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A STUDY OF THE ECONOMIC HISTORY OF
THE
STATE OF MICHIGAN

A Thesis submitted to the Faculty
of
The Michigan Agricultural College

by
Clare E. Slaughter and Harry F. Hull

Candidates for Degree
of
Bachelor of Science

June - 1924

THESIS

2000

To Professor Herman Wlock Vedder C.E.,
Professor of civil engineering at the
Michigan Agricultural College this book
is gratefully dedicated.

The authors of this book are very thankful to Major Rich and Mr. Willard Sheppard both of the Michigan Department of Health for their willingness to produce data, to give advice, and to help us in preparing our thesis. Also for their time which they so willingly gave in consultations with us.

The authors.

OBJECT

The object of this thesis is to determine which of the different methods of sewage disposal and sewage treatment is the best and under what condition is this method the best.

The factors entering into the treatment of sewage or the disposal of the sewage are many and each one is different in almost every case that arises.

The kind of sewage to be treated or disposed of. The variations in the quantity. The character of the sewage. The amount of money to be spent on the plant. The stability which must ultimately be obtained. The final disposal of the sludge and the effluent. All of the factors enter into the design of the plant and the method which must be used.

Our aim is to determine the the plant which is the most favorable taking into account all of these variables.

INTRODUCTION

INKEFF TANKS

Probably the most notable advance in tank treatment of sewage resulted from the research of Dr. Carl Inkeff in Germany about twenty years ago.

Dr. Inkeff believed that it was unnecessary and unadvisable to pass any portion of the sewage through the liquifying chamber as this would necessarily affect the anaerobic conditions and disturb the seeding action. He therefore developed the two story type known as the Inkeff or Moscher tank.

This type has been widely adopted in the United States.

In Michigan eight out of eighteen municipalities use the Inkeff tank, with secondary treatment. As a rule they have given excellent service although some tanks seem to have an inherent tendency toward violent foaming which sometimes causes large quantities of sludge to rise to the surface and overflow.

Generally there is a scum which accumulates on the top of the liquid in the gas vent. Due to an accumulation of this gas beneath the surface of the scum a difference of head occurs due to the pressure of the gas forcing the liquid down. When this head becomes too great for the settling action of the scum to keep in equilibrium the scum and sludge is forced up the gas vent and over the sides in a manner which resembles boiling.

Numbers of ways for stopping this action are suggested and when done they accomplish the desired results. Any means which will help to settle out the floating material may be applied when this scum appears.

If scum accumulates on the sedimentation chambers it should be removed or forced to settle to the bottom just as that scum on the gas vent chamber. This idea is to allow the gas to escape and to force all solid matter to the bottom.

The grit chambers of the tank should be cleaned out. If this is not done occasionally they will become filled up with grit and other refuse and that which is constantly coming into the grit chamber will pass over this refuse on into the sedimentation chamber. The idea involved is to have a device which will catch all heavy matter which the bacteria can not break down.

SEPTIC TANK

A septic tank works practically on the same principle as the Imhoff tank does. The detention period is usually six to eight hours longer. With the septic tank the digesting matter is not separated from the incoming sewage and hence the flow thru the tank must of necessity be much less in velocity so that the anaerobic conditions and the seeding action is not disturbed. This tank accomplishes the same results that the Imhoff tank does.

The sludge is accumulated and allowed to digest in the bottom of the tank the same as in the Imhoff tank. It may be drawn off with a slight pressure due to a difference in head between the surface of the sewage and the elevation to which the sludge must be raised.

CONTACT AND SAND FILTERS

The contact filter may be continuous or intermittent. In either case the action is the same. The sewage is allowed to trickle down thru the bed. In the way down small particles settle out on the stones. When the oxygen finds its way down to these stones either during doses or while the sewage is trickling down it comes in contact with this sediment and with the help of the bacteria oxidizes these small particles and in this way makes the effluent a stable product.

The sand filter accomplishes this same act only the time required is a little more than with the contact filter.

With the sand filter the effluent is a little clearer but in either case the product may be made stable with the proper attention given toward the operation of the plant.

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In 1911, by an act of the Legislature of the State of Michigan, Act 10, known as the "Act 101 Bill," brought under the control and supervision of the Michigan Department of Health all of the sewage treatment works operating in the State.

The main object of this act was to see that all plants were operating to their best efficiency. Also to regulate the sanitary conditions about the plants and give helpful information to the authorities operating these different plants for the municipalities.

In order to keep themselves informed as to the operation of these sewage treatment works, the Michigan Department of Health in 1912 required each operator to fill out a standard report blank and file it with the Department. This report covered the following: amount of tests were made, gallons of sewage treated each day, weather conditions, number of tanks in use, depth of sand and sludge, appearance of tanks, settling solids in the tank influent and effluent, contact beds of filters in use, and the settling solids and stability of the effluent from the filters or contact beds.

The report also only required two tests which are those for settling solids and stability. The test for settling solids is made as follows: 1000 cc of the influent or effluent is placed in an Imhoff cone and allowed to remain quiet for one hour. At the end of the hour the amount of solids settled out is recorded and written down

on the report blank. This test gives approximately the action of the tank and when made with both influent and effluent will give approximately the efficiency of the tank.

The test for stability is made by filling a four ounce glass stoppered bottle with the effluent and adding to this one cc of a .05 per cent solution of methylene blue. The bottle is allowed to stand until the blue color is gone and the number of days necessary for each bottle to become colorless is then recorded. If the sample retains its color for four days it is considered stable.

THE INSPECTIONS

On April 11, 12 a trip and inspection was made by Mr. J. Sheppard of the Michigan Department of Health, Claude Slaughter, and Harry Hall to the plants at Howell, Northville, Eloise, Dearborn, Springville, Grosse Pointe, and Livonia and on April 14, 15, 16, we carried on another inspection of the plants at West Grosse Pointe, Ecorse, Lincoln, Fremont, Cadillac, and Grand City.

A report on the operation of the plant, report of the tests, and a diagram of each plant accompanied with map sheets of the plant will follow in the same order as the plants were visited.

This part, which covers the state-of-the-art literature, consists of: the test set setup, test set and a synthetic filter. The old test, which is 17' x 3' x 3.5' (cover) was found to be too small and old.

Sheppard was called upon to feed the run of Bay on one which is 45' long, 11' wide, and 7' average depth. This tank has a 12 hour detention period and is well mixed with the smaller one doing the secondary treatment. Water flows out a sufficient amount of the water so that after the effluent leaves the circulating filter it is stable.

This new tank, which was put into operation in 1981, is able on the average to serve of the entire population of the institution which is about 500 persons. The total area covered by the plant is about 1/2 acre and it is situated on the side of a hill so that all of the sewage, effluent, and sludge are handled by gravity.

The plant was built solely for the purpose of preventing a nuisance. Here-to-fore the raw sewage was discharged into the Milwaukee River and not only the effluent reached this river, but the sludge it flows over and used as fertilizer on the farms of the institution.

There are two methods of measuring the quantity of sewage at this treatment work. One is by the means of an accurately leveled weir and the other method is by the use of a float and counter or tallies installed in the discharge. At intervals of time, the capacity of the receiving

chamber, and the number of sprinklers being known, the number of gallons can easily be calculated.

The dosing chamber is of irregular shape, being 5' square on the top, 2' square on the bottom, 4' deep, and having one perpendicular side. The irregularity of the shape of this dosing chamber is for the purpose of distributing the same amount of influent on a unit of the contact bed as the radius of the sprinkling is decreased due to a decrease of the head in the dosing chamber.

At the time of the visit, the sprinkling filter was not in operation and the sewage was being by-passed into the river. The dimensions of the filter are 40' long, 40' wide, and 5.5' deep with sprinklers spaced so that rectangles are made 7' x 6.5'. The filter is filled with coarse stone ranging from 1" to 5" in diameter and leaving about 55 per cent of voids.

The underdrains for the filter are composed of 4" vitrified tile for laterals and an 8" main which leads to the outfall into the river.

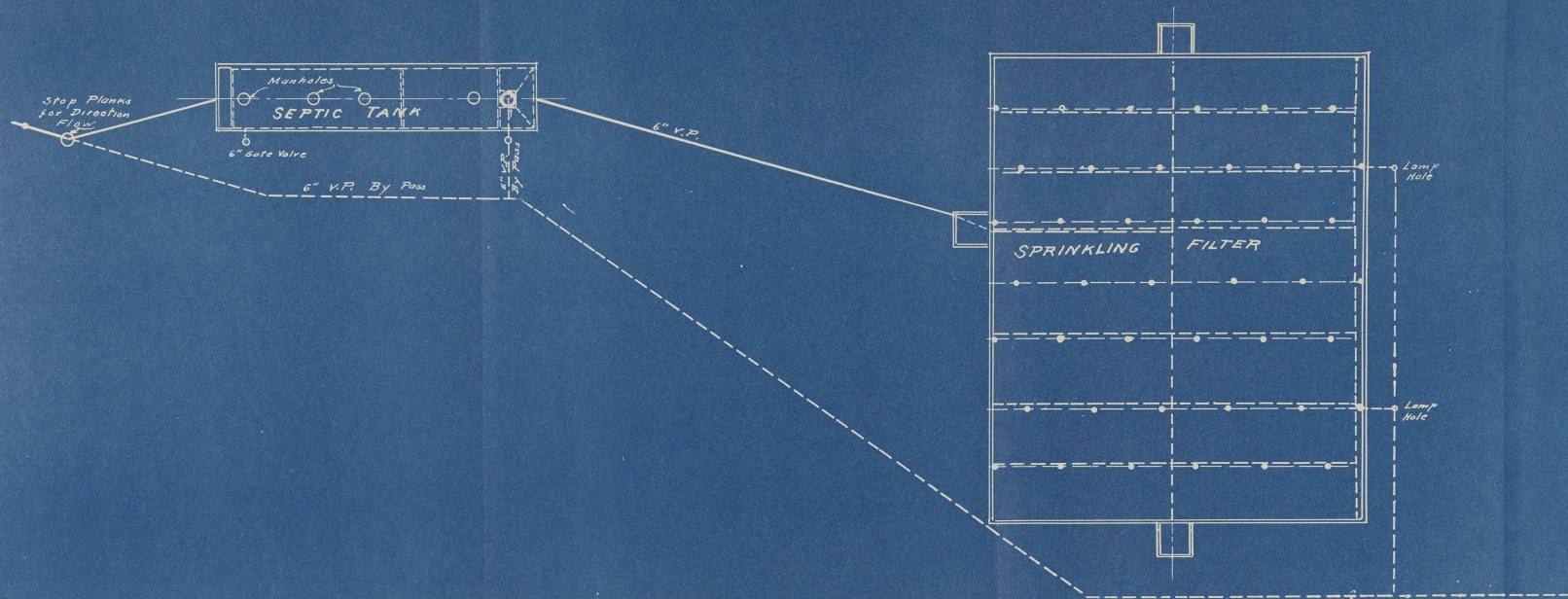
The grounds of the plant are rough and sloping and present a poor appearance. This is probably due to the fact that the new plant was just completed last year and the caretaker has not had the opportunity to clean the grounds up. Both tanks are roofed over. The purpose for putting roofs over these tanks is to keep the sewage from freezing and to keep the snow out. If too large a sheet of ice is formed the concrete might be cracked and it is

advisable for this reason to brood no any ice which might form. The appearance of the sedimentation chambers was very favorable. There was no scum on these tanks, probably due to not having been in operation very long. There are practically no odors from the tanks and are none at a distance of 20 feet. This plant is typical of most state treatment plants and institutions.

LIGHTS



Here is the view of the septic tank with the old tent in the right background. The general slope of the ground can be seen also.



GENERAL LAYOUT OF DISPOSAL PLANT AT

STATE TUBERCULOSIS SANATORIUM

HOWELL MICHIGAN

Date May. 24 1921

Scale 1" = 10'

THE MOUNTVILLE PLANT

This plant, which was designed by Mr. C. W. Habbell, consists of an Imhoff longitudinal flow tank, a dosing chamber with four 18" Miller siphons, and four sand filters.

There is at present very few house connections contributing sewage to this plant. This is due to the fact that their sewer system has been laid very recently and their disposal plant, still more recent, was completed in 1925.

The population of the town is about 1600 and the plant is designed to handle the sewage from this amount but due to the fact that there are so few house connections installed and there being no industrial wastes, the sewage is very dilute and is easy to handle with but little attention given to the plant.

The plant is situated at the city limits and about 3/4 of a mile from the center. A branch of the Long River flows around two sides of the plant and would, at the time of the visit furnish enough water to dilute the sewage so that it would be safe to empty the raw sewage into it, but we were told that in dry weather the stream practically dries up and the raw sewage would make up the greater part of the flow. Obviously the plant's purpose is to prevent a nuisance as there is no fish supply, water supply or bathing beach to protect.

At the end of the Imhoff tank is a grit chamber 7' long, 18" wide, and 2' deep. The design is such that

the flow may be reversed at will. After the sewage leaves the grit chamber it flows over two weirs into the Imhoff tank. There are two sedimentation chambers and three gas vents in the tank. Across each sedimentation chamber are three baffle boards.

They serve to hold back any scum which might accumulate and also to deflect floating material downward toward the sludge digestion chamber. The detention period of this tank is about two hours. The depth of the tank is $22\frac{1}{2}'$ and the ratio of length to depth of sedimentation chamber is 4.8 to 1 and the ratio of length to width of the same is 10.5 to 1. The slope of the bottom of the sedimentation chamber is 1 to 1.45, while that of the bottom of the sludge digestion chamber is 2 to 1. In this particular Imhoff tank there is twice the sedimentation area that there is gas vent area. The capacity of the sludge digestion chamber is 5400 cubic feet and that of the sedimentation chamber is 2325 cubic feet. The sludge may be drawn off thru three 8" cast iron pipes under a head of 5.75' into a sludge bed having an area of 2850 square feet.

The dosing chamber is covered over with a concrete slab and is operated by four 12" Miller siphons which work intermittently. The drawing depth of these siphons is $2\frac{1}{2}'$

The oxidizing device at this plant consists of four sand filters. These four units take up a total area of 1.5 acres of sand 2' deep. The effective size of the

sand being .55 mm. The dosing is done by these automatic siphons so that the filters must alternate their working time. That is, while filters two, three, and four are filling, emptying, and standing full, filter number 1 is resting.

The effluent of the tank is run onto the filters thru small holes cut in the sides. One dose covers the filter to a depth averaging 2.2". It then filters down thru the sand to the underdrains and is conveyed off thru the mains to the river.

The underdrains consist of 4" tile laterals and 6" mains laid on a .25 percent slope. The mains empty the sewage into the Rouge River as before mentioned.

The plant as a whole was very neat. The levees around the filters and the banks about the tanks were well sodded. The filters had a slight amount of sediment on them but this must be overlooked, because during the winter the beds can not be worked and it was, at the time of the inspection, still too wet to do any work on them. There was quite an amount of scum on the sedimentation chambers and the grit chamber was almost full. Undoubtedly the plant had not been cleaned out as yet because the flow thru the tank had not yet been changed nor had the sludge bed been used. The gas vents were considerably filled up with material. Although there was considerable digestion of sludge the floating material should be broken up with a fire hose stream of water or else a rake.

The effluent from the filters was very clear. No information as to the stability or amount of settleable solids is as yet available because of the recent installation but judging from the dilute sewage, the clear effluent from the Imhoff tank, the long detention period in the dosing chamber, the cleanliness of the sand filters, and the very clear filter effluent we were told by Mr. Sheppard that the effluent is undoubtedly stable.



This view shows the top of the feeding channel with steel covers above it here. The end of the Intertank is in the foreground.



Here can be seen the wooden distributing tank. The sand is removed at that when the ice freezes it will be held up by the little mounds of sand and allow the rest of the water to filter away.



This shows three of the filters with part of the sludge bed in the foreground. Note the raised levees separating the filters and at the far ends.

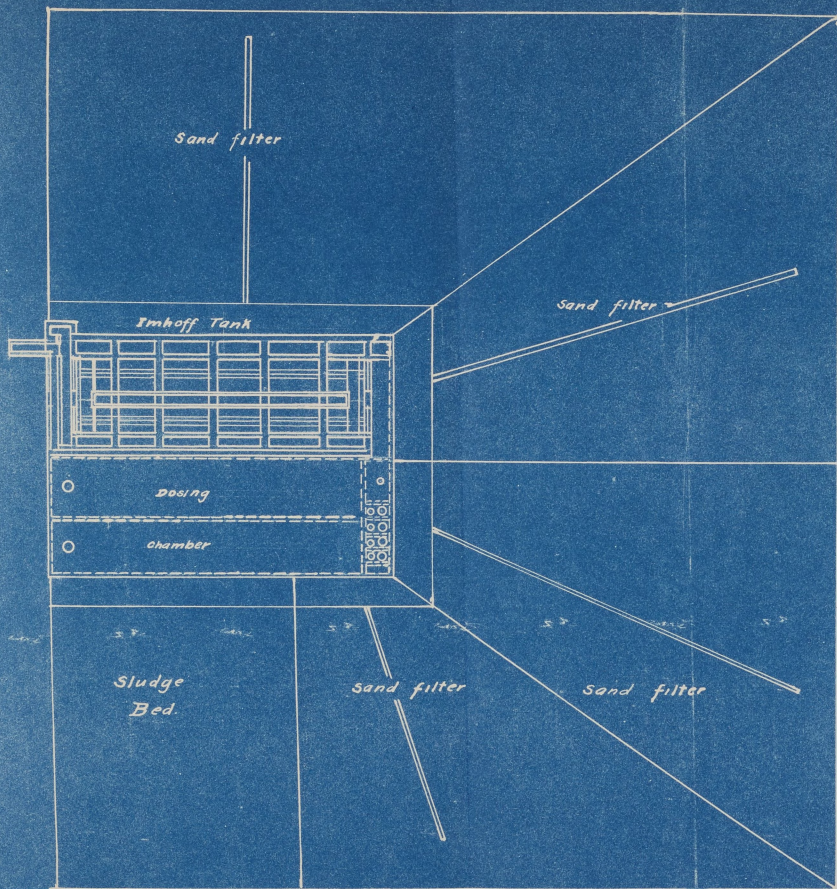


The dark spots at the left corner are caused by leakage. Note the poor concrete about these spots.



This shows the tile and the effluent, and also the
the trough. The small opening in the side of the trough
with the flow that then can be seen. This has cleared the
level and sand is.

GENERAL LAYOUT OF DISPOSAL PLANT
NORTHVILLE MICHIGAN



THE ELLIOT PLANT

This plant was designed to take care of 100 per cent separate sewage of the entire population of 2400 at the Wayne County Farm. It was designed by engineers Road and Pecker and started operation in 1916. The reason for having a sewage treatment works at Ellioise was to prevent a nuisance. Here-to-fore the raw sewage was emptied into the South Branch of the Rouge River and at certain seasons of the year this stream furnishes an insufficient amount of water to dilute the raw sewage beyond the danger point.

This plant, which covers a total area of 1 1/2 acres, consists of a screen chamber, a horizontal flow Imhoff tank, a dosing chamber, 6 contact beds and 7 sludge beds. The entire sewage is handled by gravity.

The screen chamber consists of a concrete tank about 8' by 4' and about 3' deep. Across the entire width of the chamber is placed a bar screen inclined at a slope of 5 to 1. The bars are 1" x 5/16" x 4'7" long. Every day the screenings are raked off and placed in a large ash can.

The Imhoff tank is a round horizontal flow tank and has a detention period of about four hours. The sewage is emptied into one side of the tank and flows up to and under a baffle board which deflects it downward. It has two channels in which to flow; one on each side of the gas vent which is in the center of the tank. The solids settle out and fall down into the sludge digestion chamber. The

effluent as it leaves the tank has 95 percent of the settleable solids taken out.

The capacity of the sedimentation chamber is 43,750 gallons and that of the sludge digestion chamber is 25,740 gallons. The tank is 23.9' deep, with a ratio of length to depth of sedimentation chamber of 5.5 to 1, and a ratio of length to width of the same of 2.5 to 1. The slope of the bottom of the sedimentation chamber is 1 to 1.25 while the slope of the bottom of the sludge digestion chamber is only 2 to 1. The area of gas vents to total sedimentation area is 1.0 to 16. This seems very small but due to the character of the sewage, the kind of tank, and the care taken in operating the plant, this is sufficient area to produce an odorless sludge and a highly settled out sewage. The velocity of flow in the sedimentation chamber is .13 of a foot per minute.

The sludge is drawn off due to a head of water in the Imhoff tank by a 5" wrought iron pipe into four 10' by 10' sludge beds giving a total area of 1200 square feet. The area of sludge bed per capita is .5 square feet. When the sludge is dry it is forked into wagons and drawn out upon the farm land and used as fertilizer.

As before mentioned, the oxidizing devices are contact beds. These six beds are almost triangular and have a total area of 14,400 square feet or an area for each bed of 2400 square feet. The beds are 4.5' deep with 33 per cent of them voids. The sewage treated is at a

rate of 1,000,000 gallons per acre per day or 152,000 gallons per day for the 6 beds. They operate on an 8 hour cycle. This gives the bed plenty of time to stand full, to drain, to allow the bacteria to function, and to allow the voids to fill up with fresh oxygen. The distribution system is just below the surface of the stone and consists of whole 4" vitrified tile for laterals and 10" mains. The underdrains are half tile, 4" laterals and 12" and 15" mains. These 6 beds are filled with crushed limestone ranging from 1" to 2" in diameter.

At the time of the visit they had just completed cleaning one of the beds. This cleaning consisted of taking all of the stone out and washing them thoroughly over a 1" screen and also washing out the bottom, sides, and underdrains of the filter. We were informed by the superintendent of the institution that the bed was not very dirty and that it had, in the past, done its share of the work for six years. Upon personal inspection we noticed that the counters for each dosing chamber read very nearly the same. This shows that the plant has had a steady run with but few shut-downs during the seven years of operation. These counters on the dosing chambers together with the flat weir compose the measuring apparatus of the plant.

The plant is very neat in appearance. The grounds are well sodded, shrubbs are planted here and there, a wire fence is built around the Imhoff tank primarily to prevent accidents among the inmates and secondarily to form a support for vines to grow on and hide the tank from view.

This tank was the cleanest one which was seen on our inspec-

tion trips. There was absolutely no scum on the sedimentation chamber and but very little scum on the gas vent. They were getting very good sludge digestion at the time of the visit. This is readily told by the amount of gas ebullition. This plant was the best of its kind seen and proves that with the proper quantity of care, regardless of the quality, because most of the labor at this institution is furnished by the inmates, fairly concentrated domestic sewage can be treated easily and satisfactorily.



Here is the ILLINOIS tank with the fence and wires about it. The gas vent pipe is seen in the center of the tank. The concrete tilled sludge beds are in the left side of the picture and half way up. Note the fine layer and sludge, also the clean surface of the water in the tank.

This is the distillation house in the center of this six unit hexagonal contact bed. The bridge in left background is over the South Branch of theauge River into which the catfall sewer empties.

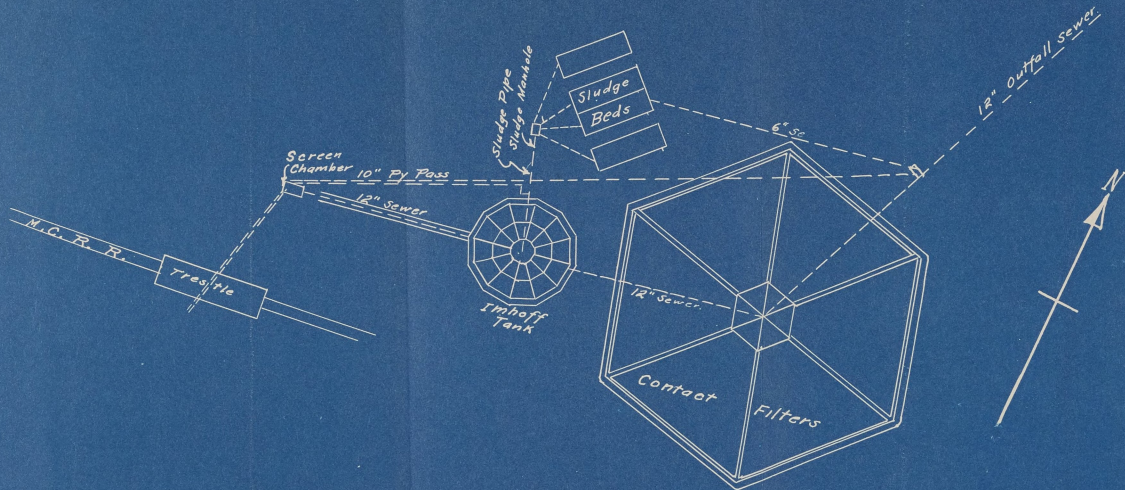


GENERAL LAYOUT OF DISPOSAL PLANT

WAYNE COUNTY INSTITUTIONS

ELOISE MICHIGAN

Scale 1" = 40'



THE DEARBORN PLANT

This plant consists of an Imhoff tank, grit chamber, and sludge beds. Mr. C. W. Hubbell, who designed this plant, completed the construction, and set this plant into operation in 1917.

There is no oxidizing device at this plant. This is due to the fact that the outfall is in the Dearborn River and since it is possible that the river will never be used as a source of water supply it is needless to treat the sewage any more than to take out the settleable matter and digest it. The sole purpose of the plant is to prevent a nuisance.

The plant was designed to take care of a population of a little over 2500 people, or about 250,000 gallons per day. It is situated about one mile from the center of Dearborn. The total area covered by the works is almost one acre.

At this plant they are not so fortunate in having their sewage handled by gravity and hence must use pumps. Two centrifugal pumps are used, one 6" and one 4", and both operating against an 8' head. The measurements of flow are taken by weir readings.

The tank is of the Imhoff radial flow type. The sewage after leaving a small grit chamber is carried thru a pipe to the center and from there it flows at a very slow rate to a number of weirs in the circumference of the tank. Here it is collected in a trough encircling the tank and

is carried off and emptied into the Fluge River. It was stated before there are no oxidizing devices and therefore no stability tests are made. The only test made is the one for settleable solids. This tank settles out 90 per cent of the solids. This percentage is considered very good.

The detention period of this tank is two hours theoretical for a 500,000 gallon flow per day. The capacity of the sedimentation and of the sludge digestion chambers are 50,000 and 25,000 gallons respectively. The tank is 26' deep. The slopes of the bottoms of the sedimentation and the sludge chambers are 7 to 9 and 11 to 5. The ratio of gas vent area to sedimentation area is 1 to 24. This is still smaller than the Aloise plant but as yet no difficulty has been encountered due to too small a gas vent area. The sludge is drawn thru two cast iron sludge pipes by a 4" centrifugal pump.

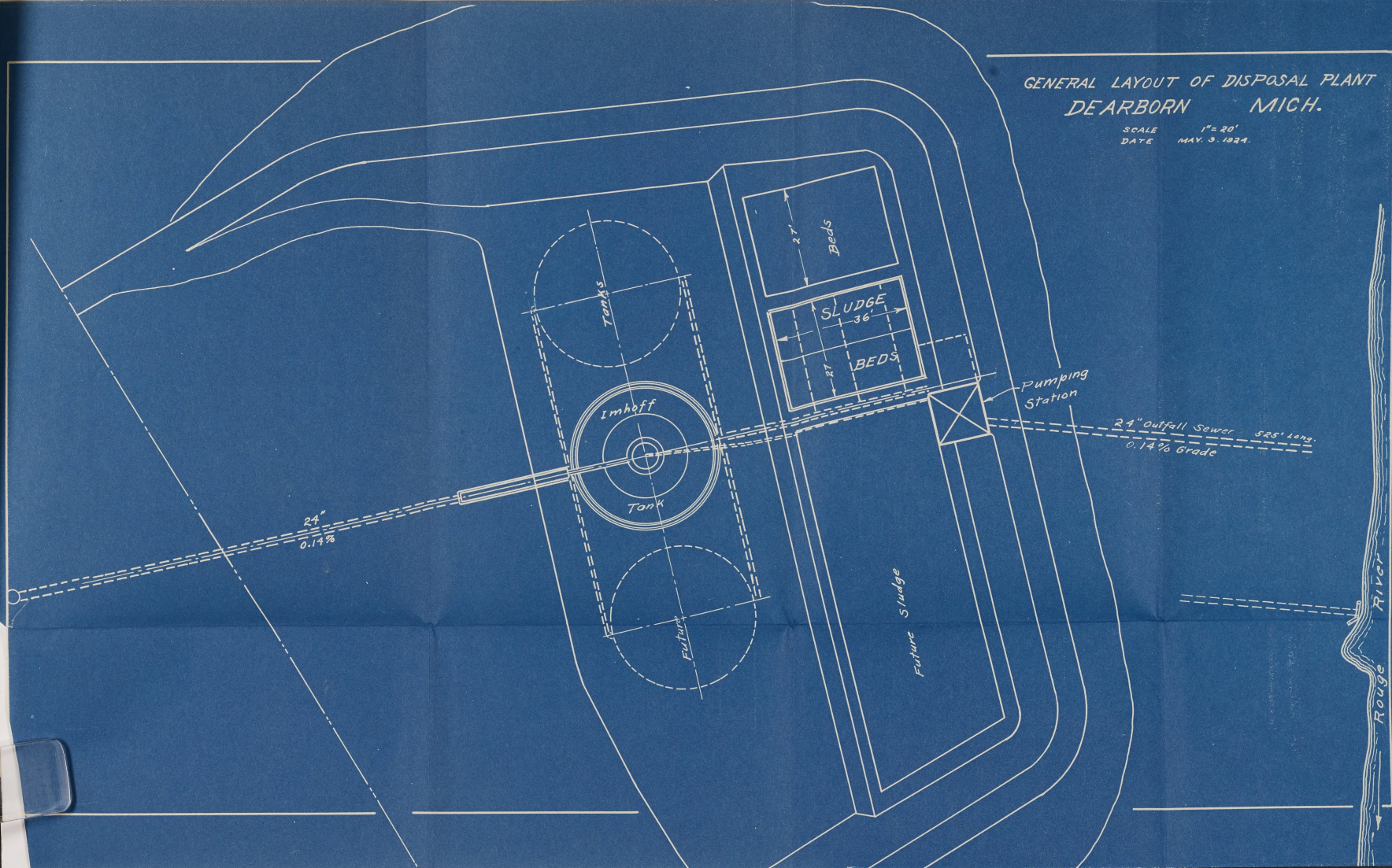
There are two sludge beds at this plant. The size of each is 27' by 50' and together they make a total of 1350 square feet of area. This gives .7 of a square foot per person contributing sewage to the plant.

At the time of the visit the plant was in very poor condition. The sewage was being by-passed into the river and the Inhoff tank was pumped dry. They had built a levee around the tank of sludge, silt, mud, and all kinds of debris. Two men were at work in the bottom of the tank picking and breaking up the sludge by other mechanical means and allowing it to air with a small quantity of sewage

which was diverted to flow down into the tank. When they were drawing this sludge up and putting it on the sludge beds which were filled and running over. They formerly had had a small centrifugal pump in the center of the sludge chamber and when running would pump out that small portion of the sludge about the pump so to allow the less dense sewage to flow down thru the small opening side by the pump and when this occurred the operator would stop the pumping, thinking that all of the sludge had been pumped out. Consequently the sludge settled down and became a solid mass having an average depth of about 5'. Probably the causes for the hardening of the sludge are that there was poor digestion during the first year of operation, that the operator did not draw it out when it was necessary, and that the method of removal was faulty. The settling of the sludge in the bottom of the tank is a good bit of experience and will probably teach the attendant something about the operation of the plant.

GENERAL LAYOUT OF DISPOSAL PLANT DEARBORN MICH.

SCALE 1" = 20'
DATE MAY. 3. 1924.



THE SPRINGVILLE PLANT

The Springville plant is another plant designed by Mr. C. W. Mubbell. It is the largest plant of its kind which we visited. It consists of 4 large Imhoff tanks, 4 grit chambers, one pump house with 8 centrifugal pumps, and 19,700 square feet of sludge bed area.

This plant, which was finished in 1924, was built primarily to prevent a nuisance. It covers an area of three acres. The sewage here is 100 per cent combined and after it has passed thru the sedimentation chambers it will be passed directly into the Rouge River. This sewage disposal works is situated one mile from the center of the town and although quite near the center of this fast growing district it will never be a nuisance in a residential district since it is almost surrounded with factory sites, factories, and railroads.

The pumps are situated in a large round brick building with the sewer entering at the south side. The screen is installed in this building. It is 15' 4" wide and 12' 10" long and is in 5' 10" sections. It consists of 1/2" x 5" bars with 1 1/2" clearance. The slope of this screen is 8.5 to 10.5. The sewage is held in one half of the pump house by an arch wall serving as a dam. The flow is allowed to accumulate in this reservoir until floats throw the switches in alternately and start the motors. The pumps are on the other side of the wall and are below the level of the sewage, hence never do require priming.

As the sewage level lowers the motors are stopped automatically in reverse order as they were started. These motors pump the sewage against a maximum head of 27' and pass it into the silt chambers.

The motors are of the vertical shaft kind. They are situated on the ground floor of the building. There are to be driven four 24", two 16" and two 12" centrifugal pumps.

The grit chambers are four in number. They are all 85' long and 3.5' deep but the width varies in order to give the sewage almost always a constant velocity of flow. There are two of these grit chambers which are 8' wide, one which is 5' wide, and one which is 2.5' wide. In this way they have a width of grit chamber ranging from 2.5' to 28 1/2', with stopping points at 2.5', 5', 7.5', 10.5', 13', 15.5', 16', 18.5', and 21' and 28 1/2'. The drainage is thru 1/4" perforated plate 12" wide with 1/4" holes. This plate is covered with 6" of gravel. The draw off is made by 8" cast iron pipes. The grit chambers are cleaned by hand into large iron buckets. These buckets are handled by a traveling crane which runs over the entire area of the grit chambers.

The flow of the sewage is carried along a long concrete channel which extends along the entire length of the Imhoff tanks. It then flows over the weirs into the the sedimentation chambers. This is a very poor way of distributing the sewage equally into each of the chambers,

because it is practically impossible to adjust the valves so that the flow over the weir will be constant during the maximum and minimum heads. And even if this could be done the sewage which enters the nearest tank is always the most concentrated because of the settling which takes place in the long channel.

The tanks are 25' deep and have a sedimentation chamber capacity of 121,000 cubic feet, and a sludge digestion chamber capacity of 52,354 cubic feet. The ratio of length to depth of the sedimentation chamber is 10 to 1, and the ratio of length to width of the same is 10 to 7.5. The slope of the bottom of the sedimentation chamber is 5 to 6 and that of the sludge chamber is much less, being 2 to 1. Less slope is needed for digested sludge than is needed for undigested material, because the solids of the undigested sewage are put into solution when they are digested. The ratio of sedimentation to gas vent area is 5 to 1. The measurements of sewage are made by taking the flow over some Herschel hollow chest weirs which are placed at the inlet end of the Imhoff tanks.

The sludge is drawn off by the air lift method. There are three 8" cast iron pipes for the sludge and one 2" compressed air pipe for each sludge pipe. The sludge is drawn off onto the beds. This method is quite new in sludge pumping and is much more economical as it cuts the number of motors down to one and combines all of the sludge pumps into one air compressor.

The beds cover an area of 11,700 square feet and are separated from each other by boards which can be removed if the adjoining bed becomes too full. The entire set of beds can be traversed by a traveling crane which is the same as the one used for the grit chambers. This method of sludge and grit removal reduces the cost of handling and conserves space.

The plant is very new and has not been fully put into use. At the time of the inspection the sewage was being by-passed into the river from the grit chambers. The tanks had not been filled and afforded a fine opportunity to observe the construction of them. The plant is surrounded with a fence and has concrete drives about it. The grounds are well sodded. On a whole the plant appears very nice.

At this plant we were given a fine opportunity to take particular notice of the debris which is caught by the screens. When we were told in our class on sewers and also when we read out of our text book about such things as bricks, boards, wires, and any other articles coming down the sewers we wondered as to the truth of the matter, but after this sight it had been proved to us. There was about two wagon loads of material which had been raked off the screens. It consisted of a large number of 4" x 4" x 8" paving bricks, water pipe in short sections, wire, stones, boards, and one piece of 8" x 8" timber about 6' long, together with much other debris of this kind.



The trunk distributing sewer to the plant is along the left edge of the picture. The large black pipe fittings are the sludge air lift pipes. The narrow openings are gutters. The bars are sedimentation bars.



No grit chambers are in the diagram. Note the fence, concrete drive, pass, and traveling crane over the sludge bed. The river is behind the railroads. Here the narrow gutters and the wide sedimentation channels can be seen along the right side of the large plot.



This gives a better view of the sludge bed with the revolvable boards which can be taken out to give the men a way for the sludge. Note the large buckets under the crane.

THE CROSSING PLANT

This plant is just one step farther in advance of complete sewage treatment than the Bloise works. The plant consists of an Imhoff tank, and contact beds which treat the sewage the same as the Bloise plant treated it, but due to the fact that Fox Creek is so small it does not afford proper dilution for sewage treated with an Imhoff tank and contact beds and they have for further treatment four sand filters making a total area of 2.5 acres.

The design was made by Mr. C. W. Fuller for an ultimate population of 6000, but at present only a few over 2000 persons contribute sewage to it. The area of the contributing district is 680 acres. The total amount of sewage that the plant will treat is 600,000 gallons per day. In 1918 the plant was completed and put into use. The total area of this sewage treatment works is 5 acres, and it is situated about one mile from the center of the town.

The sewage treated here is concentrated during dry weather flow and very dilute during the storms. Altho the sewage is 100 percent separate during dry weather flow this percentage lowers to 10 per cent during wet weather flow and the 90 per cent is due to infiltration. This is due to the fact that the surrounding territory is very level and the water table is very near the surface. The sewer was probably laid poorly and hence the seepage into the sewers. The report blank for April shows that the quantity of sewage treated during the month ranges from 10,000 gallons to 95,000 gallons per day.

There are no grit chambers or screens at this works

and the sewage flows directly into the two longitudinal flow Imhoff tanks. These tanks furnish a 1.6 hour detention period on a 300,000 gallon per day flow. The capacity of the sedimentation chamber is 5445 cubic feet and that of the sludge chamber is 3600 cubic feet. This large capacity of the sludge chamber compared with the capacity of the sedimentation chamber is due to the fact that the sewage is concentrated and contains a great amount of sludge. These tanks are 24 1/4' deep. It seems that this depth is just about correct for an Imhoff tank because nearly all of those visited were around 25' deep. The ratio of length to depth of the sedimentation chamber is 50 to 10 and that of the length to width is 5 to 1. The angle of slope of the bottom of the sedimentation chamber is about 50 degrees and the slope of the bottom of the sludge chamber is 24 degrees. There is 2.6 times the sedimentation area in these Imhoff tanks that there is gas vent area. The velocity of the flow is .53' per minute. The sludge is drawn thru four 8" cast iron pipes under a 4' head into the beds.

There are two sludge beds at this plant, each having an area of 110 square feet, which makes a total of 220 square feet. The area of sludge bed per capita is .47 square feet. This when compared with the area per capita at other plants seems very small since the sewage is quite concentrated, but as there has been no difficulty encountered in handling the sludge as yet this small area must be sufficient.

The contact beds are square at this plant instead of trapezoidal as they are at the other plants. There are four, each having an area of .175 acres, and making a total area of .7 acres. There is about 150,000 cubic feet of capacity in the whole unit with 55 percent voids, which leaves a capacity of 50,000 cubic feet of space. This space is filled once during each cycle. The filtering material is crushed lime stone ranging from $5/4$ " to $1\ 1/2$ " in diameter and is 5' deep. The distribution system for these contact beds consists of vitrified pipe laid on 57' centers. The tile are 12" to 10" to 8" at the ends. The collection system is composed of $1\ 1/2$ 6" tile which lead to a 15" main. The bed is allowed to fill with sewage and stand still for a period of time. The siphon blows off and starts draining the bed; the effluent being carried to one of the sand filters.

The sand filters are four in number and compose a total area of 2.5 acres. The daily rate in gallons per acre is 240,000. The underdrains of the filters are 4" vitrified tile laid 20' center to center and covered to a depth of 18" with graded gravel. The distribution system consists of two wooden troughs per filter. They lie on the surface and the influent is distributed thru inch square holes 2' apart on each side of the trough.

The tests from this plant show that the plant is doing very efficient work. They are getting a stable effluent continuously and are removing 85 percent of the settleable solids.

The Inhoff tanks had a rich thick scum on the surface which was composed mostly of lard, greases, and oils. The effluent from these tanks appeared very clear like Inhoff tank effluent. The contact beds were next and clean as far as the surface is concerned. The sand filters were in a very bad condition. The filters are a little higher and just across a levee from a large swamp and the water level had risen in the swamp so that the filters were covered with water. Needless to say the surface was covered with a thick layer of sediment and a green growth, probably algae. We were informed that the attendant would have had the beds clean had he not been troubled with the high water. The grounds of the plant are very neat and add to the appearance of the surrounding territory. There were no offensive odors at this plant.



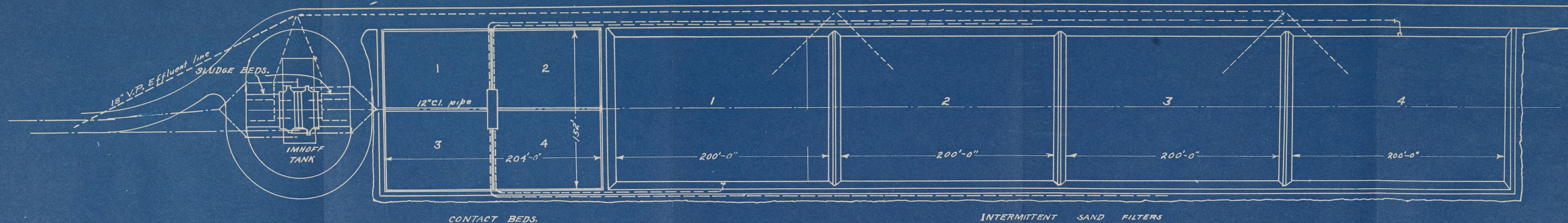
This shows how the troughs should be made in order to hold up the ice. Note the sediment and debris on the land. Also note the holes in the side of the trough.



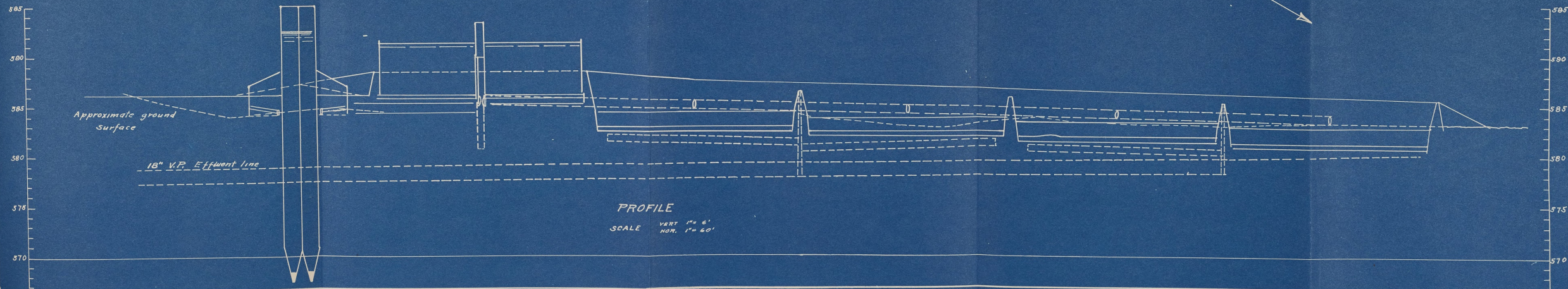
Here is the distribution house and the four unit contact bed. Note the low swampy territory in the distant background.



This shows one of the Inflow tanks with the center section which is the sedimentation chamber and the two narrow sections which are the vents. The thick scum can be seen very easily. Note the baffle board and the debris on the wire in the foreground due to a low water level. The low district can be seen in the background.



PLAN
SCALE 1" = 60'



PONTIAC PLANT

Pontiac with its population of 58,000 people found it necessary in order to prevent a nuisance to build a sewage disposal plant, because of the fact that the Clinton River which runs thru the town was not a large enough river to take care of the sewage from the city. Mr. C. L. Hubbell completed this plant in 1921 and since then there has been no trouble. The sewage is practically 100% separate with but a little storm water entering the sewers thru roof connections in the business district. It was estimated the present quantity of sewage (1921) to be 52,500 gallons which seems very low but the plant was originally designed to handle 275,000 gallons per day. The total capacity of the treatment plant is 6.1 cubic feet per second. The area occupied by this works is 15 acres and is located at the city limits with the Clinton River flowing thru it.

The plant consists of screens, grit chamber, Imhoff tanks, distributing and contact beds, and secondary sedimentation tanks.

The screens are 5' wide, $9 \frac{1}{2}$ ' long and are set at an angle of 45 degrees. They are made up of $1 \frac{1}{2}$ " x 2" bars with $1 \frac{1}{2}$ " clearance.

The grit chambers are two in number. They are 14' long and 5' wide and 6' 6" deep. The flow of the sewage may be diverted into either one so that cleans can be made at will.

The sedimentation chambers and sludge digestion chambers are all incorporated into one unit of three long-

itudinal flow Imhoff tanks. The tanks are made so that the flow may be reversed if desired. The sewage enters them over a set of rectangular weirs from which measurements of quantities of sewage may be taken. The theoretical detention period is 2.3 hours and the maximum is one half of this period. The capacities of the sedimentation and sludge digestion chambers are 95,700 and 52,800 cubic feet respectively. These tanks are a little deeper than the average. The depth is 29'. The ratio of length to depth of the sedimentation chamber is 7.5 to 1, while that of length to width for the same is 11 to 1. The slopes of the bottoms of the sedimentation and sludge chambers are 1 to 1.4 and 2 to 1 respectively, and the ration of gas vent area to sedimentation area is 1 to 6.75. The flow thru the tank is .75' per minute on the maximum flow.

The sludge is drawn off by a number of 8" cast iron pipes under a 4' head. The sludge bed is 1/2 of an acre in area which provides .41 square feet per capita. The sludge is used by the farmers in the near by vicinity for fertilizer.

The effluent is carried across the river in the super structure of a bridge. The bridge is a plain concrete girder bridge but between the girders and in the structure is built the sewer. The effluent is conveyed to the distributing arms thru a reservoir and control chamber which allows enough head to accumulate to operate

the distributing arms.

These distributing arms extend from the center of the bed to the cut side and are at right angles to each other. The influent flows out thru $1\frac{1}{2}$ " holes in the side of the pipe and the head of the liquid forces the arms to turn about the center on the same principle as some lawn sprinklers turn on. The holes are spaced at 4" at the end and gradually increase this spacing to 16" at the center. This variation in spacing is for the purpose of distributing the same quantity of influent over each unit of area of contact bed. There are eight of these circular contact filters making a total area of 1.75 acres. Their capacity per day is 2.5 million gallons per acre. The material used to fill these beds with is very coarse gravel filled to a depth of 3'. A good guess at the size of this material would be from 1" to 3" in diameter. The collection and drainage system consists of half 6" tile laid on 5' centers for laterals and 8" tile mains. From here the effluent is conveyed to three secondary chambers which have a slight detention period and then it flows thru a long channel into the Clinton River.

Altho this plant is turning out a product with 80 percent of the settleable solids removed the stability of the effluent is only 55 percent. This is due to the fact that two of the beds are not in operation and consequently the other six are being over worked. When soon these beds were filled with the influent and were picked up top. This means that there is no opportunity for carbon to get down into the voids and help the bacteria to utilize the carbon.

This point is one in favor of the intake filter because it operates from a design closer the same as a contact bed and there is no chance of seeping since the bed must be drained first before it will function again. The draining gives the voids a chance to fill with air and the material which settles or collects on the contact plate becomes oxidized.

This plant was not very neat in appearance. The screens were covered with debris and that which had been cleaned off was left beside the wall of the screen chamber. The Inhoff tank had a great quantity of sediment. This was time of both sedimentation chamber and the vent. Some of the sediment had been removed from the sedimentation chamber and was piled up at one side of the tank. This together with the sediment should have been loaded away. Now look at the collection up the vent and see what it is. The gas vents and carrying away violent gas evolution in these vents had got up and spilled over the sides of them into the sedimentation chamber and onto the walls and tanks. The vent should be located up the side of each vessel so that it will not seal up the vent and cause gas to accumulate. If enough gas accumulates a difference in head of the liquid in both sedimentation and all the chambers is caused. When this head difference is great the displacement of the gas is higher and the evolution occurs.

This is a first attempt is well directed. It is on the river outlet side of the city with the air clearing from the ground. The atmosphere also, in which

valley floor, and a series of small hills. They have a large narrow channel which extends up the secondary channel almost parallel to the river for a distance of about 500 feet. The purpose of this is to take advantage of the fall in the river between the head of the channel and that point opposite the secondary falls. What is to say that the elevation of the sillment at the head end of the channel is less than or at least equal to the elevation of the water in the river at this point opposite the secondary falls, and that the river had a steeper hydraulic grade line than the sillment in the channel.



Beyond the screens are the two grit chambers.

The board walk in line with the screens and grit chambers and between the concrete walls is the channel through which the sewage flows when the flow is reversed. The high walls are the gas vents, the others are the sedimentation chambers. Note the pile of dark material at the left of the far end of the grit chambers. This is a combination of scum, grit, and screenings which was dumped there and left. The circular contact beds are in the background.



There is one of the sand distributing tanks of the plant in the classifying pool bed. The control of the tank is at the right of the picture.



These are the three secondary sedimentation chambers. The washer which washes the gravel for the filters is in the background.

GENERAL LAYOUT OF DISPOSAL SYSTEM
AT
PONTIAC MICH.

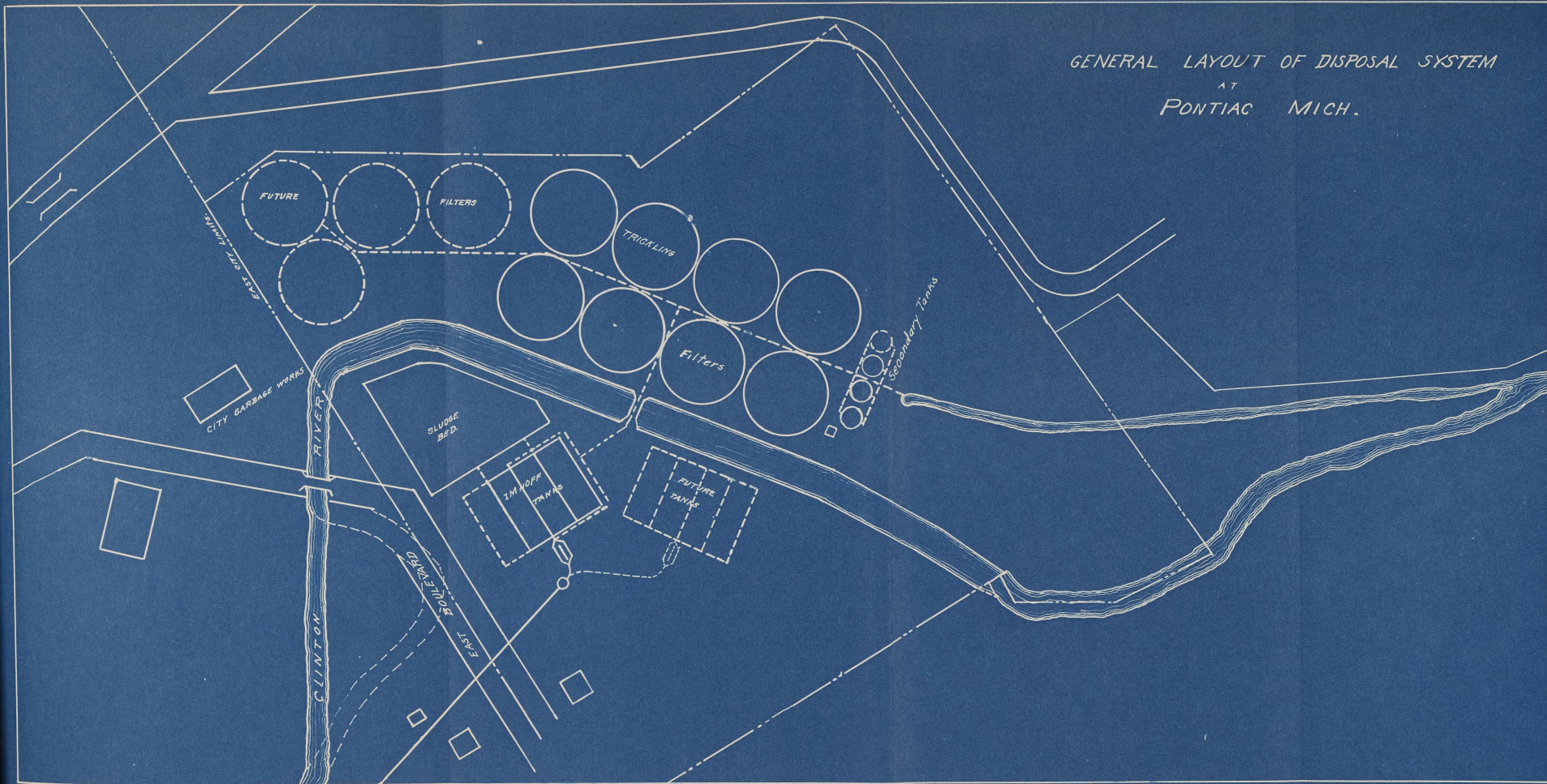


Figure 1. The effect of the concentration of the *Agrobacterium* suspension on the transformation efficiency of *Agrobacterium* strains. The concentration of the *Agrobacterium* suspension was 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0, 11.5, 12.0, 12.5, 13.0, 13.5, 14.0, 14.5, 15.0, 15.5, 16.0, 16.5, 17.0, 17.5, 18.0, 18.5, 19.0, 19.5, 20.0, 20.5, 21.0, 21.5, 22.0, 22.5, 23.0, 23.5, 24.0, 24.5, 25.0, 25.5, 26.0, 26.5, 27.0, 27.5, 28.0, 28.5, 29.0, 29.5, 30.0, 30.5, 31.0, 31.5, 32.0, 32.5, 33.0, 33.5, 34.0, 34.5, 35.0, 35.5, 36.0, 36.5, 37.0, 37.5, 38.0, 38.5, 39.0, 39.5, 40.0, 40.5, 41.0, 41.5, 42.0, 42.5, 43.0, 43.5, 44.0, 44.5, 45.0, 45.5, 46.0, 46.5, 47.0, 47.5, 48.0, 48.5, 49.0, 49.5, 50.0, 50.5, 51.0, 51.5, 52.0, 52.5, 53.0, 53.5, 54.0, 54.5, 55.0, 55.5, 56.0, 56.5, 57.0, 57.5, 58.0, 58.5, 59.0, 59.5, 60.0, 60.5, 61.0, 61.5, 62.0, 62.5, 63.0, 63.5, 64.0, 64.5, 65.0, 65.5, 66.0, 66.5, 67.0, 67.5, 68.0, 68.5, 69.0, 69.5, 70.0, 70.5, 71.0, 71.5, 72.0, 72.5, 73.0, 73.5, 74.0, 74.5, 75.0, 75.5, 76.0, 76.5, 77.0, 77.5, 78.0, 78.5, 79.0, 79.5, 80.0, 80.5, 81.0, 81.5, 82.0, 82.5, 83.0, 83.5, 84.0, 84.5, 85.0, 85.5, 86.0, 86.5, 87.0, 87.5, 88.0, 88.5, 89.0, 89.5, 90.0, 90.5, 91.0, 91.5, 92.0, 92.5, 93.0, 93.5, 94.0, 94.5, 95.0, 95.5, 96.0, 96.5, 97.0, 97.5, 98.0, 98.5, 99.0, 99.5, 100.0, 100.5, 101.0, 101.5, 102.0, 102.5, 103.0, 103.5, 104.0, 104.5, 105.0, 105.5, 106.0, 106.5, 107.0, 107.5, 108.0, 108.5, 109.0, 109.5, 110.0, 110.5, 111.0, 111.5, 112.0, 112.5, 113.0, 113.5, 114.0, 114.5, 115.0, 115.5, 116.0, 116.5, 117.0, 117.5, 118.0, 118.5, 119.0, 119.5, 120.0, 120.5, 121.0, 121.5, 122.0, 122.5, 123.0, 123.5, 124.0, 124.5, 125.0, 125.5, 126.0, 126.5, 127.0, 127.5, 128.0, 128.5, 129.0, 129.5, 130.0, 130.5, 131.0, 131.5, 132.0, 132.5, 133.0, 133.5, 134.0, 134.5, 135.0, 135.5, 136.0, 136.5, 137.0, 137.5, 138.0, 138.5, 139.0, 139.5, 140.0, 140.5, 141.0, 141.5, 142.0, 142.5, 143.0, 143.5, 144.0, 144.5, 145.0, 145.5, 146.0, 146.5, 147.0, 147.5, 148.0, 148.5, 149.0, 149.5, 150.0, 150.5, 151.0, 151.5, 152.0, 152.5, 153.0, 153.5, 154.0, 154.5, 155.0, 155.5, 156.0, 156.5, 157.0, 157.5, 158.0, 158.5, 159.0, 159.5, 160.0, 160.5, 161.0, 161.5, 162.0, 162.5, 163.0, 163.5, 164.0, 164.5, 165.0, 165.5, 166.0, 166.5, 167.0, 167.5, 168.0, 168.5, 169.0, 169.5, 170.0, 170.5, 171.0, 171.5, 172.0, 172.5, 173.0, 173.5, 174.0, 174.5, 175.0, 175.5, 176.0, 176.5, 177.0, 177.5, 178.0, 178.5, 179.0, 179.5, 180.0, 180.5, 181.0, 181.5, 182.0, 182.5, 183.0, 183.5, 184.0, 184.5, 185.0, 185.5, 186.0, 186.5, 187.0, 187.5, 188.0, 188.5, 189.0, 189.5, 190.0, 190.5, 191.0, 191.5, 192.0, 192.5, 193.0, 193.5, 194.0, 194.5, 195.0, 195.5, 196.0, 196.5, 197.0, 197.5, 198.0, 198.5, 199.0, 199.5, 200.0, 200.5, 201.0, 201.5, 202.0, 202.5, 203.0, 203.5, 204.0, 204.5, 205.0, 205.5, 206.0, 206.5, 207.0, 207.5, 208.0, 208.5, 209.0, 209.5, 210.0, 210.5, 211.0, 211.5, 212.0, 212.5, 213.0, 213.5, 214.0, 214.5, 215.0, 215.5, 216.0, 216.5, 217.0, 217.5, 218.0, 218.5, 219.0, 219.5, 220.0, 220.5, 221.0, 221.5, 222.0, 222.5, 223.0, 223.5, 224.0, 224.5, 225.0, 225.5, 226.0, 226.5, 227.0, 227.5, 228.0, 228.5, 229.0, 229.5, 230.0, 230.5, 231.0, 231.5, 232.0, 232.5, 233.0, 233.5, 234.0, 234.5, 235.0, 235.5, 236.0, 236.5, 237.0, 237.5, 238.0, 238.5, 239.0, 239.5, 240.0, 240.5, 241.0, 241.5, 242.0, 242.5, 243.0, 243.5, 244.0, 244.5, 245.0, 245.5, 246.0, 246.5, 247.0, 247.5, 248.0, 248.5, 249.0, 249.5, 250.0, 250.5, 251.0, 251.5, 252.0, 252.5, 253.0, 253.5, 254.0, 254.5, 255.0, 255.5, 256.0, 256.5, 257.0, 257.5, 258.0, 258.5, 259.0, 259.5, 260.0, 260.5, 261.0, 261.5, 262.0, 262.5, 263.0, 263.5, 264.0, 264.5, 265.0, 265.5, 266.0, 266.5, 267.0, 267.5, 268.0, 268.5, 269.0, 269.5, 270.0, 270.5, 271.0, 271.5, 272.0, 272.5, 273.0, 273.5, 274.0, 274.5, 275.0, 275.5, 276.0, 276.5, 277.0, 277.5, 278.0, 278.5, 279.0, 279.5, 280.0, 280.5, 281.0, 281.5, 282.0, 282.5, 283.0, 283.5, 284.0, 284.5, 285.0, 285.5, 286.0, 286.5, 287.0, 287.5, 288.0, 288.5, 289.0, 289.5, 290.0, 290.5, 291.0, 291.5, 292.0, 292.5, 293.0, 293.5, 294.0, 294.5, 295.0, 295.5, 296.0, 296.5, 297.0, 297.5, 298.0, 298.5, 299.0, 299.5, 300.0, 300.5, 301.0, 301.5, 302.0, 302.5, 303.0, 303.5, 304.0, 304.5

The first Greenfield plant is the first one visited on the tour. It is one of the first plants to have been in operation. The tour was conducted by this plant in one session with a capacity of 150. It is a 5.5. It was built and put into operation this year. It was in the early part of 1911. The first year it is four years in all.

[illegible][illegible]

1997年，在《中国农村扶贫开发纲要（1996-2010）》中，国家首次提出“开发式扶贫”的概念，即“国家通过提供政策、技术、资金、物资、信息、培训等支持，帮助贫困地区和贫困人口，依靠自身力量，开发当地资源，发展生产，改善生活，实现脱贫致富”。



This shows the sewer and the end of the screen chamber. Note how carelessly the screenings are dumped over the side of the chamber. This is what you find at a violent sewer. Note the bright yellow on top of the chamber to hold in the wet weather flow.



This is the flooding chamber with the ribbon cover which was tipped over. The top is of concrete and is badly broken in places.



This is the bottom tank with the influent line leading to the center of the tank. Very little sand can be seen. Note the "V" notch weirs and labeled "vents" just inside of the tank.

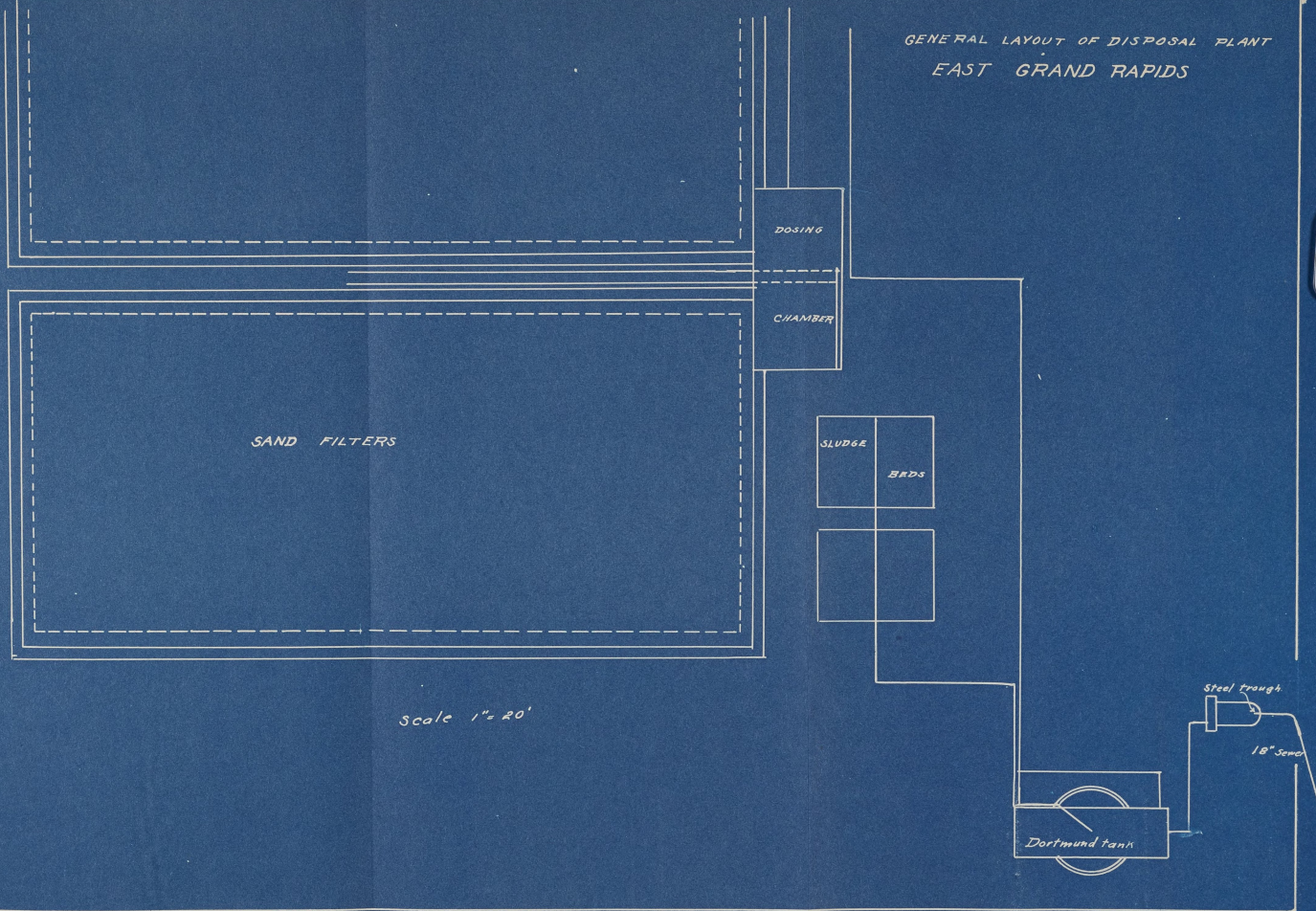


Here we have the sand filter continually covered with tank effluent. The tile along the back are the vents for the under drains.



This shows the result of a bit of negligence and faulty construction. The supporting earth has been washed away and all now the sewer has settled down. In order to save the sewer some timbers were bolted together and laid on the top of the tile. Then the tile were wired to the timbers and some boards were placed underneath. This could have been avoided by building a concrete slab on the top of the stutments. Then the earth could have been placed on top and the sewer laid properly.

GENERAL LAYOUT OF DISPOSAL PLANT
EAST GRAND RAPIDS



[illegible]

In January, 1945, the U. S. Army started the construction and started the operation of a sewage disposal plant consisting of a sewer, electric pump, settling tank, and four sand filters which were designed to completely dispose of the sewage of this city of 2700 persons. Once again the sewage disposal had to be run underground and a sewerometer was built with the disposal plant. The sewage handled is contributed by the house, a Chinese restaurant on fire, and a crematorium. The plant covers 1 1/2 acres, and is at the city limits, 1/2 mile from the center of town. Its location is on the side of a small hill so that no pumps are necessary and the sewage, all day, and all night long are all handled by gravity.

The screen cluster is 7 1/2' x 4' wide with a 5' x 4' base with a restriction of 1/8" hole & 1/8" center to the center for the screen. The hole is set on a slope of 1 to 1 1/2.

The septic tank has 37,000 gallon capacity and a 15 hour detention period. It is divided into three units. The tank area is 7' deep and has a ratio of length to depth of the sedimentation chamber of 3 to 1 and that of length to width of the same is 4.5 to 1. The slope of the bottom of the sedimentation and sludge chambers is 1 to 20 and 5 to 8 respectively. The velocity of flow in the tank is 4' per hour. The sludge is allowed to digest from 3 to 12 months. This gives a fine chance for it to be thoroughly digested. It is digested by using

in the bottom of the digester. The digester also has a capacity of 17,100 gallons and also has a bottom for the sand filters. The large volume of the sand filters is such that the quantity of sand can be calculated. At this time the bottom of the digester has a slope of 18' or 20'. The total area is 1800 square feet or an area of .52 acres per acre of its.

The sand filters are made up of 4' of sand and 4" tile laterals 18' or 21' centers and a 6' or 8' of sand. In the surface of the sand is a distribution system consisting of 6" half tile or 11' centers. The total area of these four units is .41 acres. The period of residence is from 15 to 20 minutes for a capacity of 200,000 gallons per acre per day.

Not much can be said in favor of this plant because of its poor appearance, condition, and poor quality of product. The screens were cleaned up and what had been rolled off was not drawn away but left by the air to be accumulate. The filters were heavily coated with sludge and filled with tank effluent. The ventilation pipes for the under drains were pulled up and the liquid was being bypassed off the top of the sand filter into a small counter drain making the drain an open sewer. The tank removes about 90 percent of the settleable solids and the filters when operating only produce an effluent 90 percent settleable. There always disposal problem here is very easy to see the plant is situated on the edge of a large truck farm

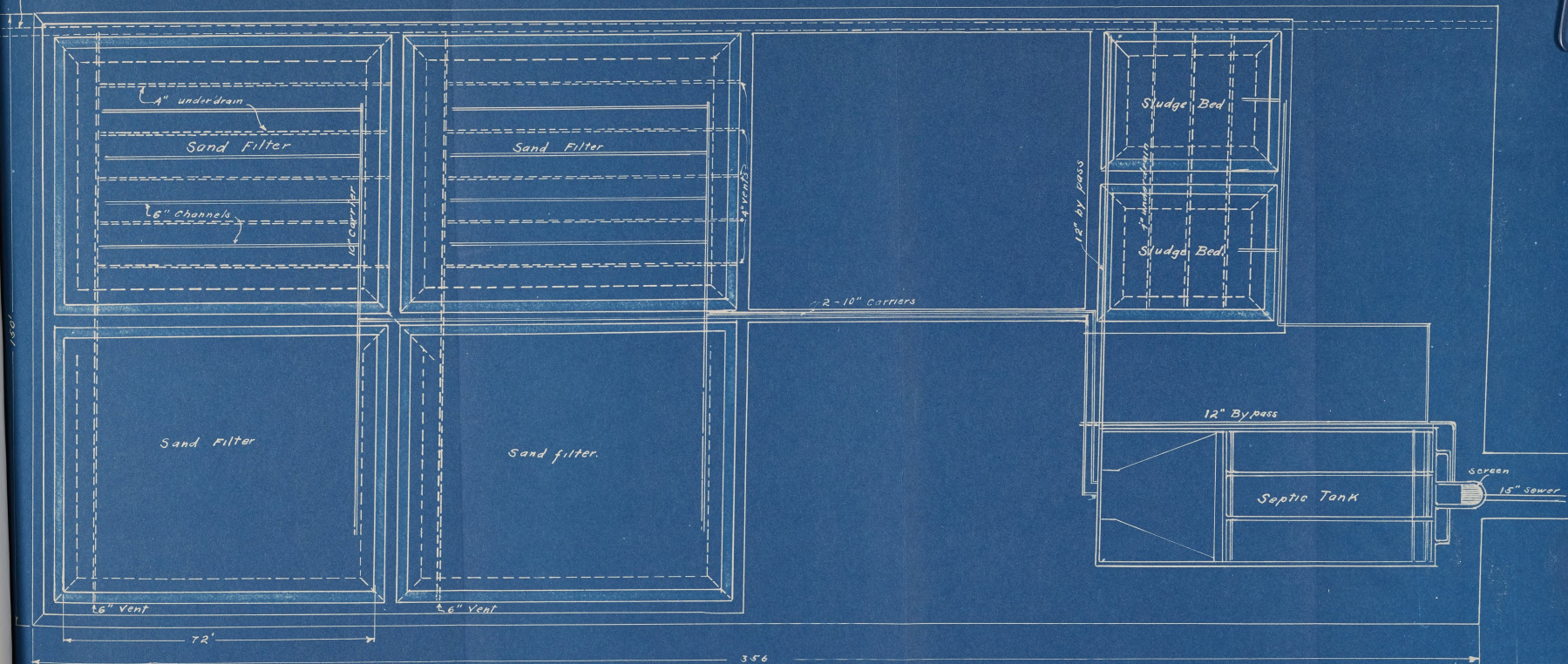
and the sludge for fertilizing purposes is in great demand. Here, too, is an example of what should not be allowed by the officials of a municipality. When instructed by the State Department of Health as to what should be done in order to keep the plant working properly, they should be made to act. If the filters are allowing the water to pass thru the entire tank effluent should be by-passed into the ditch until the filters dry up enough to make it possible to work on them and clean them up. As it was in this case these two filters were under water continuously, so saturating the beds with undesirable bacteria that it will take much work and a great deal of time to bring these filters back into satisfactory working condition. The excuse in most cases is the lack of time, but in most instances, as we were told by Mr. Shepard, the attendant supposedly operating the plant is found in the fire station or in some public office talking over the National Government in general.



This shows the distribution system at the plant. The method is rather poor because about 80 percent of the water flows to the far end of the tile and then gradually flows back toward the other end. This does allow the tank effluent to be distributed evenly over the filter and it does not allow too much sediment to accumulate at the far end of the tile.

GENERAL LAYOUT OF DISPOSAL PLANT
at
ZEELAND MICH

30" Tile 204 ft to
County drain



THE WASHINGTON SANITARY DISTRICT

The Washington Sanitary District sewage disposal plant is probably the most complete in the state. It is in every sense of the word a plant for disposing of sewage completely. Wood and Reeder are its designers. The plant, which serves 1500 people, was put into operation in 1920. It is designed to treat the sanitary sewage of the city and is so arranged as to permit of enlargement by simply adding additional units as the occasion demands. It originally built the plant consists of a screen chamber, two Portland tanks, a sludge digestion tank, a six unit contact filter, sludge beds, and three intermittent sand filters.

These two Portland tanks are of the radial flow type, designed for a detention period of two hours. They are octagonal in plan and 21 feet from outlet weir to outlet weir. There are two units with a sedimentation chamber capacity of 25,000 gallons each. The total depth of the tank is 13.9'. The inlet is an 8" wrought iron pipe leading to a sheet iron cone 8" at the top and three inches at the bottom and about 4' long. The lower end of this cone is about 7.4' below the water surface and 9.5' above the bottom of the tank. The bottom of the tank is hopper shaped with a slope of 5 to 4. An outlet is provided by 12 'V' notch weirs set around the circumference of the tank, discharging into a concrete trough which leads to an 8" sewer. The accumulation of solids settling out is pumped twice a week to a separate sludge digestion tank through

a 4" wrought iron sludge pipe. The ratio of length to depth of sedimentation chamber is 10 to 6 while the ratio of length to width of the same, being round, is 1 to 1.

The sewage treated here at present is 287,000 gallons daily with an ultimate of 2,500,000 gallons per day. The total area of the plant is 20 acres, and the sewage is 75 percent separate, 5 percent combined, and 20 percent industrial wastes. The 20 percent industrial wastes coming from tanneries, 10 or 12 factories, foundries, and wood working plants.

The sludge digestion tank is a 16 sided tank 50' in diameter and 52' deep. It has a hopper bottom with a slope of 2 to 1. Two 1 1/2" wrought iron flushing rings are placed around the tank, one about 7' and the other 5 1/2' from the bottom. These rings are perforated with 5/16" holes at 20" intervals. After digestion the sludge is drawn from the tank thru a 5" wrought iron pipe operating under at least a 5' head, and is then discharged on the sludge beds. The digestion tank is large enough to permit storage of sludge throughout cold weather.

After passing thru the sedimentation tank the sewage returns to the screen and weir house where it is passed over a weir and thru a 12" pipe to the contact filters. It is received in the regulator house where by means of siphons it is distributed to the various beds in the proper order.

These filters are arranged in equal triangular

shaped beds about 85 1/2' on a side. They are constructed of broken stone about 5.5' deep. The sewage is applied thru four inch tile laterals spaced on eight feet centers leading at right angles from a 10" main distributor that runs from the regulator house thru the center of the triangle. These distributors are placed so that the maximum depth of sewage brings the surface about 3" below the stone surface. Underdrainage is provided by a network of four inch half-tile spaced four feet center to center. These lead to main collectors which are 10" half-tile.

These filters are to be operated on an eight hour cycle, an hour each being provided for filling and drawing. Two hours for contact period and four hours for resting. At present, there is not sufficient sewage received at the plant to run it this and the actual cycle used is unknown.

After leaving the contact bed the sewage is discharged on the sand filters each being so arranged to receive the sewage from two contact beds. They are approximately 150 feet square. Distribution of the sewage is obtained by means of wooden trough distributors, varying from nine inches to eighteen inches in width. Lateral under drains of 4" tile spaced 20' on centers are laid to connect with a main 10" under drain. The under drains are covered with gravel and about 2.5' of sand.

Except for a few minor troubles incurred in drawing sludge, no difficulties have been encountered in the operation of this plant. The outfall sewer empties into

little Black Creek which has a flow of about 5 cubic feet per second. Here the sewage is treated to prevent a nuisance and also to protect the water supply and the bathing. The plant is about 1/8 mile inside of the corporation limits and about 1 mile from the center of the city. There are one 5" and two 4" centrifugal pumps used for pumping sludge. All three of the pumps work under an 8' head into a 6" force main.

The grounds of this plant were very clean and presented a fine appearance. The contact beds were being worked at the time of our visit. The sand filters did not have any scum on them but not one of the three was dry because these filters are being over worked. The final effluent was clear and is reported to be always stable. The reports show that 100 percent of the settleable solids are removed. These results show that with proper attention a plant may treat sewage up to capacity and maybe a slight bit overloaded and yet turn out a stable effluent.



Here is a sludge bed filled. The sludge is almost dry enough to be taken out. Note the central valve.

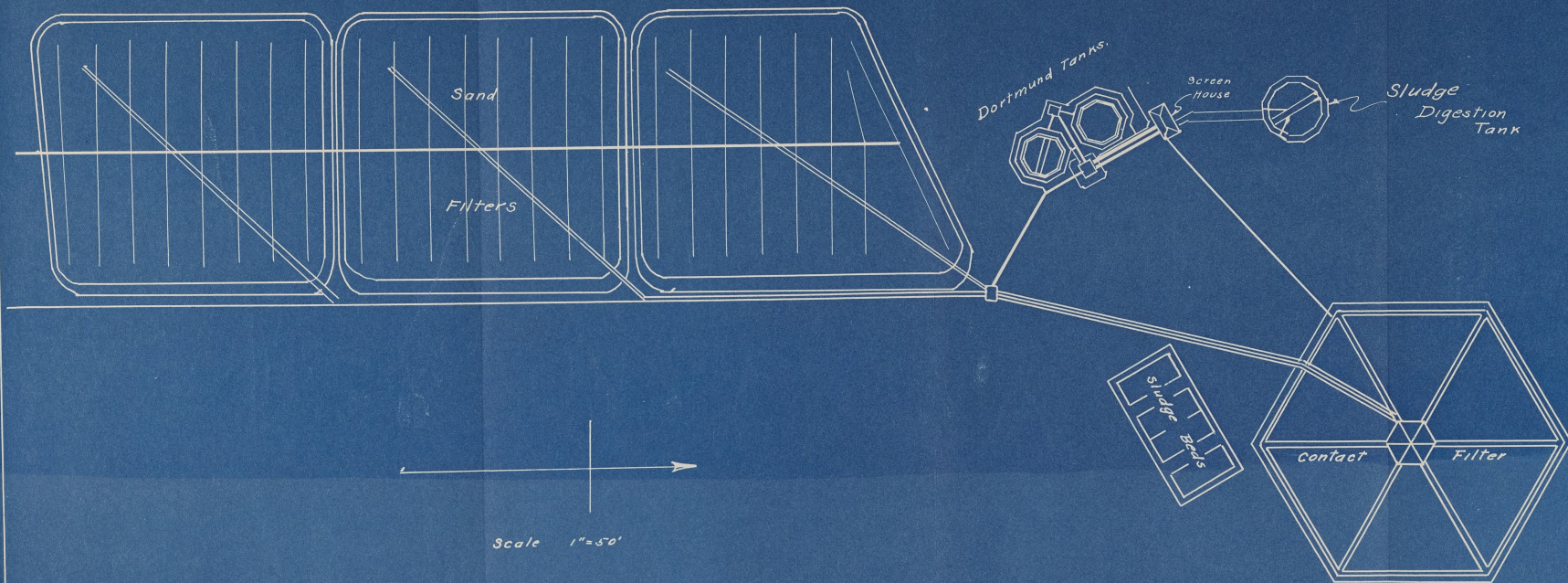


This gives a view of the under (bins of a contact filter. As a reminder as to the proper care this plant is getting, note the hose running across the filters to the left of the distribution house. The hose was used in washing out the pits seen at the sides of the filters.



This picture shows the hose again and the pits near the dividing wall. These pit are at the ends of the distribution tile. The small lake in the far background is one of the aerol filters just recently filled with the effluent from the contact filters. Note the slope of the ground and the absence of houses. This land is very rough and must be very cheap. It is the ideal spot for such as a sewage disposal plant.

GENERAL LAYOUT OF DISPOSAL PLANT
MUSKEGON HEIGHTS



WATER TREATMENT PLANT

No data was available on the Fremont plant so the report of it will be from observation and from notes taken during the inspection.

Due to some politics in the town the plans were kept or destroyed and have not as yet been filed with the city officials or the Michigan Department of Health. At the time of the visit an engineer was taking measurements of all of the units and drawing them up so that some plans could be had.

The plant consists of a screen, a circular Port-mund tank, a sludge digestion tank, a secondary tank, one contact bed, and two others under construction, a dosing chamber, sand filters, and sludge beds.

The sewage treated here is very variable. There is a canning factory and a tannery which contribute 80 percent of the sewage. In order to keep the river, which flows near the town, clean and stable something had to be done in the order of sewage disposal. The cannery agreed to pay 55 percent of the cost of the plant, and the tannery agreed to pay 25 percent if the city would pay the other 20 percent and maintain the plant.

The wastes coming from the canning factory are very hard to treat. At times the sewage is a bright yellow, consisting of small particles of either peach skins or pumpkin pulp. These small particles do not settle out with the detention period given to the tank and consequent-

goes on to the one and only filter operation. The filter becomes clogged and stopped up, and the efficiency is lowered very much. Luckily this does not last a long time, a week or so, due to the fact that the crop is changed and some other vegetable or fruit is used which does not produce such sewage.

Then again the tannery contributes a sewage which is full of chemicals. This, too, is difficult to treat. Both plants use an enormous quantity of water. All of these things together with increasing amount of domestic sewage due to new house connections each day make a problem for the operator which is very difficult.

The contact bed is circular and all above the ground. It is made up of concrete blocks laid with the holes running horizontal. The idea here was for ventilation of the filter but instead the effluent trickles down the side of the wall making a very unsightly appearance. The draw off valve in the dosing chamber was open and the effluent was being by-passed into the creek. The reason for this was to give the filters a chance to dry up enough to be cleaned. The sludge had been drawn from the sedimentation and sludge digestion tanks the day before but both were drawn again for our inspection.

Tests show that the effluent is stable and a great percentage of settleable solids is taken out. This is true only when domestic sewage is received. The entire sewage is handled by gravity and also the sludge except

for the small amount accumulating in the secondary tank.
This must be pumped back to the Portland tank.

The plant is quite a distance from the town
and the surrounding district will never be used for any
thing other than railroad yards and farms.



This is the screen and grit chamber. The flow is thru the left grit chamber, and at this time the other may be cleaned. Some of the screenings may be seen to the right of the screens.



The dosing chamber in the center of the picture. The sand filters are to the left and a contact filter with the holes for ventilation at the right.



This gives a view of the underframes of the contact filters and how the two filters are connected. The elevated iron pipe at the right of the picture is the influent pipe. This conveys the tank effluent to the center for distribution thru the grids.



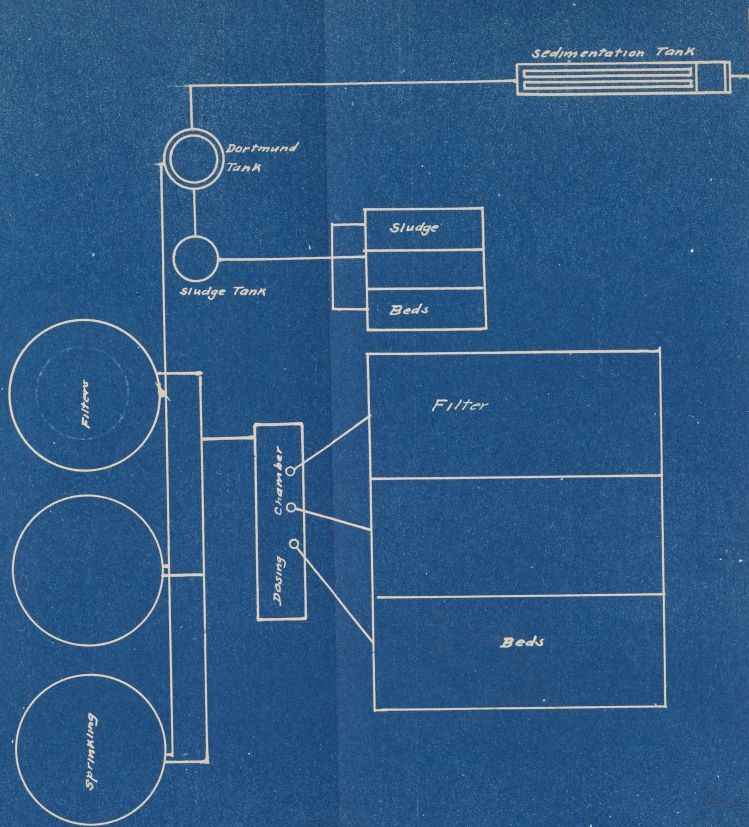
This small circular tank is the secondary. Note how the dosing chamber and this tank are connected. It is a short narrow concrete channel. Sand filters to the left and contact filter wall to the right. The Miller siphons are down toward the other end of the dosing chamber.



Just a picture to show how a sewer can be bridged across a gap with proper support and no leakage.



Here we have a general view of the plant. The aeration tank in the foreground, the sludge digestion tank behind it. The sand filters in the left background, and the three contact filters to the right.



GENERAL LAYOUT OF DISPOSAL PLANT
FREEMONT MICH.

THE CADILLAC PLANT

G. L. Pierson was the designer of the old Cadillac septic tank and contact beds. The plant was finished in 1907 and soon became inadequate to handle the sewage of a population of 10,000.

This old plant consisted of a two-compartment septic tank, dosing chamber and four horizontal flow stone filters. The final disposal of the effluent was to be had in the Glan River, a small branch of the Muskegon River.

The horizontal flow stone filters have proved worthless and were abandoned for their original purpose but were afterwards and are now used as sludge beds, as the old plant has not yet been abandoned. At present the effluent is discharged into the river.

The tank was designed to take care of 500,000 gallons per day. At that time but a few of the population was contributing to it, and now since the city has grown the flow is at present over 1,000,000 gallons per day, of which probably 75 percent is infiltration due to a poorly designed sewer which is laid under the Glan River.

The sludge was removed from the tank twice a year. This created a decided nuisance in the neighborhood and the removal was a very unpleasant job. The sludge produced had a high water content, a very offensive odor and was difficult to dry. To remove it from the tank it was necessary to by-pass the sewage, pump out the liquid matter in the tank and remove the sludge itself by hand.

This was a decidedly unsatisfactory state of affairs and had to be remedied some way. It seemed that the only way to accomplish this was to build a new plant, so Wood and Becker were called upon to design a new plant to be constructed during 1922.

The new plant, which was completed in January 1924, consists of a large septic tank, contact beds, and sludge beds. It is at the city limits and one mile from the center. It is on the same piece of ground with the old plant.

The sewage flows over weirs, where it may be measured, and then into a 3 unit septic tank. The detention period is 12 hours on a flow of 1,000,000 gallons per day. The capacity of each unit is 87,800 cubic feet. The velocity of flow in the tank is 3' per hour for the minimum amount of sewage and 12' per hour for the maximum.

The effluent of the septic tank flows to the distribution house in the center of the contact beds and then into one of the 3 units. The beds are used alternately. These beds average about 4.25' deep and have an area of 5170 square feet, and a total of .71 acres. They are of sufficient size to treat 1,400,000 gallons per acre per day. Each bed is filled with blast furnace slag broken up and screened to a size of about 1" to 5" in diameter. The influent flows out thru a 24" wooden trough into 6" tile distributors spaced 8' center to center. The collection system is thru 6" half tile 5' center to center to

24" main, then to the distribution house and out to the river. The results of tests are as follows: The total quantity of settleable solids is removed and the effluent is stable.

The sludge is drawn off or out of the septic tank thru a 10" cast iron pipe and to a pump. The one and only sludge bed has an area of 5720 square feet, or an area per capita of .57 square feet.

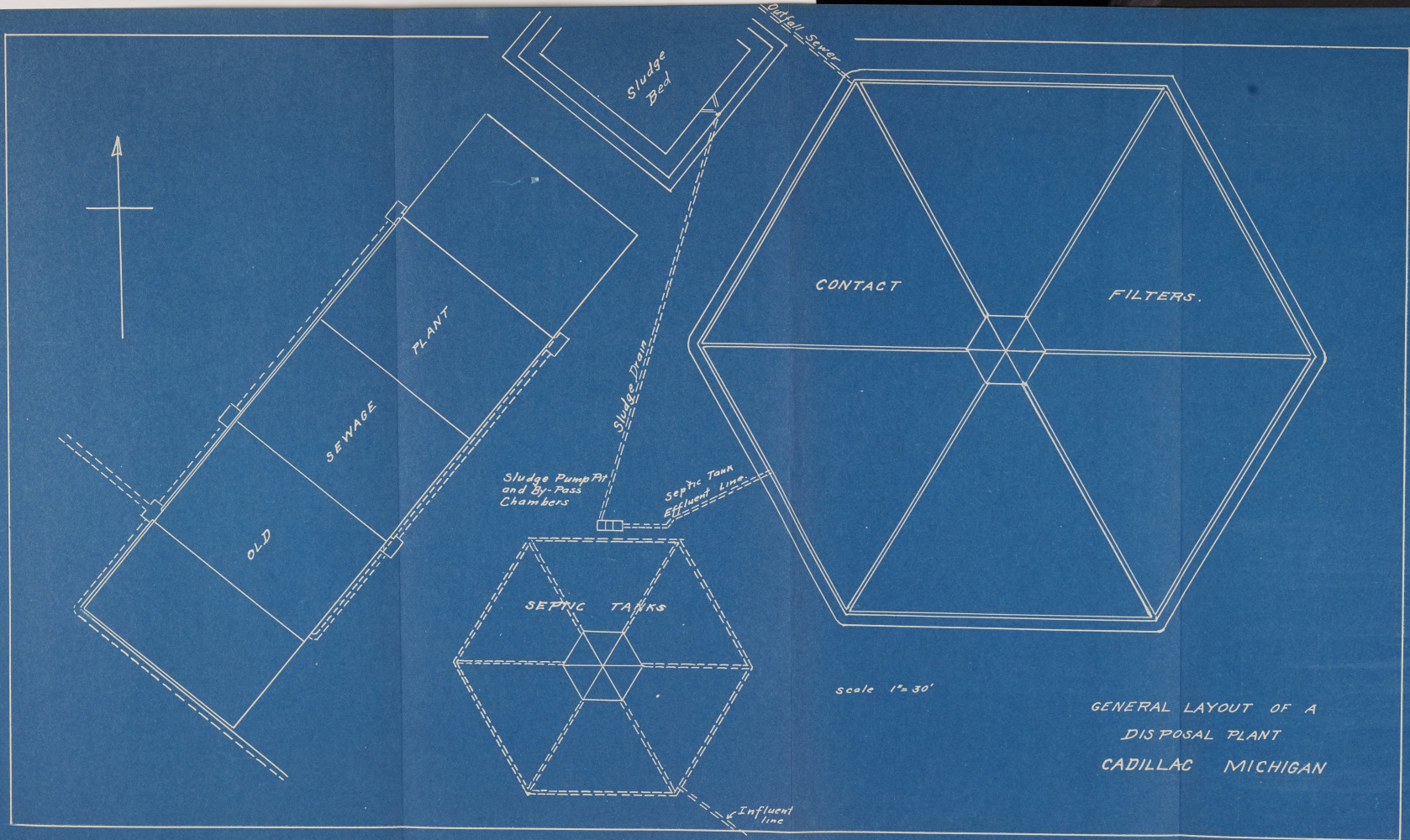
The grounds are rather rough due to recent completion of the plant. The operation of the plant is fine but not much can be said in favor or against it because not sufficient time has elapsed to show good or bad features of the design.



This is the control house for the septic tanks. The cast iron pipes which extend above the ground are the vents.



This shows the contact filters and the control house. The pipe at the extreme right is the outfall of the sludge pipe and the sludge bed is in front of it in the front right half of the picture.



THE TOWN OF HILL

The population of Hill City is about 100. It is on one side of Horse Creek which is a rather large and fast running stream. This creek has in the past furnished enough dilution for the sewage produced by Hill City, but due to the fact that other small municipalities use the creek for the small amounts of sewage which they produce by emptying it directly into the creek so it became necessary for Hill City to install a sewage treatment works, because they are not supposed to dispose of it but just treat it.

In 1913 W. G. Fetter completed the plant. The sewage treated here is 100 percent separate with a very high infiltration. The plant is $3/4$ mile from the center of the town and it located at the edge of the creek.

The sewage flows directly into the Inflow tank. After it passes thru this tank the effluent flows into the creek. The capacity of the sedimentation chamber is 1250 cubic feet, while the capacity of the sludge chamber is 1450 cubic feet. The tank is only 14' deep. This depth is 11' less than the average and from the results obtained it is obvious that this depth is not efficient. The bottom of the sludge chamber is of circular cross section which is a new thing as far as Inflow tanks are concerned. It is not known whether or not this is a good feature because the sludge has never been drawn since the tank started to operate. The ratio of sedimentation area to a 10' diameter area is 7 to 1. This is to say that the

gas vent area is 135 percent of the ventilation area. This is altogether different than that of the rest of the plants. The gas vent area should always be larger than the ventilation area and should never be smaller than it.

The sludge will be drawn off (if it over in) thru an 8" main under a 10' head into a sump. It flows in area of 600 square feet.

They did not think it necessary to enlarge the tank effluent as there were no filters or control beds constructed.

In order to gain entrance to the Inland tank, which, by the way, had a roof over it, we had to go to the fire station and find the attendant, who, as was stated before, was found talking over the politics of the country. We were very lucky to gain this desired entrance because this so-called operator had a difficult time opening the lock which was all cast welded shut.

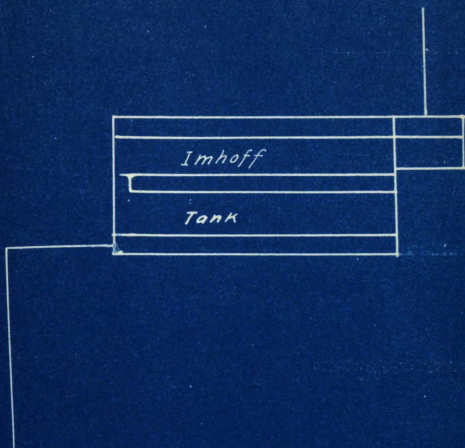
The view from the inside, after the lock was had been swept over, was disconcerting. The gas had accumulated in the ventilation chamber until the top of the lock was submerged and existed over but one could actually walk on it. It had risen over the top of the wall about 4" and stayed in place. Of course, due to the great surface tension of the gas. The effluent passed out just about as clear as the effluent entered the tank.

After a very careful look we were able to find

capital of \$100,000, which was paid in full, and
a very nice bunch of this money was which was supposed
to be the first year. The defendant was called a few years
later he had shown the money this year. This was a
catch question which proved as exclusively just like all the
the his statements were. His answer was "No".

Mr. Lloyd stated to us that he would give
them notice that the plant should be closed up within
a month and at the end of the month he would inspect the
plant again. If this had not been done at this time, his
intentions were to hire a man together with himself
and do the work, clearing the cost to the city.

This is an example of what was taking the tax
payers receive from some of their money. A very large
portion of the taxes had been spent for this plant and they
were getting absolutely no benefit from it.



GENERAL LAYOUT OF DISPOSAL PLANT
REED CITY MICH

CONCLUSION

CONCLUSION

This thesis would fail in one of its purposes if it were brought to a close without an expression of the conclusions to which the writers have been drawn in the investigations of sewage disposal systems in Michigan.

The object of all sewage treatment is first to remove from the sewage a portion of the solid and suspended matter and second to oxidize the remaining complex organic compounds into simpler more stable compounds.

The treatment of a thickly populated community becomes necessary for the following reasons:

1. To prevent a nuisance.
2. To avoid pollution of water supplies.
3. To provide protection of fish life.
4. To protect bathing.

When it is only necessary to prevent a nuisance it is sufficient to install primary treatment only, such as an Imhoff or septic tank, which will usually prevent preventable odors and unsightly appearance; provided, of course, that the effluent can be diluted by discharging it into a stream or large body of water.

This means of disposal should not be used if the stream is to be used as a water supply or if bathing beaches are located within the range of pollution.

When the facilities for dilution are not available, as when the effluent must be discharged into a small stream, more elaborate treatment must be employed.

The protection of water supplies is of increasing

importance in the state of Michigan. The pollution of a natural water supply with raw sewage raw, and frequently does result in epidemics of the well known class of diseases transmissible by water, typhoid fever, bacillary cholera, anthrax, and dysentery.

When it is deemed necessary to provide such protection the sewage must be subjected to a final treatment by filtration or disinfection.

The increasing use of disposal systems in the state has been accompanied by a very satisfactory and substantial decrease in the typhoid death rates as is shown in the accompanying chart.

The protection of fish life is important in all Michigan rivers. For such purposes primary treatment, consisting of a sedimentary, septic, or Imhoff tank is usually sufficient although some filtration may be necessary depending upon local conditions.

In all cases, in order to arrive at satisfactory results, the individual requirements must be studied carefully.

Usually some dilution of the effluent is possible but the primary object of all dilution is to provide an oxidizing agency which will break down the complex organic ingredients of sewage into a sufficiently stable and safe effluent.

If is, the available dilution, in not always able to provide and under these circumstances treatment becomes necessary.

The effectiveness of different plants has been

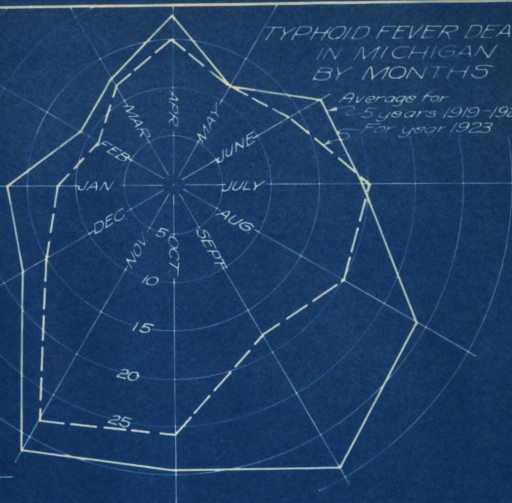
determined through experience and the type which will best fit requirements can be selected.

Judging from the plants visited these requirements have, on the whole, been met, and although a few of the plants are over-loaded at times, all are capable of functioning properly. Their failure to do so in some cases is due entirely to the lack of attention on the part of the operators or insufficient funds to keep the plant in repairs.

At the present time a factor which is most lacking and yet most important in the problem of municipal sanitation is the matter of public interest for without public interest it is impossible to secure the funds necessary to carry on any satisfactory sanitary program.

TYPHOID FEVER DEATHS IN MICHIGAN BY MONTHS

Averages for
2-5 years 1919-1923
5 For year 1923



MICHIGAN DEPARTMENT OF HEALTH TYPHOID FEVER DEATH RATES IN MICHIGAN

Deaths per 100,000 Population

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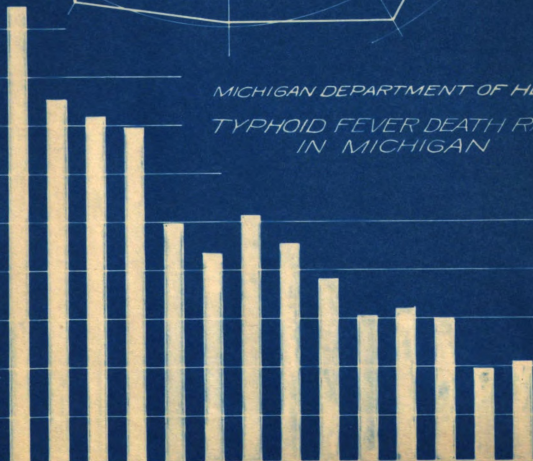
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REFERENCES

Pacific Flash-Tank Co. Catalogs 24 and 27.

Michigan Department of Health

Engineering News-Record Vol. 92 No. 13

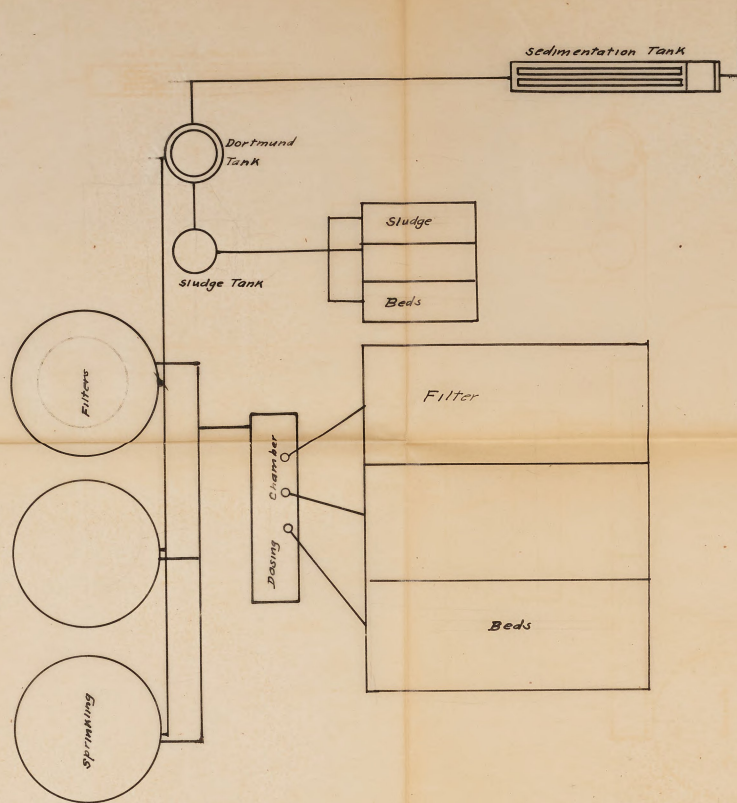
Engineering News-Record Vol. 92 No. 5

Engineering News-Record Vol. 91 No. 21

Sewerage and Sewage Disposal Metcalf and Eddy.

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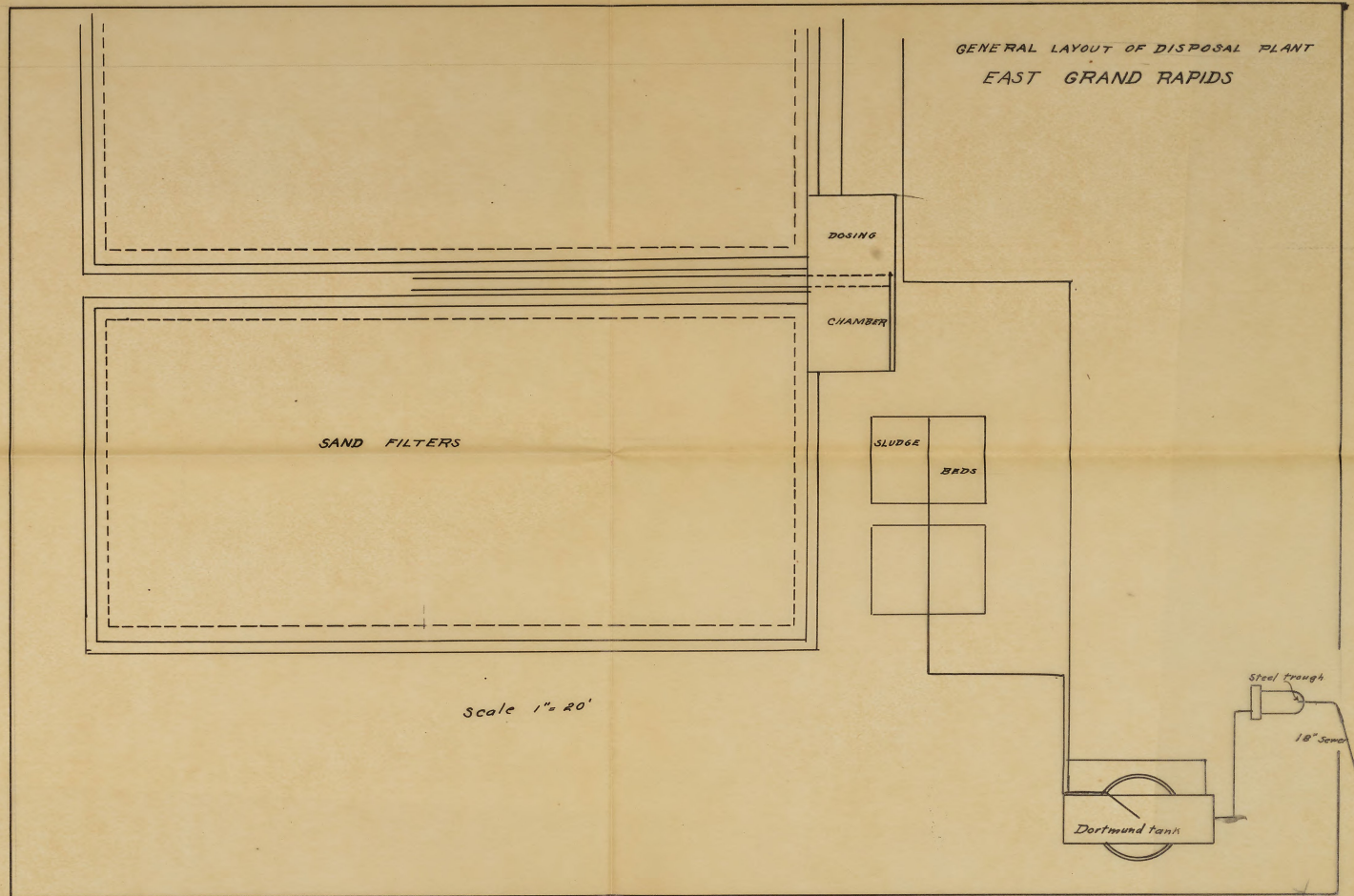


GENERAL LAYOUT OF DISPOSAL PLANT
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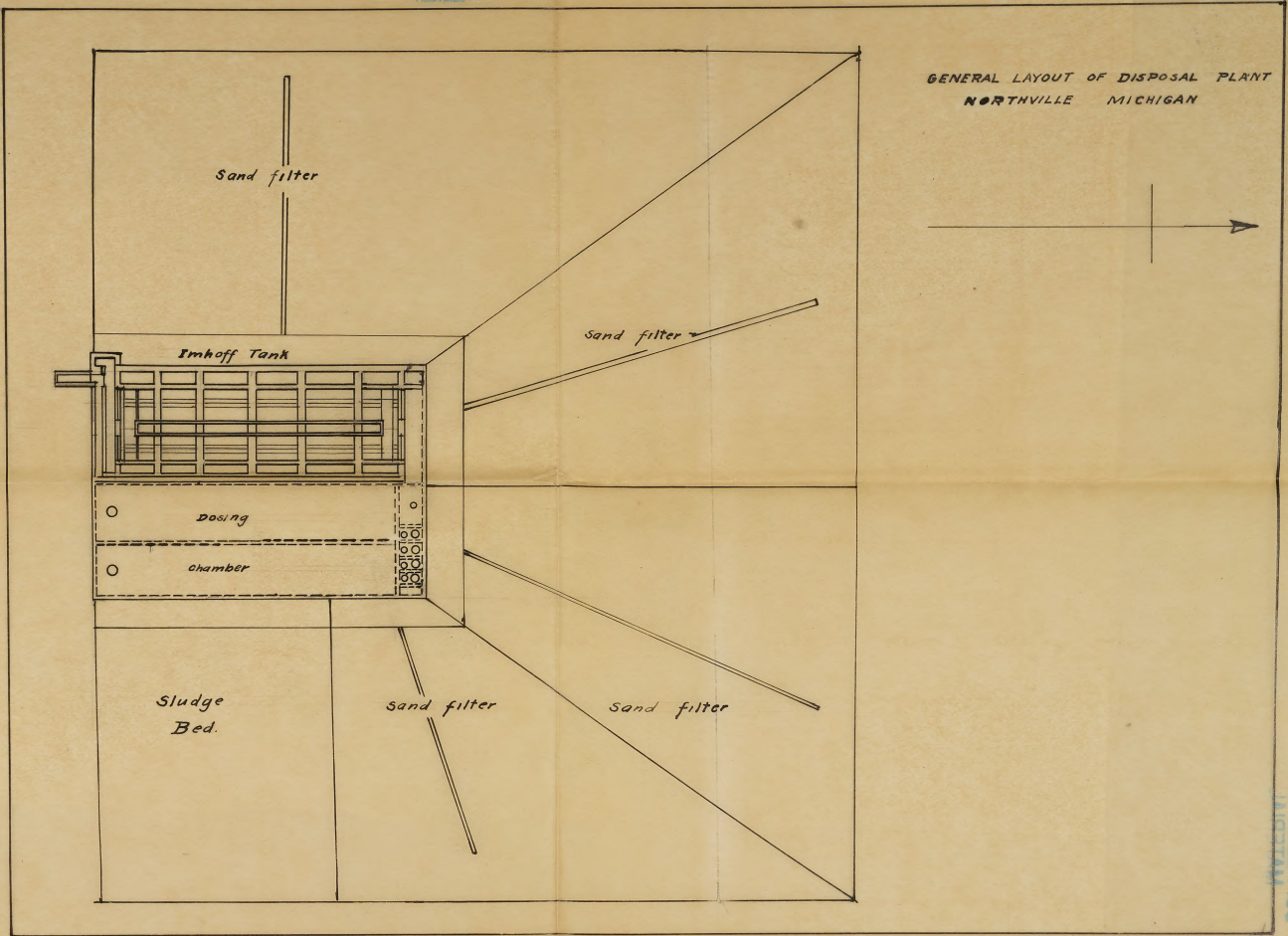
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GENERAL LAYOUT OF DISPOSAL PLANT
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Scale 1" = 20'

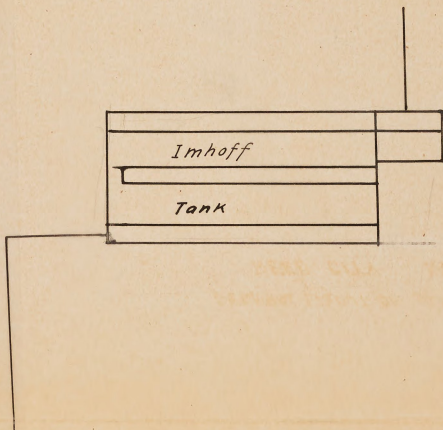
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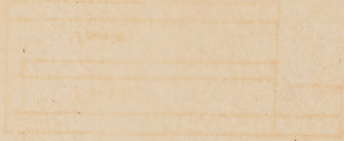
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GENERAL LAYOUT OF DISPOSAL PLANT
 REED CITY MICH



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 MICHIGAN

the 1990s, the number of people in the world who are under 15 years of age is expected to increase from 1.1 billion to 1.5 billion.

At the same time, the number of people in the world who are 65 years of age and older is expected to increase from 200 million to 400 million.

These changes in the world's population are expected to have a significant impact on the global economy.

One of the most significant impacts is expected to be on the labor force.

As the number of young people in the world increases, the labor force is expected to grow.

At the same time, as the number of older people increases, the labor force is expected to shrink.

These changes in the labor force are expected to have a significant impact on the global economy.

One of the most significant impacts is expected to be on the demand for labor.

As the labor force grows, the demand for labor is expected to increase.

At the same time, as the labor force shrinks, the demand for labor is expected to decrease.

These changes in the demand for labor are expected to have a significant impact on the global economy.

One of the most significant impacts is expected to be on the wages of workers.

As the demand for labor increases, wages are expected to rise.

At the same time, as the demand for labor decreases, wages are expected to fall.

These changes in wages are expected to have a significant impact on the global economy.

One of the most significant impacts is expected to be on the savings rate.

As wages rise, the savings rate is expected to increase.

At the same time, as wages fall, the savings rate is expected to decrease.

These changes in the savings rate are expected to have a significant impact on the global economy.

One of the most significant impacts is expected to be on the investment rate.

As the savings rate increases, the investment rate is expected to increase.

At the same time, as the savings rate decreases, the investment rate is expected to decrease.

These changes in the investment rate are expected to have a significant impact on the global economy.

One of the most significant impacts is expected to be on the growth rate of the economy.

As the investment rate increases, the growth rate of the economy is expected to increase.

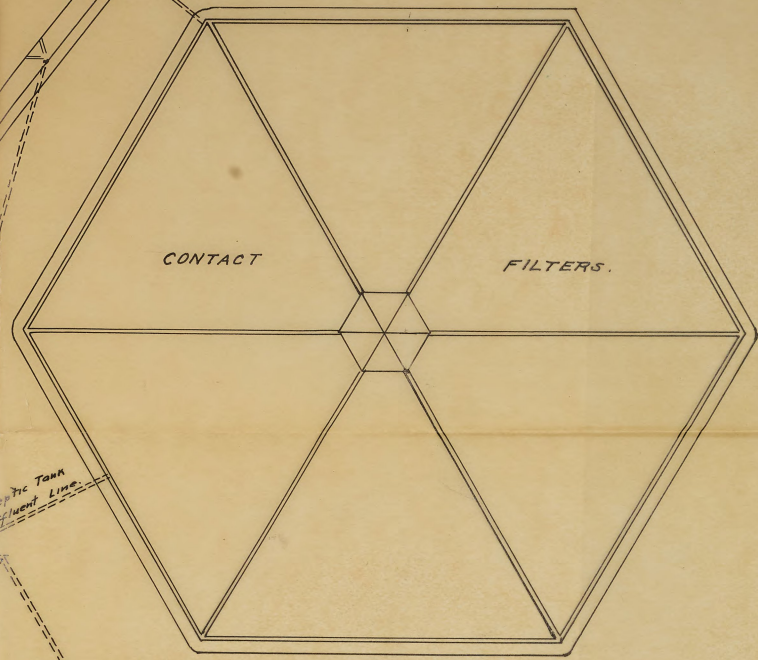
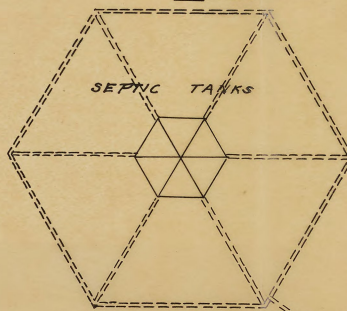
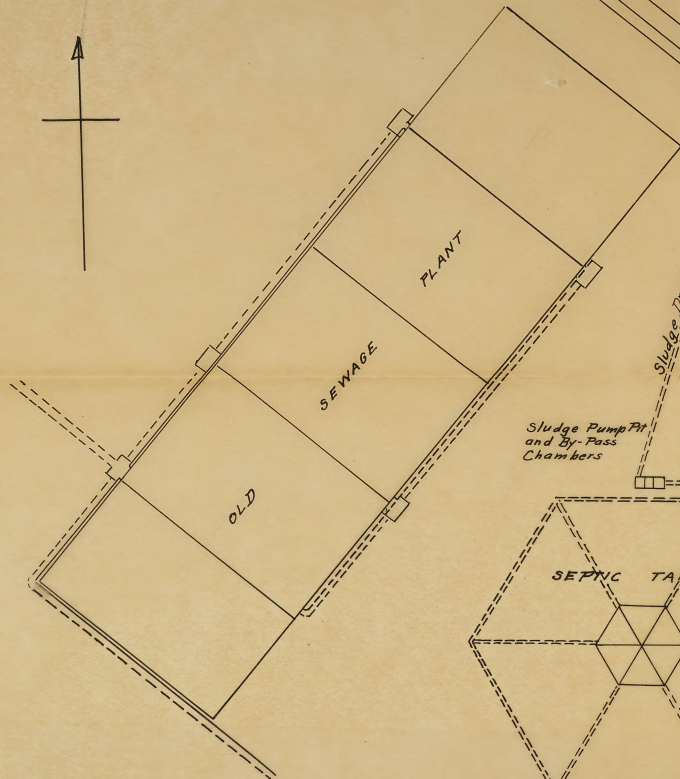
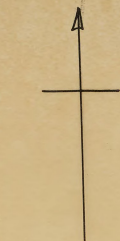
At the same time, as the investment rate decreases, the growth rate of the economy is expected to decrease.

These changes in the growth rate of the economy are expected to have a significant impact on the global economy.

One of the most significant impacts is expected to be on the standard of living.

As the growth rate of the economy increases, the standard of living is expected to rise.

At the same time, as the growth rate of the economy decreases, the standard of living is expected to fall.



Sludge Pump Pit
and By-Pass
Chambers

Sludge Drain

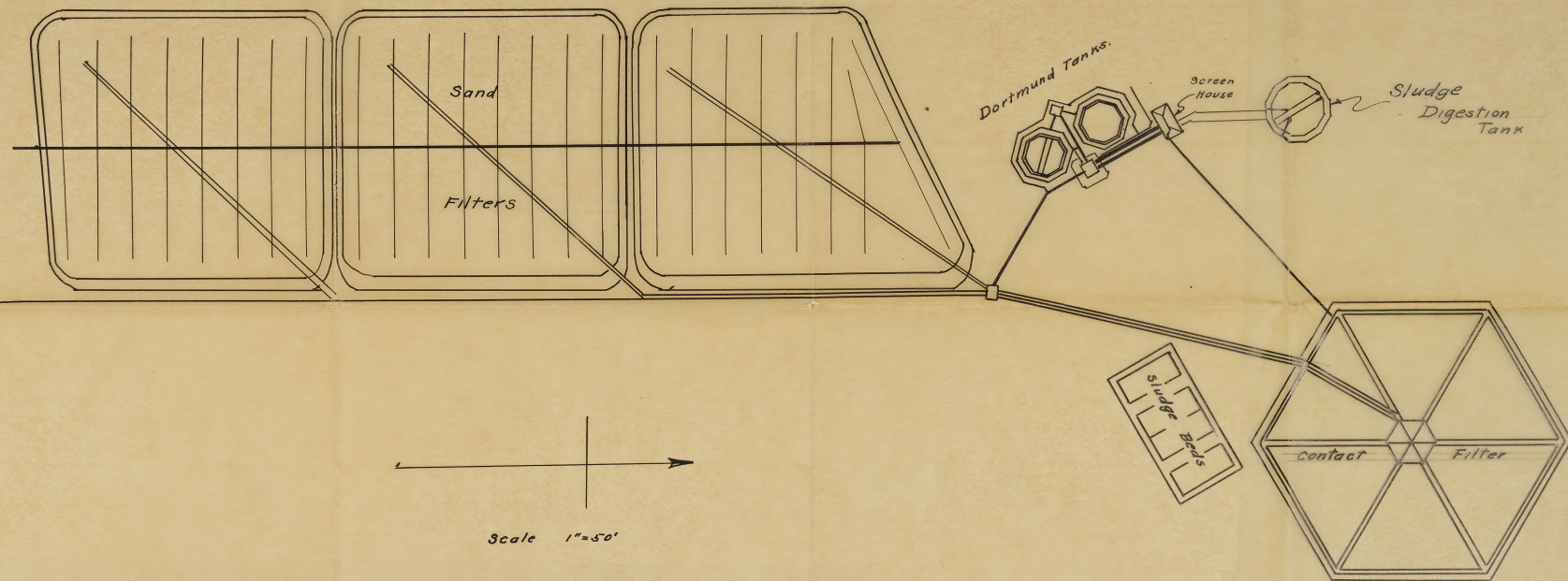
Septic Tank
Effluent Line

Scale 1" = 30'

GENERAL LAYOUT OF A
DISPOSAL PLANT
CADILLAC MICHIGAN

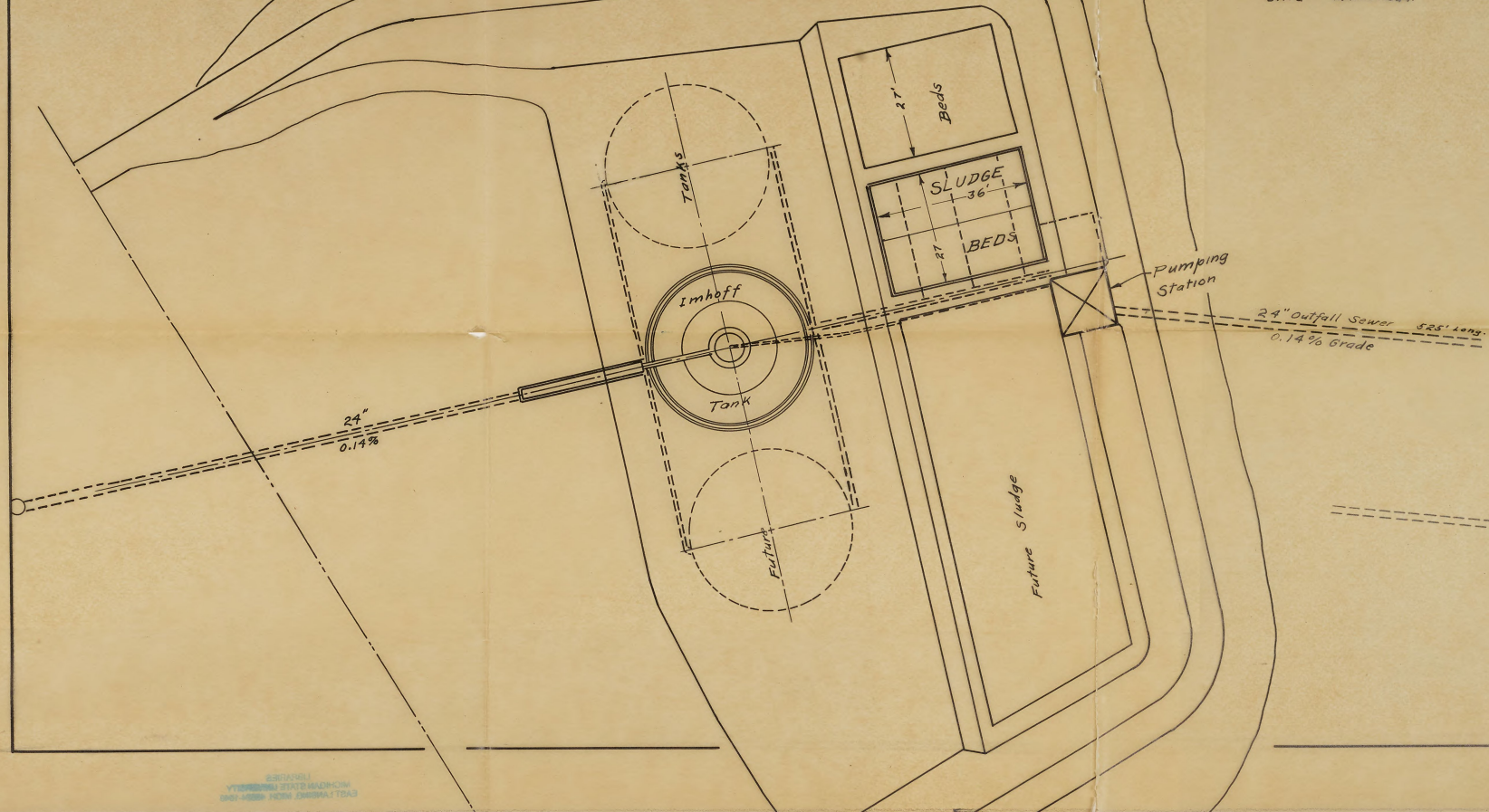
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GENERAL LAYOUT OF DISPOSAL PLANT
MUSKEGON HEIGHTS



GENERAL LAYOUT OF DISPOSAL PLANT DEARBORN MICH.

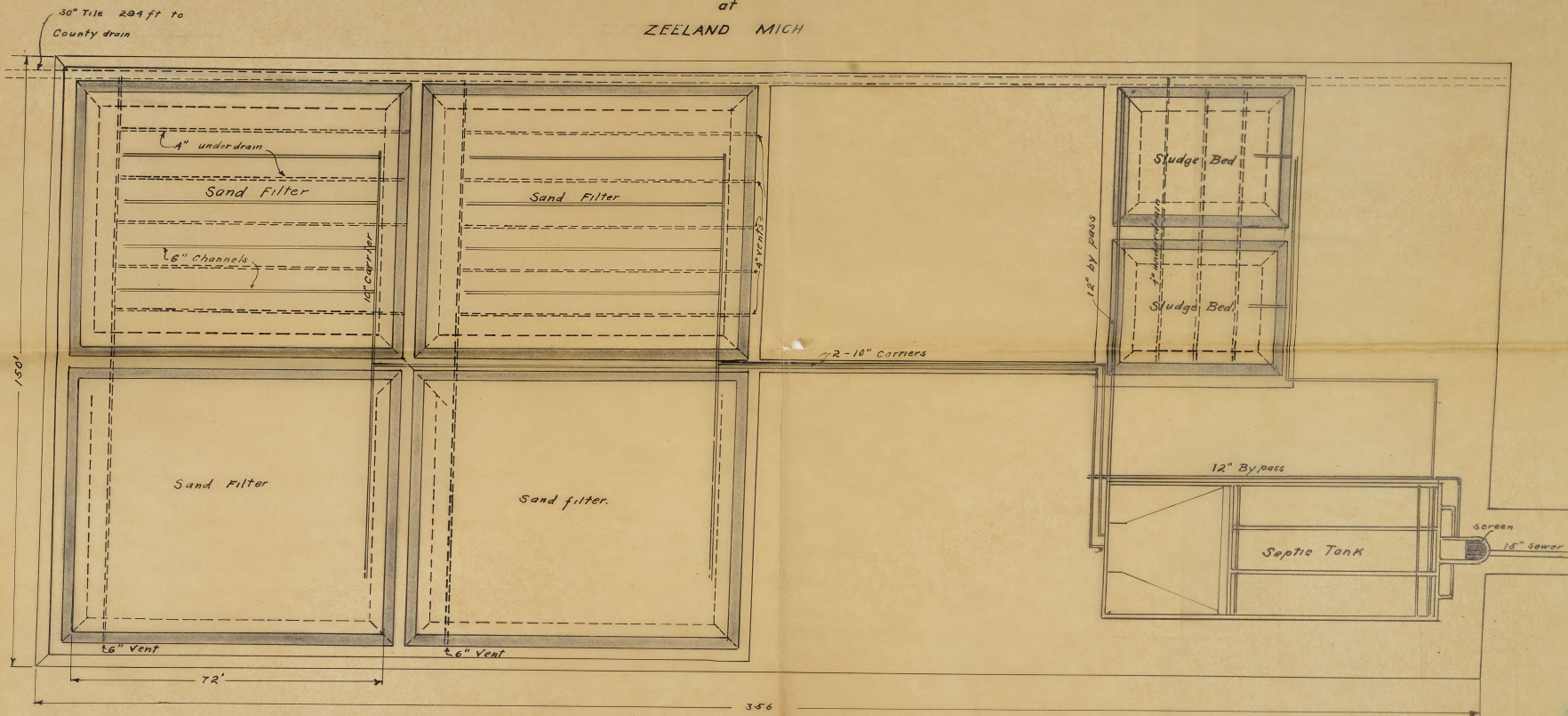
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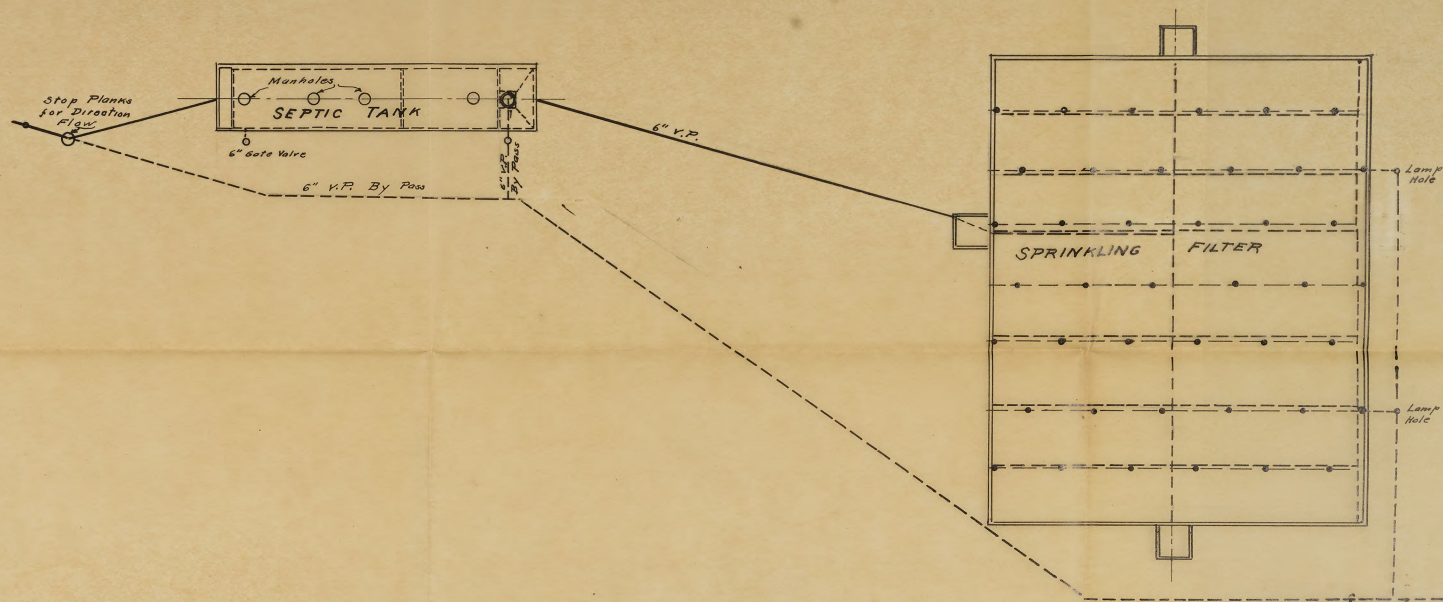
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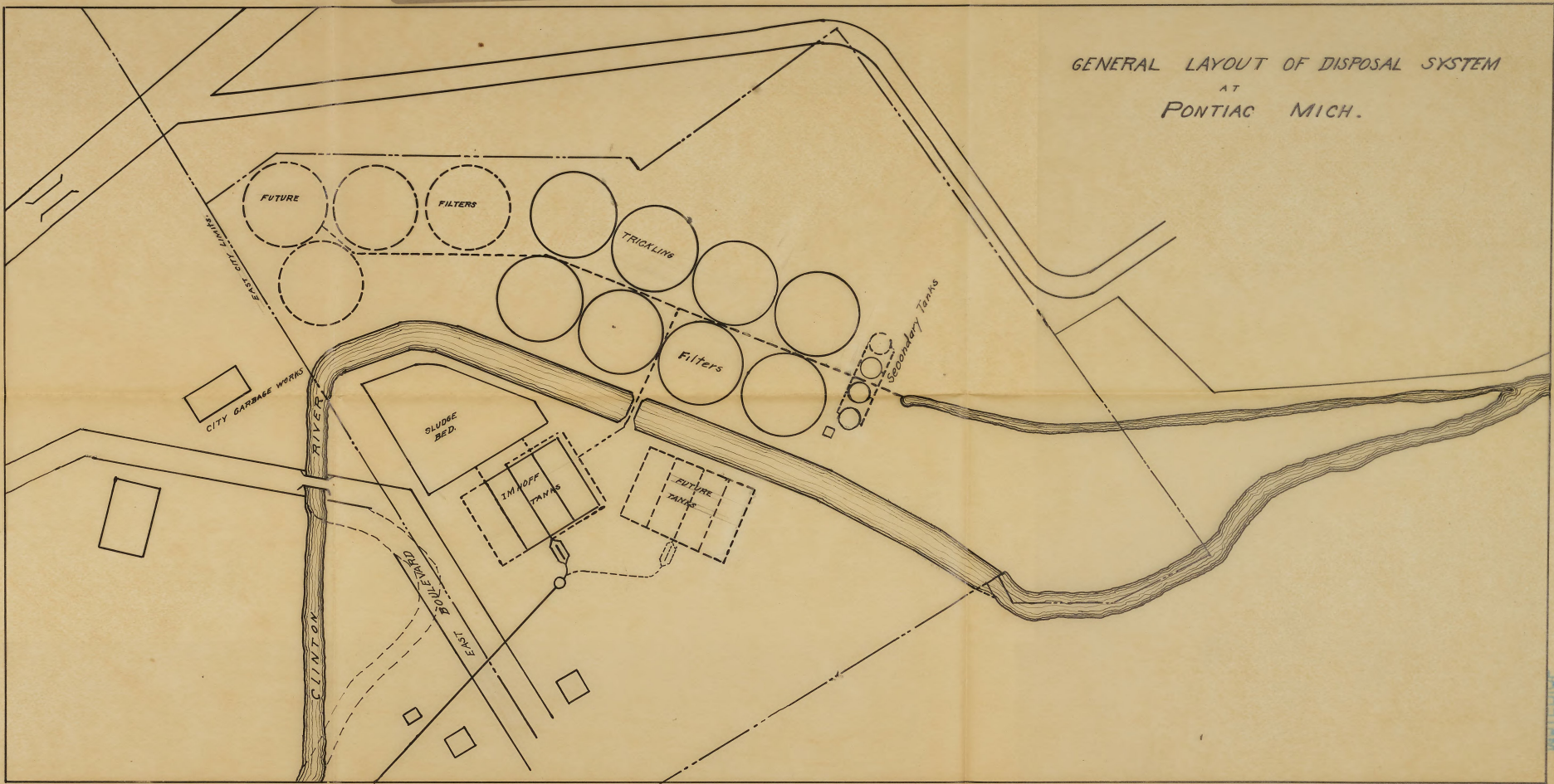
HOWELL MICHIGAN

Date May. 24 1921

Scale 1" = 10'

DESIGNED BY
ENGINEER
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GENERAL LAYOUT OF DISPOSAL SYSTEM
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the 1990s, the number of people in the world who are under 15 years of age is expected to increase by 1.5 billion, from 1.1 billion in 1990 to 2.6 billion in 2010.

As a result of the rapid increase in the number of people in the world, the world population is expected to reach 6.5 billion by 2010.

The rapid increase in the number of people in the world is expected to have a significant impact on the environment.

One of the most significant impacts is the increase in the demand for natural resources.

As the number of people in the world increases, the demand for natural resources such as water, land, and forests will also increase.

This increase in demand will lead to the depletion of natural resources and the degradation of the environment.

Another significant impact of the rapid increase in the number of people in the world is the increase in the demand for food.

As the number of people in the world increases, the demand for food will also increase, leading to the depletion of agricultural land and the degradation of the environment.

The rapid increase in the number of people in the world is also expected to have a significant impact on the economy.

As the number of people in the world increases, the demand for goods and services will also increase, leading to the depletion of natural resources and the degradation of the environment.

The rapid increase in the number of people in the world is also expected to have a significant impact on the environment.

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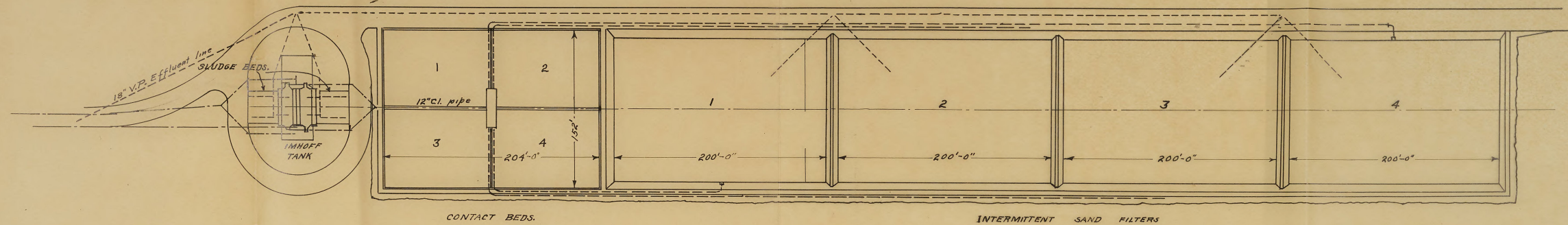
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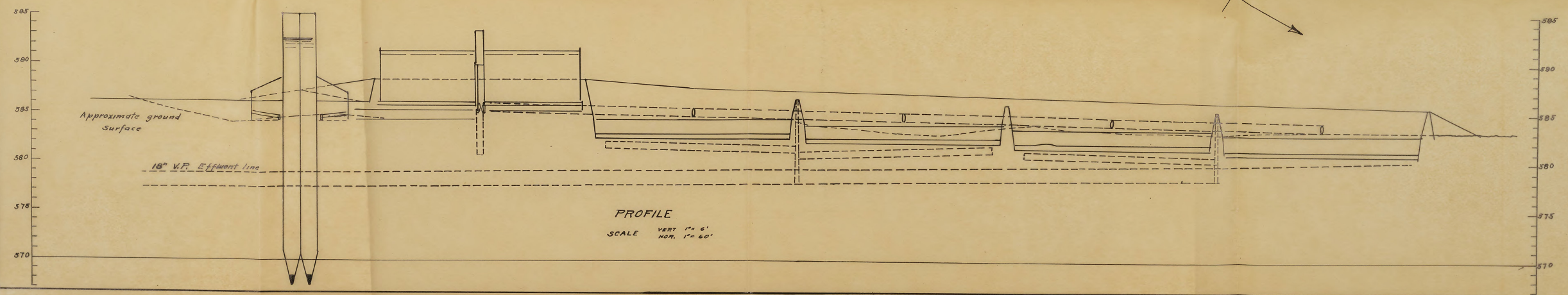
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820
830
840
850
860
870
880
890
900
910
920
930
940
950
960
970
980
990
1000

LEVEL TANKS AND PIPES
WITHIN THE PLANT
DRAINAGE



GENERAL LAYOUT OF
DISPOSAL PLANT
GROOSE POINTE MICH

PLAN
SCALE 1" = 60'



PROFILE
SCALE VERT 1" = 6'
HOR. 1" = 60'

DELTA SIGMA PHI FRATERNITY
EAST LANSING, MICHIGAN

Envelope ins:
36 Negatives

SUPPLEMENTARY
MATERIAL

126
020
THS
36
Negatives

126
020
THS
Layout
6

SUPPLEMENTARY
MATERIAL

126
020
THS
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