DECATUR, ILLINOIS SEWAGE DISPOSAL PROBLEM AND A SOLUTION

THESIS FOR DEGREE OF C. E.

FLETCHER AMOS GOULD

1914

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Sewage disposal

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The object sought in this thesis is a general method of solution for the very complex problem of disposing of the sewage of Decatur, Illinois, in such a manner that it will in no way be a public nuisance or a menace to public health. The detailed design is not sought and, in fact, could not be attempted with the limited data obtainable at the present time. Already there has been spent thousands of dollars in obtaining the present available data and it is estimated that it will cost not less than ten thousand dollars to obtain the lacking data which will be necessary before the detailed design can be undertaken.

Decatur, a city of about thirty-five thousand inhabitants, lies in Macon County, in about the central part of the State of Illinois, in the midst of a very fertile, farming community, and is one of Illinois' most rapidly growing cities.

The Sangamon River, which passes through Decatur, serves both as a source of water supply and, at present, as the channel for conveying Decatur's sewage.

In dealing with this subject, I will present my discussion under the following heads:

Historical Sketch,
Visible Evidences of Pollution,
Explanation of Plates and Discussion of the Facts Brought out by Data Contained Therein,
Summary of Facts Brought out from Foregoing Data,
A Solution of the Problem.

To aid in the explanation of the problem, a considerable part of the data is given in the form of tables,

charts, and maps, inserted in the back portion of the book.

Historical Sketch.

In the latter eighties and the early nineties the citizens of Decatur, realizing the necessity for more healthful and sanitary conditions, and knowing that these conditions, could be obtained only by carrying away the stagnant, surplus surface water and the city sewage, which until that time had been carted away in wagons or allowed to run off in open streams, engaged engineers to make the surveys and design a complete combined system of sewers.

Unlike most cities the size of Decatur at that time, the people of this city realized the need of proper drainage as well as sanitary sewage disposal and looked into the future far enough to see that it would be economy to put in the combined system in preference to the separate system, in spite of the fact that the first cost of the combined system was far in excess of the cost of a separate system of sanitary sewers. Little did they realize that they were making a gross error, which many other cities avoided, by no good judgement of their own, for it never occurred to them that the quantity and quality of Decatur's sewage would increase to the point where it would unduly pollute the Sangamon River.

In the Summer of eighteen hundred ninety the first construction was commenced by building a portion of the Broadway Main Sewer, which is a six foot circular sewer, and the Union Street sewer, an egg shaped sewer (36 x 54

inches), from the corner of West Decatur and Church Streets far north into what was then the Northwest portion of the city. Neither of these sewers were built to the river, but emptied into open ditches which ran some distance to the same. Later they were extended to the river, the Union Street Sewer in eighteen hundred ninety two and three and the Broadway in eighteen hundred ninety six.

In eighteen ninety eight the Oakland Avenue Sewer, a five foot circular sewer and the shortest one in the system, was constructed. Nothing more was done except building laterals to these already constructed mains until ten years later when the Seventh Ward Sewer was built. This is a five foot circular sewer and runs from a point west of the city well over to the north central part, covering an immense amount of territory for so small a sewer.

The cost of these trunk sewers alone, to say nothing of the extensions and laterals is as follows:

Broadway Trunk..........	$25,400.00
Union Street Trunk......	41,651.50
Oakland Avenue "	1,840.95
Seventh Ward Trunk......	75,992.14
Total..................	$147,884.59

It was not long, however, after the first constructions were completed before some complaints were heard. These first came from the fishermen, who claimed that the fish caught way down the stream tasted of the wastes from the gas works which were dumped into the sewers. These complaints did not amount to much, being only occasional at first and, in fact, not becoming very consistent or persistent until after the opening of the Staley Starch Factory about four years ago. The down stream farmers soon became very much agitated and on August first, nineteen hundred twelve an indictment was secured against the city, the complaint being that, "Decatur caused filth in the Sangamon River and rendered it unwholesome and impure."

At this time the city being granted a suspension of legal action pending an attempt on their part to correct the difficulty, asked the State Water Survey to help them. In the meantime, the farmers becoming provoked at the prolonged deliberation of the city, which seemed to them unnecessary, took up the matter with the Rivers and Lakes Commission, which commission made investigation and, finding that the city was doing its best, counseled patience. At the present time, the farmers are abiding by this counsel and the State Water Survey has just recently made its report, stating that the river is badly polluted due to Decatur sewage and recommending that the city take steps to purify the same.

Visible Evidences of Pollution.

Plate 2 is a map showing the various points along the river where samples of the water for analysis were taken and where stream gagings were made. These same points or stations show certain visible evidences of pollution which enable one, without further investigation, to see that there is present a very great nuisance if nothing more.

At Station Six, which lies just below the water works dam the water has every appearance of being normal surface water. Although there are points farther up stream where the river is polluted it has become self-purified by the time it reaches the Decatur intake.

Station Seven a couple hundred feet below station six, is below the outlet of Broadway Sewer, the discharge from which completely changes the water and gives the river the appearance, during the stages of low water, of a large open sewer. The sewer discharges into a small cove, which is completely filled with the four smelling sewage, which overflows from this into the river. The sewage is of more than average strength, containing wastes from the gas works and starch factory, and giving off a very strong odor. The gas works waste forms an oily film on the surface.

Several hundred feet farther down is the Union Street Sewer outlet, which opens into an open ditch some thousand feet long thru which the sewage flows to the river. While the discharge from this sewer is in itself sufficient to cause trouble the change which it makes in the river is scarcely noticeable, due to the much greater quantity and worse condition of the Broadway Sewer.

The river continues very filthy between this point and the outlet of the Oakland Avenue Sewer, and bubbles of gas rising indicate that active putrefaction is taking place, while the bed of the river is covered with a heavy black sludge. The Oakland Avenue outlet is about seven

eights of a mile below the Broadway Outlet, and like the Union Street Sewer, does not make much impression on the already grossly polluted river. At this point there is a highway running near the river, and a new residence addition is now being built up here, both of which will be greatly damaged by this pollution.

Station Eight lies just above the Seventh Ward Sewer outlet, and at this point the sludge is not so heavy because of the septic action which has taken place in the slowly moving stream. At this station the river has a black appearance, much in contrast to the appearance at station nine which lies two hundred feet below the Seventh Ward outlet, where the fresh, light colored sewage enters. Occupants of a residence a quarter of a mile south complain of the awful odors from the river. At this point heavy, dark gray, slimy growths begin to appear.

At Station Ten one and one half miles farther down, the river is still black and has a strong odor although this point is just below the entrance of a small creek into the river, which must help dilute the sewage. Complaints come from a residence a half mile away from the river at this point.

At the next station, number eleven, four miles from the Broadway outlet, the river is still dark colored and undergoing fermentation and slimy deposits also appear. Two miles below this station, at Jacobs' farm, cattle pasturing along banks drink the water and become sick and die. Here the stream still has the gray color of polluted water

without sufficient oxygen; the odor is strong, and there is still a thin deposit of sludge on the bed.

Station Twelve, seven miles below the Broadway Outlet, shows the water polluted and large floating masses of greenish black scum are present.

At Station Thirteen, Scroggin's Bridge, nine miles below Broadway Outlet, the water begins to show a change. There is still some sludge on the bottom, but the white starch factory waste is the main substance present. There is some odor.

At Station Fourteen, which is about fifteen miles below Station Six the condition appears about the same as at Station Thirteen.

Twenty-two miles down stream, at Station Fifteen, during the time of low water the river appears perfectly clear and contains small fish although it is said that at times when the water is higher, sludge is brought down, bad odors are noticeable and often times the fish die. This shows that while the water is low the slowly moving stream has time to purify itself, but upon a rise of water the current becomes more swift and quantities of unpurified sewage are brought down even to this point.

Explanation of Plates and Discussion of Facts Brought out by Data Contained Therein.

The data available for use in this discussion includes a map of Decatur showing the present sewer system, water analyses and stream measurements made by the State

Water Survey and others, at and below Decatur, sewage analyses and gagings, and other maps and charts which will be found valuable.

PLATE 1 shows the complete system of combined sewers as they now stand in Decatur. This system is divided into four sections known as follows:- Broadway Sewer, Union Street Sewer, Oakland Avenue Sewer, and Seventh Ward Sewer. Each section is marked on the map in a different color of ink. These sewers, which were designed to serve as sanitary and storm sewers, have already become too small, and at times of heavy rainfall and run-off the sewage bubbles out of the man-holes far back on the trunk lines of each of the three larger sections.

PLATE 2, as previously explained, is a map showing the stations or points on the river where samples of water were obtained for analysis and also where the stream gagings were made, and in general outlines the points of interest in this discussion.

PLATE 3 is composed of two tables giving the results of analysis of the water at different points and on different dates. These analyses show turbidity, color, total residue, chlorine, alkalinity, non-carbonate hardness, total organic nitrogen, free ammonia, albuminoid ammonia, nitrites, nitrates, stability, oxygen consumed, dissolved oxygen, and bacterial content.

The TURBIDITY, TOTAL RESIDUE, and ALKALINITY show very little. The COLOR does not show much beyond being of assistance in visual determination. The high CHLORINE

shows very clearly the influence of sewage and, to some extent, the dilution available and also suggests the fermenting condition of the sludge on the bed, causing it to rise and be disproportionately distributed down stream. In time of low water the NON-CARBONATE HARDNESS seems to be increased below Decatur showing the influence of pickling liquors used in some of the metal working establishments of Decatur. The TOTAL ORGANIC NITROGEN in such large quantities demonstrates that the sludge is in a state of active fermentation. The FREE and ALBUMINOID AMMONIA and OXYGEN CONSUMED show practically the same thing as the organic nitrogen, while in addition the free ammonia indicates the staleness of the sewage and occurs in greatest quantities at time of low water. The NITRITES and NITRATES both appear to reach a maximum together, indicating that oxidation is not keeping pace with nitrification, although the nitrates are not entirely excluded as is the case in more intensive purification works depending on anaerobic bacteria. The RELATIVE STABILITY shows a decrease below Decatur. The abnormal height of DISSOLVED OXYGEN at stations fourteen and fifteen is probably due to the stimulus given to plant life, which gives off oxygen, by the products of decomposition of the sewage pollution above.

The determination of BACTERIAL CONTENT seems to be the most consistent evidence of pollution. It shows a striking increase at every point where sewage enters the stream and traces the pollution farther down the stream

than does any other determination. The quantity of bacteria of intestinal origin is large just below sewer outlets but practically disappears at from seven to nine miles below Decatur.

In general the analytical data from the water of the Sangamon River shows pollution so great that much less sewage would probably pollute the stream just as badly, because the stream flow is so small that it would not even dilute a much less quantity. However, the increased discharge of sewage would probably extend the pollution farther down stream by increasing the velocity of the current.

PLATE 4 contains the analysis of the Decatur sewage. Samples were taken at half hour intervals from five thirty A. M. to ten P. M. The weighted samples which were taken from each sewer were obtained as follows: Each half hour a sample was taken and at the same time the flow was gaged. A portion of each sample, in proportion to the flow as gaged at the time the sample was taken, was put into a vessel and all mixed together. From this mixture a sample was taken and used as the weighted sample of that sewer.

The analysis shows the Broadway sewage the strongest, with the Oakland Avenue sewage only a little behind, the Union Street sewage some weaker, and the Seventh Ward quite dilute, due to its domestic character.

The average for the city seems to be above normal strength. The total residue on evaporation is above normal, the volatile solids twice normal, probably due to starch factory wastes of the Broadway Sewer. The Union and Oakland Sewers also show presence of some manufacturing wastes. Still the weighted average nitrogen content is below normal, the amount of free ammonia, nitrites, and nitrates, showing a comparatively fresh sewage.

PLATE 5 gives the measurement of sewage discharge and shows that the sewers in the order of their quantity of discharge are: Broadway, Union Street, Seventh Ward, and Oakland Avenue.

PLATE 6 is a diagram showing the discharge of the sewers based upon the measurements of plate five.

PLATE 7 is a summary of information contained in plate five.

PLATE 8 is a table showing dilution available for sewage disposal at Decatur.

PLATE 9 gives the results of stream gaging just below the waterworks dam and indicates the small flow during the low water period.

PLATES 10 and 11 show rainfall and run-off at points above and below Decatur and are the basis for the calculations of the same for Decatur, as shown in diagram of plate 12.

PLATE 12. This diagram shows, as brought out by the red line drawn, that for a large portion of the

year, the run-off is not sufficient with the present population. This proportion of the year when run-off is not sufficient will increase with increased population, as shown in diagram for nineteen hundred twenty three and nineteen hundred thirty three, as the run-off is not expected to increase. These are taken from the United States Geological Survey records.

PLATE 13 gives rainfall in inches at Springfield, also taken from U. S. G. S. records.

PLATE 14 is a diagram showing the past and estimated future population and water consumption of Decatur.

PLATE 15 shows, in the form of a diagram, the quantities of diluting water required for various quantities of storm sewage to purify to a non-putrescible state, and based on a minimum necessary dilution for sewage of 5 cu. ft. per thousand persons.

The abscissas represent the number of times dry weather flow and the ordinates represent the amount of diluting water necessary for the particular volume. It will be noticed that it is comparatively large at first, as the proportion of sewage to storm water is large, but at twenty-two times dry weather flow there is no diluting water needed.

Summary of Facts Brought Out from Foregoing Data.

The facts brought out from the foregoing data may be summarized as follows:

FIRST. The Sangamon River is grossly polluted by Decatur sewage for a distance of ten to twenty miles.

SECOND. This pollution forms a public nuisance and is probably a menace to public health and must be removed to the extent of bringing the sewage to a non-putrescible state and reasonably free from suspended matter.

THIRD. The present sewage system is a combined system which, at the present time, is not large enough to take care of the storm flow.

FOURTH. The Decatur sewage is stronger than normal sewage from a combined system of sewers, but is comparatively fresh. It has at present a daily volume of 3,000,000 gal. per twenty-four hours and an estimated probable volume of 4,400,000 gal. per 24 hours.

FIFTH. The stream flow of the Sangamon River is not sufficient to dilute the sewage during a great portion of the year, being likely to be less than 50 cu. ft. per second and sometimes less than taken out for water supply.

SIXTH. As economical a method as is practical, without sacrificing efficiency, must be adopted, as the city is in no condition financially to assume an unnecessary expense.

SEVENTH. The starch factory and gas works wastes increase the strength of the sewage very materially and will make it much more difficult of disposal. The Starch Factory wastes are from six to eight times

normal strength and have a volume of 1,000,000 gal. per twenty-four hours and will probably double. The Gas Works waste has volume of 10,000 gal. per twenty-four hours.

EIGHTH. The sewage is discharged from four different outlets necessitating an intercepting sewer to convey sewage to the site of the treatment plant.

Solution of Problem.

Degree of Purification Necessary.

There have always been two conflicting conceptions, both extreme, of the function of a stream. First, that of those people who advocate keeping the streams completely pure so that they may be available for water supply without any treatment. Second, that of those who feel that all a stream is intended for is to drain off wastes. It is evident that neither is correct, and we must strike an average, by which any given stream may meet the most important need of the community as a whole. This requires that a water supply should always be purified; a fact which is true regardless of how pure a stream appears.

On the other hand, drainage should not be of such a character as to be objectionable to the public. Not only should the stream not give off bad odors and distribute disease, but its appearance should be such as not to be repulsive to the public eye, and furthermore, streams which are used for recreation, as is the

Sangamon, should be pure enough that people would not hesitate to bathe in them.

The Sangamon is a river which is not only used for water supply by cities below Decatur, but which runs through quite a thickly populated country and is used to a considerable degree for recreation purposes in some places, and would be in others if it were not for the pollution. Therefore, it should be kept at a sufficient degree of purity that it can be utilized to the greatest degree of its usefulness by the different interests. This would not necessitate absolute purity, but would require the removal of all matter in suspension, and the bringing of the liquid effluent to a non-putrescible state.

Possible Methods of Treatment

Modern Sanitary Science affords several possible methods of treatment which are considered quite reliable. One of these, or a combination of two or more, will usually be found satisfactory for most any problem or condition. The most important and reliable of these include the following:

1. Chemical precipitation.
2. Intermittent Sand Filters.
3. Contact Beds.
4. Sprinkling Filters.
5. Settling Tanks.
6. Septic Tanks of Imhoff type.
7. Hypochloride treatment for sterilization.

8. Screening.

Chemical precipitation gives quite efficient clarification, but the quality of the effluent compared to that of some other methods does not warrant its use for ordinary sewage, because of the greater cost of operation. As we are looking for economy as well as efficiency this method is out of the question.

The Intermittent Sand Filter as a final treatment, with good management and under favorable conditions, gives the best quality of effluent to be obtained for a given cost. However, it is very expensive of construction where the sand has to be hauled any great distance and, moreover, it requires a considerable area of ground. In this locality the expense of construction for this form of treatment would make it prohibitory.

Contact beds give a fair effluent and are used to a considerable extent for small plants, but the action is very slow and they are, therefore, very expensive for large plants. The size of the Decatur problem is too large for a consideration of this method.

Sprinkling Filters remove from 70 to 90 per cent. of bacteria from the effluent, and, when used with fairly course material in the beds, have a very rapid action. While not giving the highest degree of purification, they reduce the non-settling colloidal and

dissolved organic matters to a point where the effluent will no longer putrify or decompose anaerobically. What suspended matter remains in the effluent is of such a coarse granular nature that it readily subsides in settling basins. Due to their rapidity of action they afford the cheapest available method of reducing the organic content of sewage to the point of stability, or non-putrescibility. In practically all of the large purification projects of America since nineteen hundred five, where it has been necessary to oxidize the non-settling colloidal and dissolved organic matters, sprinkling filters have been recommended for adoption. It, therefore, appears that the Sprinkling Filter is the best adapted to the conditions of the problem under discussion, and will, therefore, be adopted as a portion of the suggested solution.

Settling or Sedimentation Tanks are not recommended as a final treatment, but merely to remove sixty to sixty-five per cent. of the suspended matters as an aid to filtration. The matter removed, known as sludge, must then be disposed of in some one of several available methods.

However, Septic Tanks, and particularly the two story tanks of the Imhoff type, are recommended for the same purposes as the settling tanks, but are far more efficient in that they partly digest the sludge before it is removed, and thereby make the sludge disposal more simple. With these two-story tanks the upper story acts as a settling tank. The sludge is convey-

ed from this story to the lower story where it remains until partly digested. This lower story arrangement removes the trouble of having sludge lifted by the gases and carried off in the effluent, as is the case with the single story septic tanks. The Imhoff Tank is really the only one which is giving complete satisfaction at the present time, and will, therefore, be given consideration.

The Hypochloride treatment is essentially to destroy the bacteria of intestinal origin which still persist after other treatment. It is only used as a final treatment or sterilization for sewage known or suspected to have contained such bacteria and will not be necessary in the Decatur problem.

Screening is a process for the removal, before entrance to the treatment works, of the very large suspended matter which might hinder action in treatment. It is quite essential in some form for all treatment works.

In reviewing the advantages and disadvantages of each of these methods of disposal, it does not seem difficult to see that the treatment best adapted to the requirements of the Decatur problem is the Sprinkling Filter treatment. However, it will not do as a complete treatment in itself, but must be preceeded by a settling tank of some kind. The Imhoff Tank is by far the best one available at the present time and should

be adopted. Then, to preceed this, we should have a screen for removing the larger and more troublesome suspended matter. The effluent from the Sprinkling Filter would be more or less turbid and would leave the water in an undesirable condition for recreation or bathing purposes. Another final Imhoff Tank should, then, receive the effluent from the sprinkling filter and thus remove this coarse granular matter after which the effluent could be turned into the river.

It seems to the writer that it is very desirable, if not absolutely necessary, to treat the Gas Works and Starch Factory wastes separately. It seems, in the case of the Starch Factory wastes, that there must be some method of evaporation which would yield a valuable by-product. If on investigation this does not prove feasible, then some biological method should be adopted and this waste treated separately. Whether the city is forced to assume the burden or the Staley Starch Company is required to do so is another question which does not concern this problem. The Gas Works waste can be satisfactorily treated, as suggested by studies made by the Massachusetts State Board of Health, by sedimentation of the wastes, assisted by treatment of lime and followed by a rapid filtration through some coarse filtering material.

The next question which confronts us is what quantity of sewage to treat. As we have seen, there is at present a combined system of sewerage which, though not adequate for all possible story flow, does very well

for the dry weather flow and for the flow caused by the average storm. These sewers empty into the river at widely separated points and an intercepting sewer would be necessary to convey all the sewage to one point for treatment, or build several plants at the several outlets. The latter would be very poor policy, being much more expensive in first cost and maintenance.

It has been suggested that an intercepting sewer large enough to carry three times dry weather flow be built to conduct this amount of sewage to the plant for treatment; when flow exceeds that, to run the sewage through sedimentation tanks at the outlets and discharge directly into the river, it being argued that when flow is over three times dry weather flow, it will be sufficiently diluted to be turned into the river after removing that portion of the solid matter which would be deposited by a rapid passage through a sedimentation tank. As you will notice from table 15 this brings it very close to the limit, requiring fifty cubic feet per second dilution, which figure is hardly dependable in the Sangamon.

Moreover, the question of economy comes in here for consideration. Treatment works of the type suggested, herein, including filter beds, land, septic tanks, screens, buildings, etc., would cost, for three times the dry weather flow which is expected within ten years, in the neighborhood of $500,000, $240,000 being necessary for the filter beds alone, based on Mr. Geo. W. Fuller's estimate of $40,000 per acre of two million

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gallons daily capacity. In addition to this there would be the expense of the intercepting sewer and the sedimentation tanks.

Should we consider treating only the dry weather flow, it would be necessary to keep the storm water and the dry weather flow separate, requiring a separate system of sewerage. A treatment works for the estimated dry weather flow of nineteen hundred twenty four (4,400,000 gallons per day), based on the same figures as used above, would cost about $210,000, thus leaving $290,000 to reconstrut the present sewer system into a separate system. This would mean the construction of an entire, new, sanitary, sewer system, utilizing the present system for a storm sewer only. True, this system is not at present large enough to take care of the storm water on certain occasions, but it would certainly be as capable of doing it after the dry weather flow was removed as at present. The $290,000 above mentioned would easily construct the sanitary system designed to discharge at the chosen location of the treatment works, thus saving the city the price of the proposed intercepting sewer and the sedimentation tanks.

It might occur to some that the trouble caused by tearing up the city to construct the new system would off-set the reduction in cost, but it appears to the writer that, with the large number of public alleys in the city, the small portion of the cost of the inter-

cepting sewer and the sedimentation tanks which it would require to obtain the right-of-way over the rear of private lots would still leave a considerable portion of the reduced cost, as saving. Placing the sewers in the middle of the blocks would avoid any destructive tearing up of the city. Later, when the city of Decatur has recovered from the burden of purifying its sewage, it could add a sufficient number of storm sewers to adequately take care of the storm water.

Conclusion.

Taking everything into consideration, it seems that the best solution for the problem is as follows:

1. Convert the present combined system of sewerage into a system of storm sewers, to be extended and completed when the city sees its way clear, financially.
2. Construct a separate system of sanitary sewers designed to discharge at one point chosen as the site of a sewage treatment plant.
3. Choose this site at some secluded point along the river lowlands below the city. There is plenty of chance for a good site.
4. Construct on this site a treatment works which will include the following:
    - (a) Medium Bar Screens,
    - (b) Primary Imhoff Two-Story Septic Tanks,
    - (c) Sprinkling Filter Beds,
    - (d) Secondary Imhoff Two-Story Septic Tanks.

5. Use separate treatments for the wastes from the Starch Factory and Gas Works as suggested elsewhere.

With this method of treatment, conducted in an intelligent manner, it is thought there will be no further complaint of the pollution of the Sangamon River by Decatur Sewage.

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Plate 5

Measurement of Sewer Discharge at Decatur. Dec. 21,

Quantities expressed in cubic Ft. per second

Time	Broadway	Union St.	Oakland	7th Ward.
5:00 A. M.	4.320	.585	.0514	.128
5:30	4.945	.585	.0788	.178
6:00	4.640	.621	.0580	.178
6:30	3.123	.641	.0336	.178
7:00	2.372	.679	.0863	.204
7:30	2.795	1.003	.144	.204
8:00	2.980	1.110	.152	.204
8:30	3.085	1.178	.180	.204
9:00	3.308	1.315	.161	.204
9:30	3.160	1.361	.101	.244
10:00	2.980	1.430	.190	.244
10:30	2.867	1.455	.135	.244
11:00	3.160	1.269	.110	.244
11:30	3.308	0.982	.118	.244
12:00	2.900	1.269	.126	.302
12:30 P. M.	2.867	1.178	.110	.302
1:00	2.940	1.134	.144	.302
1:30	2.900	1.090	.151	.302
2:00	3.085	1.269	.144	.273
2:30	3.308	1.224	.135	.273
3:00	3.384	1.292	.126	.273
3:30	3.500	1.224	.110	.273
4:00	4.644	1.012	.101	.273
4:30	5.350	1.068	.0717	.273
5:00	6.000	1.154	.0646	.244
5:30	5.270	1.134	.0580	.244
6:00	4.001	1.068	.0580	.244
6:30	2.867	.919	.0863	.244
7:00	2.442	.940	.0938	.191
7:30	2.867	.961	.161	.191
8:00	2.795	1.003	.144	.332
8:30	2.652	.983	.0788	.259
9:00	2.652	.961	.0863	.244
9:30	2.652	.919	.144	.244
10:00 P. M.	2.581	.919	.0863	.244
Average	3.391	1.055	.116	.277

Plate 5

Measurement of Sewer Discharge at Decatur. Dec. 21,

Quantities expressed in cubic Ft. per second

Time	Broadway	Union St.	Oakland	7th Ward
5:00 A. M.	4.320	.585	.0514	.128
5:30	4.945	.585	.0788	.178
6:00	4.640	.621	.0580	.178
6:30	3.123	.641	.0336	.178
7:00	2.372	.679	.0863	.204
7:30	2.795	1.003	.144	.204
8:00	2.980	1.110	.152	.204
8:30	3.085	1.178	.180	.204
9:00	3.308	1.315	.161	.204
9:30	3.160	1.361	.101	.244
10:00	2.980	1.430	.190	.244
10:30	2.867	1.455	.135	.244
11:00	3.160	1.269	.110	.244
11:30	3.308	0.982	.118	.244
12:00	2.900	1.269	.126	.302
12:30 P. M.	2.867	1.178	.110	.302
1:00	2.940	1.134	.144	.302
1:30	2.900	1.090	.151	.302
2:00	3.085	1.269	.144	.273
2:30	3.308	1.224	.135	.273
3:00	3.384	1.292	.126	.273
3:30	3.500	1.224	.110	.273
4:00	4.644	1.012	.101	.273
4:30	5.350	1.068	.0717	.273
5:00	6.000	1.154	.0646	.244
5:30	5.270	1.134	.0580	.244
6:00	4.001	1.068	.0580	.244
6:30	2.867	.919	.0863	.244
7:00	2.442	.940	.0938	.191
7:30	2.867	.961	.161	.191
8:00	2.795	1.003	.144	.332
8:30	2.652	.983	.0788	.259
9:00	2.652	.961	.0863	.244
9:30	2.652	.919	.144	.244
10:00 P. M.	2.581	.919	.0863	.244
Average	3.391	1.055	.116	.277

Plate 7.

Summary of Sewage Flow Measuremen

on Dec. 21, 1912.

Name of Sewer	Av. Discharge in cu. ft. per Second	Av. Discharge in gal. per 24 hours.	Minir in ga 24 h
Broadway	3.15	2,040,000	1,5
Union St.	0.787	510,000	37
Oakland	0.0974	63,000	2
7th Ward	0.248	161,000	115
Total	4.282	2,774,000	

Plate 8.

Showing dilution available for Sewage Disposal at Decatur. (Based on measurements made by State Water Survey)

Date	Discharge		
	Sec. Ft.	Gal. per Day	Sec. Ft. per 1000 population *
Nov. 30, 1912	89.5	58,000,000	2.52
Dec. 20, 1912	66.9	43,300,000	1.91
July 7-11, 1913	25.0	16,173,000	.72
Aug. 5-7, 1913	0.18	114,000	.005
Sept. 25, 1913	2.01	1,418,000	.06

* Present population of Decatur = 35,000.

Plate 9.

Stream Gagings of Sangamon River below Dam at Decatur Ill.

Date	Sec. Feet	Gallons per day
Nov. 30, 1912	89.5	58,000,000
Dec. 20, 1912	66.9	43,300,000
July 7-10, 1913	25.0	16,173,000
Aug. 5-7, 1913	0.18	114,000
Sept. 25, 1913	2.01	1,418,000

Plate 10.

Rainfall and Runoff at Monticello - Sangamon River

Watershed Area 550 square miles.

Season	Rainfall — Avg. Sec. ft. on Watershed: Normal	Actual	Percent Departure	Run-off sec. feet: Maximum	Minimum	Mean	Percent of Rainfall
Spring March - May 1908	1700	2635	54.9	9,280	505	2,033	73.4
Summer June - August, 1908	1764	1520	-13.8	756	8	111.	7.3
Fall September - November 1908	1158	571	-50.6	25	6	8.9	1.6
Winter December, 1908, - February, 1909	1093	1195	9.3	3,120	11	321	27.0
Spring March. - May, 1909	1700	2220	30.7	2,880	182	664	29.8
Summer June - August, 1909	1763	2155	22.2	8,720	11	517	24.0
Fall September - November, 1909	1158	1326	14.4	320	10	48	3.6
Winter December 1909 - February 1910	1093	1140	4.3	2,120	128	536.	47.0
Spring March May, 1910	1700	1080	-36.5	1,480	74	283	26.2

Plate II.

Rainfall and Runoff at Riverton – Sangamon River

Watershed Area 2560 Square-miles

Season	RAINFALL Av. sec. ft. on watershed			RUN-OFF SEC. FEET			
	Normal	Actual	Percent Departure	Maximum	Minimum	Mean	Percent of Rainfall
Spring March – May, 1908	7110	11,340	59.5	13,100	1,830	5,867	51.7
Summer. June – August, 1908	8420	8,040	– 4.5	3.320	101	526	6.5
Fall September – December 1908	6120	3.110	-49.2	148	60	85	2.7
Winter December 1908 – February 1909	5000	5 540	10.8	179	101	785	14.2
Spring March – May, 1909	7110	9,590	34.9	5,580	856	2,783	29.0
Summer June – August, 1909	8420	8,970	6.5	10,600	148	2,285	25.4
Fall September – November 1909	6120	6,340	3.6	254	148	371	5.9
Winter December 1909 – February 1910	5000	4,970	– 0.6	7,020	– –	1,708	34.2
Spring March – May 1910	7110	6,060	-14.7	6,020	344	1,970	32.5

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