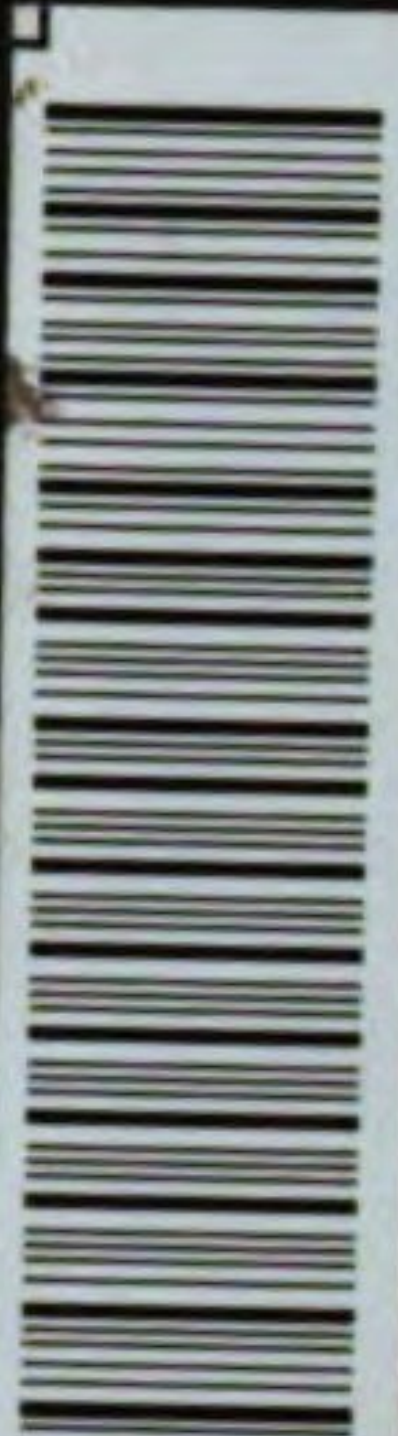




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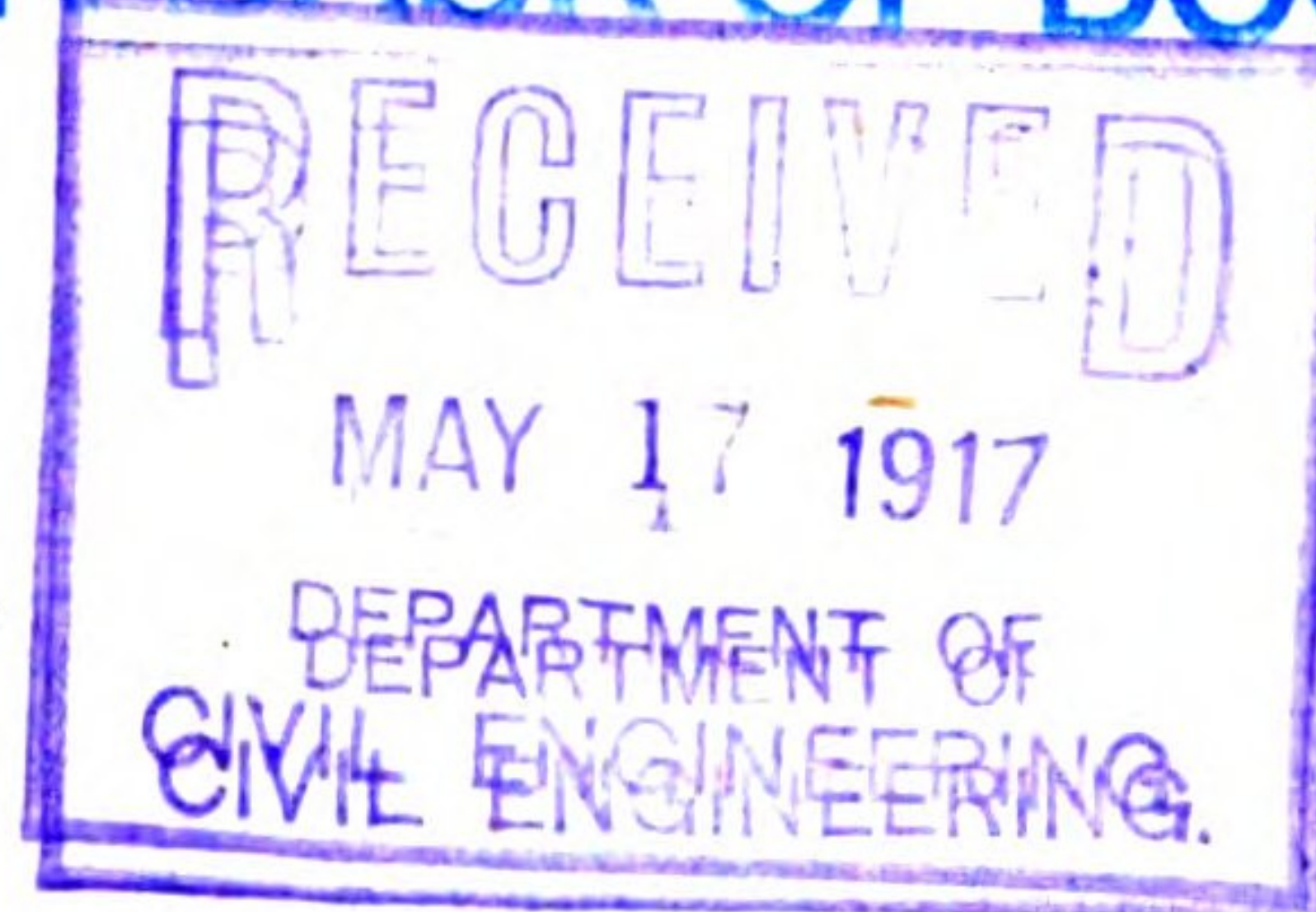
THESIS  
AN INVESTIGATION OF THE  
OTSEGO SEWER SYSTEM  
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An Investigation of  
The Otsego Sewer System

A Thesis Submitted to  
The Faculty of  
MICHIGAN AGRICULTURAL COLLEGE

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Candidates for the Degree  
of  
Bachelor of Science

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THESIS

## **AN INVESTIGATION OF THE SEWER SYSTEM OF OTSEGO, MICHIGAN.**

Every sewer system is apt to have many defects due to faulty design, construction, or a combination of the two, and also perhaps due to the rapid growth of the city. And inasmuch as the Otsego System was giving poor satisfaction, and seemed to be almost a failure, due to the above reasons, and also because of very radical changes which were made in the construction from the original plans, we chose this subject as a thesis, for the purpose of proposing improvements for the existing system. And as this system only covers about one-half of the city and is running sixty-four percent full now, we propose to design a new system, complete with new trunk line and septic tank for this portion of the city not already supplied with a sewer system.

We made a complete survey of the existing system, as well as taking a complete set of levels over the area to be covered by the proposed sewer.

### **LOCATION AND TOPOGRAPHICAL DESCRIPTION.**

Otsego is a village of about three thousand population, and is situated about fifteen miles north of Kalamazoo, in the County of Allegan. The L. N. & M. S. Railway connects the village with Grand Rapids on the north and Kalamazoo on the south.

Running through the center of the village is the Kalamazoo River, which also flows through the center of Allegan twelve miles below. The resident district is spread out on both sides

of the river, with the largest portion being on the south side. On the north side, the residences follow only one street which runs parallel to the river, and are of the cheaper class tenement houses. The railroad is on this side also the total of six large paper mills, a shoe factory and a chair factory. These mills and factories have their private Sewer Systems, as have also a few of the houses. The stores and the better class tenement houses are located on the south side, extending about a half of a mile from the river and about three quarters of a mile along the river. This portion of the village is practically level ground, the center contour not varying over three feet. The original plan was to cover this side of the river with one system, having the trunk line on the west side of town. However, upon investigation, it seemed to be practicable, from both a sanitary and economical standpoint, to cover the eastern portion, which has not been piped as yet, with a separate system.

The Palamazoo River affords a very acceptable outlet for the sewage at the present time. However, with the present advance along the lines of sanitation it will only be a short time before the authorities will take steps to solve the problem in a scientific, as well as economic manner. They are becoming aroused as to the value of maintaining streams in a pure condition, because even if not used for drinking purposes, it is usually used for domestic purposes, and then it also is of great value to have the water pure, so as to preserve fish life, and in order to have the ice pure as possible

and finally because on the broad ground, that water courses belong to the country as a whole, and must be kept pure for the sake of succeeding generations, not spoiled for them on account of the selfishness of a few at the present time. It will be only a few years before the laws of Michigan will compel the city to put in some kind of disposal, or purifying plant, because the sewage is certainly a nuisance to the public. In case Septic tanks are installed, two systems could be used, one with each trunk line

#### PRESENT SYSTEM.

The present sewerage system in Otsego was installed between the year 1912 and the present time, a little being added each year. Up to that time, the only sewers in use were a few private ones. The system, as originally designed, had one trunk line upon North street, emptying directly in the Kalamazoo River. From this trunk line, parallel laterals were to be placed upon each east and west street, running the entire length of the street, or as far as needed.

During the process of construction, many changes were made from the original plans, the location of some of the laterals being changed by the village authorities, for the purpose of making a cheaper system, and the efficiency of the system thereby being lessened; the elevations and grades were changed during the process of construction by the contractor. This change in elevation primarily started in the trunk line between Orleans and Allegan streets, where quick-sand, or at least bad water sand, was encountered. The contractor spent

twenty-two days trying to lay tile in this material, but was unable to make any progress at the specified elevation, and as he had been hired to do the engineering work as well as the construction, there was nothing to prevent him from raising the sewer, and in order to clear himself, this is what was done. This made it necessary to raise all the laterals above this point, and in order to have the most remote parts of the laterals somewhere near the specified elevations, the grades had to be greatly reduced. The original plan was to place siphon flushing tanks at the ends of each lateral, but this plan was never carried out. However, the Franklin street sewer is flushed by a two inch bore stream, which is turned in from the county drain upon Morrell street. Instead of running laterals eastward from North to the Plainwell Road on Farmer, Franklin, Morrell and Hammond, as the original design called for, they have only been run to Fair on Allegan, the whole length of Franklin, and up as far as Fair on Hammond. On Orleans and Morrell, two of the principal resident streets, short laterals have been run for the length of a block in a few places, then connecting to the longer laterals by short lines up to north and south streets. This arrangement, of course, necessitates a very small amount of sewage flow in each one, and also several dead ends, which are factors to be avoided if possible, and would have been if the original plan had been followed. On Allegan street, the conditions are not so bad, as this sewer, as far as constructed, is very near the proper

grade and elevations, so that it can be extended up as far as the Plainwell Road, if so desired. The Hammond street sewer, being laid to a very low grade, is at a low enough elevation so that it can be extended if desired.

Upon investigating the sewer, we found many of the lines in very bad condition, many of the pipes being completely filled with filthy material, which sometimes extended up in the man-holes, and upon opening up the man-holes, gave off the foulest kind of gases, showing that the flow had been stopped by the lack of flushing water, and by the flatness of the grades, causing sedimentation to take place to such an extent that the pipes had been completely filled, and they had been in this condition so long that putrefaction had taken place. The Hammond sewer was in this condition, being completely filled, and with no apparent flow along its length and as far up North street to Franklin. This was a surprise to us as the village authorities supposed they had this sewer flushed out only a few days before, but the flushing evidently only consisted of turning a fire hose in the pipe at Fair street until the flow was started, washing the sludge and sediment down the pipe for a little way, making its condition worse instead of flushing it out clean. The Franklin street sewer was completely dry at its upper end, the two inch bore stream from the county drain on Morrell street having been shut off, and at the man-hole on Kalamazoo and Franklin, we found the worse conditions of all, here the sludge and filth was one and three-tenths of a foot deep; the next man-hole, down on the section line, was filled up to a depth of

seven-tenths of a foot, and with no apparent flow, but at its junction with the trunk line 290 feet further down, we found the pipe flowing half full of clear water, showing that there was quite a perceptable leak in the line here. This may have been caused by the springs washing the dirt out from under the tile and allowing it to settle, and then break open the joints, or else due to faulty construction, and the joints never being cemented together properly in the first place. The rest of the pipes were either dry, due to the lack of customers having tapped to the sewer, or else was in good condition with enough flow to be self cleaning. The trunk line north of Allegan street, which is a fifteen inch pipe, was found to be flowing eight-tenths of a foot deep, or 64% of the total depth, and as this system is comparatively new, and only a very small percent of the families along its course have taken advantage of it as yet, and also as it is the intentions to extend the lines and laterals further, it should have a factor of safety of at least three, or in other words, the present flow should be one-third the capacity of the pipe, instead of flowing nearly two-thirds full. However, this may be partly due to the ground water, and may be removed, to a small extent at least, by digging up the sewer where the worst leaks have occurred, and relaying it upon some kind of strong mattress, and cementing the joints thoroughly.

There is a separate storm water sewer system to take care of the storm water in the business district, so that the

sewage from this district is not large, the principal contributors being the hotel, the barber shop and the laundry.

In the eastern portion of the town, especially along the river, the private sewers are in operation, but it is only a matter of a few years before they will connect to the main sewer system, either by their own free will, or else by compulsory means.

#### Proposed System.

One of the main things we endeavored to correct was the inadequacy of extending the system any further east, as originally designed. This would be inadequate for several reasons; first, because of the small size of the trunk line, which is flowing 64% full at the present time; second, because of the flat grades which would result in the extension of the lines to the Plainwell Road, and lastly, because of the fact that the population is increasing yearly and two systems would be necessary in a few years at the very best.

We propose to have a trunk line upon Platt street, emptying into the river, by means of a trunk line running from the corner of Platt and Court to the river, a distance of 300 feet, with a septic tank to remove the suspended matter, which is thereby subjected to hydrolytic or bacterial action. By these means a portion of the organic matter is converted into unoffensive gases or soluble compounds which pass off with the outflowing sewage. From this trunk line, a main

line is to be run southeast up Plainwell Road to Morrell street, up Morrell street to Walnut street, up Walnut street to Hammond street and following Hammond west to the county drain; here for a flushing device, we propose to have a constant supply of water on hand by means of a small dam with slash boards; and by fitting a wooden head in the end of the tile here at the drain, with a two inch bore hole, an amount of water sufficient to keep the sewer clean will flow through the line all the time.

We propose to run laterals east on Mitchell street, with a branch for a block north on Edsell street, also a lateral west on Allegan running up within 100 feet of the man-hole on Fair, and with a branch taking in the block south on Wilmet, and a lateral west on Court street with short branches running south for the distances of a block on Fair and Wilmet, also one north on Wilmet for a distance of 400 feet.

Inasmuch as the Hammond street sewer is laid to such a flat grade that it requires constant attention, with flushing at short intervals of time, which is a big bother as well as expense, and also because upon investigation we found it possible to extend the line and connect with the county drain. This is what we proposed to do. It is a distance of 1700 feet, and we found that it could have a grade of .26%, which will be sufficient, with a two inch bore stream flowing through the line, from the drain, the same as in the Franklin

street sewer. And this improvement is practical from another standpoint other than that of flushing, as the population is thick enough along this section of the street to warrant the extension alone.

This proposed system takes in all the resident district in the eastern portion of the village not already supplied with a sewer system. The portion of the west of the trunk line should be connected to the trunk line, as this will not amount to enough sewage to make any particular difference. The most economical way to take care of the portion across the river is with a separate system, but as this will not be needed for a few years at the very best, we will leave its design for some future date.

Automatic flushing tanks should be installed at the dead ends of the laterals which do not have sufficient grade to be self-cleaning. These tanks should be built of concrete and a constant flow of water allowed to flow into them from the mains. The automatic siphon discharges the contents into the sewer whenever the tank becomes full, and sends a wave through the system, cleaning it out. If this method of flushing is not used, the following method should be followed whenever the lines appear to become blocked, or to fill up. A temporary dam should be placed in a man-hole, and a section of the sewer and man-holes above the dam filled with water from the fire hydrant discharged through a hose, and then quickly removing the dam and allowing the water to flow rapid-

ly, and flush the sewer below, in this way force is given to the flushing water and better results are obtained. If the trouble seems to be in one particular<sup>place</sup>, or if the sewer is in extra bad shape, a pill or round wooden ball, a little smaller than the pipe is placed in one man-hole and allowed to go to the next man-hole; a fire hose is used again, and the water accumulates behind the pill until sufficient pressure is developed to drive it forward. As the pill tends to float most of the water discharges underneath, and scours out deposits on the bottom of the sewer, thereby cleaning it.

We gave the proposed system definite grades, depending upon conditions, and in figuring the sizes of the pipes to be used, we took each city block in the residential district and divided it into thirty foot lots, allowing five persons to the lot, and estimating the amount of sewage to be one hundred and twenty-five gallons per capita per day. Then knowing the discharge in gallons per day, and the percent of grade, we determined the size of pipes to be used by a set of curves based upon Kutters formula, with the constant  $(n=0.013)$ . But under no conditions would we allow a smaller pipe than eight inches, and we also allowed for the fact that owing to the flatness of some of the sewers, the present ones might be replaced by some of steeper grades, and connecting to the proposed system.

In the proposed system, we propose to place man-holes at each corner, and also at the ends of lines which occur mid-

way in a block.

The septic tank should be designed for the maximum flow of 100,000 gallons per day, which will take care of the flow for a few years, and additions should be made as needed. The tank should be covered in order to exclude the light and air, so that septic action which is preformed with anaerobic bacteria will take place. It must be large enough to retain the flow of sewage for from eight to twenty-four hours or longer. The plat should be built in one compartment, in which both the sedimentation and septic action takes place. The estimated cost is \$1,000.00

The following table gives the results of our computations and the sizes of pipes we proposed to use in the different lines.

PROPOSED SIZES OF PIPE.

| From                                  | To                                    | Proposed Sizes. |
|---------------------------------------|---------------------------------------|-----------------|
| Mouth of main trunk sewer             | Cor. of Court St.<br>& Platt St.      | 15"             |
| Cor. of Court St.<br>& Platt St.      | Cor. of Platt St.<br>& Plainwell R'd. | 12"             |
| Cor. of Platt St.<br>& Plainwell R'd. | Cor. of Mitchell<br>& Plainwell R'd.  | 10"             |
| Cor. of Mitchell<br>& Plainwell R'd.  | Cor. of Morrell<br>& Plainwell R'd.   | 8"              |
| Cor. of Morrell<br>& Plainwell R'd.   | The County Drain                      | 8"              |
| Cor. Platt St.<br>& Plainwell Rd.     | Cor. of Wilmot St.<br>& Allegan St.   | 10"             |
| Cor. Platt St.<br>& Court St.         | Cor. Wilmot St.<br>& Court St.        | 10"             |

All other branches and laterals, including the addition on the Hammond street sewer, to be 8" pipes.

#### RECOMMENDATIONS AND CONCLUSIONS.

We recommend that the ends of all lines, not flushed by the county drain, be flushed at regular intervals, not to exceed one week, by one of the methods explained in previous paragraphs, with the use of the fire hose. And as flushing is seldom effective for more than 800 to 1000 feet below the point of entrance of the flushing water, man-holes further down than this should be inspected every few weeks, to insure their clean condition, and flushed out whenever necessary.

Another improvement, which might be added, is to perforate the man-hole covers. These, as they exist now, make perfect<sup>-ly</sup> tight covers over the man-holes, allowing no ventilation through them. By having the covers perforated, considerable circulation will take place, as the cold air will go down through a certain number of them and up through the others. However, the ventilation of sewers is primarily a questions of aesthetics, and not of sanitation.

Because of the fact that sediment has settled in the inverts of the pipes, making a hard coating which is quite deep in places, and which cannot be removed by flushing alone, we recommend a thorough cleaning of all laterals by some mechanical means. The best method to use consists of a heavy plank disk to which three short light chains are

fastened to as many bolts through the disk. One of these chains is attached to each side and one at the bottom of the disk, and their relative lengths are so arranged that when all are taut the top of the disk will incline a little away from the rope. Upon the other side of the disk, at its top, is fastened another rope. By the latter, it is pulled a short distance into the sewer, lying flat; the other rope is then pulled, when the disk rises into an upright position and scrapes along the deposit in front of it. It is well not to draw this too far into the sewer at once, but to clean only a few feet at each trip. The dirt can then be scraped to a man-hole and there removed by buckets. In case the sewer is entirely stopped, so that no cord can be gotten through it, an opening must be forced through. A rod of some kind is used for this purpose.

This sewer system with the improvements and proper attention that we have proposed, and suggested, should give good satisfaction. The county drain will keep the lines, that it is connected to, clean at all times of the year as it is of almost constant flow. And the other lines will not bother if properly attended to.

The system, although not of the most economical design, or of the design to give the best satisfaction, still can be used for from ten to thirty years, and give good service, making the village much better than it was under the old conditions.

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