-litmus agar. It was found by experiment that the best quantities for the raw water plates were 0.1 cc. and 0.3 cc. and for the filtered water 1 cc. With the fermentation

tubes 0.1 cc. and 1 cc. inoculums were used with the raw water and 1 cc. and sometimes 3 cc. of filtered water. On two different occasions the total count in the raw water rose approximately ten thousand, and two or three times there was an accumulation of bacteria in a filter which made accurate counting impossible. Ordinarily these amounts gave good results.

Special tests were made at certain times instead of the routine analysis. In some instances filter 3 received special attention due to the fact that defects in construction resulting in erratic filtration were rendering the water from the whole plant dangerous at times, and lowering greatly the efficiency. Filter 1 was also slightly defective and was given special attention, but in most cases three filters were tested against the raw water.

The following data with charts include the results from the weekly tests carried on during the seven months from November 1912 to May 1913 inclusive.



BACTERIAL TEST.

Nov. 9, 1912.

Weather very wet having rained almost continually for two weeks. The turbidity of the water was high and the amount of alum used 1.2 grs. per gal. "Floc." very coarse. Soda ash used.

Count of Total No. of Bacteria in Raw Water.

1/10	cc.	equal	140	equal 1400	per cc.
1/10	cc.	"	120	" 1200	" "
1/10	cc.	"	125	" 1250	" "
1/8	cc.	"	250	" 1000	" "
1	cc.	too numerous to count			
1	cc.	"	"	" "	

Ave. is 1200 per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter 2.

1	cc.	equal	2
1	cc.	"	4
1	cc.	"	0
1	cc.	"	1
1	cc.	"	1
1	cc.	"	3

Ave. equal 2 per cc.

Filter 3.

1	cc.	equal	3
1	cc.	"	3
1	cc.	"	3
1	cc.	"	3
1	cc.	"	2
1	cc.	"	5

Ave. equal 3 per cc.

Filter 4.

1	cc.	equal	0
1	cc.	"	0
1	cc.	"	3
1	cc.	"	3
1	cc.	"	1
1	cc.	"	3

Ave. equals 2 per cc.

BACTERIAL TEST.

Nov. 9, 1912. (continued)

Qualitative Test for Sewage Bacteria.

Gas formation in Raw Water.

5 cc. gas	=	B. coli
1/2 cc. "		Not B. coli
1 cc. "		B. coli
1 cc. "		Not B. coli
1 cc. no gas		----------
1/10 cc. gas		Not B. coli.

B. coli found in 1cc dilution.

Gas-formation in Water from Filter 2.

5 cc.	=	none
3 cc.		"
1 cc.		"
1 cc.		"
1 cc.		"
1/10 cc.		"

Gas-forming bacteria in Water from Filter 3.

5 cc.	-	none
5 cc.		"
1 cc.		"
1 cc.		"
1 cc.		"
1/10 cc.		"

Ave. 0 per cc.

Gas-forming Bacteria in Water from Filter 4.

5 cc.	-	none
5 cc.		"
1 cc.		"
1 cc.		"
1 cc.		"
1/10 cc.		"

BACTERIAL TEST.

Nov. 9, 1912. (continued)

Efficiency of Filter.

Ave. in Raw Water 1200 per cc.
" " Filtered Water 2 " "

$$1200 - 2 = \frac{1195}{1200} = 99.6$$

Percent total no. of bacteria removed	99.6
" sewage bacteria	100,0

BACTERIAL TEST.

Nov. 16, 1912.

Weather cold - no rain for twenty-four hours, likewise no dredging in the canal for the same length of time. Turbidity lower - raw water 22 P.P.M. Alkalinity 19 P.P.M. No soda ash used - Alum used .9 per gal. "Floc" medium coarse.

Counts of Total No. of Bacteria in Raw Water.

1/10 cc.	=	18	=	180 per cc.
1/10 cc.				200 " "
3/10 cc.		60		200 " "
3/10 cc.		60		200 " "
1/2 cc.		60		120 " "
1/2 cc.		60		120 " "

Ave. = 170 per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter 2.

1 cc.	=	0
1 cc.		0
1 cc.		1
1 cc		1
1 cc		1
1 cc		0

Ave. - 1 per cc.

Filter 3.

1 cc.	=	0
1 cc.		1
1 cc.		2
1 cc.		0
1 cc.		1
1 cc.		1

Ave. is 1 per cc.

Filter 4.

1 cc.	=	0
1 cc.		0
1 cc.		1
1 cc.		1
1 cc.		0
1 cc.		0

Ave. 1 per cc.

BACTERIAL TEST.

Nov. 16, 1912. (continued)

Ave. no. of bacteria in raw water 170 per cc.
" " " " " filtered water 1 " "

Efficiency of filter = 170 - 1 or $\frac{169}{170}$ = 99.4%

No gas-forming bacteria in raw or filtered water.

Chemical Test from Sanitary Standpoint.
Nov. 16, 1912.

Total solids	26 parts per million
Chlorine	3 " " "
Nitrites	trace
Nitrates	"
Ammonia Free	"
" Albuminoid	.13 " " "

Total alkalinity (raw water)	17 - 22 parts per million
(filtered water)	15 - 20 parts per million
Normal carbonates	none
Bicarbonates	8 parts per million.

November 25, 1912.

Weather clear cold for several days.

Water clear in canal, turbidity in settling basin. 12 - 10.5 P.P.M.
"Floc" fine .6 gr. 2% sol.

Filter 1, 2 & 3 running.

Count of Total No. of Bacteria in Water.

1/10 cc.	- 13	- 130	per cc.	
1/10 cc.	- 15	150	"	"
1/10 cc.	10	100	"	"
1/2 cc.	40	80	"	"
1/2 cc.	36	72	"	"
1 cc.	95	95	"	"
1 cc.	125	125	"	"

Ave. 110 per cc.

Count of Total No. of Bacteria in Water from Filter 1.

1 cc. =	90
1 cc.	75
1 cc.	100
1 cc.	95
1 cc.	150
1 cc.	65

Ave. is 95 per cc.

Count of Total No. of Bacteria in Filter 2.

1 cc. =	very numerous (overgrowth)
1 cc.	" " "
1 cc.	100 (approximate)
1 cc.	95 "
1 cc.	overgrowth
1 cc.	"

Ave. 100 (approximate)

Count of Total No of Bacteria in Filter 3.

1 cc. =	45
1 cc.	95
1 cc.	--
1 cc.	--
1 cc.	70
1 cc.	60

Ave. is 70 per cc.

November 25, 1912. (continued)

Qualitative Test for Gas-forming Bacteria.

Raw Water.

1/10 cc.	Gas - B coli
1/10 cc.	No gas
1/2 cc.	Gas - not B. coli
1 cc.	" - B. coli
1 cc.	" - " "
1 cc.	" - " "

Water from Filter 1.

1 cc.	Gas - B. coli
1 cc.	No gas
5 cc.	Gas - B. coli
1 cc.	No gas
5 cc.	Gas - B. coli

Water from Filter 2.

1 cc.	Gas - not B. coli
1 cc.	No gas
1 cc.	" "
5 cc.	Gas - B. coli
5 cc.	" " "

Water from Filter 3.

1 cc.	No gas
1 cc.	" "
1 cc.	" "
5 cc.	Gas - B. coli
5 cc.	" " "

BACTERIAL TEST.
Nov. 30, 1912.

Weather clear and cold for over a week. Water in canal very clear. Turbidity in settling basin 12 - 10.5. "Floc" very good, medium coarse - .6 grs. per gal.

Filter 1 - 2 & 3 in operation.

Count of Total No. of Bacteria in Raw Water.

1/10 cc.	=	8	= 80	per cc.
1/10 cc.		9	90	" "
1/10 cc.		10	100	" "
1/2 cc.		--	---	" "
1/2 cc.		overgrowth		
1 cc.		80	80,	" "

Ave. 90 PER c.c.

Count of Total No. of Bacteria in Water from Filter 1.

1 cc.	=	0
1 cc.		0
1 cc.		0
1 cc.		1
1 cc.		1
1 cc.		6

Ave. 1 per cc.

Count of Total No. of Bacteria in Water from Filter 2.

1 cc.	=	1
1 cc.		0
1 cc.		2
1 cc.		2
1 cc.		0
1 cc.		1

Ave. 1 per cc.

Count of Total No. of Bacteria in Water from Filter 3.

1 cc.	-	3
1cc.		5
1 cc.		0
1 cc.		0
1 cc.		6
1 cc.		6

Ave. is 3 per cc.

BACTERIAL TEST.
Nov. 30, 1912. (continued)

Qualitative Test for Sewage Bacteria.

Gas formation in Raw Water.

5 cc. Gas - not B. coli.
1 cc. " " "
1 cc. " " "
1 cc. No gas."
1/2 cc. " "
1/10 cc. " "

Gas Formation in Water from Filter 1.

5 cc. none.
5 cc. "
1 cc. "
1 cc. "
1 cc. "
1/10 cc. "

Gas Formation in Water from Filter 2.

5 cc. None.
5 cc. "
1 cc. "
1 cc. "
1 cc. "
1/10 cc. "

Gas Formation in Water from Filter 3.

5 cc. none.
5 cc. "
1 cc. "
1 cc. "
1 cc. "
1/10 cc. "

Per cent of Total No. of Bacteria removed.

Raw Water ave. 80
Filtered water ave.2

80 - 2 = 78/80 = 97.5%.

Percent of gas-forming Bacteria removed 100%.

BACTERIAL TEST OF ALBANY FILTER PLANT.
December 7, 1912.

Weather cold, frosty, with no rain during the preceding two or three days. Water in the canal very clear with the turbidity in settling tank 10 parts per million.

"Floc" rather too fine for greatest efficiency. Alum used .65 gr. per gal. with alkalinity of raw water 17 ppm.; filtered water 15 ppm.

Count of total no. of bacteria in raw water.

1/10	cc.	contain	10	equal	100	per cc.
1/10	cc.	"	10	"	100	" "
1/10	cc.	"	13	"	130	" "
1/10	cc.	"	9	"	90	" "
1/2	cc.	"	52	"	104	" "
1/2	cc.	"	42	"	84	" "
3/10	cc.	"	39	"	130	" "
3/10	cc.	"	36	"	120	" "
1	cc.	"	82	"	82	" "

Ave. is 105 per cc.

Count of total no. of bacteria in filtered water.

Filter 1.

1	cc.	contained	2
1	cc.	"	4
1	cc.	"	0
1	cc.	"	4
1	cc.	"	0
1	cc.	"	3

Ave. is 2 per cc.

Filter 2.

1	cc.	contained	2
1	cc.	"	1
1	cc.	"	2
1	cc.	"	2
1	cc.	"	2

Ave. is 2 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
December 7, 1912. (continued)

Count of total no of bacteria in filtered water.

Filter 3.

1 cc.	contained	0
1 cc.	"	1
1 cc.	"	3
1 cc.	"	2
1 cc.	"	1

Ave. is 1 per cc.

Qualitative Test for Sewage Bacteria.

No sewage bacteria in 1 cc. in either raw or filtered water.

BACTERIAL TEST OF ALBANY FILTER PLANT.
December 14, 1912. (continued)

Count of Total No. of Bacteria in Raw Water.

Filter 3.

1 cc. too numerous to count.
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Qualitative Test for Sewage Bacteria.

Raw Water - B. coli in every 1/10 cc.
Filter water " " " " 1 cc. (smallest amt. tested)

Efficiency ----------

BACTERIAL TEST OF ALBANY FILTER PLANT.
December 21, 1912.

Weather cold and foggy with recent showers and heavy rain. Turbidity of raw water varied from 10 - 24 in a very short time. Alkalinity low, 11 ppm. in settling basins and 14 ppm. in raw water. "Floc" very fine. Considerable trouble was experienced in getting a satisfactory "floc." until finally the alum was raised from .6 gr. to 1.2 grs. per. gal. with the addition of soda ash. As soon as this had time to act there was a good, coarse "floc." in the settling basin. The alkalinity remained at 11 ppm. in settling tank with the increased amount of alum and the addition of soda ash.

Count of Total No. of Bacteria in Raw Water.

1/10	cc.	contained	11	equals	110	per cc.
1/10	cc,	"	13	"	130	" "
1/10	cc.	"	10	"	100	" "
1/10	cc.	"	14	"	140	" "
3/10	cc.	"	33	"	110	" "
3/10	cc.	"	36	"	120	" "
1/20	cc.	"	7	"	140	" "

Ave. = 120 per cc.

Count of Total Bacteria in Filtered Water.

Filter 1.

2/10	cc.	contained	2	or	10	per	cc.
2/10	cc.	"	1	"	5	"	"
5/10	cc.	"	3	"	6	"	"
1	cc.	"	6	"	6	"	"
1	cc.	"	2	"	2	"	"
1	cc.	"	6	"	6	"	"

Ave. is 6 per cc.

Filter 2.

1/10	cc.	contained	0	or	0	per	cc.
1/10	cc.	"	1	"	10	"	"
5/10	cc.	"	0	"	0	"	"
1	cc.	"	3	"	3	"	"
1	cc.	"	1	"	1	"	"

Ave. is 5 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
December 21, 1912. (continued)

Count of Total Bacteria in Filtered Water.

Filter 3.

1/10 cc, too numerous to count.
1/10 cc. " " " "
1/10 cc. " " " "
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Ave. much higher than raw water.

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc, contained B. Coli.
1/10 cc. " " "
1/10 cc, " " "
1 cc. " " "
1 cc. " " "

Filtered Water.

No sewage bacteria found.

Efficiency of Filter Plant.

Filter 1. - 95% of total no. removed
" 2. - 96% " " " "
" 3. - more bacteria than in the raw water.

Percent of sewage forms removed - 100%

Note: Due to some unknown cause there was a considerable accumulation of bacteria in Filter 3.

Filter 1 and 2 did very well considering the poor "floc."

BACTERIAL TEST OF ALBANY FILTER PLANT.
December 28, 1912.

Weather very cold, rain and snow in sudden squalls during the three preceding days. Water in canal muddy, turbidity 30 today - 45 the previous night.

"Floc" very good.

Alkalinity raw water 18 parts per million.
" filtered water 15 parts per million.

Alum used 1.1 grs. per gal.

Count of Total No, of Bacteria in raw water.

1/10 cc.	contained	3	equals	30	per	cc.
1/10 cc.	"	3	"	30	"	"
1/10 cc.	"	9	"	90	"	"
1/10 cc.	"	2	"	20	"	"
3/10 cc.	"	9	"	30	"	"
3/10 cc.	"	5	"	15	"	"
3/10 cc.	"	9	"	30	"	"
1 cc.	overgrowth.					

Ave, is 35 per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter 1.

1/10 cc.	contained	0	equals	0	per	cc.
1/10 cc.	"	0	"	0	"	"
1 cc.	"	0	"	0	"	"
1 cc.	"	0	"	0	"	"
1 cc.	"	2	"	2	"	"

Ave. is 0 per cc.

Filter 3.

1/10 cc.	contained	0	equals	0	per	cc.
1/10 cc.	"	0	"	0	"	"
1/10 cc.	"	0	"	0	"	"
1/10 cc.	"	0	"	0	"	"
1 cc.	"	1	"	1	"	"
1 cc.	"	0	"	0	"	"
1 cc.	"	0	"	0	"	"
1 cc.	"	0	"	0	"	"

Ave. is 0 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
December 28, 1913. (continued)

Note:- Extra plates were poured in this case because of its previous poor test. This test is remarkably good.

Qualitative Test for Sewage Bacteria.

No sewage forms in either raw or filtered water. 1 cc. quantities used in raw water or 5 cc. quantities used in filtered water.

Efficiency of filter plant.

Percent of total no. removed 99.9%.

Chemical Analysis of Albany City Water.
December 28, 1912.

Total solids,	76 ppm.
Chlorine,	3 "
Nitrites,	none
Nitrates,	"
Ammonia, (free)	trace
Ammonia (albuminoid).	03 ppm.
Total alkalinity, raw water,	15-18 "
Total alkalinity, filtered water,	11-15 "
Normal carbonates,	none
Bicarbonates,	8-11 "

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 4, 1913.

Weather clear, very cold with hard frost. Heavy showers during the last three days had caused a heavy turbidity until today when it was somewhat more clear. Present turbidity 26 - alkalinity of raw water 18 parts per million; filtered water 14 parts per million. Alum 1 gr. per gal. The "floc." was very good bu t the water in the clear well was somewhat turbid.

Count of Total No. of Bacteria in Raw Water.

1/10	cc,	contained	54	equals	540	per cc.
1/10	cc.	"	47	"	470	" "
1/10	cc.	"	37	"	370	" "
1/10	cc.	"	40	"	400	" "
3/10	cc.	"	180	"	600	" "
3/10	cc.	"	170	"	565	" "
1	cc.	"	400	"	400	" "
1	cc.	"	overgrowth.			

Ave. is 480

Count of Total No. of Bacteria in Filtered Water.

Filter 1.

1	cc.	contained	20	or	20	per cc.
1	cc.	"	25	"	25	" "
1	cc.	"	17	"	17	" "
1	cc.	"	17	"	17	" "
1/10	cc.	"	2	"	20	" "
1/10	cc.	"	2	"	20	" "

Ave. is 20 per cc.

Filter 3.

1/10	cc.	contained	2	or	20	per cc.
1/10	cc.	"	0	"	0	" "
1	cc.	"	6	"	6	" "
1	cc.	"	4	"	4	" "
1	cc.	"	6	"	6	" "
1	cc.	"	6	"	6	" "

1

Ave. is 7 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 4, 1913. (continued)

Count of Total No. of Bacteria in Filtered Water.

Filter 4.

1/10 cc. contained 3 or 30 per cc.
1/10 cc. " 0 " 0 " "
1 cc. " 15 " 15 " "
1 cc. " 14 " 14 " "
1 cc. " 17 " 17 " "

Ave. is 15 per cc.

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc. no B. Coli.
1/10 cc. " " "
1/10 cc. " " "
1 cc. " " "
1 cc. B. Coli.
1 cc. " "

Filter 1.

1/10 cc. no B. Coli.
1/10 cc. " " "
1/10 cc. " " "
1 cc. " " "
1 cc. " " "
5 cc. " " "

Filter 3.

1/10 cc. no B. Coli.
1/10 cc. " " "
1/10 cc. " " "
1 cc. " " "
1 cc. " " "
5 cc. " " "

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 4, 1913. (continued)

Qualitative Test for Sewage Bacteria.

Filter 4.

1/10 cc. no B. Coli.
1/10 cc. " " "
1/10 cc. " " "
1 cc. " " "
1 cc. " " "
5 cc. " " "

Efficiency of Filter Plant.

Total no. of bacteria raw water	480
" " " " filtered water	14

480 - 14 = 466 = 466 ÷ 480 = 97

Efficiency 97%.

Percentage of sewage forms removed = 100%

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 11, 1913.

Weather cloudy with frequent storms on preceding days. Water turbid, alkalinity 21 parts per million. "Floc" very fine - alum used was .8 gr. per gal. The test was made by the engineering students in charge of Professor Beckwith.

Count of total No. of Bacteria in raw water.

1/10	cc.	contained	20	equals	200	per cc.
1/10	cc.	"	45	"	450	" "
1/10	cc.	"	25	"	250	" "
1/4	cc.	overgrowth				
3/10	cc.	contained	104	equals	350	per cc.
3/10	cc.	"	89	"	295	" "
1/2	cc.	"	158	"	315	" "
1	cc.	overgrowth.				

Ave. is 310 per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter 1.

1	cc.	contained	59	per	cc.
1	cc.	"	37	"	"
1	cc.	"	7	"	"
1	cc.	"	20	"	"
1	cc.	"	overgrowth.		

Ave. is 30 per cc.

Filter 2.

1	cc.	contained	3	per	cc.
1	cc.	"	1	"	"
1	cc.	"	3	"	"
1	cc.	"	1	"	"
1	cc.	"	1	"	"

Ave. is 2 per cc.

Filter 3.

1	cc.	contained	6	per	cc.
1	cc.	"	3	"	"
1	cc.	"	0	"	"
1	cc.	"	7	"	"
1	cc.	"	1	"	"

Ave. is 3 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 11, 1913. (continued)

Filter 4.

1 cc. contained 7 per cc.
1 cc. " 5 " "
1 cc. " 3 " "
1 cc. " 3 " "
1 cc. " overgrowth.

Ave. is 5 per cc.

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc. no B. Coli.
1/10 cc. " " "
1/10 cc. " " "
1 cc. " " "
1 cc. " " "

Filter 1.

1 cc. no B. Coli.
1 cc. " " "
1 cc. " " "
1 cc. " " "

Filter 2.

1 cc. no B. Coli.
1 cc. " " "
1 cc. " " "
1 cc. " " "

Filter 3.

1 cc. no B. Coli.
1 cc. " " "
1 cc. " " "
1 cc. " " "

Filter 4,

1 cc. no B. Coli.
1 cc. " " "
1 cc. " " "
1 cc. " " "

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 11, 1913. (continued)

Total no. of bacteria in raw water is 310 per cc.
" " " " " filter 1 is 30 " "
Ave. total no. of bacteria in filters 2,3,4 is 3 " "

Efficiency of filter 1 is 310 - 30 - 280/310 - 90%
" " filters 2, 3 & 4 is 310 - 3 = 307/310 = 99%
Ave. efficiency is 310-10 = 300 ÷ 310 = 97%.

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 18, 1913.

Weather unsettled with heavy wet snow on proceding day that turned to rain. Water in the canal the worst of the season, being very turbid, turbidity 160 parts per million. Water in settling tanks very muddy with water in clear well also somewhat turbid. Alkalinity of raw water 14 parts per million; filtered water 11 parts per million. "Floc" very heavy and coarse, 1.9 gr. per gal. of alum and .6 gr. per gal. of soda ash used. All filters tested, the "loss of head" ranging from 5.2 ft. to 8.5 ft.

Count of Total No. of Bacteria in Raw Water.

1/10 cc. contained 900 equals 9000 per cc,
1/10 cc. " 1000 " 10000 " "
1/10 cc. " 1100 " 11000 " "
3/10 cc. too numerous to count
3/10 cc. " " " "
3/10 cc. " " " "
1/2 cc. " " " "
1/2 cc. " " " "

Ave. is 10,000 per cc.

Count of total no. of Bacteria in Filtered Water.

Filter 1.

1/10 cc. contained 19 equals 190 per cc.
1/10 cc. " 20 " 200 " "
1 cc. " 190 " 190 " "
1 cc. " 150 " 150 " "
1 cc. " 200 " 200 " "

Ave. is 185 per cc.

Filter 2.

1 cc. contained 90
1 cc. " 125
1 cc. " 100
1 cc. " 105
1 cc. overgrowth.

Ave. is 105.

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 18, 1913. (continued)

Count of Total No. of Bacteria in Filtered Water.

Filter 3.

1 cc. contained 35 per cc.
1 cc. " 35 " "
1 cc. " 35 " "
1 cc. " 35 " "
1 cc. " 50 " "

Ave. is 38 per cc.

Filter 4.

1 cc. contained 105 per cc.
1 cc. " 90 " "
1 cc. " 75 " "
1 cc. " 70 " "
1 cc. overgrowth.

Ave. is 70 per cc.

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc. contained no B. Coli
1/10 cc. " " " "
1/10 cc. " B. Coli.
1 cc. " " "
1 cc. " " "
1 cc. " " "

Filter 1.

1 cc. contained no B. Coli.
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Filter 2

1 cc. contained no B. Coli.
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

BACTERIAL TEST OF ALBANY FILTER PLANT

January 18, 1913 (continued)

Qualitative Test for Sewage Bacteria.

Filter 3.

1 cc. contained no B. Coli.

1 cc. " " " "

1 cc. " " " "

1 cc. " " " "

Filter 4.

1 cc. contained no B. Coli.

1 cc. " " " "

1 cc. " " " "

1 cc. " " " "

Efficiency of Filter Plant.

Total no. of bacteria in raw water 10,000 per cc.

Ave. " " " " filtered water 100 " "

10,000 - 100 = 9,900 ÷ 10,000 = 99%

Per cent of total no. of bacteria removed = 99%

" " " sewage bacteria removed = 100%

Chemical Analysis of Albany Water.

Note: This sample was taken from the canal during the worst conditions of the season, after exceptionally heavy rains and melting snow. Sample taken January 18, 1913.

Turbidity	160	parts per million.
Total solids	65	" " "
Suspended matter	94	" " "
Chlorine	3	" " "
Nitrites	none	
Nitrates	6	" " "
Ammonia (free)	.106	" " "
Ammonia (albuminoid)	274	" " "
Alkalinity (total)	14	" " "
Bicarbonates	6	" " "

Normal carbonates none.

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 26, 1913.

Weather clear and mild with no rain during the proceding 48 hours. Water in the canal perfectly clear; "Floc" rather fine. Alum used .65 gr. per gal. Alkalinity of raw water 17 parts per million. Alkalinity of filtered water 14 parts per million. Turbidity 17 parts per million. Temperature 5° C.

Count of total No. of Bacteria in Raw Water.

1/10	cc.	contained	3	equals	30	per cc.
1/10	cc.	"	3	"	30	" "
1/10	cc.	"	2	"	20	" "
1/10	cc.	"	6	"	60	" "
3/10	cc.	"	2	"	7	" "
1/2	cc.	"	12	"	24	" "
1/2	cc.	"	13	"	26	" "

Ave. is 28 per cc.

Count of total No. of Bacteria in Filtered Water.

Filter 1.

1	cc.	contained	2	per	cc.
1	cc.	"	3	"	"
1	cc.	"	0	"	"
1	cc.	"	3	"	"
1	cc.	"	0	"	"
1	cc.	"	3	"	"

Ave. is 2 per cc.

Filter 2.

1	cc.	contained	0
1	cc.	"	2
1	cc.	"	0
1	cc.	"	1
1	cc.	"	0
1	cc.	"	2

Ave. is 1 per cc.

Filter 3.

1	cc.	contained	1	per	cc.
1	cc.	"	1	"	"
1	cc.	"	1	"	"
1	cc.	"	0	"	"
1	cc.	"	1	"	"
1	cc.	"	1	"	"

Ave. is 1 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
January 26, 1913. (continued)

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc. contained no B. Coli.
1/10 cc. " " " "
1/10 cc. " B. Coli
1 cc. " " "
1 cc. " " "
1 cc. " " "

Filter 1.

1 cc. contained B. Coli.
1 cc. " No B. Coli.
1 cc. " " " "
1 cc. " " " "

Filter 2.

1 cc. contained no B. Coli.
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Filter 3.

1 cc. contained no B. Coli.
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Efficiency of Filter Plant.

Total No. of bacteria in raw water is 28 per cc.
Ave. " " " " filtered " 1 " "
28 - 1 = 27 ÷ 28 = 96

Percentage of total no. of bacteria removed is 96. %
" " sewage bacteria removed is 99. %

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 2, 1913.

Weather clear and settled with no rain during the preceding week. Water in canal exceptionally clear. Turbidity ten parts per million.

Alkalinity of raw water 16 parts per million.
" " filtered water 12 parts per million.
"Floc" very good, alum used is .65 gr. per gal.
Filters, 1, 2, and 3 tested.

Total Count of Bacteria in Raw Water.

1/10	cc.	contained	10	bacteria	or 100	per	cc.
1/10	cc.	"	25	"	or 250	"	"
1/10	cc.	"	15	"	or 150	"	"
3/10	cc.	"	19	"	or 63	"	"
3/10	cc.	"	17	"	or 36	"	"
1	cc.	"	71	"	or 71	"	"
1	cc.	"	69	"	or 69	"	"
1	cc.	"	51	"	or 51	"	"

Ave. per cc. is 100.

Total Count of Bacteria in Filtered Water.

Filter 1.

1	cc.	contained	0	bacteria	per cc.
1	cc.	"	4	"	" "
1	cc.	"	13	"	" "
1	cc.	"	1	"	" "
1	cc.	"	27	"	" "

Ave. is 9 per cc.

Filter 2.

1	cc.	contained	1	bacteria	per cc.
1	cc.	"	11	"	" "
1	cc.	"	10	"	" "
1	cc.	"	3	"	" "
1	cc.	"	0	"	" "

Ave. is 5 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 2, 1913. (continued)

Total Count of Bacteria in Filtered Water.

Filter 3.

1 cc. contained 1190 bacteria per cc.
1 cc. " 1280 " " "
1 cc. " 1305 " " "
1 cc. " 1330 " " "
1 cc. " 1000 " " "

Ave. is 1220.

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc. no gas forming bacteria.
1/10 cc. " " " "
1/10 cc. " " " "
1 cc. gas-forming bacteria.
1 cc. " " "
1 cc. " " "

Gas in every 1 cc.

Filtered Water.

Filter 1.

1 cc. no gas-forming bacteria
1 cc. " " " "
1 cc. " " " "
3 cc. " " " "

No gas in 3 cc.

Filter 2.

1 cc. contained no gas-forming bacteria.
1 cc. " " " " "
1 cc. " " " " "
3 cc. " " " " "

No gas in 3 cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 2, 1913. (continued)

Qualitative Test for Sewage Bacteria.

Filter 3.

1 cc. contained no gas-forming bacteria.
1 cc. " " " " "
1 cc. " " " " "
3 cc. " " " " "

No gas in 3 cc.

Efficiency of Filter Plant.

Filter 1 removed 100 - 9 or 91 is 91%
" 2 " 100 - 5 or 95 is 95%
" 3 accumulated 1220 is --- %.

All filters removed 100% of gas-forming bacteria.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 8, 1913.

Weather clear frosty, temperature 26° C. No rain for over a week. Water in canal very clear, turbidity in settling tanks 10 parts per million. "Floc" fair. Alum used .65 gr. per gal. Alkalinity of raw water 17 parts per million; of filtered water 13 parts per million.

Four filters tested.

Loss	of	Head	Filter	1.	5.8 ft.
"	"	"	"	2.	7.5 ft.
"	"	"	"	3.	3.9 ft.
"	"	"	"	4.	7.5 ft.

Total count of Bacteria in Raw Water.

1/10	cc.	contained	4 or 40	bacteria	per	cc.
1/10	cc.	"	4 or 40	"	"	"
1/10	cc.	"	2 or 20	"	"	"
3/10	cc.	"	12 or 40	"	"	"
3/10	cc.	"	7 or 23	"	"	"
1	cc.	"	29 or 29	"	"	"
1	cc.	"	17 or 17	"	"	"

Ave. is 30 per cc.

Total Count of Bacteria in Filtered Water.

Filter 1.

1	cc.	contained	18	bacteria	per cc.
1	cc.	"	6	"	" "
1	cc.	"	6	"	" "
1	cc.	"	6	"	" "
1	cc.	"	4	"	" "

Ave. is 8 per cc.

Filter 2.

1	cc.	contained	1	bacteria	per cc.
1	cc.	"	1	"	" "
1	cc.	"	1	"	" "
1	cc.	"	0	"	" "
1	cc.	"	1	"	" "

Ave. is 1 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 8, 1913. (continued)

Filter 3.

1 cc. contained 17 bacteria per cc.
1 cc. " 33 " " "
1 cc. " 50 " " "

Ave. is 35 per cc.

Filter 4.

1 cc. contained 2 bacteria per cc.
1 cc. " 7 " " "
1 cc. " 1 " " "
1 cc. " 8 " " "
1 cc. " 0 " " "

Ave. is 4 per cc.

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc. no gas forming bacteria.
1/10 cc. " " " "
1/10 cc. " " " "
1 cc. " " " "
1 cc. gas-forming bacteria (B coli)
1 cc. " " " " "

Filtered Water.

Filter 1.

1 cc. contained no gas-forming bactèria
1 cc. " " " " "
1 cc. " " " " "
1 cc. gas-forming bacteria (B. coli)

Filter 2.

1 cc. no gas-forming bacteria.
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 8, 1913. (continued)

Qualitative Test for Sewage Bacteria.

Filter 3.

1 cc. no gas-forming bacteria.
1 cc. " " " "
1 cc. gas-forming bacteria.
1 cc. " " "

Filter 4.

1 cc. no gas-forming bacteria.
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Efficiency of Filters.

Filter	1	removed	30 - 8	or 24	is	73.3%
"	2	"	30 - 1	or 29	is	97 %
"	3	"	30 -35	or	is	-- %
"	4	"	30 - 4	or 26	is	87 %.

CHEMICAL ANALYSIS OF ALBANY RAW WATER.

Feb. 8, 1913.

Turbidity	10 parts per million.
Total Solids	Not determined.
Chlorine	3 parts per million.
Nitrites	None
Nitrates	Trace
Ammonia (albuminoid	.084 parts per million.
Ammonia (free)	None
Alkalinity (total)	18 parts per million.
Bicarbonates	11 parts per million.
Normal carbonates	None.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 9, 1913.

Note.-- This test was made twenty four hours later than the test of Feb. 8th, in order to determine the efficiency of the filters at the extreme in "Loss of Head". For this purpose two filters were allowed to "run over" the time at which they would ordinarily have been washed.

Weather, same as previous day. Water clear. Turbidity ten parts per million. "Floc" not as good as on the previous day, alum increased to .8 gr. per gal. and soda ash added. Water in clear well somewhat turbid.

Filter 1 & 3 allowed to run over.

Loss	of	Head	Filter	1 -	10.4 ft.	(before washing)
"	"	"	"	1 -	2.5 ft.	(after washing)
"	"	"	"	2 -	5.5 ft.	
"	"	"	"	3 -	11.8 ft.	
"	"	"	"	4 -	6.5 ft.	

Total count of Bacteria in Raw Water.

1/10	cc.	contained	10	or	100	bacteria per cc.
1/10	cc.	"	11	or	110	" " "
3/10	cc.	"	26	or	90	" " "
3/10	cc.	"	58	or	190	" " "

Ave. is 120 per cc.

Total count of Bacteria in Filtered Water.

Filter 1. (before washing)

1	cc.	contained	8	bacteria	per cc.
1	cc.	"	4	"	" "
1	cc.	"	4	"	" "
1	cc.	"	5	"	" "

Ave. is 5 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 9, 1913. (continued)

Total count of Bacteria in Filtered Water.

Filter 1. (after washing)

1 cc.	contained	17	bacteria	per	cc.
1 cc.	"	6	"	"	"
1 cc.	"	13	"	"	"
1 cc.	"	45	"	"	"

Ave. is 20 per cc.

Filter 2.

1 cc.	contained	1	bacteria	per	cc.
1 cc.	"	4	"	"	"
1 cc.	"	0	"	"	"
1 cc.	"	0	"	"	"

Ave. is 1 per cc.

Filter 3. (after washing)

1 cc.	contained	62	bacteria	per	cc.
1 cc.	"	47	"	"	"
1 cc.	"	25	"	"	"
1 cc.	"	6	"	"	"
1 cc.	"	68	"	"	"

Ave. is 40 per cc.

Filter 5.

1 cc.	contained	4	bacteria	per	cc.
1 cc.	"	29	"	"	"
1 cc.	"	0	"	"	"
1 cc.	"	4	"	"	"

Ave. is 9 per cc.

Qualitative test for Sewage Bacteria.
No gas-forming bacteria found in either "raw" or filtered water.

BACTERIAL TEST OF ALBANY FILTER PLANT

Feb. 9, 1913 (continued)

Efficiency of Filter

Filter 1.	(before washing)	removed	120-5 - 115	or 95.8%
" 1.	(after washing)	removed	120-20- 100	or 83.3%
" 2.		removed	120-1 - 119	or 99.1%
" 3.	(before washing)	removed	120-40- 80	or 66.6%
" 4.		removed	120-9 - 111	or 92.5%

Bacterial Test of Albany Filter Plant.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 22, 1913.

Weather, clear cold without frost, no rain for several days. Water in the canal very clear, turbidity 10 parts per million, Alkalinity"raw" water 19 parts per million. "Floc" good; alum used .7 gr. per gal.

Filter No. 2 tested throughout one entire run. Initial test made at 9 A. M. Feb. 22d with 6 ft. "loss of head" Filter was there washed, drained, given air for 4 minutes at 5 points. At 9:20 A. M. Washed 8 minutes then filtered waste opened for 15 minutes. Next sample taken at 10 A. M.

Loss of Head During Run.

Feb. 22d.

9 A. M.	6 ft.
10 "	1.55 ft.
11 "	1.7 ft.
12 noon	1.95 ft.
1 P. M.	1.98 ft.
2 "	2.03 ft.
4 "	2.53 ft.
5 "	2.7 ft.
6 "	2.8 ft.
9 "	3.8 ft.
10 "	3.95 ft.
11 "	4.01 ft.
12 "	4.33 ft.

Feb. 23d.

3 A. M.	5.25 ft.
6 "	6.25 ft.
8 "	6.95 ft.
9 "	7.27 ft.
11 "	8.20 ft.
12 noon	8.5 ft.
1 P. M.	9.0 ft.
3 "	9.63 ft.
4:30 "	10.00 ft.

Total Count of Bacteria in Filter No. 2.

Feb. 22d.

9 A. M. 1 cc. contained 13 or 13 per cc.
2 cc. " 63 or 32 " "

Ave. is 20 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 22, 1913. (continued)

Total Count of Bacteria in Filter No. 2.

Feb. 23d.

3 A. M.	1 cc.	contained	8 or 8	per	cc.
	2 cc.	"	22 or11	"	"
	1 cc.	"	6 or 6	"	"
	2 cc.	"	28 or14	"	"
	2 cc.	"	27 or14	"	"

Ave. is 11 per cc.

6 A. M.	1 cc.	contained	38 or 38	per	cc.
	2 cc.	"	20 or 10	"	"
	1 cc.	"	13 or 13	"	"
	2 cc.	"	23 or 12	"	"
	2 cc.	"	18 or 9	"	"

Ave. is 16 per cc.

9 A. M.	2 cc.	contained	35 or 17	per	cc.
	2 cc.	"	13 or 6	per	cc.
	1 cc.	"	14 or 14	"	"
	1 cc.	"	17 or 17	"	"
	2 cc.	"	11 or 5	"	"

Ave is 12 per cc.

12 noon	1 cc.	contained	6 or 6	per	cc.
	1 cc.	"	5 or 5	"	"
	2 cc.	"	31 or16	"	"
	2 cc.	"	38 or19	"	"
	2 cc.	"	26 or13	"	"

Ave. is 12 per cc.

3 P. M.	1 cc.	contained	9 or 9	per	cc.
	2 cc.	"	24 or12	"	"
	1 cc.	"	20 or20	"	"
	2 cc.	"	16 or 8	"	"
	1 cc.	"	41 or41	"	"
	2 cc.	"	36 or18	"	"

Ave. is 18 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 22, 1913. (continued)

Total Count of Bacteria in Filter No. 2.

10 A. M.	1 cc.	contained	27 or 27	per cc.
	2 cc.	"	41 or 20	" "

Ave. is 15 per cc.

1 P. M.	1 cc.	contained	12 or 12	per cc.
	1 cc.	"	20 or 20	" "
	½ cc.	"	5 or 10	" "
	½ cc.	"	5 or 10	" "

Ave. is 13 per cc.

4 P. M.	½ cc.	contained	48 or 96	per cc.
	1 cc.	"	23 or 23	" "
	2 cc.	"	29 or 15	" "

Ave. is 44 per cc.

6 P. M.	1 cc.	contained	32 or 32	per cc.
	1 cc.	"	27 or 27	" "
	1 cc.	"	11 or 11	" "
	2 cc.	"	38 or 19	" "
	2 cc.	"	130 or 65	" "

Ave. is 31 per cc.

9 P. M.	2 cc.	contained	176 or 88	per cc.
	1 cc.	"	17 or 17	" "
	1 cc.	"	3 or 3	" "
	2 cc.	"	19 or 10	" "

Ave. is 29 per cc.

12 P. M.	1 cc.	contained	5 or 5	per cc.
	1 cc.	"	5 or 5	" "
	2 cc.	"	10 or 5	" "
	2 cc.	"	12 or 6	" "
	1 cc.	"	8 or 8	" "

Ave. is 6 per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
Feb. 22, 1913. (continued)

Total Count of Bacteria in Filter No. 2.

4:30 P. M.	1 cc.	contained	18	or	18	per cc.
	2 cc.	"	35	or	18	" "
	2 cc.	"	35	or	17	" "
	1 cc.	"	20	or	20	" "
	1 cc.	"	17	or	17	" "

Ave. is 18 per cc.

COUNT OF TOTAL NUMBER OF BACTERIA IN RAW WATER.
Feb. 22, 1913.

9.A. M. 1/10 cc. contained 135 or 1350 per cc.
1/4 cc. " 265 or 1060 " "

Ave. is 1205 per cc.

10.A. M. 1/10 cc. contained 114 or 1140 per cc.
1/10 cc. " 128 or 1280 " "

Ave. is 1210 per cc.

1.P. M. 1/10 cc. contained 71 or 710 per cc.
1/4 cc. " 231 or 924 " "

Ave.is 850 per cc.

6.P. M. 1/10 cc. contained 76 or 760 per cc.
1/10 cc. " 126 or 1260 per cc.
3/10 cc. " 227 or 760 " "
3/10 cc. " 206 or 690 " "

Ave. is 868 per cc.

9.P. M. 3/10 cc. contained 203 or 680 per cc.
3/10 cc. " 131 or 440 " "

Ave. is 570 per cc.

12.P. M. 3/10 cc. contained 185 or 620 per cc.
1/10 cc. " 43 or 430 " "

Ave. is 520 per cc.

3.A. M. 1/10 cc. contained 62 or 620 per cc.
3/10 cc. " 243 or 810 " "
1/10 cc. " 47 or 470 " "
3/10 cc. " 256 or 850 " "

Ave. is 685 per cc.

6.A. M. 1/10 cc. contained 56 or 560 per cc.
1/10 cc. " 35 or 350 " "
3/10 cc. " 93 or 310 " "

Ave. is 406 per cc.

9.A. M. 1/10 cc. contained 107 or 1070 per cc.
1/10 cc. " 70 or 700 " "
1/10 cc. " 77 or 770 " "

Ave. is 846 per cc.

COUNT OF TOTAL NUMBER OF BACTERIA IN RAW WATER.
Feb. 22, 1913. (continued)

12 noon.	1/10 cc.	contained	40 or 400	per cc.
	1/10 cc.	"	37 or 370	" "
	1/10 cc.	"	34 or 340	" "

Ave. is 370 per cc.

3. P. M.	1/10 cc.	contained	62 or 620	per cc.
	1/10 cc.	"	56 or 560	" "
	3/10 cc.	"	168 or 560	" "
	3/10 cc.	"	169 or 560	" "

Ave. is 550 per cc.

4:30 P. M.	1/10 cc.	contained	71 or 710	per cc.
	1/2 cc.	"	259 or 518	" "
	1/2 cc.	"	226 or 452	" "

Ave. is 560 per cc.

QUALITATIVE TEST FOR SEWAGE BACTERIA.

Test for gas forming bacteria were made in connection with each test for "total count". Dilutions of 1/10 cc. and 0 cc. were made of the raw water and 1 cc. and 3 cc. dilutions of the filtered water. From four to six dilutions of both raw and filtered water were made each time and the following showed gas formation. Not all, however, proved to contain B. Coli.

Gas-forming Bacteria in Raw Water.

Feb. 22d.

9 P. M. in 3 cc. dilution
6 P. M. " 3 " "
12 P. M. " 1 " "

Feb. 23d.

2 A. M. in 1 cc. dilution
6 A. M. " 1 cc. "
6 A. M. " 1/10 cc. "
9 A. M. " 1/10 cc. "
9 A. M. " 1 cc. "
9 A. M. " 1 cc. "
12 noon. " 1/10 cc. "
12 " " 1 cc. "
12 " " 1 cc. "
3 P. M. " 1/10 cc. "
3 P. M. " 1/10 cc. "
3 P. M. " 1 cc. "
3 P. M. " 1 cc. "

Gas-forming Bacteria in Filter No. 2.

6 P. M. Feb. 22 in 1cc. dilution.
6 P. M. " " " 3" "

9 A. M. Feb. 23 in 3 cc. "
3 P. M. " " " 1 cc. "
3 P. M. " " " 1 cc. "
3 P. M. " " " 1 cc. "
3 P. M. " " " 3 cc. "
3 P. M. " " " 3 cc. "
3 P. M. " " " 3 cc. "
4:30 P. M. Feb. 23 in 1 cc. "

BACTERIAL ANALYSIS OF ALBANY WATER.
March 1, 1913.

Weather clear, cold and settled during the last week. Water in canal very clear. Turbidity 10 parts per million. "Floc" good, very coarse with the addition of .2 gr. of soda ash per gal. Alum used .65 gr. per gal. Alkalinity of "raw" water 17 parts per million; of filtered water 15 parts per million.

Count of total No. of Bacteria in Raw Water.

1/10	cc.	contained	9	equals	90	per	cc.
1/10	cc.	"	14	"	140	"	"
1/10	cc.	"	10	"	100	"	"
3/10	cc.	"	27	"	90	"	"
3/10	cc.	"	27	"	90	"	"
1	cc.	"	75	"	75	"	"
1	cc.	"	113	"	113	"	"

Ave. is 100 per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter No. 1.

1	cc.	contained	3	bacteria	per	cc.
1	cc.	"	0	"	"	"
1	cc.	"	2	"	"	"
1	cc.	"	4	"	"	"
1	cc.	"	overgrowth		"	"
1	cc	"	"		"	"

Ave. is 2 per cc.

Filter No. 3.

½	cc.	contained	2	equals	4	per cc.
½	cc.	"	2	"	4	" "
½	cc.	"	12	"	24	" "
½	cc.	"	9	"	18	" "
1	cc.	"	0	"	0	" "
1	cc.	"	4	"	4	" "
1	cc.	"	10	"	10	" "
1	cc.	"	4	"	4	" "

Ave. is 8 per cc.

BACTERIAL ANALYSIS OF ALBANY WATER.
March 1, 1913. (continued)

Count of total No. of Bacteria in Filtered Water.

Filter No. 4.

1 cc.	contained	4	bacteria	per cc.
1 cc.	"	9	"	" "
1 cc.	"	3	"	" "
1 cc.	"	3	"	" "
1 cc.	"	overgrowth		" "
1 cc.	"	"		" "

Ave. is 5 per cc.

Qualitative Test for Sewage Bacteria.

No. "B. Coli" found in either "raw" or filtered water.

Efficiency of Filters.

No. 1	removed	98 or 98/100	is	98 %,
" 3	"	92 or 92/100	is	92 %,
" 4	"	95 or 95/100	is	95 %.

Ave. efficiency is 95%.

The following dilutions contained B. Coli.

Raw Water.

3 A. M.	Feb.	23	1 cc. dilution
9 A. M.	"	"	1 cc. "
3 P. M.	"	"	1/10 cc. "
3 P. M.	"	"	1/10 cc. "
3 P. M.	"	"	1 cc. "
3 P. M.	"	"	1 cc. "

Filter No. 2.

3 P. M.	Feb.	23	1 cc. dilution
3 P. M.	"	"	1 cc. "
3 P. M.	"	"	1 cc. "
3 P. M.	"	"	3 cc. "
3 P. M.	"	"	3 cc. "
3 P. M.	"	"	3 cc. "

EFFICIENCY OF FILTER ~~II~~. DURING ENTIRE RUN.

8 A. M.	Feb.	22	is	98.1%
10 A. M.	"	"	"	98.0%
1 P. M.	"	"	"	99.0%
4 P. M.	"	"	"	93.3%
6 P. M.	"	"	"	96.4%
9 P. M.	"	"	"	94.2%
12 P. M.	"	"	"	98.9%

3 A. M.	Feb	23	is	98.0%
6 A. M.	"	"	"	97.8%
9 A. M.	"	"	"	97.0%
12 noon	"	"	"	98.6%
3 P. M.	"	"	"	95.1%
4:30 P. M.	Feb.	23	is	96.7%

Ave. efficiency is 97.0%.

BACTERIAL ANALYSIS OF ALBANY WATER.
March 9, 1913.

Weather clear, settled, water in canal fairly clear though rather dark in color. Turbidity in settling tanks 10 parts per million. Alum used .7 gr. per gal. Soda ash .1-2 gr. per gal. "Floc" very poor, being fine and not very much of it.

Alkalinity of "raw" water 16 parts per million.
" " filtered " 14 " " "
Temperature of water in tanks is 7° C.

Count of total No. of Bacteria in "Raw"Water.

1/10	cc.	contained	20	equals	200	per cc.
1/10	cc.	"	25	"	250	" "
1/10	cc.	"	27	"	270	" "
3/10	cc.	"	65	"	220	" "
3/10	cc.	"	81	"	270	" "
½	cc.	"	140	"	280	" "
½	cc.	"	132	"	264	" "

Ave. is 250 per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter No. 1.

1	cc.	contained	45	per cc.
1	cc.	"	48	" "
1	cc.	"	42	" "
1	cc.	"	45	" "
1	cc.	"	17	" "

Ave. is 40 per cc.

Filter No. 3.

1	cc.	contained	7	per cc.
1	cc.	"	10	" "
1	cc.	"	7	" "
1	cc.	"	0	" "
1	cc.	"	4	" "
1	cc.	"	6	" "
1	cc.	"	2	" "
1	cc.	"	5	" "

Ave. is 5 per cc.

BACTERIAL ANALYSIS OF ALBANY WATER.
March 9, 1913. (continued)

Count of total No, of Bacteria in Filtered Water.

Filter No. 4.

1 cc. contained 10 per cc.
1 cc. " 10 " "
1 cc. " 7 " "
1 cc. " 13 " "
1 cc. " 22 " "
1 cc. " 11 " "

Ave. is 9 per cc.

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc. contained no "B. coli"
1/10 cc. " " " "
1/10 cc. " " " "
1 cc. " "B. Coli"
1 cc. " " "
1 cc. " " "

Filtered Water.

Filter No. 1.

1 cc. contained no "B. coli"
1 cc. " " " "
1 cc. " "B. Coli"
1 cc. " " "

Filter No. 3.

1 cc. contained no "B. coli"
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

BACTERIAL ANALYSIS OF ALBANY WATER.
March 9, 1913. (continued)

Qualitative test for Sewage Bacteria.

Filter No. 5.

1 cc. contained no "B. Coli"
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Efficiency of Filters.

Filter 1 removed 250 - 40 or 84%,
" 3 " 250 - 5 or 98%,
" 4 " 250 - 9 or 96%.

Ave. efficiency is 93%.

BACTERIAL ANALYSIS OF ALBANY WATER.
March 16, 1913.

Weather somewhat unsettled, light showers but turbidity only 12 parts per million. "Floc" fairly good though not coarse. Alum used .7 gr. per gal. Soda ash about .1 gr. per gal. Alkalinity of "raw" water 19 parts per million; filtered water 15 parts per million. Temperature of water 7° C.

Count of total No. of Bacteria in Raw Water.

1/10 cc.	contained	10	equals	100	per	cc.
1/10 cc.	"	9	"	90	"	"
1/10 cc.	"	16	"	160	"	"
1/10 cc.	"	6	"	60	"	"
3/10 cc.	"	9	"	30	"	"
3/10 cc.	"	15	"	50	"	"
3/10 cc.	"	25	"	75	"	"
3/10 cc.	"	19	"	63	"	"

Ave. is 70 per cc.

Count of total No, of Bacteria in Filtered Water.

Filter No. 1.

1 cc.	contained	2	bacteria	per	cc.
1 cc.	"	2	"	"	"
1 cc.	"	2	"	"	"
1 cc.	"	5	"	"	"

Ave. is 3 bacteria per cc.

Filter No. 3.

1 cc.	contained	5	bacteria	per	cc.
1 cc.	"	4	"	"	"
1 cc.	"	0	"	"	"
1 cc.	"	2	"	"	"
1 cc.	"	3	"	"	"
1 cc.	"	1	"	"	"

Ave. is 2 bacteria per cc.

BACTERIAL ANALYSIS OF ALBANY WATER.
March 16, 1913. (continued)

Count of total No. of Bacteria in Filtered Water.

Filter No. 4.

1 cc.	contained	1	bacteria	per	cc.
1 cc.	"	1	"	"	"
1 cc.	"	8	"	"	"
1 cc.	"	0	"	"	"
1 cc.	"	1	"	"	"
1 cc.	"	3	"	"	"

Ave. is 3 bacteria per cc.

Qualitative Test for Sewage Bacteria.

"B. coli" found in only one 1 cc. dilution of "raw" water. None on the filtered water.

Efficiency of Filters.

Filter	No. 1	removed	70-3	or 95.7%,
"	" 3	"	70-2	or 97. %,
"	" 4	"	70-3	or 95.7%.

Ave. efficiency is 96.1%.

BACTERIAL ANALYSIS OF ALBANY WATER.
March 22, 1913.

Weather:- stormy with snow flurries and showers for past forty-eight hours. Water in canal somewhat turbid. "Floc" very good and course. Alum used .9 gr. per gal. Soda ash .1 gr. per gal. Alkalinity of raw water 19 parts per million; of filtered water 13 parts per million.

Filter 1 & 111 tested. A special test was made of Filter 111. to determine the efficiency before and after washing.

Count of Total No. of Bacteria in "Raw Water".

1/10 cc.	contained	21	equals	210	bacteria	per	cc.
1/10 cc.	"	17	"	170	"	"	"
1/10 cc.	"	51	"	510	"	"	"
1/10 cc.	"	47	"	470	"	"	"
3/10 cc.	"	93	"	310	"	"	"
3/10 cc.	"	147	"	490	"	"	"
3/10 cc.	"	127	"	420	"	"	"
3/10 cc.	"	125	"	415	"	"	"

Ave. is 480 bacteria per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter No. 1.

1 cc.	contained	25	bacteria	per	cc.
1 cc.	"	44	"	"	"
1 cc.	"	29	"	"	"
1 cc.	"	24	"	"	"

Ave. is 31 bacteria per cc.

Filter No. 3. (before washing)

"Loss of Head" 9.2 ft.

1 cc.	contained	140	bacteria	per	cc.
1 cc.	"	58	"	"	"
1 cc.	"	32	"	"	"
1 cc.	"	39	"	"	"
1 cc.	"	44	"	"	"
1 cc.	"	57	"	"	"
1 cc.	"	108	"	"	"
1 cc.	"	48	"	"	"

Ave. is 65 bacteria per cc.

BACTERIAL ANALYSIS OF ALBANY WATER.
MArch 22, 1913. (continued)

Count of Total No. of Bacteria in Filtered Water.

Filter No. 3. (after washing)

"Loss of Head" 1.5 ft.

1 cc. contained 1690 bacteria per cc.
1 cc. " 2060 " " "
1 cc. " 2130 " " "
1 cc. " 2200 " " "
1 cc. " 2120 " " "
1 cc. not counted
1 cc. " "
1 cc. " "

Ave. 2045 bacteria per cc.

Qualitative Test for Sewage Bacteria.

"Raw Water".

1/10 cc. contained "B. coli"
1/10 cc. " " "
1/10 cc. " " "
1 cc. " " "
1 cc. " " "
1 cc. " No "B. coli".

No. "B. coli" in any dilutions of filtered water.

Efficiency of Filters.

Filter 1 removed 410 - 30 or 92.7%,
" 3 (before washing) removed 410 - 65 or 84.1%,
" 3 (after washing) accumulated bacteria -- %.

Percent of sewage bacteria removed is 100%.

BACTERIAL ANALYSIS OF ALBANY WATER.
March 29, 1913.

Weather:- raining steadily for two days but mild. Water in canal muddy with turbidity of 100 parts per million and rising rapidly. "Floc" good though not coarse. Alum used 1.5 gr. per gal. soda ash .3 gr. per gal. Alkalinity of "raw" water 18 parts per million. Alkalinity of filtered water 14 parts per million.

Count of Total No. of Bacteria in "Raw" Water.

1/10 cc.	contained	58	equals	580	bacteria	per	cc.
1/10 cc.	"	64	"	640	"	"	"
1/10 cc.	"	103	"	1030	"	"	"
3/10 cc.	"	260	"	870	"	"	"
3/10 cc.	"	248	"	830	"	"	"

Ave. is 790 bacteria per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter No. 2.

1 cc.	contained	3	bacteria	per	cc.
1 cc.	"	9	"	"	"
1 cc.	"	12	"	"	"
1 cc.	"	13	"	"	"
1 cc.	"	5	"	"	"

Ave. is 8 bacteria per cc.

Filter No. 3.

1 cc.	contained	11	bacteria	per	cc.
1 cc.	"	3	"	"	"
1 cc.	"	0	"	"	"
1 cc.	"	1	"	"	"
1 cc.	"	1	"	"	"

Ave. is 3 bacteria per cc.

BACTERIAL ANALYSIS OF ALBANY WATER.
March 29, 1913. (continued)

Count of Total No. of Bacteria in Filtered Water.

Filter No. 4.

1 cc.	contained	1	bacteria	per	cc.
1 cc.	contained	3	"	"	"
1 cc.	"	4	"	"	"
1 cc.	"	1	"	"	"
1 cc.	"	1	"	"	"
1 cc.	"	2	"	"	"

Ave. is 2 bacteria per cc.

Qualitative Test for Sewage Bacteria "B. coli" found in every 1 cc. dilution of "raw water".

Efficiency of Filters.

Filter 11 removed 790 -- 8 or 98.8%,
" 111 " 790 -- 3 or 99.6%,
" 1V " 790 -- 2 or 99.7%.

Average efficiency is 99.3%.
Per cent of sewage forms removed is 100%.

BACTERIAL ANALYSIS OF ALBANY WATER.
April 12, 1913.

Weather:- raining, mild, water in canal fairly clean. "Floc" good, coarse, Alum used .9 gr. per gal. Soda ash .2 gr. per gal. Alkalinity of raw water 19 parts per million. Alkalinity of filtered water 14 parts per million.

Count of Total No. of Bacteria in Raw Water.

1/10 cc.	contained	27	or	270	bacteria	per	cc.
1/10 cc.	"	31	"	310	"	"	"
1/10 cc.	"	36	"	360	"	"	"
1/10 cc.	"	26	"	260	"	"	"
3/10 cc.	"	89	"	290	"	"	"
3/10 cc.	"	87	"	290	"	"	"
3/10 cc.	"	108	"	360	"	"	"

Ave. is 305 bacteria per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter No. 2.

1 cc.	contained	9	bacteria	per	cc.
1 cc.	"	14	"	"	"
1 cc.	"	23	"	"	"
1 cc.	"	13	"	"	"
1 cc.	"	16	"	"	"

Ave. is 15 bacteria per cc.

Filter No. 3.

1 cc.	contained	44	bacteria	per	cc.
1 cc.	"	9	"	"	"
1 cc.	"	2	"	"	"
1 cc.	"	3	"	"	"
1 cc.	"	11	"	"	"

Ave. is 14 bacteria per cc.

Filter No. 4.

1 cc.	contained	16	bacteria	per	cc.
1 cc.	"	35	"	"	"
1 cc.	"	34	"	"	"
1 cc.	"	28	"	"	"

Ave. is 28 bacteria per cc.

BACTERIAL ANALYSIS OF ALBANY WATER.
April 12, 1913. (continued)

Qualitative Test for Sewage Bacteria.

No. "B. Coli" found in either raw or filtered water.

Efficiency of Filters.

Filter 2 removed 305 - 15 or 290 is 95 %,
" 3 " 305 - 14 or 291 is 95.4%,
" 4 " 305 - 28 or 277 is 90.8%.

Ave. efficiency of filter plant is 93.7%.

QUALITATIVE TEST FOR SEWAGE BACTERIA.
April 19, 1913. (continued)

Filtered Water.

Filter No. 1. (before washing)

1 cc. contained no "B. coli".
1 cc. " " " "
1 cc. " " " "
1 cc. " "B. Coli".

Filter No. 1. (after washing)

1 cc. contained no "B. Coli."
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Filter No. 3.

1 cc. contained no "B. Coli."
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Filter No. 4.

1 cc. contained no "B. Coli?
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Efficiency of Filters.

Filter 1 (before washing) removed 180 - 7 is 96.1%,
" 1 (after washing) " 180 - 2 " 98.9%,
" 3 " 180 - 2 " 98.9%,
" 4 " 180 - 3 " 98.3%.

Ave. efficiency of plant is 98%.

BACTERIAL ANALYSIS OF ALBANY WATER.
April 26, 1913.

Weather clear and settled. Water in canal clear, turbidity about 10 parts per million. "Floc" fair, alum used .7 gn. per gal. soda ash .15 gn. per gal.

Alkalinity of raw water 18 parts per million.
" " filtered water 13 parts per million.

Filters 1, 3, & 4 tested.

Loss of Head Filter 1 - - 4.3 ft.
" " " " 3 - - 5.8 ft.
" " " " 4 - - 8.2 ft.

Count of Total No. of Bacteria in Raw Water.

1/10 cc.	contained	32 or 320	per cc.
1/10 cc.	"	38 or 380	" "
1/10 cc.	"	25 or 250	" "
1/10 cc.	"	22 or 220	" "
3/10 cc.	"	89 or 300	" "
3/10 cc.	"	67 or 220	" "
3/10 cc.	"	89 or 300	" "
3/10 cc.	"	49 or 160	" "

Ave. is 270 bacteria per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter 1.

1 cc.	contained	54	bacteria	per cc.
1 cc.	"	4	"	" "
1 cc.	"	39	"	" "
1 cc.	"	14	"	" "
1 cc.	"	25	"	" "

Ave. is 27 bacteria per cc.

Filter 3.

1 cc.	contained	5	bacteria	per cc.
1 cc.	"	3	"	" "
1 cc.	"	2	"	" "
1 cc.	"	7	"	" "
1 cc.	"	1	"	" "

Ave. is 4 bacteria per cc.

BACTERIAL ANALYSIS OF ALBANY WATER.
April 26, 1913. (continued)

Count of Total No. of Bacteria in Filtered Water.

Filter 4.

1 cc. contained -- bacteria per cc.
1 cc. " 19 " " "
1 cc. " 3 " " "
1 cc. " 15 " " "
1 cc. " 12 " " "

Ave. is 12 bacteria per cc.

Qualitative Test for Sewage Bacteria.

No "B. coli" on either Raw or Filtered Water.

Efficiency of Filters.

Filter 1 removed 270 - 27 or 243 is 90 %,
" 3 " 270 - 4 or 266 is 98.5%,
" 4 " 270 - 12 or 258 is 95.5%.

Ave. efficiency of Filter Plant is 95%.

BACTERIAL ANALYSIS OF ALBANY WATER.
May 3, 1913.

Weather somewhat unsettled but no rain for several days. Water in canal very clear. "Floc" good, alum used .7 gn. per gal. Soda ash used .1 gn. per gal. Alkalinity of filtered water 14 parts per million.

Filter 1, 2, 3, & 4 tested.

"Loss of Head" Filter 1 - 5.4 ft.
"Loss of Head" Filter 2 - 3.4 ft.
"Loss of Head" Filter 3 - 3.8 ft.
"Loss of Head" Filter 4 - 4.6 ft.

Count of Total No. of Bacteria in Raw Water.

1/10 cc.	contained	3	or 30	per	cc.
1/10 cc.	"	3	or 30	"	"
1/10 cc.	"	2	or 20	"	"
3/10 cc.	"	6	or 20	"	"
3/10 cc.	"	17	or 50	"	"
3/10 cc.	"	6	or 20	"	"
3/10 cc.	"	10	or 30	"	"

Ave. is 30 Bacteria per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter 2.

1 cc.	contained	1	per	cc.
1 cc.	"	0	"	"
1 cc.	"	1	"	"
1 cc.	"	0	"	"
1 cc.	"	1	"	"
1 cc.	"	2	"	"
1 cc.	"	2	"	"

Ave. is 1 per cc.

Filter 3.

1 cc.	contained	2	per	cc.
1 cc.	"	3	"	"
1 cc.	"	2	"	"
1 cc.	"	1	"	"
1 cc.	"	2	"	"

Ave. is 2 per cc.

BACTERIAL ANALYSIS OF ALBANY WATER.
May 3, 1913. (continued)

Count of Total No. of Bacteria in Filtered Water.

Filter 4.

1 cc. contained 1 per cc.
1 cc. " 1 " "
1 cc. " 2 " "
1 cc. " 0 " "
1 cc. " 1 " "

Ave. is 1 per cc.

Filter 1.

1 cc. contained 7 bacteria per cc.
1 cc. " 6 " " "
1 cc. " 13 " " "
1 cc. " 4 " " "
1 cc. " 1 " " "
1 cc. " 11 " " "

Ave. is 8 bacteria per cc.

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc. contained no "B. coli"
1/10 cc. " " " "
1/10 cc. " " " "
1 cc. " " " "
1 cc. " " " "
1 cc. " "B. coli".

No. "B. Coli" found in filtered Water.

Efficiency of Filters.

Filter 1 removed 30 - 8 is 22 or 73.3%,
Filter 2 " 30 - 1 is 29 or 96.6%,
Filter 3 " 30 - 2 is 28 or 93.3%,
Filter 4 " 30 - 1 is 29 or 96.6%.

Ave. efficiency of plant is 90%.

BACTERIAL ANALYSIS OF ALBANY WATER.
May 11, 1913.

Weather:-raining, warm. Weather in canal slightly turbid; water in clear well very clear. "Floc" good. Alum used .7 gn. per gal. Soda ash 1 gn. per gal.

Filter 1 & 3 tested; also water in clear well just outside the generator room.

Filter 3 tested before and after washing.

"Loss of Head" Filter 1 - 2.8 ft.
"Loss of Head" Filter 3 - 9.0 ft.
"Loss of Head" Filter 3 - 1.4 ft.

Count of Total No. of Bacteria in Raw Water.

1/10	contained	58 or 580	bacteria	per	cc.
1/10	"	53 or 530	"	"	"
1/10	"	67 or 670	"	"	"
1/10	"	41 or 410	"	"	"
3/10	"	116 or 390	"	"	"
3/10	"	102 or 340	"	"	"
3/10	"	159 or 530	"	"	"
3/10	"	157 or 530	"	"	"

Ave. is 500 bacteria per cc.

Count of Total No, of Bacteria in Filtered Water.

Filter 1.

1 cc.	contained	3	bacteria	per	cc.
1 cc.	"	3	"	"	"
1 cc.	"	3	"	"	"
1 cc.	"	1	"	"	"
1 cc.	"	1	"	"	"

Ave. is 2 bacteria per cc.

BACTERIAL ANALYSIS OF ALBANY WATER.
May 11, 1913. (continued)

Count of Total No. of Bacteria in Filtered Water.

Filter 3.
(before washing)

1 cc.	contained	3	bacteria	per	cc.
1 cc.	"	0	"	"	"
1 cc.	"	4	"	"	"
1 cc.	"	3	"	"	"
1 cc.	"	3	"	"	"
1 cc.	"	3	"	"	"

Ave. is 3 bacteria per cc.

Filter 3.
(after washing)

1 cc.	contained	2	bacteria	per	cc.
1 cc.	"	3	"	"	"
1 cc.	"	5	"	"	"
1 cc.	"	4	"	"	"
1 cc.	"	1	"	"	"
1 cc.	"	2	"	"	"

Ave. is 3 bacteria per cc.

Clear Well.
(outside)

1 cc.	contained	26	bacteria	per	cc.
1 cc.	"	20	"	"	"
1 cc.	"	16	"	"	"
1 cc.	"	13	"	"	"
1 cc.	"	14	"	"	"
1 cc.	"	8	"	"	"

Ave. is 16 bacteria per cc.

Qualitative Test for Sewage Bacteria.

No "B. coli" found in either "raw" or filtered water.

Efficiency of Filter Plant:

Filter 1 removed 500 - 2 or 498 is 99.6%,

BACTERIAL ANALYSIS OF ALBANY WATER.
May 11, 1913. (continued)

Efficiency of Filter Plant:

Filter 3 (before washing removed) 99.4%,
Filter 3 (after washing removed) 99.4%.

Water in clear well 55 0 16 or 484 is 96.8%,

Ave. efficiency of filters is 99.5%.

Note: The comparison between the water of the "clear well" and that of the filters would indicate contamination in the "clear well" either through the cement walls or through the opening into the well.

BACTERIAL TEST OF ALBANY FILTER PLANT

May 21, 1913.

Weather:- Fair and settled, but previous rains had caused a slight turbidity in the water in the canal. "Floc" good, alum used .75 gn. per gallon; soda ash .1 gn. per gallon.

Filters 1 and 4 and "clear well" tested.
"Loss of Head" Filter 1 - 2.3 ft.
" " " " 4 - 2.1 "

Count of Total No. of Bacteria in Raw Water.

1/10 cc. contained 12 or 120 bacteria per cc.
1/10 cc. " 15 or 150 " " "
1/10 cc. " 11 or 110 " " "
3/10 cc. " 29 or 100 " " "
3/10 cc. " 54 or 180 " " "
3/10 cc. " 25 or 80 " " "

Ave. is 125 bacteria per cc.

Count of Total No. of Bacteria in Filtered Water.

Filter 1

1 cc. contained 3 bacteria per cc.
1 cc. " 5 bacteria " "
1 cc. " 1 " " "
1 cc. " 3 " " "
1 cc. " 1 " " "
1 cc. " 3 " " "

Ave. is 3 bacteria per cc.

Filter 4

1 cc. contained 3 bacteria per cc.
1 cc. contained 3 " " "
1 cc. " 2 " " "
1 cc. " 2 " " "
1 cc. " 7 " " "
1 cc. " 5 " " "

Ave. is 4 bacteria per cc.

"Clear Well".

1 cc. contained 2 bacteria per cc.
1 cc. " 0 " " "
1 cc. " 1 " " "
1 cc. " 0 " " "
1 cc. " 6 " " "
1 cc. " 4 " " "

Ave. is 2 bacteria per cc.

QUALITATIVE TEST FOR SEWAGE BACTERIA

Raw Water.

1/10 cc. contained no "B. coli"

1/10 cc. " " " "

1/10 cc. " " " "

1 cc. " " " "

1 cc. " "B. coli"

1 cc. " " "

Filtered Water.

No "B. coli" in filtered water.

Efficiency of Filter Plant.

Filter 1 removed 125 - 3 or 122 is 97.6%

" 4 " 125 - 4 or 121 is 96.8%

" Clear Well" removed 125 - 2 or 123 is 98.6%

Ave. efficiency is 97.6%.

BACTERIAL TEST OF ALBANY FILTER PLANT.
May 31, 1913.

Weather:- Clear, settled and warm. Water in canal clear, turbidity about 12 parts per million. Alum used .7 gr. per gal. Soda ash .1 gr. per gal.

Filter 3 tested as soon as water was filtering into "clear well" after washing. Water from "clear well" outside tested for possible contamination.

Total No. of Bacteria in Raw Water.

1/10 cc.	contained	10	or	100	bacteria	per cc.
1/10 cc.	"	14	or	140	"	" "
1/10 cc.	"	9	or	90	"	" "
3/10 cc.	"	27	or	90	"	" "
3/10 cc.	"	24	or	80	"	" "
3/10 cc.	"	40	or	130	"	" "

Ave. is 105 bacteria per cc.

Total No. of Bacteria in Filtered Water.

Filter No. 3. (after washing)

1 cc.	contained	5	bacteria	per	cc.
1 cc.	"	4	"	"	"
1 cc.	"	2	"	"	"
1 cc.	"	6	"	"	"
1 cc.	"	6	"	"	"
1 cc.	"	5	"	"	"

Ave. is 5 bacteria per cc.

Clear Well (outside)

1 cc.	contained	1340	bacteria	per	cc.
1 cc.	"	900	"	"	"
1 cc.	"	1600	"	"	"
1 cc.	"	350	"	"	"
1 cc.	"	1580	"	"	"

Ave. is 1220 bacteria per cc.

BACTERIAL TEST OF ALBANY FILTER PLANT.
May 31, 1913. (continued)

Qualitative Test for Sewage Bacteria.

Raw Water.

1/10 cc. contained no "B. Coli"
1/10 cc. " " " "
1/10 cc. " " " "
1 cc. " " " "
1 cc. " "B. Coli"
1 cc. " " "

Filter No. 3.

1 cc. contained no "B. Coli"
1 cc. " " " "
1 cc. " " " "
1 cc. " "B. Coli"

Clear Well.

1 cc. contained no "B. Coli"
1 cc. " " " "
1 cc. " " " "
1 cc. " " " "

Efficiency of Filter Plant.

Filter 3 (after washing) removed 105-5 or 95.2%.
Clear Well showed an excessive accumulation apparently due to outside contamination.

Plate 1.

Canal that carries the raw water from the Santiam River at Lebanon to the Filtration Plant at Albany.

(Courtesy of the Oregon Power Co.)

Plate 2.

Interior of Filter Plant showing operating room.

(Courtesy of the Oregon Power Co.)

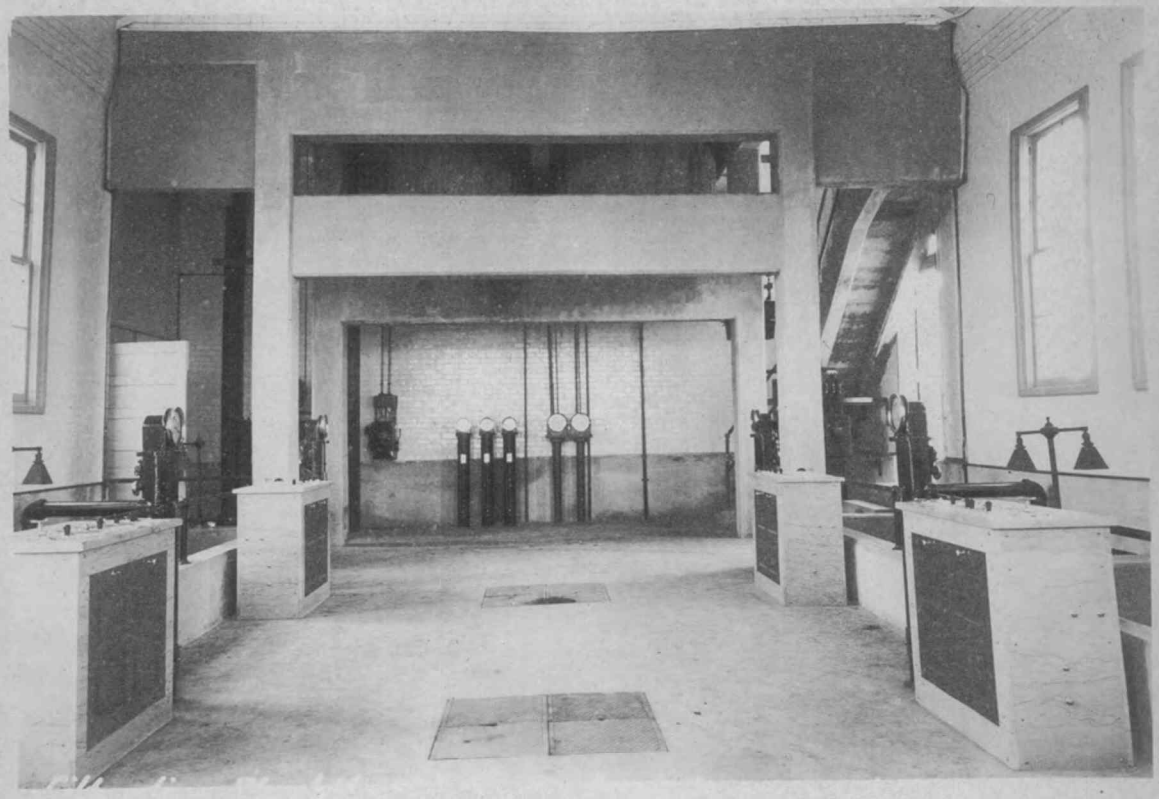


Plate 3.

View of collecting system at the bottom of a filter bed before filtering layers are put into place.

(Courtesy of the Oregon Power Co.)

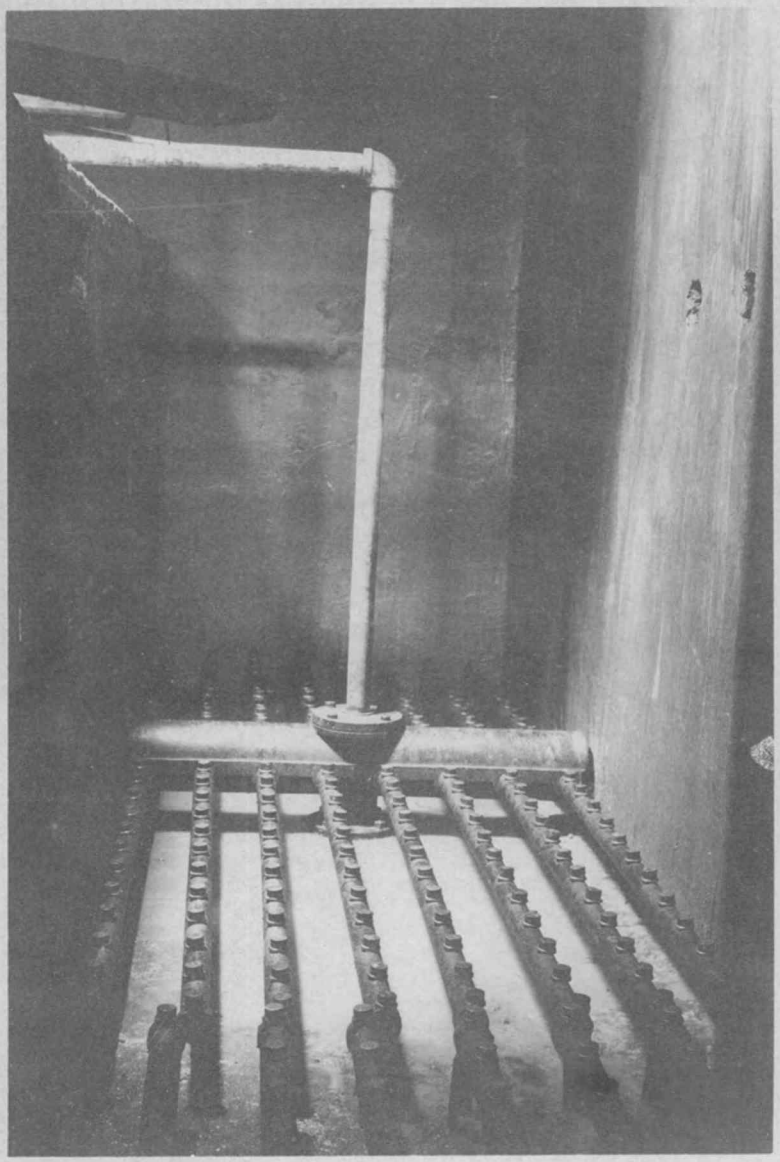


Plate 4.

Operating table and Venturàmeter.

Courtesy of Bacteriology Department, O. A. C.

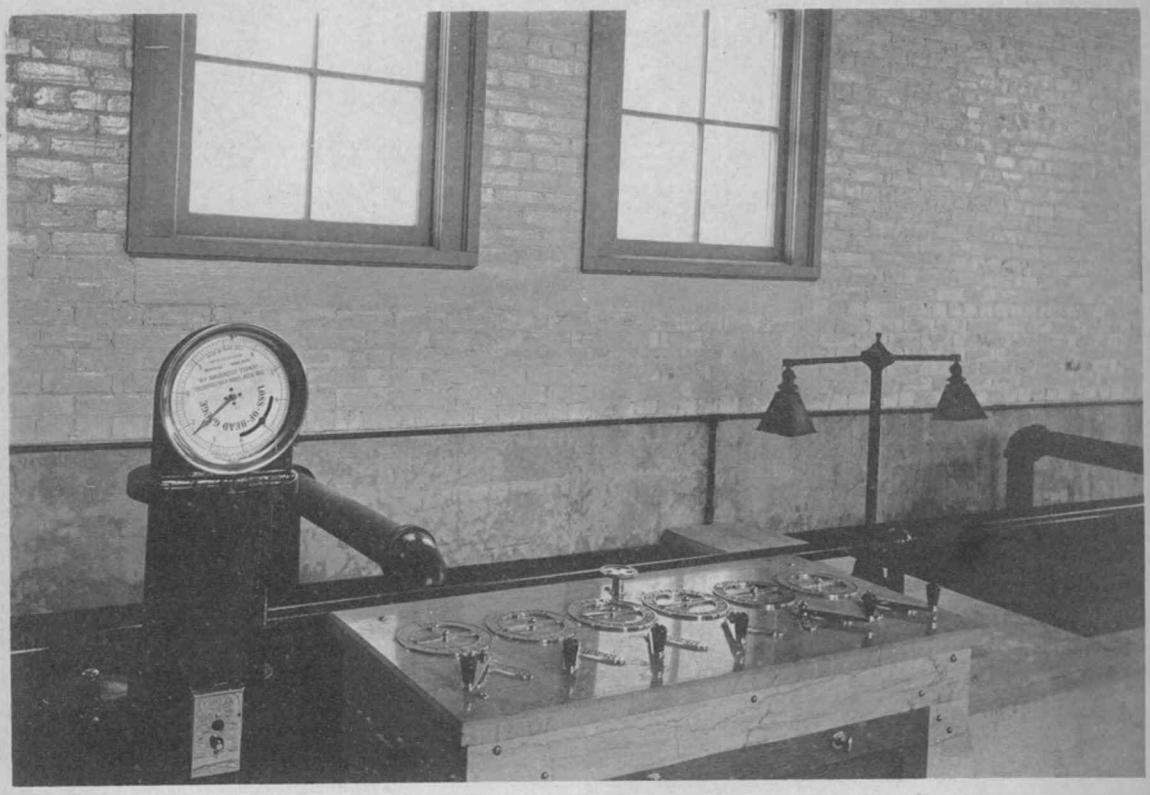
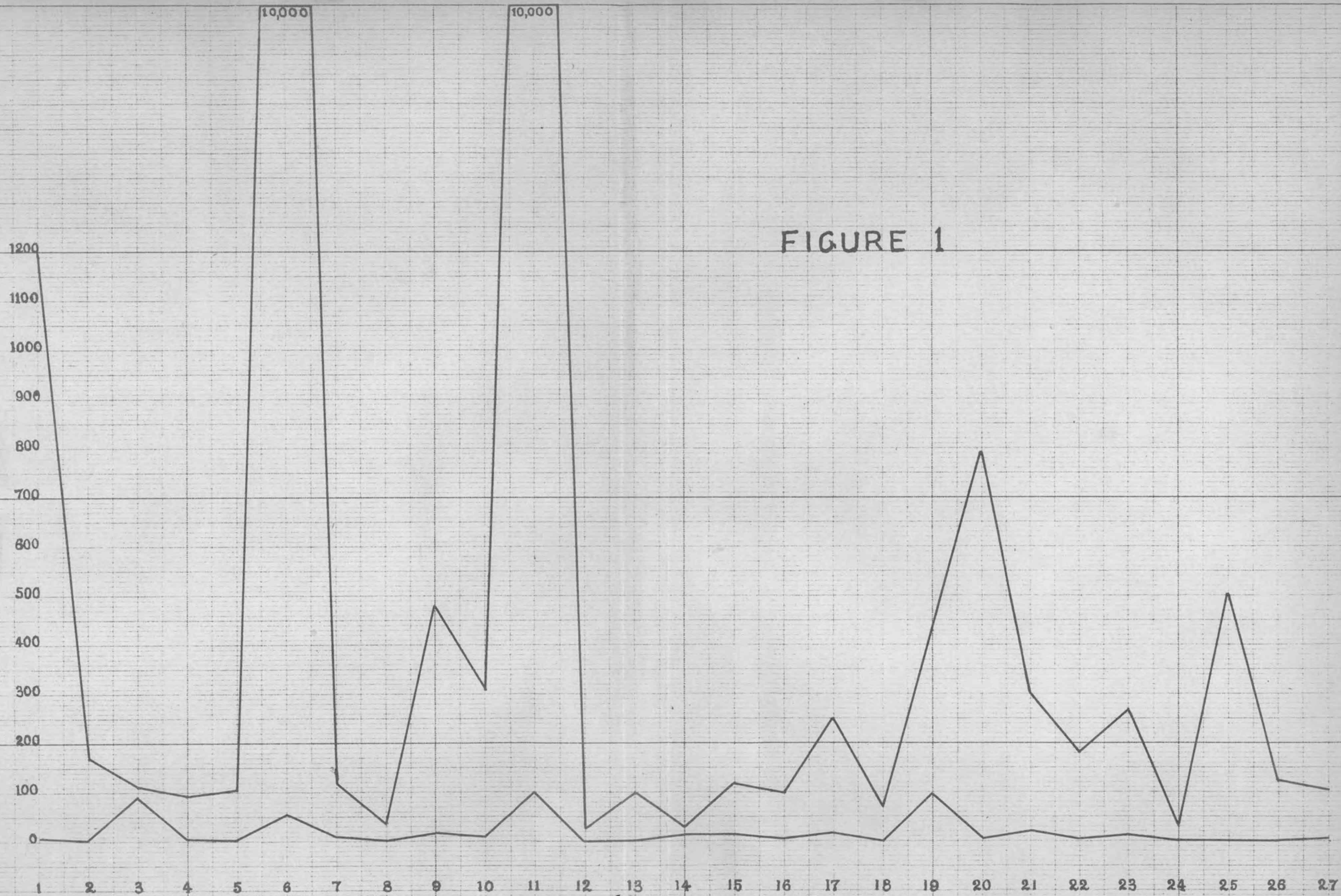


Figure 1.

Diagram showing comparison between total number of bacteria in raw and filtered water during the period of seven months. The tests were made at intervals of one week.

FIGURE 1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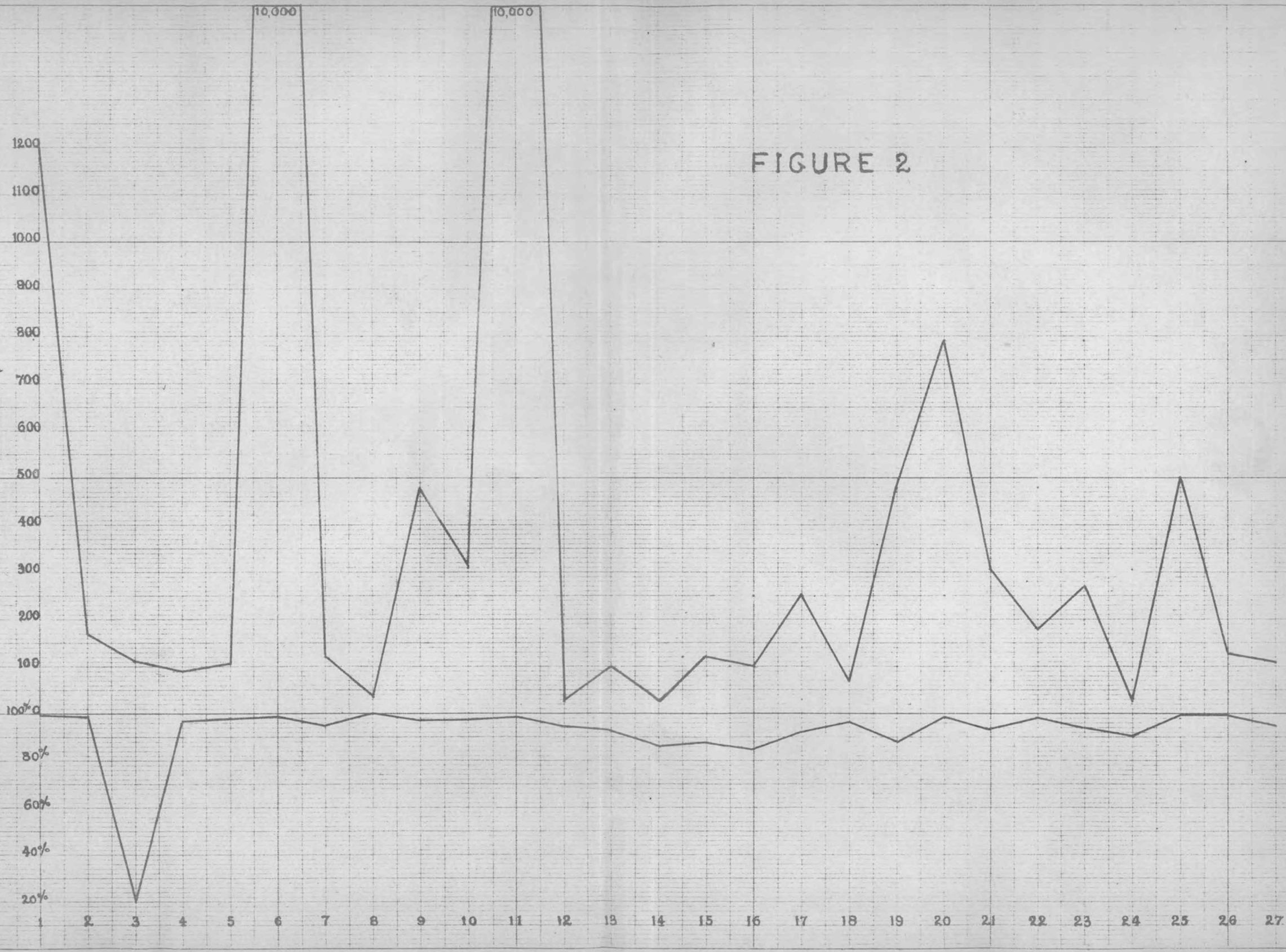
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

Figure 2.

Diagram showing relation between total number of bacteria in raw water and the average efficiency of the four filters. The results were computed from the weekly tests.

FIGURE 2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27

Figure 3.

Diagram showing the efficiency of the individual filters during the period of seven months. The efficiency was computed from the weekly tests, the dotted lines being used when no test of the individual filter was made.

FIGURE 3

Figure 4.

Diagram showing comparison between the total number of bacteria in the raw and filtered water during an entire "run" of a filter. Tests were made every three hours from the time the filter was started after being washed until a "Loss of Head" of 9 ft. had been reached.

FIGURE 4

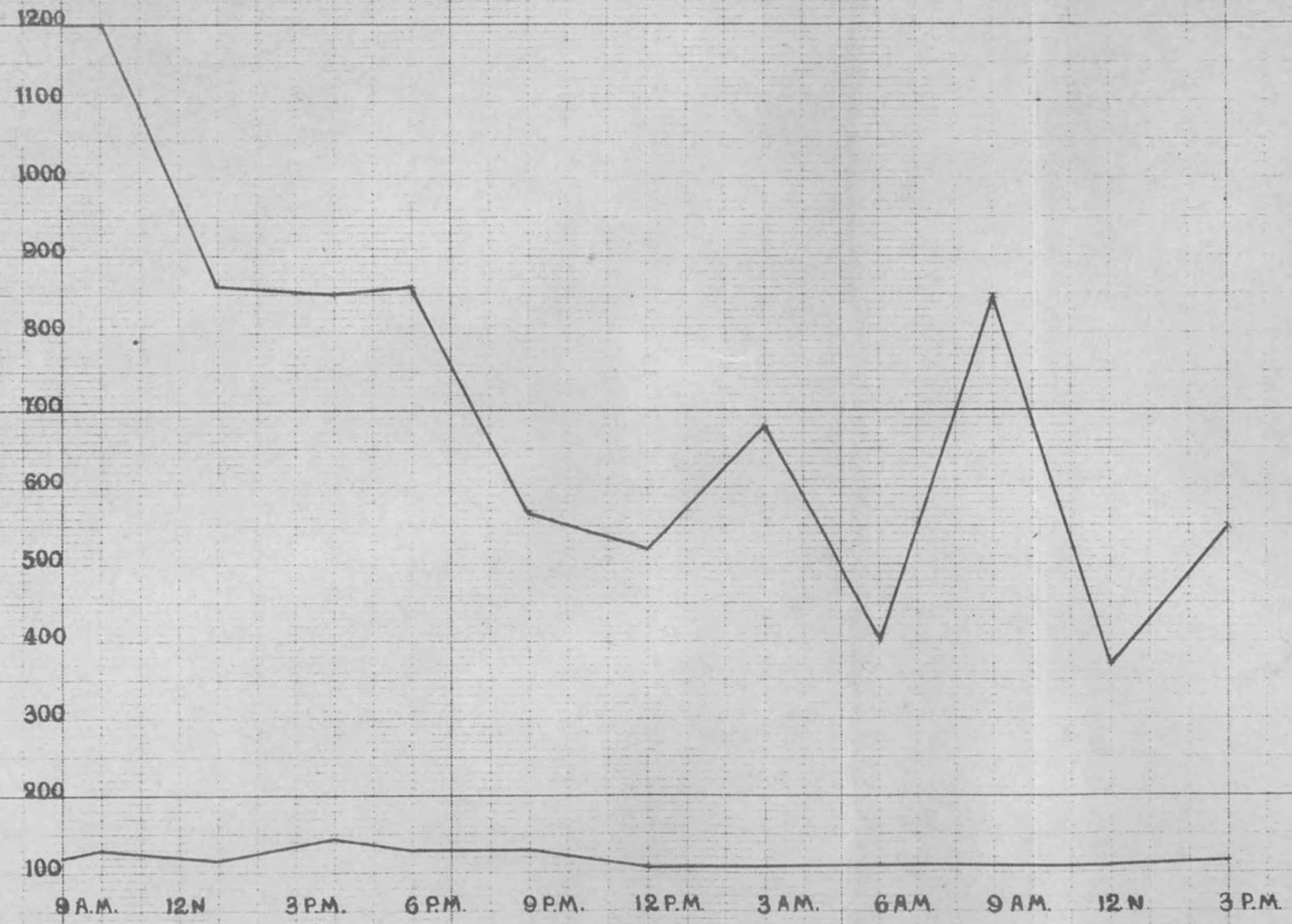
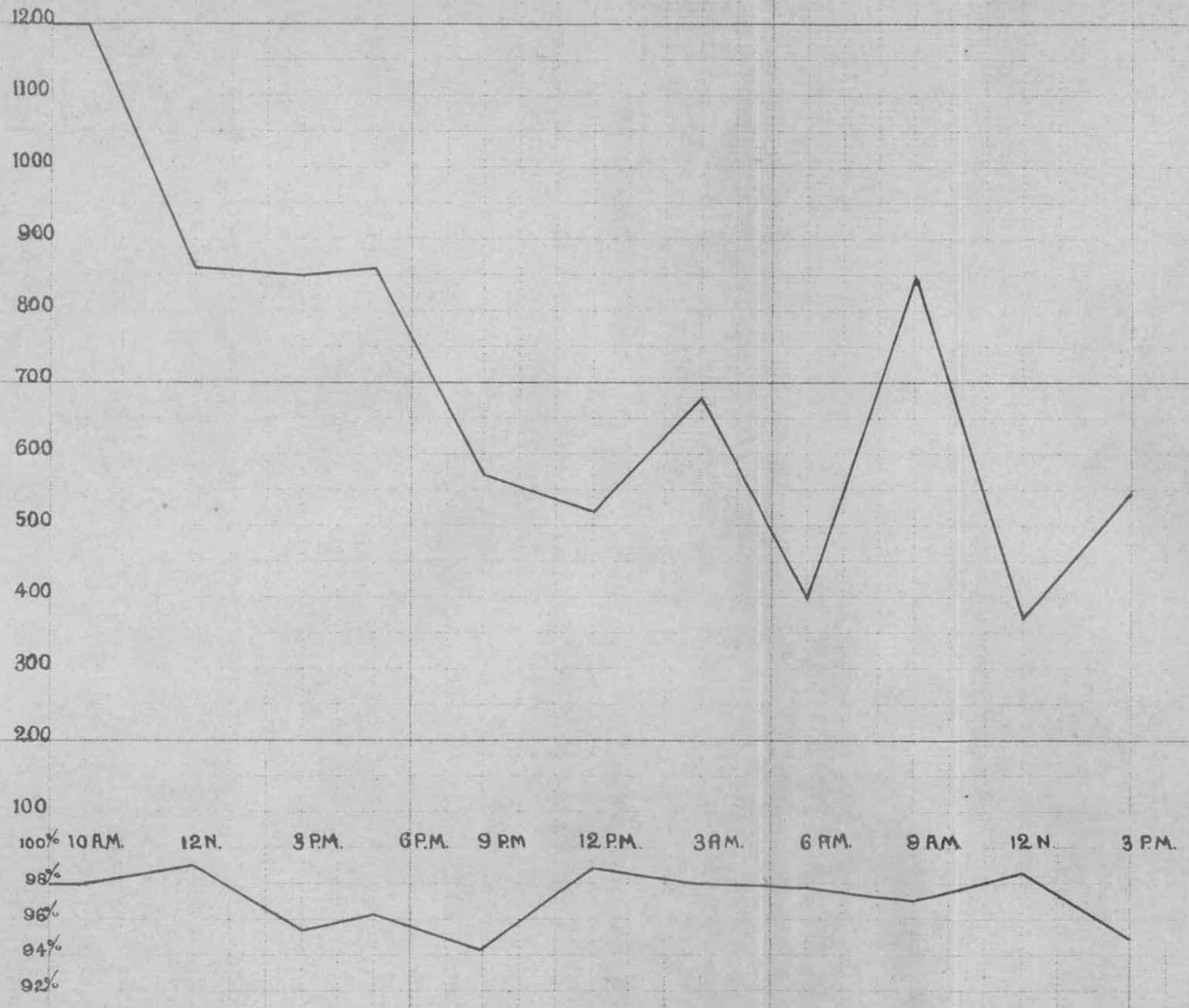

1200
1100
1000
900
800
700
600
500
400
300
200
100
9 A.M.
12 N
3 P.M.
6 P.M.
9 P.M.
12 P.M.
3 A.M.
6 A.M.
9 A.M.
12 N
3 P.M.

Figure 5.

Diagram showing relation between total number of bacteria in raw water and the efficiency of the filter during an entire "run". Tests were made every three hours from the time the filter was started after being washed until a "Loss of Head" of 9 ft. had been reached.

FIGURE 5



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