REPORT

OF THE

WATER COMMISSIONERS

TO THE

COMMON COUNCIL OF THE CITY OF ALBANY;

TRANSMITTING THE

REPORT

OF THE

SUPERINTENDENT OF THE WATER WORKS

FOR THE YEAR 1865.

ALBANY:
ARGUS COMPANY, PRINTERS.
1866.

WATER COMMISSIONERS' OFFICE,
ALBANY, *February* 6, 1866.

To the Board of Water Commissioners:

GENTLEMEN:

The following Report, showing the extensions, repairs, improvements and expenditures upon the City Water Works, for the year ending December 31st, 1865, is respectfully submitted.

As essential changes have been made in the City Distribution, materially relieving that portion of the City lying west of Pearl street, and diminishing the chances of another failure in the supply, I have particularly described these, and the results which they immediately produced.

RENSSELAER LAKE.

The remarkable drought of 1864 extended into 1865, and the Lake continued to fall, reaching its *minimum* height—one foot and ten and one-half inches—on the 14th day of February, which it maintained without change, until the 26th day of February, when it raised one-half an inch. On the 28th of February it had attained a height of two feet and two inches, and on March 5th a height of two feet and six inches.

A slight rain on the 9th of March raised the flow line to two feet and nine inches, and the heavy Spring rains between the 15th and 18th of March, largely increasing the volume of the streams, the Lake rapidly rose from two feet and nine inches to ten feet and ten inches. On the 27th of March the height reached was eleven feet and eleven inches, and on the 31st of March twelve feet, after which it continued to rise gradually, and on the 30th of April the gauge gave a flow-line of thirteen feet two and one-half inches.

On the 31st of May the depth of water in the Lake had increased to fifteen feet and six inches, notwithstanding a large waste had been continued for two days, and an ordinary one for a day and a half, to prevent the flow-line from passing its *maximum* limit.

During the month of June the flow-line fell one foot and five and one-half inches; in July four inches; in August two feet and one-half an inch; in September two feet and six inches, and in October four inches. On the 31st of October it stood at seven feet and ten inches.

From the foregoing it will be seen, that notwithstanding the long drought of 1865, so severely felt throughout large sections of the country, our supply did not fail. While much anxiety was felt in Washington, Philadelphia, New York and other cities, in regard to their supply, and the necessity of an economical use of the water was urged by their respective Water Boards, our citizens have been abundantly supplied, and Bleecker Reservoir maintained at its maximum height, with a large reserve in the Lake.

These facts show, that with the best matured systems of supply, a failure may take place; but they do not prove the original plans for these cities to have been defective. It is the dictate of sound policy to provide, as far as practicable, against the *possibility* of a failure in water supplies, and it is the design of the Engineer to embrace within his estimate every element that may affect its result; still there are contingencies which no forecast, no science, can anticipate.

Among these elements, the most important one, and upon which the least reliance can be placed, is the rain-fall; and yet, upon this, the certainty of an uninterrupted supply depends. While the character of the soil may easily be determined, the area of the water shed accurately computed, and the daily supply for any definite number of consumers ascertained, the rain-fall, notwithstanding all the advances of science, can not yet be implicitly relied on. The period during which observations to determine the value of this element have been made, is too short to form a sure basis for computation; and yet, the Engineer must be guided by the data which these afford. The mean annual rain-fall for fifty years, will undoubtedly approximate very closely to the mean for one hundred years, and no appreciable error result in applying the one to the other.

But the same reliance cannot be placed upon the minimum rain-fall; observations continued through a period of fifty years will determine the *minimum* fall during that period; but this is not applicable to the succeeding fifty years, when it may fall short or be

in excess of this quantity. Nor have any observations determined the relative positions of the *minimum* and *maximum* years in the series.

The years 1826, 1834, 1852 and 1854 were the *minimum* years, from 1826 to 1854 inclusive. In 1826 the rain-fall was $33\frac{12}{100}$ inches, succeeded by a fall, in 1827, of $49\frac{79}{100}$ inches. In 1834 the rain-fall was $32\frac{45}{100}$ inches, succeeded by a fall in 1835 of $40\frac{44}{100}$ inches; in 1852 the rain-fall was $31\frac{79}{100}$ inches, succeeded in 1853 by a fall of $45\frac{79}{100}$ inches; in 1854 the rain-fall was $34\frac{10}{100}$ inches, succeeded in 1855 by a fall of $41\frac{48}{100}$ inches. The mean annual rain fall for this period was $40\frac{63}{100}$ inches.

Now, these observations appear to indicate that a *minimum* annual fall is uniformly succeeded by a fall equal to, or largely in excess of the mean annual rain-fall; and that such is the law of compensation regulating this department in the physical world, and yet this is not the fact. More extended observations are necessary to determine the law, if any, which exists; for in 1859, the fall was $34\frac{1}{100}$ inches, preceded (in 1858) by a fall of only $35\frac{6}{100}$ inches, and succeeded (in 1860) by a fall of $29\frac{96}{100}$ inches; all three years being far below the mean since 1826, and thus destroying all deductions on this point that might have been drawn from prior observations.

During the past year a failure in the supply to Syracuse took place, and as this is a forcible illustration of the inability of the highest engineering skill, to provide for all the contingencies entering into water supplies, a brief history of their works will be given.

Within the last two years the works in Syracuse have been much improved and extended. A large Retaining Reservoir, covering an area of nineteen acres of land, and containing about one hundred and fifty millions of gallons, was constructed last year; the Company have also two Distributing Reservoirs, with a capacity of from six to eight millions of gallons. The depth of water in the Retaining Reservoir is from twenty-five to forty feet.

When the improvements were commenced in 1862, it was designed to limit the capacity of the Retaining Reservoir to fifty millions of gallons, which it was believed would supply all deficiencies of the springs, and carry them through the dryest season; but

the plan was finally enlarged as stated. It was now supposed that their former supply, consisting of hard water, could be abandoned.

The Retaining Reservoir was full last Spring. In the Summer, for precautionary reasons, about five feet were drawn off; after which it remained stationary until the 1st of August, when the surface commenced falling rapidly.

Under date of November 3d, 1865, the President of the Company, Hon. E. W. Lowenworth, writes:

"The springs which have heretofore supplied us for fifteen years, had now (August 1st,) nearly failed, and the City was supplied mainly from the Reservoir till the first week in September, when the great drought alarmed us; we then shut off the water from the City, from 10 P. M. till 5 A. M. each night, until the 14th of October, when our water was all exhausted, except about six million gallons in the Distributing Reservoir, kept for fire purposes." * * * * * * * From the 14th to the 20th (October) the springs furnished perhaps one-quarter to one-third of a supply." * * * * "We supposed that thirty gallons to each person in the City would be a sufficient supply. Such was the generally received opinion a few years since. We now furnish, and have all the Spring and Summer, more than sixty gallons for each man, woman and child, daily."

The above has been submitted to show, that our failure in 1864, was not caused by any neglect of supervision, but was the result of contingencies not yet eliminated by science, and which, by deranging the best matured plans, so frequently disappoint all anticipations.

The gates in the well chamber at the west terminus of our Conduit failed to control the waste in July; when examined, they were found unfit for use, and were at once replaced by new ones.

During the past season the shores of the Lake, along its whole circuit, have been carefully and thoroughly cleaned, and all vegetable matter removed above high water mark. In addition to this, the two north ravines have been graded on a slope from high flow-line to the streams. I recommend that the shores of the south ravine be similarly graded.

The old Seven Mile House, upon the one hundred and sixty acre tract, purchased from Steven Van Rensselaer, has been repaired and made tenantable. It was in a very dilapidated condition, no repairs

(except re-shingling a portion of the roof) having been made upon it for the last fourteen years.

The dwelling will now last for years; and, as it will always be necessary to keep a resident upon the premises, the repairs were demanded, both by the comfort of the tenant and the interests of the City.

Portions of the land purchased from Stephen Van Rensselaer and William Enos, have been fenced, and I can now report that the Lake, and such portions of the land attached thereto as require it, are properly inclosed. It affords me pleasure to add that the keeper is both vigilant and faithful in the discharge of his duties, and that all directions given him are promptly obeyed.

FLOW-LINE IN RENSSELAER LAKE IN 1865.

	Feet.	In.
On the 31st January	1	11
" 28th February	2	2
" 31st March	12	0
" 30th April	13	2½
" 31st May	15	6
" 30th June	14	0½
" 31st July	12	8½
" 31st August	10	8
" 30th September	8	2
" 31st October	7	10
" 30th November	9	7
" 31st December	9	4

EXHIBIT

Showing the Moneys paid in 1865 *for Keeper's Salary, Cleaning &c., at* Rensselaer Lake.

Fencing and repairs to Seven Mile House and Well Chamber	$693 88
Cleaning and grading shores of Lake	855 02
Clover and other grass seed	34 00
Keeper's salary and repairs	159 47
	$1,742 37

TIVOLI LAKES.

An uninterrupted supply of pure water has been furnished from this source during the past year. Repairs have been made to the gate which regulates the supply to the Mill Pond, and to the picket fence. Many of the hemlock strips to which the pickets are nailed are nearly useless; new ones will be required this year.

The shores of the Lakes have been thoroughly cleaned—the Upper Lake down to low water mark. The Upper Lake is rapidly filling up with deposits brought down by the Creek during the Spring freshets and heavy rains. Large expenditures will soon be required to deepen the water.

FLOW-LINE OF TIVOLI DISTRIBUTING LAKE, IN 1865.

On the	31st January.....	At high flow-line.
"	28th February.....	" "
"	31st March.....	One inch below high flow-line.
"	30th April.....	At high flow-line.
"	31st May.....	One inch below high flow-line.
"	30th June.....	Ten inches " "
"	31st July.....	At high flow-line.
"	31st August.....	" "
"	30th September.....	" "
"	31st October.....	One-half inch above high flow-line.
"	30th November.....	At high flow-line.
"	31st December.....	" "

EXHIBIT

Showing the Moneys paid in 1865, *for Keeper's Salary &c., upon*

TIVOLI LAKES.

Keeper's salary.....	$300 00
New frame canal (constructed in 1864.).....	1,916 17
Cleaning shores, lumber &c.,.....	136 36
	$2,352 53

BLEECKER RESERVOIR.

On the 1st day of January, 1865, the flow-line in Bleecker Reservoir stood at six feet eight and one-half inches; the rains of the 6th and 10th of January raised it one foot. After the 12th of January the water began again to fall, and on the 31st had reached six feet and one and a quarter inches; during all this time, the gates controlling the supply mains were partly closed.

On the 19th of February, the flow-line had receded to four feet and nine and three-quarters inches, when, in order to retain sufficient for fire purposes, it became necessary to further close the gates, and reduce proportionably, the already limited supply to the Upper Service.

Upon the first partial closing of the gates, made on the 31st of November, 1864, to retain the little remaining in the Reservoir for the extinguishment of fires, the supply at once failed along the Bowery and other elevated sections of the City, while the efficiency of the Fire Hydrants west of Knox street was materially diminished.

To mitigate, as far as possible, the evils of a short supply, the stop cocks in Washington Avenue and along Lark streets, were closed for three hours each day; thus affording the residents upon the hills, an opportunity to procure a supply for the next twenty-four hours. This was all the relief that could possibly be given under the circumstances.

So great were the consumption and waste that, within a few minutes after closing the cocks, the pipes were emptied as far east as Eagle street; and within an hour, the failure extended over a greater portion of the Upper Service.

To afford all possible protection against fire, one watchman was stationed during the day, and two during the night, upon the bank, with strict orders to open the gates upon the first alarm of fire.

As the drought continued, the streams flowing into Rensselaer Lake diminished; and the failure in supply passing east of Lark street, finally reached Eagle street, when (on the 22d of January, 1865,) it became necessary, between the hours of 6 P. M. and 10 P. M. each day, to close the cocks along Eagle street, and thus temporarily fill the mains lying west. This gave partial relief, and, although

great inconvenience was still experienced, but few complaints were made by those cognizant of the true cause of the failure in supply.

On the 7th of February I made a personal examination of all the streams flowing into Rensselaer Lake, and found their volume very small, thus corroborating the deductions drawn from the rain-fall of 1864. It was apparent that no relief could be afforded without rain, and, as this did not occur, the streams gradually diminished, reaching their *minimum* flow on the 13th February, when the thermometer stood at 10 degrees below zero.

The effect of severely cold weather, is not only to lessen the flow of the streams, but also to increase wastes in the City, to protect Service Mains improperly laid, against freezing. At such times, house cisterns are generally empty, and consumers compelled to depend for a supply entirely upon the City Works. Thus, while a larger than ordinary quantity of water was required, an amount smaller than usual was given by the streams.

Prior to 1864, the flow of the streams, added to the quantity stored in the Lake and Reservoirs, had been equal to the increased demand of Winter, and no inconvenience had been experienced, or the possibility of a failure apprehended; but the Winter of 1864–5, following, a long and severe drought set in, and a failure in the supply at once took place, with no relief in prospect except from rain.

The watchmen at Bleecker Reservoir remained on duty from the 3d of November, 1864, to the 16th of March, 1865. At 4 o'clock P. M. on the 16th of March, the flow-line having reached thirteen feet, the Supply Gates were opened and consumers furnished with their usual quantity.

Since the date of my last Report, many improvements and repairs have been made to Bleecker Reservoir. The east fence, which was in a very dilapidated condition, and liable to be blown down, has been rebuilt; the old posts and a greater portion of the pickets and boards were again used, and the work principally performed by the regular employees of the Works. All the land attached to the Reservoir is now inclosed by a high picket fence; the materials however, are old, and in a few years it will become necessary to replace it by a more substantial one.

In 1861, to provide for cleaning the gate-house, which controls the two sixteen-inch mains passing through the Bowery, a six inch

waste pipe was laid thereupon, extending to the brick culvert used for emptying the Reservoir.

This pipe has been removed, and the waste from the gate house discharged into the stop cock well under the sidewalk of Clinton Avenue, whence it flows through a twelve inch box drain into the new City Sewer in Partridge street. This box drain, about five hundred feet in length, has also been laid during the past year; it answers a double purpose, not only carrying off the waste water from the gate-house, but also thoroughly draining the sidewalk on the Avenue.

A six inch tile drain has been laid near the foot of the east slope, terminating in the stop-cock box at the northeast corner of the Reservoir. This at once made passable the ground between the bank and the east fence, which had always been wet and covered with swamp grass. It may now be ploughed and seeded, and a fine, firm sod secured. For several days after its completion, a constant stream of water passed through it into the brick drain.

Along the sidewalk of Clinton Avenue, thirty-five shade trees have been set out to replace those that were killed through transplanting and the failure to grade the carriage-way in time last year.

To save the expense of bailing in the future, should this again become necessary, as well as to speedily remove from the water, leaves and every other foreign substance brought down the Conduit from the Lake, a waste-pipe has been laid through the bank at the northwest corner of the Reservoir; it is under the control of the keeper, is easily operated, and has already proved very serviceable; the waste from this pipe passes along a trench at the bottom of the slope into the street drain.

Plain and substantial bridges to the gate-houses, to replace the old ones found to be unsafe, have also been constructed.

The garden attached to the Reservoir, containing many rare and valuable shrubs and trees, has been much improved during the past year; and, from the large and increasing number of visitors, it is evident that the efforts of the Commissioners to make these grounds attractive, have been successful and are appreciated by the citizens.

FLOW-LINE IN BLEECKER RESERVOIR IN 1865.

	Feet	In.
On the 31st January	6	8¾
" 28th February	6	2
" 31st March	13	6½
" 30th April	13	9
" 31st May	13	2
" 30th June	14	0½
" 31st July	14	0
" 31st August	13	9½
" 30th September	13	9
" 31st October	13	9
" 30th November	13	6
" 31st December	13	11

Ordinary high water mark is at fourteen feet. The waste-gate is brought into use, when the water reaches fourteen feet and one and one-half inches.

EXHIBIT

Showing the Moneys paid in 1865 *for Keeper's Salary, Fencing, Grading, Drains, &c., &c., at*

BLEECKER RESERVOIR.

Keeper's salary	$300 00
Fence posts	15 04
Lumber	162 86
Watchmen, during failure in water	447 20
Shade trees and shrubs	143 26
Painting, repairs to roofs, &c.,	320 98
Labor in laying box and tile drains	226 05
Removing six inch main	112 00
New bridges, shed and repairs to house	574 11
Other labor and repairs	438 01
	$2,739 51

CONDUIT.

In July last the Conduit was cleaned, including the well and gate-house at Rensselaer Lake. The quantity of deposits removed was very small, not exceeding two cubic yards of solid material. At the same time the top and slopes of the back-filling were grubbed.

Repairs have been made to the well chamber in Washington Avenue, and to the waste-drain leading therefrom. No other repairs have been required on the Conduit, although it is nearly four miles in length, and in constant use.

The total amount paid on account of Conduit during the year 1865, is two hundred and fifty-eight dollars and twenty-seven cents.

MAEZLANDT KILL.

This source of supply has not been interrupted since my last report. The frame canal, constructed by the old Water Works Company, to conduct the water to the Reservoir, and to receive the sand brought down the stream in heavy rains, has been cleaned several times during the past season.

Prior to the construction of the present works, this stream was the main source of supply for the City. During that time, however, the amount of sand deposited in the canal was small, compared with what it now is.

As Maezlandt Kill is hereafter to supply a large section of the City, formerly dependant upon Bleecker Reservoir, it will be necessary, as soon as practicable, to have the buildings repaired, the Reservoirs cleaned and the waste-drains opened and put in working condition. All these repairs and improvements can be made at a comparatively small outlay.

The amount paid during the year 1865 for cleaning and repairs made to Maezlandt Kill, is two hundred and forty-one dollars and fifty-two cents.

NEW MAINS LAID IN 1865.

New mains have been laid in the following streets, during the year 1865:

A four inch main in Morton street, from Hawk to Dove streets; length of main thirteen hundred and twenty-six feet.

A three inch main in Warren street, from Grand street to a point sixty-six feet west of Elizabeth street; length of main five hundred and fifty-two feet, together with eleven feet of hydrant pipe.

A three inch main in Road street, from Canal to Swan streets; length of main three hundred and eighty-three feet.

A six and four inch line of mains in Clinton street, from Arch street south to Delaware street; length of six inch main six hundred and thirty-three feet; and of four inch main two hundred and seventy-nine feet.

This line is to be used exclusively in supplying Morton, Catharine, Delaware and Alexander streets, from the west; the six inch, after connecting with the mains in Morton, Catharine and Delaware streets, is reduced to a four inch main, which is continued south, and connected with the main in Alexander street.

The change made in the division line between the services, rendered this improvement necessary; without it, consumers west of Clinton street could not have received a supply. Whenever a main shall be laid in Neucella street, it will become necessary to supply it by continuing the new four inch main south from Alexander street. The water in the Morton street main now flows as far west as Dove street.

An eight inch main in Lark street, from Washington Avenue to Lydius street; length of main nineteen hundred and eighty-four feet. As great complaints have for sometime existed of a want of head upon the service pipes south of Lydius street and west of Hawk street, and the eight inch main has been laid to remove the evil, it is not connected with any of the intersecting streets.

The reason for the loss of head upon the service pipes was patent; so great were the draughts made upon the old eight inch main in Lark street, at Chestnut, Lancaster, Jay, Hudson and Hamilton streets, that before it reached Lydius street, very little water

remained in it for distribution—not sufficient to reach the second stories.

The new eight inch main has accomplished the object designed, no complaints having been made since its completion. The hydrants have also been rendered much more serviceable, and the danger from fires proportionably lessened.

A four inch main in Vine street, from Green to Dallius streets; length of main two hundred and sixty-one feet, together with nine feet of hydrant pipe.

MAINS LAID IN 1865.

LOCATION.	FROM	TO	Hydrant Pipe.	3 Inch.	4 Inch.	6 Inch.	8 Inch.
Morton Street.....	Hawk.....	Dove.....			1,326		
Warren "	Grand.....	West of Elizabeth	11	552			
Road "	Canal.....	Swan.....		383			
Clinton "	Arch.....	Dallius.....			279	633	
Lark "	Washington Ave.	Lydius.....					1,984
Vine "	Green.....	Dallius.....	9		261		
Hydrant Pipe	Cor. of B'way...	And South Ferry.	17				
			37	935	1,866	633	1,984

HYDRANTS.

On the 31st of December, 1864, the total number of hydrants connected with the works, was two hundred and seventy-five, since which time four have been put up, located as follows:

One on the southwest corner of Vine and Dallius streets; one on the southwest corner of Warren and Elizabeth streets; one on the northwest corner of Broadway and South Ferry streets; one on the southwest corner of Pearl street and Maiden Lane.

Number of hydrants on the 31st December, 1864..... 275
Added during the year 1865..... 4

Total number on the 31st December, 1865..... 279

STOP-COCKS.

The number of stop-cocks has been largely increased during the past year.

Number of stop-cocks December 31st, 1864	174
Added during the year 1865	18
Total number on the 31st December 1865	192

This large additional number has been required in changing the division line between the services from Pearl street to Swan, William, Grand and Clinton streets; and for subdividing two of the largest sections, so that they may be more easily controlled.

Although the works have been improved, and the convenience of consumers promoted, by reducing the areas of these sections, some of the remaining ones are still entirely too large, requiring too much time and labor to manage them.

That portion of the City lying south of Arch street, and east of Pearl street, constitutes one section. To make repairs or additions all the mains within this large area must be emptied. Besides the time required to close and open the stop-cocks, and the large number of consumers inconvenienced thereby, great destruction of property might ensue in the event of a fire.

I therefore recommend that this and other large sections be subdivided. As the principal part of the work will be performed by the regular employees, all that will be required to make these important changes will be a few stop-cocks.

LOCATION OF STOP-COCKS SET IN 1865.

Diameter in inches.	Location.	Number.
8	Lark street, south of Washington Avenue	1
6	Arch street, east of Clinton street	1
6	Clinton street, south of Arch street	1
4	Neucella street, west of Pearl street	1
3	Alexander street, west of Pearl street	1
4	Schuyler street, " "	1
4	Beaver street, east of Green street	1

p. 19-34 missing

NEW DIVISION LINE BETWEEN THE SERVICES.

When the distribution was arranged upon the completion of the Works, it was designed to have the division line between the two services pass through the centre of Ten Broeck, Chapel, Lodge and Grand streets. This was partly carried into effect, branches having been placed at the requisite points, and two lines of mains having been laid in Ten Broeck and Grand streets; the west lines connected with Bleecker Reservoir, and the east lines with Tivoli Lake.

It was soon discovered, however, that the water from Tivoli would not rise to the assumed division line between the services, and it was moved to Pearl street, where it remained until nearly the close of 1865.

The failure in the water to reach Ten Broeck, Lodge and Grand streets, was not caused by want of head in Tivoli Lake, but originated in the supply main leading therefrom being too small. In 1857, this main (only twelve inches in diameter) was replaced by one of four times its capacity. At the same time, an additional distributing main—a portion of it being sixteen inches, and the remainder twelve inches in diameter, was laid through Van Woert street and Broadway to Lydius street.

It is also proper to state, that in the original distribution, *as carried into effect*, Pearl street, between State and Lydius streets was omitted; and that all that section of the City, east of Pearl street and south of State street was dependant for a supply upon a six inch main in Green street, and a four inch main in Quay street.

Had the supply main from Tivoli Lake been of proper dimensions, and had sufficient outlets been provided at Van Woert street, it is now certain that the original division line between the services could have been retained. It is due to the Engineer to state, however, that nearly one-half of the twelve inch supply main had been laid and used by the Old Water Works Company; and that, from motives of economy, it was added to the new works; under other circumstances a larger one would undoubtedly have been laid.

After the failure of 1864, a thorough examination of the supply and demand upon the respective services, convinced me that a change in the division line between them might be made, meterially

reducing the area of the Upper Service, and thus protecting the residents against the evils suffered by them during the last Winter.

The plan was submitted to the Commissioners—met their approval, and has been carried into effect, and with results entirely satisfactory; indeed it has proved a complete success. The following is a description of the changes made:

1. Maezlandt Kill now furnishes a supply to the following streets taken from the Upper Service: Chapel street, from Columbia street to Clinton Avenue; Hawk street, from Canal to Orange streets; Orange street, from Pearl to Swan streets; Van Tromp street; Van Schaick street, from Pearl to Cross streets; Cross street and Canal street, from Pearl to Swan streets.

2. That portion of the City west of Pearl street, and extending from Lydius to Howard streets, and bounded on the west by a line drawn through the centre of Grand street, from Lydius to Beaver streets, and through William street from Beaver to Howard streets, has been added to the Lower Service.

3. Clinton street, from Arch to Neucella streets; Broad street, from Arch street to the south bounds of the City; Neucella street, from Pearl to Clinton streets; Alexander street, from Pearl to Clinton streets; Schuyler street, from Pearl to Clinton streets, and Arch street, from Pearl to Clinton streets, have also been taken from the Upper Service and connected with the supply from Tivoli Lake.

Thus Bleecker Reservoir has been relieved from three large sections, densely populated, and where, from the great head upon the service pipes, the quantity of water daily lost from wastes was exceedingly large.

Upon the completion of these changes, the effect produced upon the flow in the Conduit was at once apparent. The connection of Maezlandt Kill with the Canal street section was made on the 13th day of September, and the connection of Tivoli Lake with the section south of Arch street, was completed on the 27th day of September.

The mean daily flow in the Conduit, from September 1st to September 13th, inclusive, was $23\frac{76}{100}$ inches, Bleecker Reservoir rising in the meantime one and one-half inches; while from September 14th to September 30th, inclusive, it was only $20\frac{33}{100}$ inches, Bleecker

Reservoir rising one and one-half inches, showing a diminished flow of $2\frac{79}{100}$ inches.

Upon comparing the mean daily flow of the last seventeen days of September, 1865, with the mean daily flow for a similar period in September, 1863, I find that, notwithstanding the increase in the number of ordinary consumers and of manufacturing establishments, using extra quantities of water, the flow in the Conduit was $2\frac{87}{100}$ inches less in 1865 than it was in 1863.

There are no reliable means of accurately determining the quantity of water thus saved to the Upper Service. The amount, however, is large, and, in my judgment, will protect consumers from a recurrence of the evils experienced in 1864, until arrangements for increasing the supply, either by raising the dam or introducing additional streams, are perfected and carried into successful operation.

WASTES.

Since the failure in the supply in 1864, the imperative necessity of systematic examinations of the water fixtures in the City, so as to secure repairs and thus prevent wastes, has become apparent.

In obedience to instructions received from your Board, a special agent was employed last May, whose duty it was to report all wastes from carelessness or defective fixtures, and to notify the owners or occupants to make necessary repairs.

He entered upon his duties on the 25th of May, and temporarily supended them in June. During this period, from May 25th to June 12th, inclusive, one hundred and seventy-one wastes (some from broken pipes, some from defective hydrants, some from worn out faucets, and many of them very large,) were stopped by suitable repairs made by the owners.

On the 1st of August re-examinations of the City were again commenced, and continued till the 15th of November. During August, repairs were made to two hundred and forty-seven broken fixtures; during September to one hundred and twenty-four, and during October to forty-five.

Besides the water thus saved by repairs, a large number of wastes from hydrants and faucets in perfect order, were discovered and

promptly stopped. In all such cases notices were served on the tenants that if the evil was repeated, the supply would at once be cut off at the street main. These have been registered for future and repeated examinations during the Winter.

Although the repairs were generally made with willingness and dispatch, some owners paid no attention to the notices sent them, and the water was accordingly cut off. During August, September and October, recourse was had to this remedy in sixteen instances. By these repairs, an enormous quantity of water has been saved for legitimate consumption; and it cannot be doubted that, if only ordinary economy was practiced by the citizens, the necessity for an increased supply might be postponed for years.

Under the great head upon some of the service pipes, one broken fixture will frequently discharge thousands of gallons every twenty-four hours; and, when we consider the great number detected, it is not surprising that the daily flow of the streams, during a portion of the year, falls short of the daily consumption.

Many of the consumers fail to remember that the Works are owned and maintained by the City and not by a company; and that in wasting the water unnecessarily, they are injuring their own interests, and hastening the period when large expenditures, to be met by increased taxation, must be made to procure additional sources of supply.

The logic of experience proves that appeals to the citizens to be economical in the use of the water will not produce a reform, and that the only effectual remedy for this evil, which, in its results, affects alike those who obey "the Rules and Regulations," as well as those who disregard them, is to insist upon prompt repairs, or to cut off the water until the fixtures are put in order.

Under your instructions, examinations will be continued from time to time, and all premises deprived of water, where the owners neglect or refuse to comply with the law. Undoubtedly this will be deemed by some an arbitrary exersise of power, but the water was introduced into the City for the accommodation of *all the consumers*, and when wasted by a few, so as to deprive others of its use, manifest injustice is done. Neither are those who permit wastes upon their premises, in the least benefited by the operation; they injure others, without any corresponding advantage to themselves.

The rule, therefore, which insists upon repairs is both proper and just, and ought to be enforced.

I am aware that the excuse uniformly urged in winter for wastes, is to prevent the freezing of the water in the service pipes; but surely this excuse (under no circumstances a valid one), cannot be applicable during the warm weather. If the pipes are properly laid, ordinary care is all that is necessary to prevent the water from freezing.

Neither can it be said that the large number of wastes detected in 1865, was due to the impurities, which the consumers supposed might thus be removed from the water; for the wastes prevailed as generally upon the Lower Service, where the water was good, as they did upon the Upper Service, where it was bad.

There is, in reality, no good excuse for the evil; and to continue it after due notice, evidences gross carelessness and a disregard for the convenience and comfort of others, thereby deprived of their just supply.

If, during the winter of 1864–5, only such quantity of water as was required for use had been drawn from the mains, sufficient would have been saved to have relieved, if not entirely removed, the inconveniences suffered by the residents west of Lark street.

IMPURITIES IN THE WATER.

A recurrence of impurities in the waters of Rennselaer Lake and Bleecker Reservoir, during the past year, renders it both proper and necessary, that I submit for your consideration such facts upon this interesting subject as I have been able to collect, and which may, in future, aid others in their examinations.

There are two distinct causes (each imparting to the water an odor and taste peculiar to itself,) that have affected our Reservoirs, at different periods during the past few years; the one giving to the water the odor and taste of fish, the other imparting to it a musty odor and taste, sometimes detected in dead wood.

In the former it is extremely difficult to satisfy consumers that the impurities are not due solely to fish in the Reservoirs; while, in the latter, they are equally confident that the Reservoirs are little else than stagnant pools.

Both kinds of impurities are unpleasant, and when fully developed, exceedingly offensive; so much so indeed, that it is impossible to convince some that water so impregnated can possibly be innoxious.

Other cities have suffered from the same causes. New York, Boston and Brooklyn, where, from commercial as well as sanitary reasons, every possible expedient is adopted to "keep and maintain," at all times, a supply of pure water, have experienced the evils now under discussion. Other cities have also been visited by them.

In 1864 the water in the Reservoir supplying the City of New Haven became offensive, being affected with the fishy odor and taste. In 1865 these returned, and soon became so powerful as to destroy whole brewings of ale.

In the Reservoir at Cohoes, supplied by pumping from the Mohawk river, and in the Reservoir at West Albany, the water during the past Summer possessed the same offensive qualities that characterized our supply on the Upper Service.

A brief history of the impurities in some of the cities mentioned, so far as I possess the necessary data therefor, will now be given, together with their probable cause, and such other information upon the subject as may be deemed relevent and important.

In 1854, the waters of Cochituate Lake (supplying Boston) were affected by the fishy odor and taste. They were first noticed in October, commenced improving about the middle of January, and finally disappeared on the first of February. Great solicitude was felt upon the subject, and Prof. Hosford and Dr. C. T. Jackson were appointed to examine into "the nature and origin" of the evil. After examinations and a thorough analysis of the water, taken from different portions of the Lake, they arrived at the same conclusion, viz.: "that the impurity complained of is derived from vegetable decomposition existing in the Lake itself. That it might be attributed to the unusually long and severe drought of the last Summer, and to the subsequent rains acting upon the peculiar soil of part of the Lake, and over the whole water-shed; and that complete relief might be anticipated from the natural agency of the approaching cold and rains.

The reports were interesting, elaborate and able, and at once dispelled the idea, at that time so prevalent among the consumers, that the offensiveness of the water proceeded from fish in a state of decomposition in the Lake.

The Cochituate Board also instituted inquiries to ascertain whether the deterioration of the water was peculiar to the Lake, "or whether other Lakes and ponds had not been subject to the same trouble." Upon this point they say, "As far as the Board have been able to institute any inquiries, they have found that the difficulty has, by no means, been confined to the Lake. Among others, *Round Pond*, near Haverhill, and which supplies that town, was examined by the City Engineer, and some of the water brought to this City. It was precisely similar in taste to the Cochituate water. There was also sufficient evidence that *Jamaica Pond* had been in the same state recently. The waters of the latter pond, which are usually exceedingly pure, some years since were, for a time, quite offensive both to the taste and smell. The cause of the impurity, however, was never discovered." The Board also add, "There is also proof that *several* wells near the Lake, and in other places, have had their water

affected in a similar way; and also that the water in the *Chicopee River* was for a time quite offensive."

In 1862, the water in Ridgwood Reservoir, Brooklyn, became affected with the fishy odor and taste; the following extract from the *Brooklyn Eagle*, of May 22d, 1862, describes the impurity: "Complaints have recently been made, that the water from Ridgewood Reservoir, from which the City is supplied, was so disagreeable to the taste, that many were compelled to abandon its use for culinary purposes, and, last Saturday and Sunday, a general raid was made upon the old pumps, for a supply of the necessary article.

To obviate the difficulty, the Reservoir had to be emptied; and, says one who was present at the time, presented a singular, and by no means a gratifying spectacle to an Engineer. Coming towards it from the north, with a southerly wind, the 'fishy odor' was palpable, etc., etc."

In 1864, the fishy odor and taste appeared in the Reservoir supplying the City of New Haven. The evil returned in a much more aggravated form in 1865.

On the 1st September I visited New Haven, where I learned the following facts:

Their Distributing Reservoir is elliptical in form, and divided into two apartments along its transverse diameter. It contains ten millions of gallons, the daily supply being about one million. Its water is derived from Lake Whitney, which is two and one-half miles long, three-quarters of a mile in width, and very deep.

The impurities could not be detected in the waters of the Lake, but were confined exclusively to the Reservoir. Investigations to ascertain the cause of the impurities, entirely failed, and, therefore, could not indicate a remedy, either to remove the unpleasant taste and odor, or to prevent their re-appearance.

Finally, the Reservoir was emptied, and thoroughly cleaned; but, in less than one week thereafter, and while refilling it, the water again exhibited its offensive qualities The Engineer then discovered that the valves controlling the proper exit of the water, were closed; thus preventing that constant circulation through the Reservoir, which it was designed to maintain. Upon opening these, the impurities disappeared, and the water was restored to its normal condition.

The Engineer attributes the offensive properties of the water to want of circulation; from the fact, that upon opening the valves, and thus receiving the supply at one extremity of the Reservoir, and discharging it at the other, as originally contemplated, the water became pure.

Now, while it is true, that the greater the circulation, the nearer the approach to a running stream, the purer will be the water, it is equally true, that the cause of the fishy odor and taste has a limit to its duration; and that as this is approached the water improves, and when finally reached, the evil entirely disappears.

It is probable that this limit was reached shortly after opening the valves; the increased circulation thus secured, undoubtedly improved the water, and aided the operations of nature in purifying it.

Besides, the first indications of a change in the water in Boston appeared in October, nor was there any preceptible change for the better, until about the middle of January, when the odor and taste became less marked; nor until the 1st of February, was the purity of the water restored.

Now, the season of the year in which the impurities appeared and continued in Cochituate, precludes the conclusion that they arose from want of circulation. The Water Board, as well as Prof. Hosford and Dr. Jackson, attribute them to vegetable decomposition, existing in the Lake itself, and brought there from the whole watershed, after a long and severe drought, followed by rains.

As it is an axium in Natural Philosophy that like causes produce like effects, if the fishy odor and taste of the water in New Haven originated from want of circulation, then to the same cause must be attributed similar impurities which affected the Cochituate Lake; and yet, the Water Board and Scientific Commission, after a careful and thorough examination and analysis, conclude that the change in the Boston supply arose from vegetable decomposition.

Although sufficient data may not yet have been collected to determine with absolute certainty whether the fishy odor and taste have an animal or vegetable origin, from the observations which I have made I am convinced that they are due to infusoriæ rapidly developed under certain favorable physical conditions of the atmosphere and water. In what these conditions exist, how far their

operations may be modified by counteracting influences under our control, why they are not confined to any particular period of the year, and whether they are not climatic, are questions which cannot, at present, be satisfactorily answered. Long continued observations and experiments in the future may discover the true cause of the evil, when a remedy to lessen or remove it may be applied.

Besides the fishy odor and taste, the waters of some of our cities, including Albany, have been affected by a musty taste and odor, the latter sometimes exceedingly offensive, and similar to sulphuretted hydrogen gas.

This impurity has appeared several times in the waters of Rensselaer Lake and Bleecker Reservoir. During the past year it continued from the first of May to the last of August. Many of our citizens, fearing that it would prove deleterious to health, felt great solicitude upon the subject. To relieve them from their apprehensions, and at the same time to determine, if possible, the probable cause of the evil and to suggest a remedy for its removal, the Board of Health invited Prof. Philip Ten Eyck, Doctors Thomas Hun, S. O. Vanderpoel, Jacob S. Mosher and J. R. Boulware, to visit and carefully examine the Lake and Reservoir, and submit the result of their investigations in a Report. All these gentlemen, except Dr. Vanderpoel, who was prevented by professional engagements, kindly responded to the invitation. Their Report was made on the 11th of August.

Satisfied that no filth or impurities flowed into the water from the adjacent grounds, they attributed the evil to vegetable matter, brought into the Lake by the streams upon which it depends for its supply.

In regard to the *quality* of the water they say: "We fully appreciate the inconvenience caused by the bad water, but while we are by no means disposed to make light of it, it is satisfactory to be able to state, that thus far at least it has not proved injurious to health. There is no more sickness than usual in the City, nor are those parts to which the water is distributed more unhealthy than the rest."

The impurities that affected the Croton water in 1859 were from descriptions so similar in kind, though not in degree, to those which appeared in our Reservoirs in 1865, that I take the liberty of laying before your Board the following Reports of Messrs. Chilton and

Torrey, made, as will be seen, in answer to a request from the Croton Aqueduct Board:

CROTON AQUEDUCT BOARD, ROTUNDA PARK,
NEW YORK, *August 27th*, 1859.

The unpleasant taste of the Croton water in the early part of the month, induced the Croton Aqueduct Board to call upon Messrs. Chilton and Torrey to make a thorough chemical examination.

The reports of these gentlemen are herewith submitted to the public, and it is confidently believed will prove as satisfactorily to the community as they have been to this Board. The Board would take this opportunity of saying, that from the first appearance of the objectionable taste in the water, every available means have been employed to discover the cause and counteract its effect; and are happy to add, that, in a few days the entire renewal of the water in the pipes and in the Reservoirs will do away with the last trace of anything objectionable in its taste.

MYNDERT VAN SCHAICK,
THOMAS B. TAPPAN,
A. W. CRAVEN,
Croton Aqueduct Board.

NEW YORK, *August 25th*, 1859.

To MYNDERT VAN SCHAICK, THOMAS B. TAPPAN,
and A. W. CRAVEN, ESQS., *Croton Aqueduct Board:*

Gentlemen—At your request, and in company with Dr. Chilton, I visited Croton Lake on the 18th inst., for the purpose of ascertaining, if possible, the cause of the disagreeable quality observed in the water distributed through the City, and which had been the subject of serious and general complaint for a week or two previous. On driving down the hill that leads to the dam, and before reaching the Lake, we noticed the same musty odor that characterized the water of the hydrants in the City. Mr. Adamson, the gate-keeper, afforded us every facility in prosecuting our researches, and piloted us to various places on the Lake. He brought to our notice a bright green substance that had appeared within the last twenty-four hours in the water near the dam. This material had been driven by a favorable wind, to the outlet of the Lake, where it accumulated so

as to form a considerable stratum in quiet recesses near the shore. The water at the time was very low, only a small portion flowing over the dam. A quantity of the water, quite thick with the green material, had been reserved for our examination, and we had collected some of it ourselves from the surface of the Lake. We soon became convinced that this unusual ingredient was the cause of the peculiar taste and odor of the water. After examining the character of the larger aquatic plants that grew abundantly in the western portion of the Lake, and taking new samples of the water from various places, we returned to the City, and I commenced my examination immediately, before any obvious change had taken place in the properties of the water.

On placing a portion of it under a microscope, it was fonnd to be filled with little straight filaments, which were composed of oblong roundish cells, in a single row like a string of beads, and in no case did I find these threads to be branching. Most of the cells were about one-third longer than broad, and were filled with a bright green substance, composed of irregular grains. This matter was proved to be chlorophyl, or the green coloring substance of leaves. Interposed, here and there, in the bead like filaments were two other kinds of cells, the one perfectly spherical, three times the size of the oblong ones, and filled with green spores or seeds, by which the plant is reproduced; the other also spherical, but much smaller, and containing a yellowish fluid, but no green grains. The function of the latter is unknown to me.

There were only a few other kinds of microscopic plants in the water, nearly all of which belong to a particular tribe, called by botanists Désmideæ. In ordinary seasons these constitute the chief vegetable forms existing in the Croton. The number of living animalculæ was also unusually small. In repeated instances, on concentrating the water of the city hydrants at the time that it exhibited the offensive properties complained of, I found its characteristics precisely those of the water taken at the dam. The day after collecting the sample of bright green water at the Lake, I submitted it again to the microscope, and was surprised to find that all the beaded filaments had disappeared, but there was floating in the liquid, in a separate state, the larger spherical green cells and the smaller yellowish ones. I had noticed in my first examination

several of the filaments break up by the successive bursting of the little cells. Without doubt the myriads of little plants obtained in my sample had disappeared in the same way. I have since repeatedly seen the filament break up in water taken from the hydrants. They undergo dissolution much more quickly when they are confined in a bottle. After the rupture of the cells the water retains its green color for some time, but it finally becomes bleached from the decomposition of chlorophyl. The bright green water from the Croton Dam became quite viscid in less than twenty-four hours, and the following day it was somewhat putrid, and emitted a little ammonia, but not the least trace of sulphuretted hydrogen. Most of the spherical cells just noticed remained entire, but the green ones had evidently matured their spores or seeds.

Before the green water had decomposed, I evaporated a portion to dryness, with great care, so as to avoid scorching it. Sulphuric ether agitated with the residue became of a lively grass green tint, but without materially diminishing the color of the mass. The solution after spontaneous evaporation of the ether left a thick brownish green matter, which was resoluble in ether and alcohol, but not in water. It was doubtless one of the coloring bodies of clorophyl.

A portion of the green water was then boiled for some time; it lost its color and odor, and deposited brownish flakes on cooling. The water that distilled over contained the odorous principle in a concentrated form.

From this examination, and from the researches of Dr. Chilton, I think we are warranted in concluding that the recent offensive condition of the Croton water was owing to a rapid and abundant growth of microscopic conferva-like plant, which abounds in a volatile, odorous principle, soluble to some extent in water.

We were extremely fortunate in making our visit to the Lake at just the time when a favorable wind drove the little plant (floating by adhering bubbles of oxygen gas) to the outlet; thus bringing within the space of a cubic inch as many of the filaments as could be separated by filtration from a hogshead of the water a short distance from the dam.

I have not yet satisfied myself as to the origin of these little filaments; whether they are an entire plant, or once constituted a part

of a more complex algæ. They are more minute than in any true conferva known to me, being over 2,500th to 2,000th of an inch in diameter, and from a 50th to the 20th of an inch long. I strongly suspect that they are derived from a species of the genus *Nostoc* of Botanists. The genus usually consists of a globular or oblong vesicle, from the size of a buckshot to the bigness of a plum, and filled with mucus which is loaded with minute, bead-like filaments. When the little bladders burst, the contents escape, the mucus dissolves in the water, and the filaments are set free. Sometimes the waters of small Lakes are filled with these small bladders of *Nostoc*. Since examining the water I have had no opportunity of revisiting the Lake to verify my conjecture.

The question naturally arises, why this plant should have made its appearance in such quantities, and not have been noticed before. We can only reply that the case is not a singular one. Even in the higher order of plants, it is a common circumstance for a particular species to abound at one time, and then almost disappear for years; and in the lower vegetable tribes, especially those which inhabit the water, is this strikingly the case. The present Summer has been unusually favorable to vegetation of all kinds; but what are the circumstances which have so remarkably multiplied this little algæ, I have not yet determined. It is a plant of short duration, and should it reappear another season, the probability is that it will not annoy us long. Very likely more or less of it occurs every Summer, but this is the first time that it has been offensively brought to our notice. Even when it was most abundant in the Croton, I do not believe that it communicated any unwholesome quality to the water. Its odor and taste were certainly unpleasant. While the unpleasant quality of the water continues, the ordinary filter will remove all the suspended matter, and a little fresh-burned vegetable, charcoal, or animal carbon, will take away the disagreeable smell and taste. A good method of using the charcoal is to heat some small pieces red hot, and, after quenching, inclose them in a little bag of gause, and suspend them in the water. The charcoal should be renewed or reburned every day or two.

I am, gentlemen, very respectfully,

Your obedient servant,

(Signed) JOHN TORREY.

New York, *Aug. 25th*, 1859.

To Myndert Van Schaick, Thomas B. Tappen,
and A. W. Craven, Esqs., *Croton Aqueduct Board:*

Gentlemen—In compliance with the request received from your Honorable Board, that I would make a chemical investigation and analysis of the Croton water, for the special purpose of ascertaining the cause of its peculiar unpleasant condition, I beg leave to offer the following report as the result of my investigation:

On the 12th of August, inst., I received from Mr. A. W. Craven, Chief Engineer of the works, three demijohns of the water, numbered and labeled, as follows:

No. 1. Water from the mouth of the aqueduct at the Receiving Reservoir.

No. 2. From the east side of the gate house, southeast corner of Receiving Reservoir, south basin.

No. 3. Water from Forty-second Street Reservoir.

On emptying the water from each of the demijohns into separate large glass jars, it presented the same general appearance in all. The color, when viewed thus in bulk, by reflected light, was of a faint, brownish hue, but by transmitted light, it had a shade of green. It was nearly transparent, but upon close inspection, some minute particles were observed suspended throughout the mass. The taste and odor of each were the same as that of the water drawn from the hydrants in the City, and in these particulars closely resembled the water of ponds and marshes, abounding in vegetable matter. After remaining at rest for a few hours, a deposit of light, floculent matter was observed at the bottom of each of the jars containing the water. Portions of this matter were removed and examined with a microscope, and in each case numerous minute aquatic plants and siliceous remains of Brittle worts (Desmideas) with a few living animalcules, were easily detected. A similar sediment was obtained from a new filter attached to the hydrant in my laboratory, by allowing the water to pass through it for a short time. In this concentrated form it was decidedly of a green color.

By the application of nitrate of silver, to each of the samples of water, they were found to change color quickly, under the influence of solar light, to a deep claret color. The change of color being

greater than I had observed by similar treatment of Croton water on former occasions, indicated that it contained an unusual amount of vegetable matter.

One gallon (231 cubic inches, 58,327 grains) of the water No. 1 was carefully evaporated in a porcelain dish to dryness, and the dry residuum, which was of a brown color, was found to weigh 3.68 grains. This was heated in a platinum capsule until the organic matter was burnt off. During the combustion, it emitted the odor of burning vegetable matter, mixed with a small quantity of animal substance. It was again weighed, and found to have lost 0.92 of a grain. The solid contents, therefore, of one gallon of water No. 1, consisted of

	Grains.
Inorganic (mineral) matters	2.76
Organic (chiefly vegetable) matters	0.92
Total	3.68

One gallon of water No. 2, similarly treated, gave:

Inorganic matters	2.769
Organic matters	0.930
Total	3.699

One gallon of water No. 3, treated in the same way, gave:

Inorganic matters	2.765
Organic matters	0.940
Total	3.705

A qualitative analysis of the inorganic matter showed the presence of lime, magnesia, sulphuric acid, chlorine, soda and a trace of postassa.

The organic matter was mainly composed of extremely minute aquatic plants, of which an account will be given by Dr. Torrey in his report, but I detected in it also crenic acid, in combination with alkaline bases.

To determine the relative proportions of the several constiuents of the water, I made a quantitive analysis of three gallons of the

water No. 3. The results thus obtained when reduced by calculation, gave the following as contained in one gallon:

Chloride of Sodium	0.4040
Chloride of Calcium	0.1036
Chloride of Magnesium	0.1466
Sulphate of Lime	0.3536
Carbonate of Lime	0.8366
Carbonate of Magnesia	0.3900
Carbonate of Soda and a trace of Carbonate of Potassa	0.2700
Silica, Alumina and a trace of Iron	0.1698
Total	2.6742
Organic Matters	0.9158
Total grains	3.5900

While the preceding investigation was in progress, I was requested, on the 16th inst., to visit the Croton Lake, in company with the President and Mr. J. C. Winder, Assistant Engineer. We traversed the entire length of the Lake, a distance of five miles, taking samples of water from different parts of it. The first sample was procured from that part of the dam where the water first enters the Aqueduct. The next about one-fourth of a mile distant. The next sample about one mile further on. The fourth from the vicinity of Pine's Bridge. Fifth from Kisco Creek, where it mingles with the water of the Lake. Lastly a sample from the head of the Lake.

A physical examination made at the time of taking the samples revealed nothing unusual or different from what I had observed in the water obtained from the Reservoirs in the City.

The odor and taste were similar, and the same kind of minute floating particles were observed in each when examined with the aid of a magnifier. The extraneous particles were most abundant in the water from the dam. They were found to be less apparent as we approached the head of the Lake, where the water was clear and transparent.

On the following day I again visited the Lake in company with Prof. Torrey, who, through some misunderstanding, did not accompany us on the first excursion.

Upon arriving at the Lake we learned that Mr. Adamson, the keeper of the dam and gate had observed since the preceeding day an unusual quantity of a light green matter floating on the water near the dam. Upon the slightest agitation of the water this green substance was diffused so as to appear lost, but with care he had procured a pailful of it, which he had reserved for our inspection. Some of the same material we procured ourselves from the surface of the Lake, and we took home with us samples for chemical and microscopic examination.

Before leaving the spot we had a strong conviction that to this substance might be attributed all the unusual qualities lately observed in the Croton water throughout the City. It had precisely the same taste and odor, but in a very concentrated degree. Of its vegetable nature we entertained no doubt.

A chemical examination of the green matter gave the following results:

A portion of it mingled with water was gently heated and finally boiled. Upon the first application of a moderate heat, the color quickly changed from a green to a light buff color. When near the boiling point, the whole was converted into a thin, mucus substance, and, by continuing the heat, the odorous matter all disappeared.

Some of the green matter, mixed with water, was submitted to distillation, when the odorous principle passed over in union with watery vapor, and condensed in the receiver as a colorless, transparent liquid, possessing the characteristic flavor of the original substance. A portion of the same green material was agitated with pure sulphuric ether. After subsidence, the ether, which arose to the surface, was separated and allowed to evaporate. A minute quantity of an oily substance, slightly tinged with green, was thus obtained. The coloring matter was probably due to chlorophyl, the green coloring matter of plants.

When examined with a microscope of high power, the green substance was seen to consist of some minute aquatic plant, a detailed description of which is given by Dr. Torrey. There was also observed among it a few of the living animalculæ, such as the microscope usually reveals in unfiltered water from fresh water ponds. It may be worthy of remark, that so far as I have observed,

the apparent number of these living forms is much less in the Croton water now than I have noticed in former examinations.

It is quite evident that the flavor of the Croton water, so much complained of during the past week or two, is now rapidly disappearing, and that the water has nearly regained its normal condition. I believe the unusual little plant which we have found in it, and which gave it the peculiar flavor complained of, to be of a perfectly harmless character, and, consequently, the wholesomeness of the water has not been impaired by it in the least degree.

I have drank freely of it during the time when it was in the worst condition, and have partaken of the green matter which was procured from the Lake in its concentrated state, and also after it had been converted into a jelly by heat, without experiencing any ill effects whatever from it.

Filtration of the water through the porous filters, now so much in use, was found to separate effectually all the minute floating particles from it, and thus rendered it more palatable.

Upon comparing the present analysis with the results that I obtained in the year 1836, and again in 1842, as well as with the analysis by Prof. B. Silliman, Jr., in 1845, I find that the Croton water at the present day is purer, or in other words, contains a smaller proportion of inorganic and other constituents than has been found in it since the liberality and wise forethought of our rulers caused the introduction of this source of countless blessings to our great City.

Respectfully your obedient servant,

JAMES R. CHILTON.

From repeated and careful observations made by me, while the impurities existed in Bleecker Reservoir, as well as from microscopic examinations by Prof. Philip Ten Eyck, it is apparent that the foregoing description of the Croton water is applicable to our City water, while affected with the musty odor and taste.

Messrs. Chilton and Torrey, however, saw the impurities in the Lake only as they were passing away; and, as many opportunities have been afforded me, for noting some of the more obvious changes that take place in the appearance of the water, from the time when its impurities are first detected until it again returns to its normal

condition, I have thought it not irrelevant, but that it might prove useful for future reference, to state briefly what these changes are.

For a short time prior to any impurities, noticeable either to the taste or smell, the water in the Reservoir, when viewed from the bank, presents a dark, inky hue, even with a cloudless sky and a clear atmosphere. Viewed in a tumbler or other small vessel, nothing unusual in its appearance can be discovered.

In a few days the dark color disappears and the water gradually loses its transparency, when examined from the bank; not sufficiently so, however, as to be detected by consumers. So general and evenly distributed throughout the water (at least at or near the surface) is the foreign substance that has discolored it, that it would entirely escape the notice of a casual observer. Indeed, it is doubtful, whether the changes thus far would attract any attention from visitors, especially as no discoloration has yet been complained of by consumers.

The semi-roily appearance soon grows more apparent, when the musty odor and taste make their appearance in the City; at first scarcely perceptible and confined to particular localities: soon, however, more palpable and general throughout the service.

The water now assumes a distinct smoky appearance, so dense, that it is impossible for the vision to penetrate more than a few inches below the surface; this sometimes partially disappears, returning after a few hours or days; the water in the meantime assuming its dark hue. These changes may be repeated several times, occupying a period of days or weeks.

Frequently only portions of the Reservoir, varying from a quarter of an acre to three acres, assume the smoaky color, the remainder presenting the dark appearance.

The separation between these two colors, is, at times, remarkably distinct and well defined, frequently extending in an unbroken line across the whole Reservoir. This line is rapidly shifted under the influence of light atmospherical currents; sometimes moving a distance of fifty feet in a few minutes, but still sharply defined; showing that the coloring matter lies only at or near the surface. An examintion corroborates this, for at the depth of one or two inches, the smoaky hue cannot be detected. A heavy wind not only dissipates the coloring matter, but sometimes postpones its

reappearance for several days; its collection upon the surface is promoted by a hot atmosphere and a cloudless sky.

To the unaided eye, the water now appears filled with fine particles of inorganic matter; magnified, these are precisely similar to the filaments described in the Reports of Messrs. Torrey and Chilton, and which affected the Croton water in 1859.

In a few days, another marked change takes place, distinct from any that has preceded; the surface becoming covered in places with a thin scum of a yellowish green color. This forms with great rapidity, and, after remaining for a short time—depending upon the condition of the atmosphere—disappears. During the past season this has been frequently repeated, the water in the meantime remaining offensive.

On some occasions it has formed and covered large portions of the water, within the space of a few minutes, remained for a short time, and then been dissipated without any apparent cause.

The collection of this scum upon the surface often takes place during the night, or very early in the morning, though generally about noon, dependant, undoubtedly, upon the condition of the atmosphere at the time, as well as upon the state of the water. Always broken up by a wind, it frequently disappears under a still air. This process, the result of natural agencies, as yet but little understood, may be repeated on several successive days, or at intervals of several days. Its formation is a sure indication that the water will soon return to its normal state (unless the process is checked), as the foreign matter, causing the unpleasant taste and odor, is becoming specifically lighter than the water and rising to the surface.

When in this state, the quality of the water may be improved by taking the supply from near the bottom.

At the final change (and the Croton water was in this state when Messrs. Chilton and Torrey made their examination), all the impurities collect, with great rapidity, upon the surface, forming, in a few hours, a glutinous mass of varied hue, the yellow, green and brown, however, predominating, the whole mottled with white spots. When driven by the wind to the side of the Reservoir, it attains a thickness of from one to two, or even three inches, while the water underlying the mass is also quite thick, and of a dingy

green color. This arises, undoubtedly, from portions of the foreign matter, before reaching the surface, being driven under the mass already formed, and thus removed from the direct action of the atmosphere.

Immediately upon the last change being perfected, the water, except at its surface, has become pure. The material should now be removed from the Reservoir as expeditiously as possible. This is a precautionary measure that ought never to be omitted; for, although it decomposes with wonderful rapidity, its whole appearance changing in a few hours, giving off to the atmosphere its offensive qualities, and leaving only earthy matter, it is readily broken up into fragments by the wind. When this occurs the large pieces gravitate below the surface, are carried into the mains and distributed throughout the City. In such instances the impurities, in a concentrated form reach the consumers. Not only are the taste and odor rendered more offensive, but the coloring matter makes the water unfit for washing.

This last process, by which the impurities are brought to the surface, never takes place, except during a perfectly calm atmosphere. If a wind interrupts the operation it will be continued and completed at some subsequent period.*

Although these masses are exceedingly offensive to the eye, and their odor and taste concentrated, the water is transparent at the depth of a few inches, and all impurities disappear near the bottom of the Reservoir.

While the impurities continued, frequent microscopic examinations were made by Prof. Ten Eyck, who found them to consist of minute vegetable organisms, similar to those described by Messrs. Chilton and Torrey in their interesting reports.

When examined with a hand microscope, the water appeared filled with minute filaments, resembling fine threads of glass, or lines of light. Their axes assumed all directions,—horizontal, vertical and oblique. They were motionless, having the same specific gravity as the water. Under a microscope of high power, their forms and structures were beautifully developed.

* When this final change took place in 1864, it was completed in a very short period and without interruption; whereas, in 1865, after the foreign matter commenced forming in masses upon the surface, the operation was checked, and several weeks transpired before it was resumed and completed.

The accompanying drawings, for which I am indebted to the kindness of Prof. Ten Eyck, who has devoted no little time in microscopic examinations of the water, will convey a much more correct idea of the form, size and general structure of this plant, than can possibly be given in a written description. By comparing these with the description of the plants which appeared in the Croton Lake in 1859, it will be seen that they are identical.

In August last, while the water was peculiarly offensive, a portion of it was sent to Dr. Julius G. Pohle, of New York, for his examination.

The following is a copy of his report:

LABORATORY OF JULIUS G. POHLE, M. D.,
(Formerly of and successor to Dr. JAS. R. CHILTON, &c.,)
Analytical and Consulting Chemist,
489 Broadway, N. W. corner of Broome street,
NEW YORK, *August 12th*, 1865.

I have analysed a water sent me by Messrs. Hageman & Co., and found it to contain saline constituents, &c., in the proportion of $5\frac{3}{10}$ grains to the gallon. These consist mainly of the following, and exist apparently in proportion, in the order stated:

Chloride Sodium,
Carbonate Soda,
Chloride Calcium,
Chloride Magnesium,
Vegetable Organic Matter,
Sulphate Lime,
Silicic Acid,
Carb. Lime and Carb. Iron.

The saline constituents of the above are too small in amount to prove deleterious to health. They are no greater than those held in solution by the Croton water. The objectionable salts of lime in this case are very small in amount. I consider the water perfectly wholesome.

JULIUS G. POHLE, M. D.,
Late of JAS. R. CHILTON & Co.,
Analytical Chemist.