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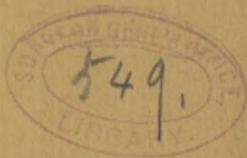
THE
SEWERAGE



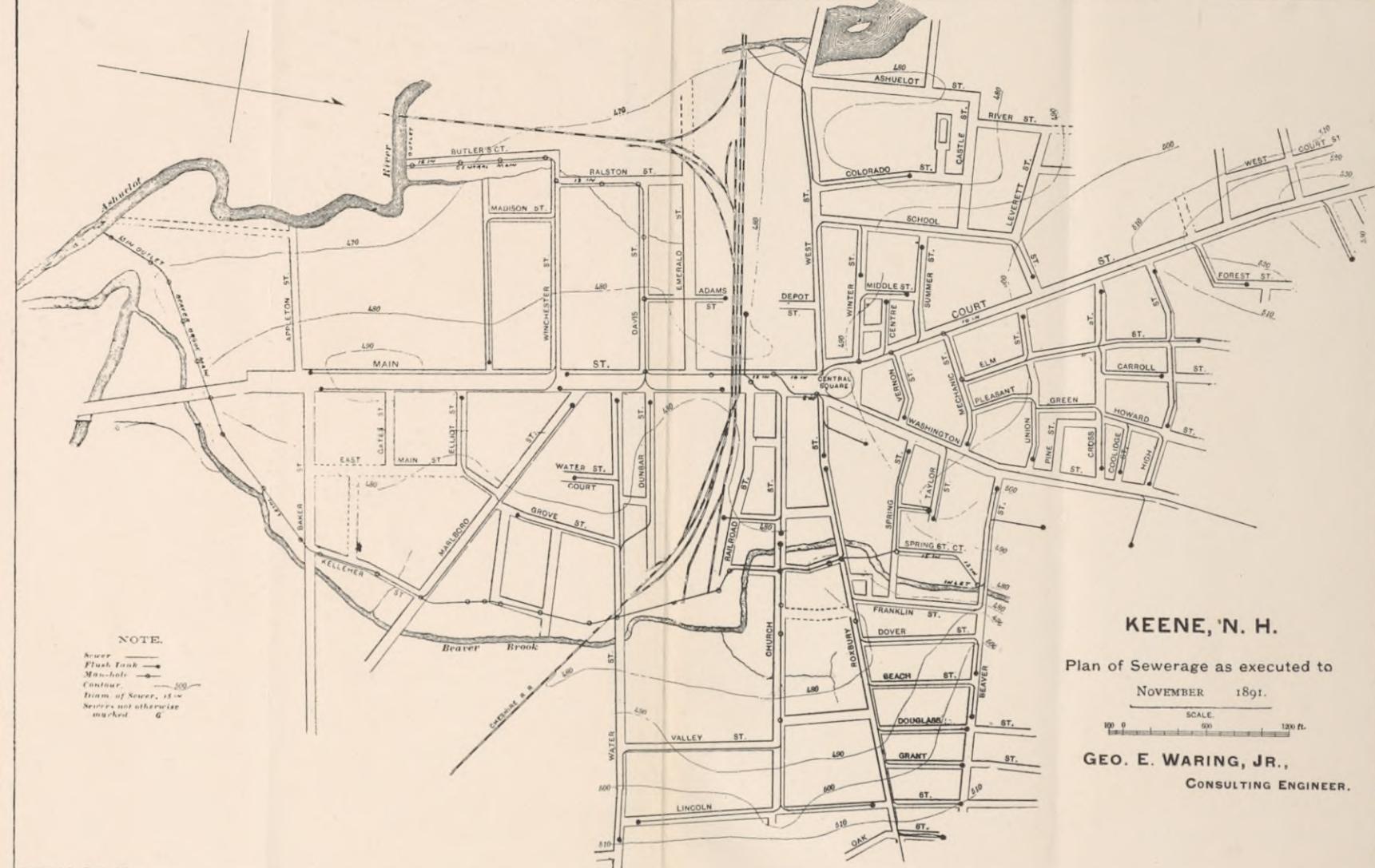
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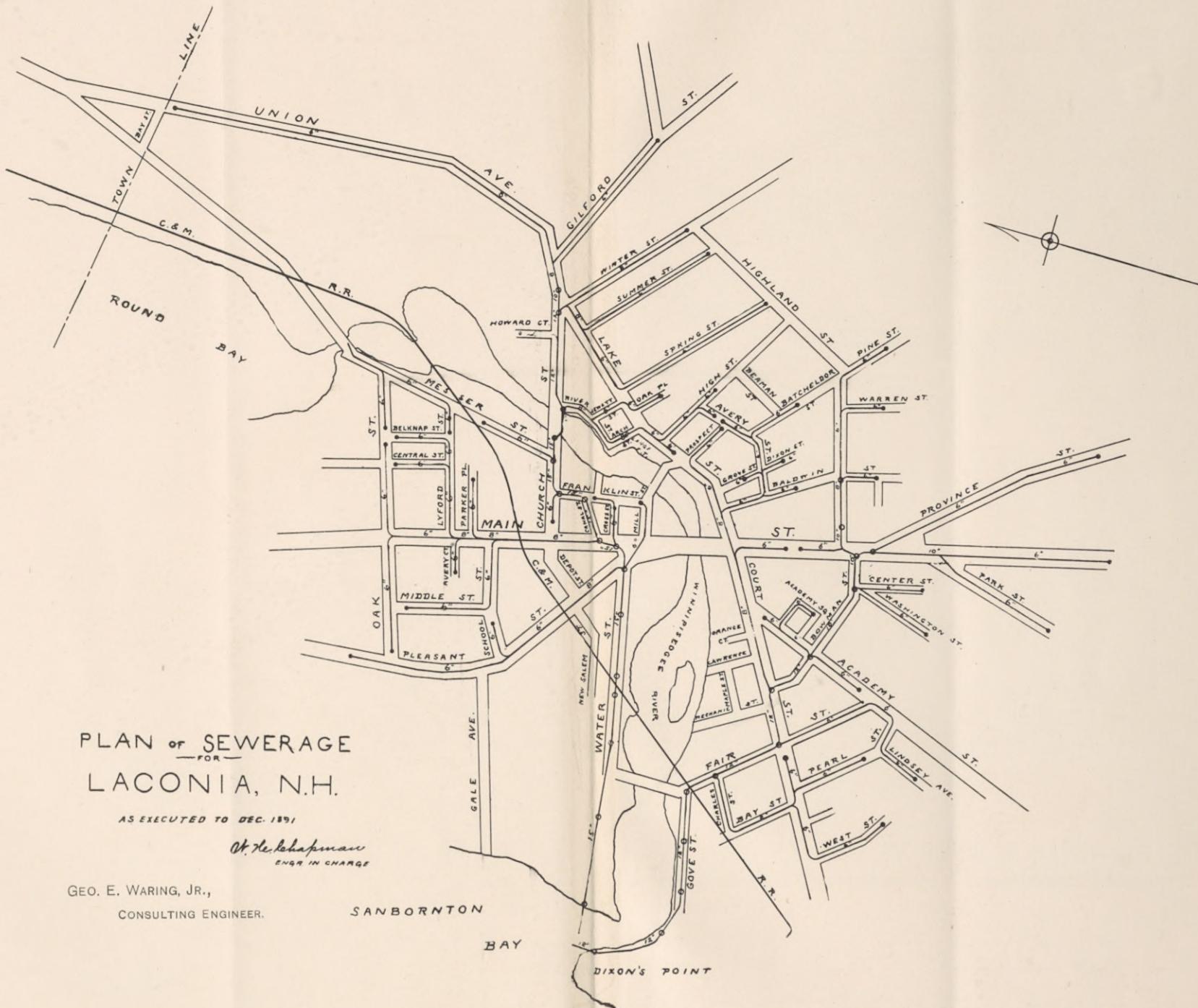
TWO
NEW HAMPSHIRE TOWNS,

KEENE AND LACONIA,



BY
GEO. E. WARING, JR.,
M. INST. C. E.,
NEWPORT, R. I.





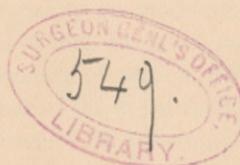
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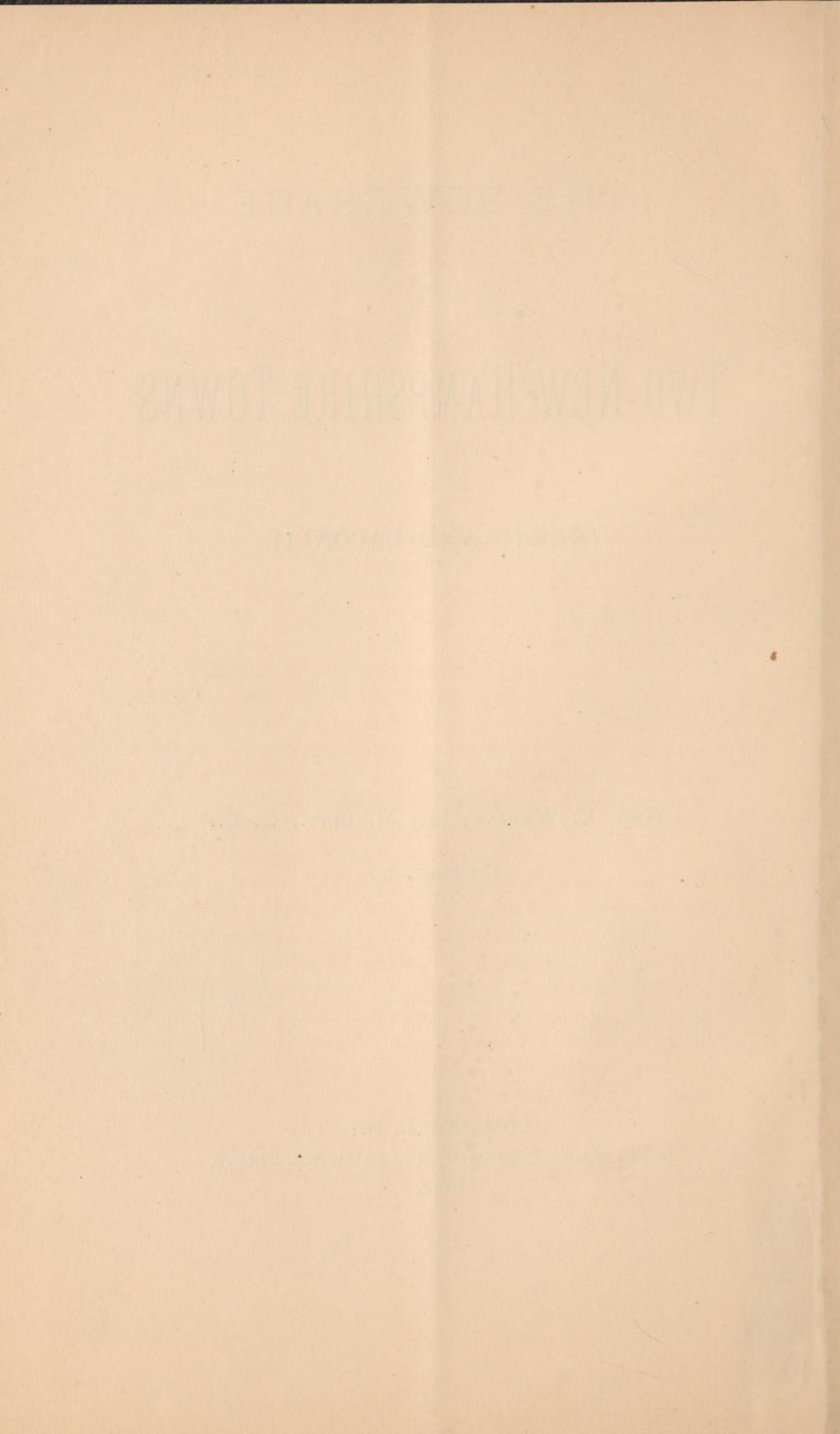
THE SEWERAGE
OF
TWO NEW HAMPSHIRE TOWNS
(KEENE AND LACONIA).

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NEWPORT, R. I.



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THE SEWERAGE OF TWO NEW HAMPSHIRE TOWNS.

BY GEO. E. WARING, JR., M. INST., C. E., NEWPORT, R. I.

It may be of interest to the readers of the report of the Board of Health in New Hampshire to be informed as to the sewerage of Keene and of Laconia, works which have been carried out on a system materially different from what had before been used in this State; this being the same system that was introduced in the city of Memphis, Tennessee, after the yellow fever epidemic of 1878-9.

It is a peculiarity of this system that it is used for the removal of foul sewage only, no rain water being admitted either from the surface of the ground or from the roofs of houses. The sizes of the sewer pipes are proportioned to the limited but uniform work of removing the daily foul waste of houses and manufacturing establishments. The lateral sewers, constituting a very large proportion of the system, are only six inches in diameter. When enough building lots have been passed to make the future maximum flow of sewage sufficient to fill a sewer one half full, its size is increased to eight inches, which about doubles the capacity on moderate grades. When the eight-inch sewer would run as much as half full, an increase is made to ten inches, of which the capacity is about 60 per cent more than that of the eight-inch. As no rain water is admitted for the flushing of the sewers, it becomes necessary to substitute other means for keeping them clean. This is done by placing at the head of each sewer, below the surface of the street, a small cistern, called a flush-tank, and holding, when full to the level of its discharging point, about 150 gallons of clean water admitted from the water supply in a very small dribbling stream, sufficient to

fill it about once in twenty-four hours. When it becomes filled, an automatic siphon is brought into operation, discharging the whole volume suddenly in a strong flushing stream, flowing freely down the sewer and carrying with it all matter stranded by the normal flow, which, toward the upper end of each line, is not sufficient for the removal of all solids. In addition to its effect in cleansing the sewers, this discharge from the flushtank drives along the air contained above the flow in the sewer, forcing it out at the different ventilators as these are approached, and drawing in air through the ventilators which it has passed. The ventilators of the whole system are the house drains and soil pipes of all the houses connected, there being no trap between the sewer and the open mouth of the soil pipe above the houses. This ensures a free and copious ventilation of the sewers at all times; not only during the flushing from the tanks, but from a constant interchange of current between different soil pipes, influenced by the wind, by changes of temperature, by the discharge of fixtures in houses, etc. If properly cared for in the matter of obstructions, and if regularly flushed as above described, these sewers with their house drains and soil pipes are so constantly and freely ventilated that the accumulation of the gaseous products of decomposition is impossible. What is known as "sewer gas" cannot exist in such a system of drainage, if the most ordinary care is taken to prevent deposits of organic matter therein. The general principles under which the system is constructed are substantially the same as those used in other sewerage work. Manholes, inspection holes, facilities for cleaning, etc. being measurably the same.

The system has three preponderating advantages: (*a*) Its cost is, on the average, not more than two fifths of that of a system arranged to remove surface water and house drainage together. (*b*) As it does not depend on the occasional, and frequently lacking, flushing by rain, nor on precarious and costly flushing by hand, but is, on the contrary, thoroughly washed out by automatic process every day, the accumulation of deposits, at least unperceived and neglected accumulations, cannot occur. It is one great advantage of this system that if

a deposit forms which the flush tank cannot remove, it is pretty sure to make itself known by a complete stoppage of the sewer and to demand the removal of the obstructing material; while in systems with large pipes, there is ample room for the accumulation of an offensive and dangerous amount of organic deposit with ample water way above or around it. Such sewers may go for a long time without cleaning, simply because they will perform their main office of carrying away sewage without being cleaned. (*c*) The ventilation of the system is much more complete than it would be possible to secure with the use of the larger pipes of the combined system. (*d*) There is no opening between the sewers and the surface of the street through which offensive odors can escape to the annoyance of the people, nor are there the filthy and objectionable catch basins by which it is attempted, not always successfully, to hold back street dirt, and which often become very offensive by decomposition during the intervals between storms. These serious drawbacks are entirely eliminated.

In most towns of moderate size there is no occasion for the universal removal of surface water through underground channels. It is often, and indeed generally, necessary to carry street wash from points where it accumulates to a dangerous or inconvenient extent. Channels for this purpose may either be independent, shallow, and often short lines, leading to a near point of outfall; or, if the outfall of the foul system is sufficiently near at hand, its main sewer may, from the desired point, be sufficiently increased in size to take the surface water as well. Whether or not, and to what extent, this should be done, is a question, the decision of which calls for the judgment and experience of a competent engineer.

KEENE.

A movement was made for the sewage of Keene about 1876, when it was proposed to construct a combined system of sewers, varying in size from pipes twelve inches in diameter to brick sewers forty inches wide and sixty inches high. The cost of this work would have been so large that nothing was done toward its execution. The question was taken up

again after 1880, when the success of the work at Memphis had become known, and, as a result, the work of construction was begun in 1882 and was substantially completed in the following year, the total length of sewer constructed being a little more than eleven and one half miles, all of pipes ranging in size from six inches in diameter to fifteen inches in diameter. The six-inch pipes constitute about 73 per cent of the whole. The system then included forty-four automatic flush-tanks and fifty-one manholes. The total amount paid for the work under the contract was about \$84,000.

There have been almost yearly extensions of the system, which at the end of 1890 comprised about thirteen and one half miles of sewers with fifty-two flush-tanks, fifty-one manholes, and three outlets into the Ashuelot river. The two principal outlets, discharging the sewage of nearly the whole city, are fifteen inches in diameter. There has never been any offense or difficulty connected with these outlets.

The Ashuelot is subject to high floods. The outlet of the central main sewer is sometimes submerged to a depth of six or eight feet, and much of the flat area through which the Beaver brook main runs is under water, in some cases over the tops of the manholes. These conditions indicated that it would probably be necessary to make use of jet pumps near the outlets of these lines, to maintain a flow during high stages of the river. It was found, however, that during the spring flood of 1884, which was unusually high, the natural flow of the sewers maintained a constant current through the whole system. No inconvenience was caused by the failure of the house drains, even in the lower portions of the town, to discharge freely and it was thought unnecessary to carry out this part of the plan at present. The indications now (1891) are, that such an aid may be required at the outlet of the central main.

The sewerage of Keene was not carried out without the opposition that is so often raised, by certain classes of the community, to all public improvements calling for taxation. Indeed, the opposition was at one time very serious. It was, however, overcome by the persistent energy of those who had

inaugurated the enterprise. After the system had been in operation for more than a year, Dr. George B. Twitchell, to whom more than to any one else the credit of the completion of the undertaking is due, wrote: "The system has been now, after a year's trial, found to work well, and to give complete satisfaction, and the people are constantly making connection with it. The croakers have ceased to find fault, and petitions are now before the city government for extensions into certain streets. The system is working better than its most sanguine friends ever dared to hope."

Mayor Kimball wrote at the same time: "It seems to me that the construction of our sewers is as nearly perfect as can be. From the fact that no impediment to a steady flow has been discovered from the beginning, and I have not heard that any one of the forty-four flush tanks has failed at any time to perform its duty with accuracy. In brief, I think if a vote were to be taken now, a large majority of our citizens would say that our sewerage system, and the manner of its construction, meet with their full approval."

Mr. P. F. Babbidge, the superintendent of water-works and sewers, who has been in charge of both construction and maintenance for some years past, writes: "The whole system here is working like a clock." He gives the entire cost of maintenance, including \$400 of his own salary, the compensation of the inspector of plumbing, all repairs, inspection tools, and everything else chargeable to the account of maintenance in the last fiscal year as \$828.53.

He says of the West and School street main, of which the length is about 3,000 feet of six-inch pipe with a grade of 1 to 400, and flushed by two tanks: "There are forty-five connections with this line, all large houses. I have to run a ball through this line twice a year to remove the sludge as it has such a slight fall; but have not had a stoppage in it since the first summer I was here (1888), when, in fact, all the lines were more or less clogged." Concerning this clogging, he says, "I find that considerable sand gets into the pipes when connections are made, especially when a Y has to be

cut in. I am also troubled a little with roots, and everything that is made by man gets into the sewers—dish rags, bones, spoons, old aprons, skirts, newspapers, etc. I could fill a page with the different things I have found in the pipes. The balls locate partial stoppages and so prevent a full stop."

There are now, in Keene, about 800 families whose premises are connected with the sewers.

LACONIA.

The writer also made a plan for the sewerage of Laconia in 1886. The conditions here were much more difficult than they were in Keene, where the chief obstacle to satisfactory working lay in the quicksand, of which a good deal was encountered, much of the city being low and flat.

Laconia lies on both sides of the Winnipesaukee river, a stream of great volume, with a mill dam in the heart of the town, making a deep channel above with an exceedingly rapid current below, the discharge into Sanbornton bay being within the town limits. The conformation of the territory is such that it was not possible to carry all of the drainage from the area east of the river to the outlet on that side, a very considerable portion of it had, necessarily, to be carried across the river to be delivered by the main sewer of the west side. A pipe might have been suspended under the bridge crossing the river at Church street, which would have resisted the flow of the stream, that point being above the dam, but it could not have withstood the rush of logs liable at any time to be brought against it. This difficulty was overcome by making an inverted siphon of iron pipe, descending to the bottom of the river and embedded in it, and rising at the outgoing side to the level of the sewer into which it is to discharge. As this pipe will always be full and will consequently have but a sluggish current, provision has been made for keeping it clear by placing a large automatic flushtank (capacity 1,600 gals.) near the corner of River street and Arch street, in the line of the Arch street sewer. There is sufficient fall to the ground here to allow a drop in the grade

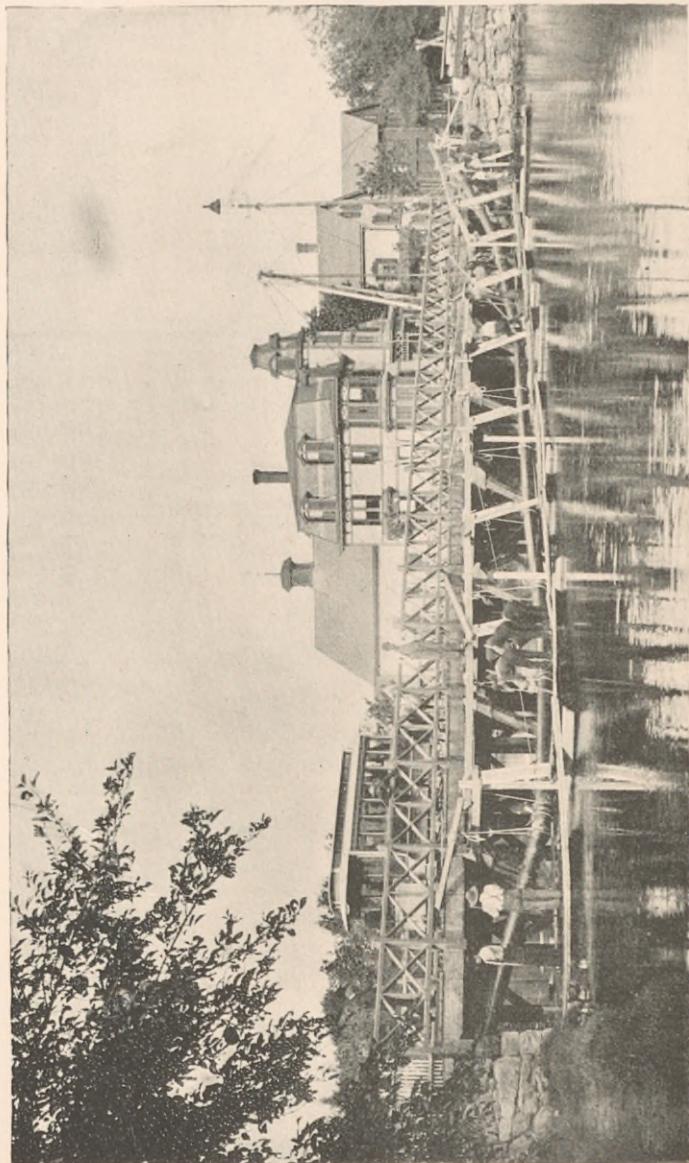


FIGURE I.
LAYING THE SIPHON AT THE CHURCH STREET BRIDGE.

of 5.6 feet. The flushtank is placed at this point, receiving the entire flow from the sewer above, retaining it until full, and then discharging the whole mass in such volume and with such head as to ensure the production of a cleansing flow through the siphon, the construction of which is as follows:

It was necessary to lay the siphon at one side of the bridge on account of the mud sills interfering with its bedding if placed under the bridge. Piles four inches square were driven opposite each bent of the bridge and capped and supported. A temporary platform was built at the water level to work from, both in excavating the bottom and in leading the joints. The pipe was supported from timbers six inches square placed on top of the cap pieces. There was quite a strong current, and guides were driven at every other joint to prevent the pipe swinging out of line in lowering. The excavation was mostly sand. Clay was encountered in two places. A few small stones were encountered but these were easily removed with rakes. After the bottom was excavated, the lower staging was removed. Men were placed at the supporting ropes at each joint; a mark was made on each rope one foot from the timber, and every line was slackened off as uniformly as possible and held at the mark. This operation was repeated until the pipe rested on the bottom.

The accompanying illustration shows the pipe swung, ready for lowering. Figure 1.

Another difficulty consisted in the fact that as the lower portion of the Winnipesaukee river and the adjoining bay of the lake into which it discharges are so much used for pleasure boating ("The Laconia Navy"), it was entirely inadmissible to discharge sewage at the shore. Both outlets are carried to the deep channel where the river flows into the lake, through iron pipes, that on the east side being twelve inches in diameter and one hundred and thirty-five feet long, and that on the west side being fourteen inches in diameter and three hundred and thirty-one feet long. These pipes are laid in the sand from the shore to about the point of discharge.

The placing of the fourteen-inch outlet (Water street) is

shown in figures 2 and 3. The trench was close sheeted and it was found necessary in places to drive a board outside in order to cover the joint. Pieces of bagging were also used for the same purpose. The water was not pumped out at all but the sand was so fine in places that it ran through the smallest opening. One set of rangers was placed at the water line and the sheeting was driven about a foot below the bottom of the trench. This held it in place perfectly. The last three lengths of pipe were laid on a platform which was lowered to a pile support at its outer end. The pipe was supported in the same manner as at the other outlet and at the bridge. It was lowered nearly to the rangers at the surface of the water. These rangers were then taken out and placed above the pipe. The pipe was then lowered to grade and enough sand thrown in to bed it. The sheeting was then drawn.

Except for these peculiarities and for the use of "inspection pipes," to be described below, the system is substantially the same as that at Keene. It comprises 10.28 miles of sewers, all of pipes ranging in diameter from six inches to fifteen inches, 65 per cent of the whole being six-inch. There are forty-five flush tanks, thirty-one manholes, and eighty-two inspection pipes. The work is not yet entirely completed and exact figures cannot be given, but the amount paid under the contract will be not far from \$54,000.

The work was begun July 7, 1891 and was practically completed by November 20, 1891. It was all carried out under the engineering control of Waring, Chapman & Farquhar of Newport, R. I., my partner, Mr. Chapman, being the engineer in charge.

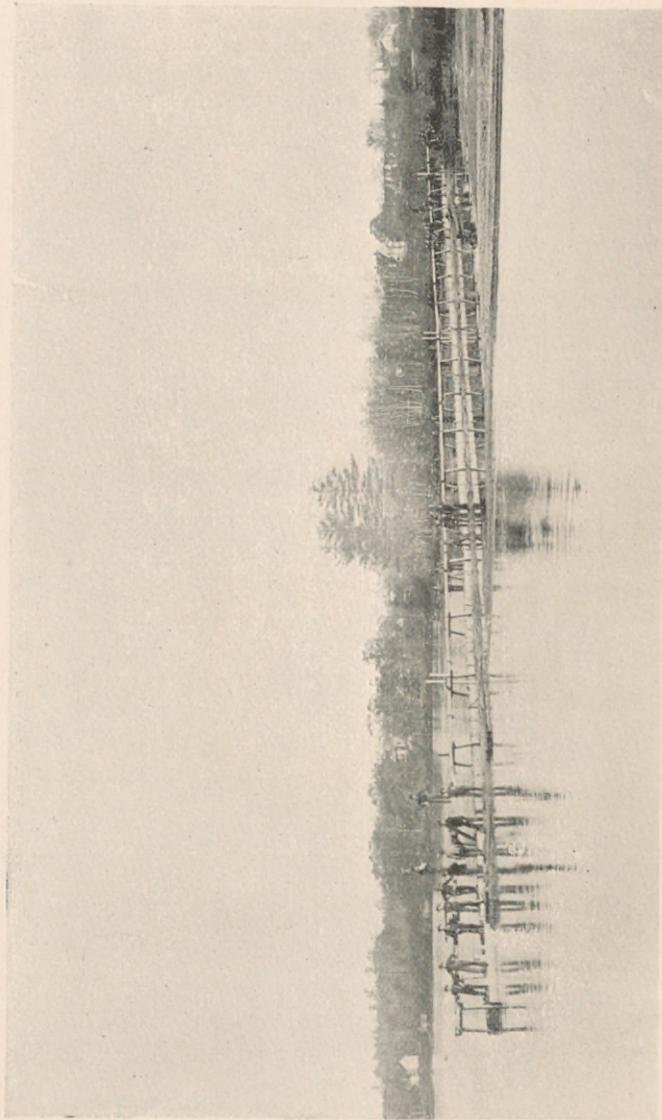
The inspection pipes referred to above are an improvement added since the work at Keene was done. They take, very largely, the place of manholes and are placed at intervals of about two hundred to three hundred feet, average. They consist of an iron pot or chamber built at the surface of the street with an iron cover, all being strong enough to stand the concussion of traffic. This chamber which is about



14-INCH OUTLET BEING LOWERED.

FIGURE 2.

FIGURE 3.
ARRANGEMENTS FOR LOWERING THE 14-INCH OUTLET.



twenty inches in diameter has two oblique arms, set at an angle of forty-five degrees and pointing, one up stream and one down stream. The openings into these arms are closed by cast iron doors, held fast by an iron bar between them which is fastened in place with a Yale lock. The arms are long enough to enter the collars of eight-inch pipe, which rise obliquely toward them from the top of the sewer. The lowest pipe of this oblique connection, on six-inch sewers, reduces in size from eight-inch to six-inch and enters the branch of the sewer. By removing the cover, releasing the bar, and uncovering the arms, a straight line of sight is given into the sewer so that by throwing down the light from a bull's-eye lantern, the condition and character of the flow can be perfectly inspected.

The details of these appliances are shown in the accompanying cuts. Figures 4 and 5.

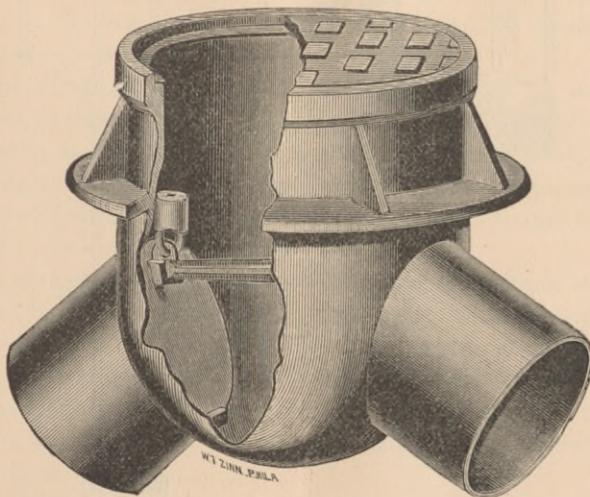


FIGURE 4.

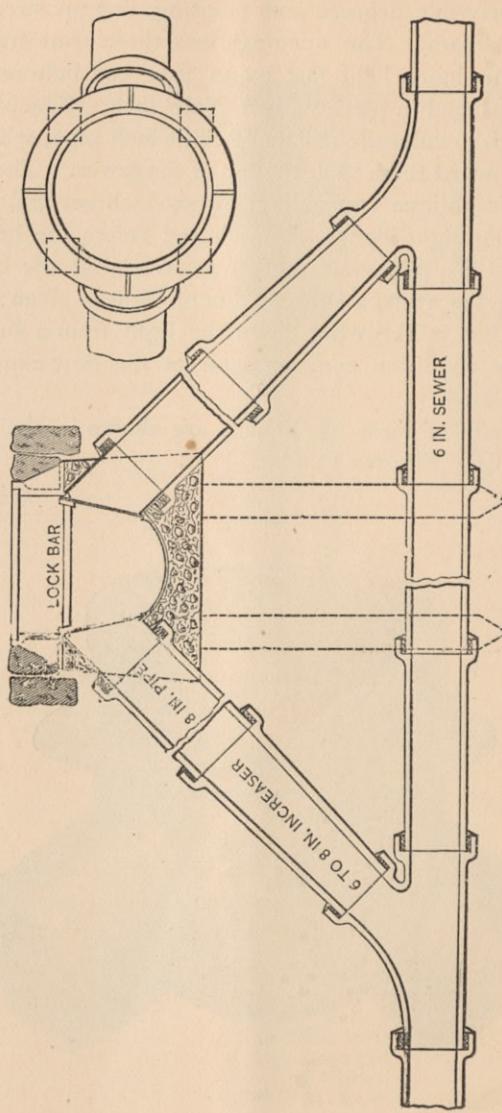


FIGURE 5.

Cords can be floated from the down-stream arm of one chamber to the up-stream arm of the next below, by which ropes may be drawn through, carrying steel brushes, or whatever other appliances may be used in cleansing. When sewers are to be cleansed by passing balls through them slightly smaller than their interior diameter, so as to produce a cleansing current as the sewage flows around the ball, a strong cord is attached to the ball by which it is kept under control until it shows itself at the inspection pipe below, where it may be pulled up, or it may be drawn back to the starting point.

In case of stoppage, the sewer may be easily plugged, through the down-stream branch of the inspection pipe next below, and then filled with a solid column of water, which being churned with a plunger from the up-stream pipe, produces a direct movement on the obstruction and sets it free. These pipes have the advantage that they make it possible to do all cleansing work from the surface of the street instead of working in the contracted quarters at the bottom of a manhole. As their openings are locked fast, one of the most serious objections to manholes, the opportunity offered for malicious persons to throw in obstructions, is obviated.

Some difficulty was caused in construction by the uncertainty as to the location of water pipes. "These were laid in the centre, at one side, or diagonally across the streets as the case might be. No record of their location was kept, and a margin of five feet from where the pipes were supposed to be, proved to be none too much.

The material used for these sewers was granite pipe, manufactured by Knowles, Taylor & Anderson of East Liverpool, Ohio. It was very satisfactory save that a considerable amount of the smaller sizes had to be rejected because it was not straight. "The bells were especially large and there was not a single pipe that required chipping." This is a great recommendation.

The joints of the pipes were inspected and carefully covered before the cement had set. Damage to be caused by jarring the pipe and cracking set cement was thus avoided.

Wherever water was encountered even to a small amount in the holes dug for the bells of pipes, the cement was held in place by a strip of muslin tied around it. Where the water was very troublesome, Stanford's joints were used with very satisfactory results.

During the whole time of construction, from July 7 to November 22, only one whole day and five half days were lost on account of rain.

The ground in which the sewers are laid is varied, some of it difficult. Much trouble was caused by unexpected caving and sliding, largely due to the proximity of old water and gas ditches near the line.

At this writing, the system is being tested by passing through all of the lines balls two inches less in diameter than the bore of the pipe. These balls are attached to cords and are flushed through from one inspection pipe or manhole to another, demonstrating the safe condition of all the work.

