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DESIGN OF A SEWAGE DISPOSAL PLANT

FOR CHARLOTTE, MICHIGAN

THESIS FOR DEGREE OF B. S.

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THESIS

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UNIVERSITY
MICHIGAN STATE COLLEGE
OF AGRIC. AND APP. SCIENCE

Design of a Sewage Disposal Plant for Charlotte, Michigan.

A Thesis Submitted to
The Faculty of

THE MICHIGAN STATE COLLEGE

by

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Candidates for the Degree of

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Introduction

A Sewerage Plant for the city of Charlotte, Michigan, has long been a necessity. Due to the light flow of the Battle Creek River during the summer months, the sewerage is not disposed of adequately by natural means, causing not only a disagreeable and unhealthful condition for the inhabitants in the vicinity of the outlet but preventing fish life from developing. A place of beauty in one of the State Highways has also been bothered with the disagreeable stench from this waste.

After considering the above objections, in the city of Charlotte, the detriment to the inhabitants along the Battle Creek River, and the necessity of cleaning up the rivers of the State for the preservation of wild life and natural beauty, the State has ordered the city of Charlotte to build a sewerage disposal plant.

Thus a plant at Charlotte is not only an apparent necessity in the minds of the people who are detrimentally affected but is a project for immediate solution by city legislation and engineering.

This report shall deal entirely with the engineering of the project, and shall include location of the plant, selection of type and size of units, design and general plans of the most important of these units, and will not include the detail and construction drawings.

The purpose of this report is to furnish the writers a practical problem in the field of sewage disposal; and the attempt, in the solution, has been to produce a practical design as complete as possible in the time available.

Preliminary Survey

The first step in the solution of the problem was the determination of the available and suitable location for the plant. The most suitable location that is easily available was found to be on a twenty acre parcel owned by Mr. Ledyard and described as follows:-

All that part of the N E $\frac{1}{4}$ of the S E $\frac{1}{4}$ of Sec. 24 lying N & W of the Battle Creek Drain excepting therefrom a parcel commencing 25 $\frac{1}{2}$ ' West of the N E Corner of the S E $\frac{1}{4}$ of Sec. 24, thence West 9.15 rods, thence S. 336.55' thence S 74°E 158.00', thence N 377.8' to beginning. Also excepting the following parcel this day deeded to the State of Michigan. Commencing at a point on the E & W line of said Sec, 24, 176.475' W of the E line of Sec. 24, thence running S parallel to said E line 431.4', thence N 564.3' to the E & W $\frac{1}{4}$ line, thence along the E & W $\frac{1}{4}$ line 440.0' to beginning. The last exception containing 5 Acres of land subject to a right of way. (Armory)

This parcel and the adjoining topography is shown on the location map.

A preliminary survey of the above piece of land was then made in the following manner. A transit traverse was made and seven points located. A level traverse was then made and six bench marks were established using the city datum. From the above seven points, 227 readings were taken to locate the high and low points on the ground and to determine their elevation. The fences roads, buildings, etc.

were also located at the same time. Stadia rod and transit being used on all of the topography work. Soundings were then made at various points. Table #1 will show the results of these soundings.

The above mentioned location map was made from this survey.

In compiling data for estimating the size of the plant necessary, the following data was obtained.

A Census Report given in Table #2.

A Weather Report for the year 1925, given in Table #3.

A Water Pumpage Record showing maximum daily pumpage and total monthly pumpage for the year 1925, given in Table #4.

Gaugings were then taken by measuring depth of flow in the main sewers and the velocity of flow. The time of and weather for each gauging was taken and recorded.

An authentic sewerage map of the city of Charlotte was procured from Mr. H.A. Williams, and all preliminary elevations for the plant were referred to the same datum as given on these plans. A set of these plans may be found attached to this report.

From the above information the following conclusions were drawn relative to amounts of sewerage to be handled at present and in the future. Present gaugings show that for a population of approximately 5,000 people a plant would be required to handle 480,000 gallons per day, this however, will be increased at times of precipitation due to a number of storm sewers being connected to the main sewer. The bulk of the storm water, however, is

taken care of by a separate system. Thus our estimate of 100 gallons per day per capita will be adequate to cover the present needs and give a factor of safety for any contingency that might increase the rating per capita per day; such as high water pressure in the supply for domestic uses, inventions that use water power, and so on.

In figuring the capacity of the plant for future needs the census report, natural resources, manufacturing possibilities, and transportation were taken into account. From the above information the following conclusions were drawn:- Every indication points to a practically static population, first because natural resources offer no possibilities to new enterprises; secondly, though centrally located and offering good transportation facilities, no additions have been made to the list of industries in the city during the period in which the present industrial order of the State has developed; Thirdly, present industries show no tendencies of expanding such that it would increase the requirements of this project. Fourth, an increase of only 600 people occurred during the ten years between 1910 and 1920. Since that date it has remained practically constant. Thus this would seem to indicate that the population will be fairly constant for a period of years and the only kind of growth to be expected would be a phenomenal one which could be provided for by additional units. Therefore this design is for 6000 people and 600,000 gallons per day.

Selection of Type

Before a selection of type was made a number of plants were visited with the idea of obtaining all possible information about the construction and operation from men who have had practical experience. Following is a list of these plants:-

Northville

Plymouth

Royal Oak

Pontiac

State Home at Lapeer

The treatment of sewage has been quite generally separated into the following divisions; and the selection of the plant has been guided by this classification.

1. Preliminary Treatment

Screening (a) Course screens

(b) Fine screens

Sedimentation

(a) Grit chambers

(b) Septic tanks

(c) Imhoff tanks

(d) Dortmund tanks

2. Secondary Treatment

Filtration

(a) Broad irrigation and sewage farming

(b) Sand filters

(c) Contact filters

(d) Sprinkling filters

Activated Sludge Method

3. Final Treatment

(a) Secondary sedimentation

(b) Disinfection

4. Ultimate Disposal

Dilution with

(a) Ground water

(b) Lake or Ocean

(c) Stream

The treatment selected for the Charlotte Plant is :- Coarse screens, Imhoff tanks, sprinkling filters (nozzle type), and disposal into a stream.

The reason for the selection of coarse and not fine screens is that the character of the suspended material in the sewerage is such that most material not suitable for sludge can be removed by a coarse screen.

The sewerage seems to be fairly free from grit thereby eliminating necessity for grit chambers.

An Imhoff tank was selected in preference to a Septic tank because of the better type of sludge produced by an Imhoff tank. The sludge from a Septic tank is apt to be offensive, while good sludge from an Imhoff tank has no offensive odor.

The sprinkling filter was selected because it allows for a high rate of filtration, small area, and moderate expense at a slight sacrifice in the quality of the effluent. A high grade of effluent is not necessary in this plant because of the nature of the stream into which it flows. The quality of the effluent will be comparable

to the quality of the water in the stream. Nozzle type sprinklers were selected because of their relative simplicity of operation.

The activated sludge method has proven undesirable for small installations.

Final treatment has also been eliminated because of the lack of necessity for a high quality of effluent.

In the final disposal of the effluent the course of least resistance is followed and the effluent allowed to flow into the Battle Creek River.

This is in brief an explanation of the "Selection of Type" of plant with some few reasons for the selection. There are a number of additional reasons for such selections that have not been mentioned here because of lack of space.

Location

In locating the plant, two places on the Ledyard property were considered. One was the S E Corner adjoining the road opposite the water works. The other was in the N E Corner of the said piece of property as shown on the location and layout map. The latter location was selected for the following reasons:- All disagreeable odors which might arise from the operation of the plant would not make it uncomfortable for people on the road or interfere with the proposed Armory which is to be built on the adjoining property.

While it will take a longer connecting sewer line to connect this location with the present main than if located in the first position, the difference in cost will readily be made up in the price of foundations. As the foundations at location #1 are very uncertain while at #2 they are of sand clay. If located at #1, a plant of the size recommended would be crowded and any increase in size in the future would necessitate building at #2. Thus the plant would be scattered causing a much larger expense for extension.

Thus summing up the advantages of location #2 we have :- First, a more desirable location, as disagreeable odors will be taken away from populated districts. Second, better foundations available. Third, room for extension of the plant in the future. With the one disadvantage that a longer connecting sewer will be necessary.

Design

1. Pipe Lines

Under this head have been included all connecting pipes between units and the inlet and outlet sewers.

The inlet sewer runs from the main on S, Main St. along the dirt road and across the Ledyard property, as shown on the location map, to the pumping station, a distance of about 1080 feet at a grade of 0.25%. This is essentially a continuation of the main sewer and is 20" V. P.

The elevation of the point of junction of the two is 63.4 and the elevation of the connecting sewer at the pump house is 60.7 .

The pipe lines connecting the pumping station to the Imhoff tank, and the line from the tank to the filters are all 10" cast iron flange pipe and are as shown on the location map and plans. The pipe from the tank to the filters is 100' long with a grade of 0.50%.

The effluent line from the filters to the river is 600' of 10" V.P. at a grade of 0.25%. The elevation of the outlet at the river is 57.0 and the elevation of the pipe at the filter is 58.5 . The elevation of the outlet at the filter is 62.0 leaving a 3.5 sump.

2. Wet Well and Pumps.

The sewerage must be raised a distance of 23.5 feet at the pumping station. The pumping station consists of a wet well and a dry well. The sewerage enters the station at an elevation of 60.7 and passes thru a coarse screen

with a loss of head of 1 foot. The wet well is five feet deep, the bottom elevation being 54.7

The pumps are set in the dry well, which is adjacent to the wet well, and are at the very bottom level.

The type of pumps recommended for this installation are as follows :-

Three Vertical Type Trash and Sewage pumps of 140 Gal. per minute capacity when operating against a head of 23.5 feet, at a speed of 1710 R.P.M. Each pump to use a 3 H.P. electric motor. These pumps are manufactured by the Pacific Flush Tank Co. of 4241 Ravenwood Ave., Chicago, Ill.

The pumps are to be operated by automatic float switches which start the pumps at successive heights of sewerage in the wet well, these heights to be adjusted to suit the flow.

3. Imhoff Tank.

The Imhoff Tank was designed for a minimum detention period of five hours and the sludge capacity is ample to provide for 25 cu. ft. per capita.

Reversal of flow was provided for by means of a system of cast iron pipe outside of the tank. This eliminates construction difficulties and makes operation easier than in the usual arrangement of channels.

Further information about the Imhoff Tank can be obtained from the attached plans.

There are two tanks of this design used in this installation.

4. Dosing Chamber & Filters

From the Imhoff Tanks the sewerage is then piped to the filtering tank for secondary treatment.

In selection of type of filter a trickling filter was selected for the following reasons :-

It has a high rate of treatment, being two to four times faster than a contact bed and about seventy times as fast as a sand filter. There is an abundance of local material suitable for this type of filter, where as material for the other types would have to be shipped in. The characteristics of the sewerage lends itself readily to this type of treatment. The effluent from this filter is in all ways suitable for disposal in the Battle Creek River.

From the Imhoff Tank the sewerage will first enter a dosing chamber, the details of which are given in the plan, and whose size was designed to hold ten minutes of the average flow. The maximum drawing depth of 8' 6" was figured in order to vary the head at the nozzles from 2' to 7 $\frac{1}{4}$ '. A 12" Miller Sewerage Siphon will adequately serve in intermittently emptying the tank.

The 12" siphon is connected with a 14" main distributor which runs the length of the flushing gallery. From the main there are 6" feeds that go to the nozzles. The nozzles be Type B Circular Spray Nozzles, 7/8" orifice, spaced as shown in plan. The bed of the filter shall be made up of gravel free from foreign material, graded from 1" to 3", with a minimum depth of 5'.

The floor is of three inch concrete reinforced with lock woven wire fabric and shall be laid in a grade of two tenths foot per 10 feet. The false floor shall be made up of 6" vitrified tile, 12" long, split, spaced 8" center to center, with 1" clearance between the ends of the tile. There shall be collecting gutters of split 6" vitrified sewer tile imbedded in concrete with a grade of 1% sloping down to the longitudinal gutters. The cross drains shall have port holes into the flushing gallery to provide for cleaning and aeration. A covering shall be provided for the gutters by imbedding a vitrified clay brick in concrete (see detail in drawing).

The longitudinal gutter shall be an 8" split tile imbedded in concrete with a grade of 1%. These gutters, of which there shall be two, will empty at the center of their length, into a 20" tile which shall connect with the main to the river. These gutters shall have port holes thru the main walls.

The main walls shall be 8" wide on top and 12" on the bottom with a depth of six feet, and made of plain concrete. This design was not made for either maximum pressure from the earth or the rock and water but as a stabilizer between the two.

The flushing gallery shall be built with 6" reinforced concrete walls, with cross beam every 12' for supports for the distributing main.

Other details of this unit may be found on a drawing in the pocket in the back of this book.

Cost

A detailed estimate of cost cannot be made by the authors due to the inability to get cost figures on the various units shipped to the site. But a general cost figure can be given by comparing this plant with the cost of plants already built.

The following figures are only a rough estimate of the cost :-

Site	\$2,500.00
Pipe Line from main to Plant	3,500.00
Pumping Station & Equipment	10,000.00
Imhoff Tanks & Excavation	10,000.00
Dosing Chamber & Filters	13,000.00
Pipe Line from Plant to river	<u>1,000.00</u>
Total -	\$40,000.00

TABLE #1
SOUNDINGS

Position	Depth	Soil
S.W.COR. of Flats	6'	Gravel
Center of W.End of Flats	5'	Gravel
N.W.COR. of Flats	2'	Water Sand
S. Side of Center of Flats	5'	Water Sand
Center of Flats	5'	Gravel
E.End	3'	Gravel
High Ground		Sandy Loam

TABLE #11
CENSUS REPORT

Year	Population
1920	5126
1910	4486

TABLE # 111

WEATHER REPORT

Month	Snow Fall		Rain	
	Max. Daily	Total Month.	Max. Daily	Total Month.
Jan.1925	4.0	5.5		
Feb.	6.0	6.0	1.04	1.28
Mar.	4.0	9.0	0.40	1.43
Apr.			0.94	1.63
May			0.45	0.86
June			0.60	1.84
July			1.24	4.60
Aug.			1.25	
Sept.			1.30	5.20
Oct.			2.15	4.95
Nov.	5.0	7.5	1.40	2.14
Dec.	1.0	4.0	1.31	1.31

1***

TABLE #1V
WATER RECORDS

Month	Max. Daily	Total Monthly
Jan. 1925	925,200	25,660,800
Feb.	900,000	22,387,080
Mar.	795,600	22,336,100
Apr.	788,400	21,873,600
May	867,600	22,810,800
June	1,152,000	26,000,800
July	1,033,200	22,367,800
Aug.	784,800	21,583,200
Sept.	860,400	21,440,600
Oct.	784,800	20,445,600
Nov.	687,600	19,093,200
Dec.	673,600	19,519,200

Bibliography

Books

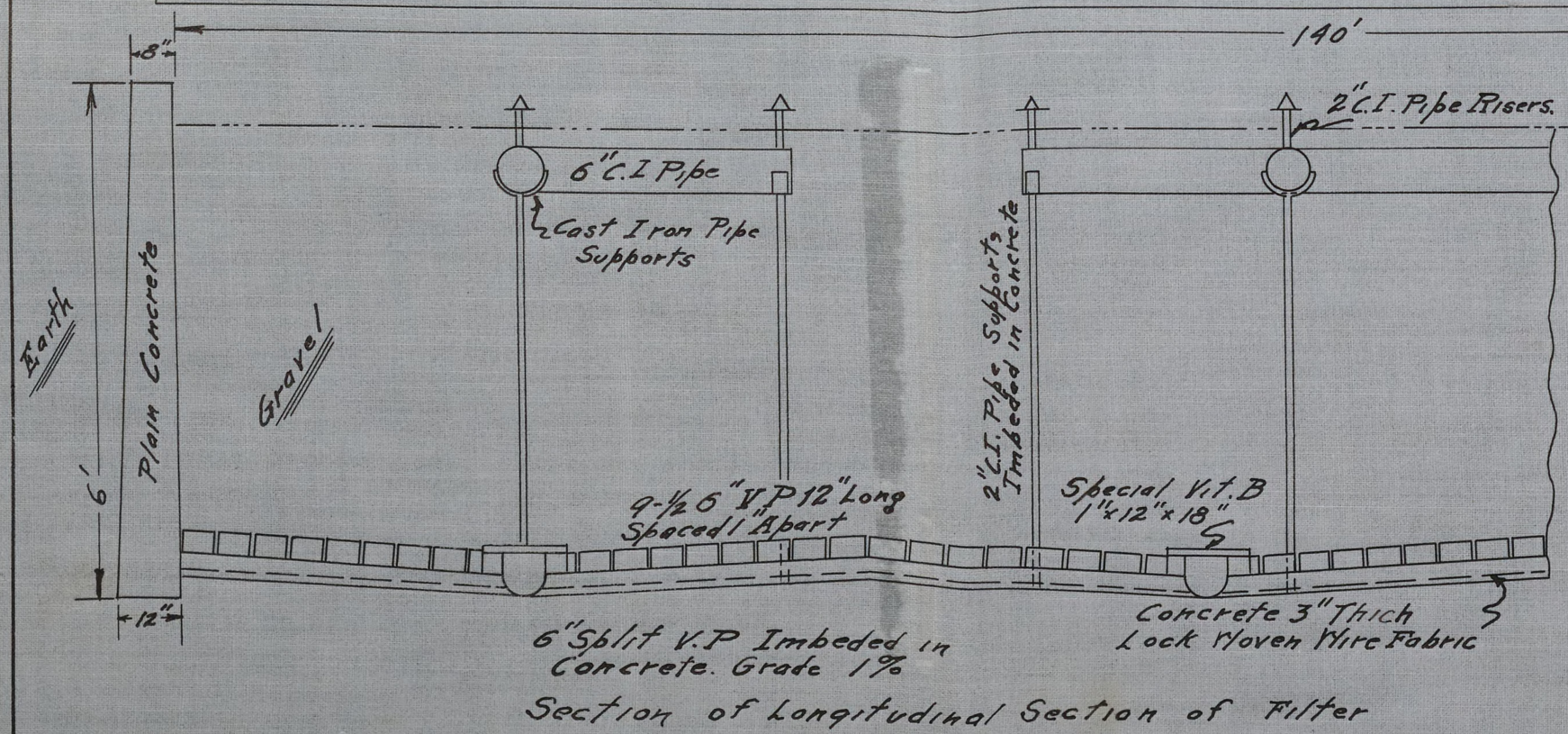
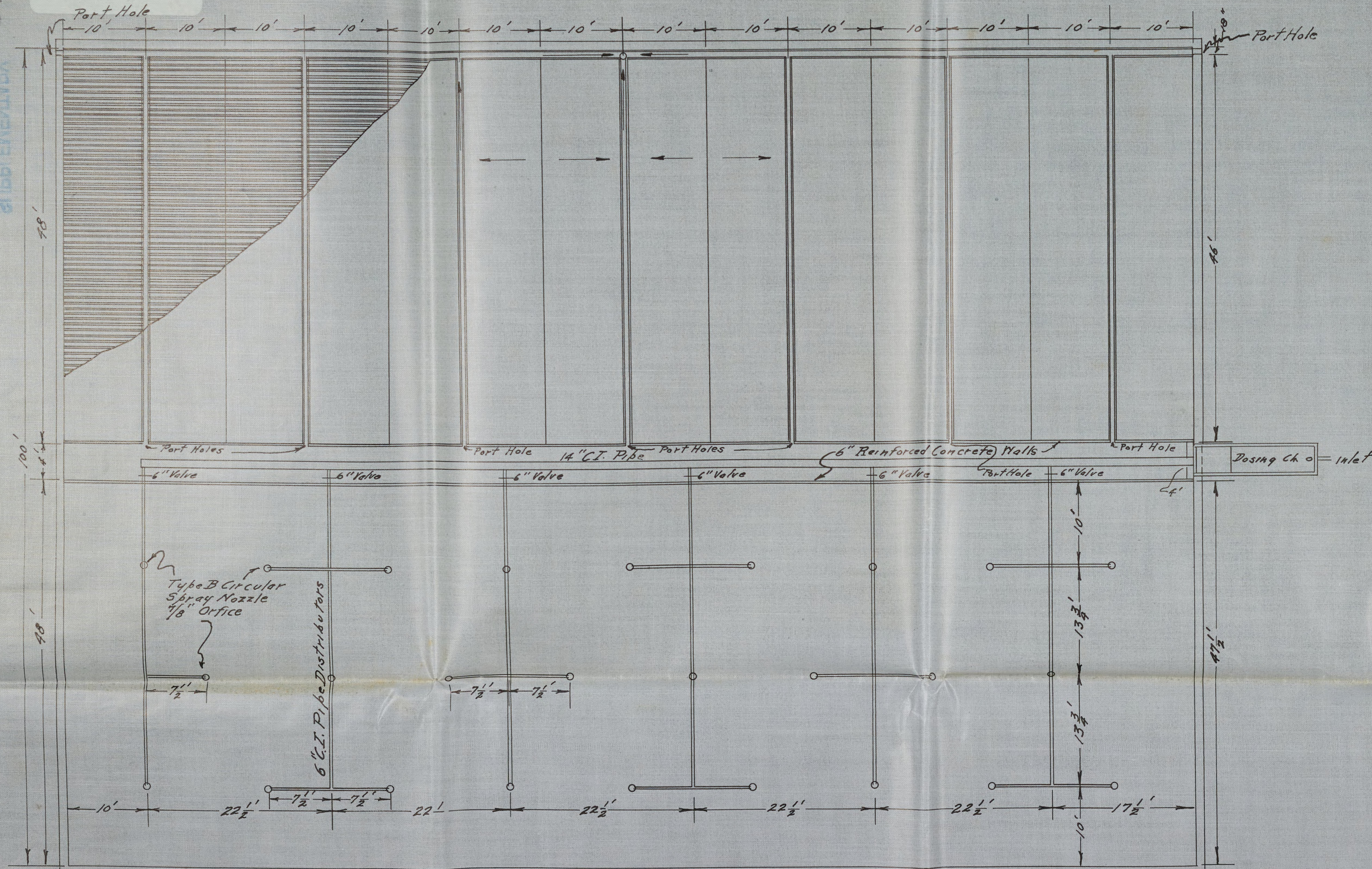
- | | |
|---------------------------------|----------------|
| "Sewerage and Sewage Treatment" | Babbitt |
| "Sewerage and Sewage Disposal" | Metcalf & Eddy |
| "Sewage Disposal" | Fuller |

Pamphlets

- | | |
|---|--------------------------|
| "Wood Trash and Sewage Pump" | Catalog #28a |
| "Sewage - Nozzles and Siphons for Sprinkling Filters" | |
| Pacific Flush Tank Co., Chicago, Ill. | Catalog #23 |
| "Sewerage and Sewage Disposal" | |
| Michigan Dep't. of Health | Engineering Bulletin #11 |

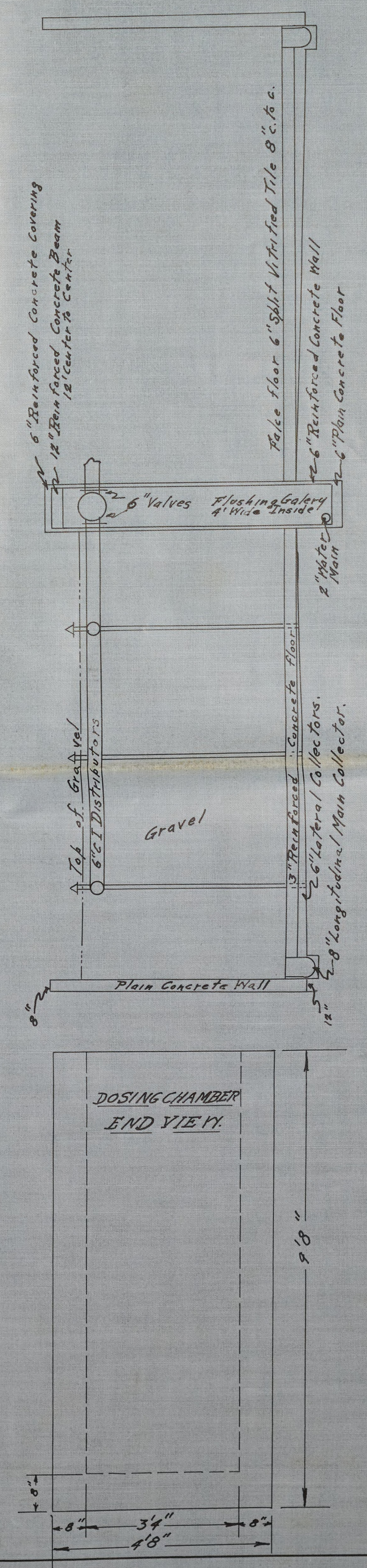
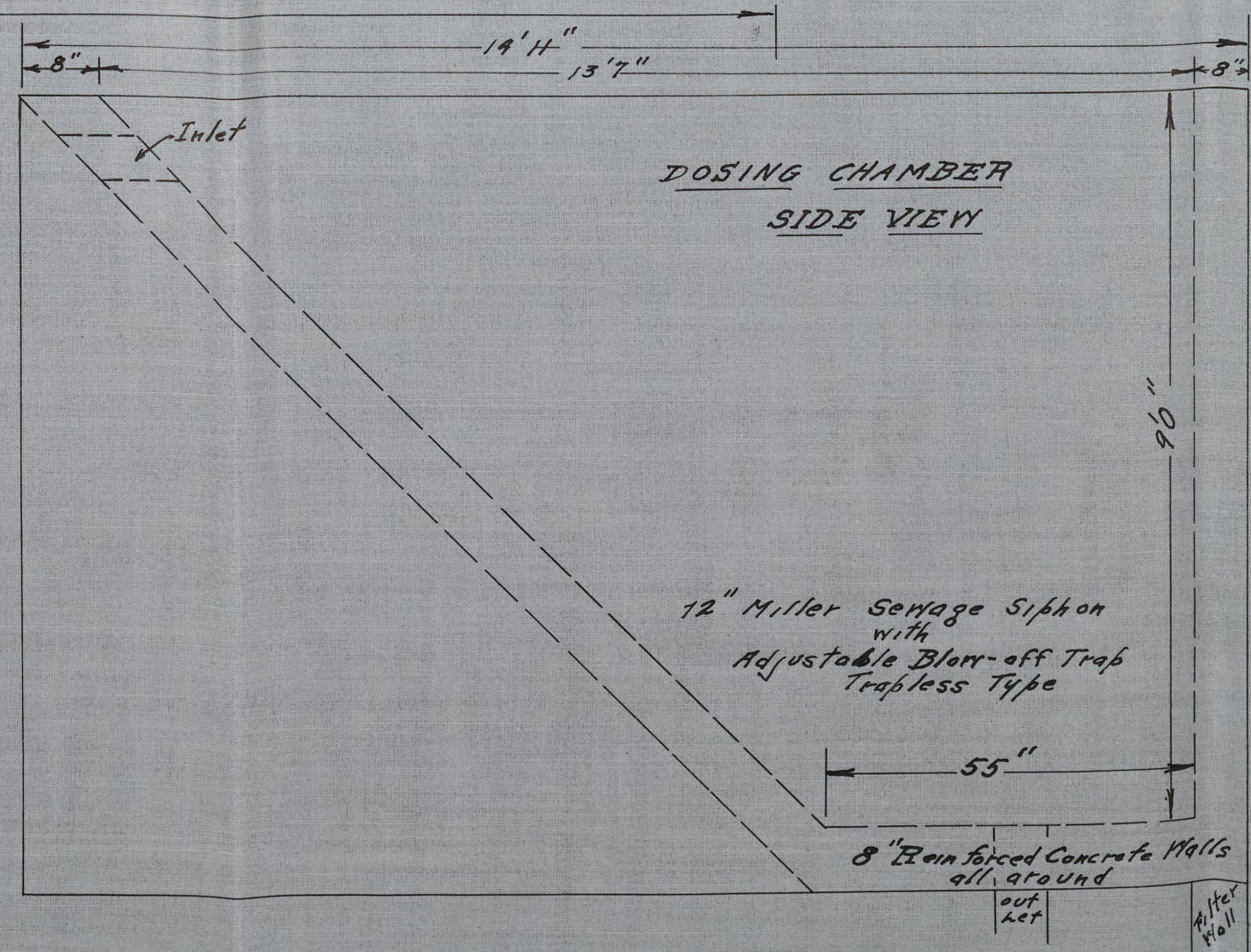
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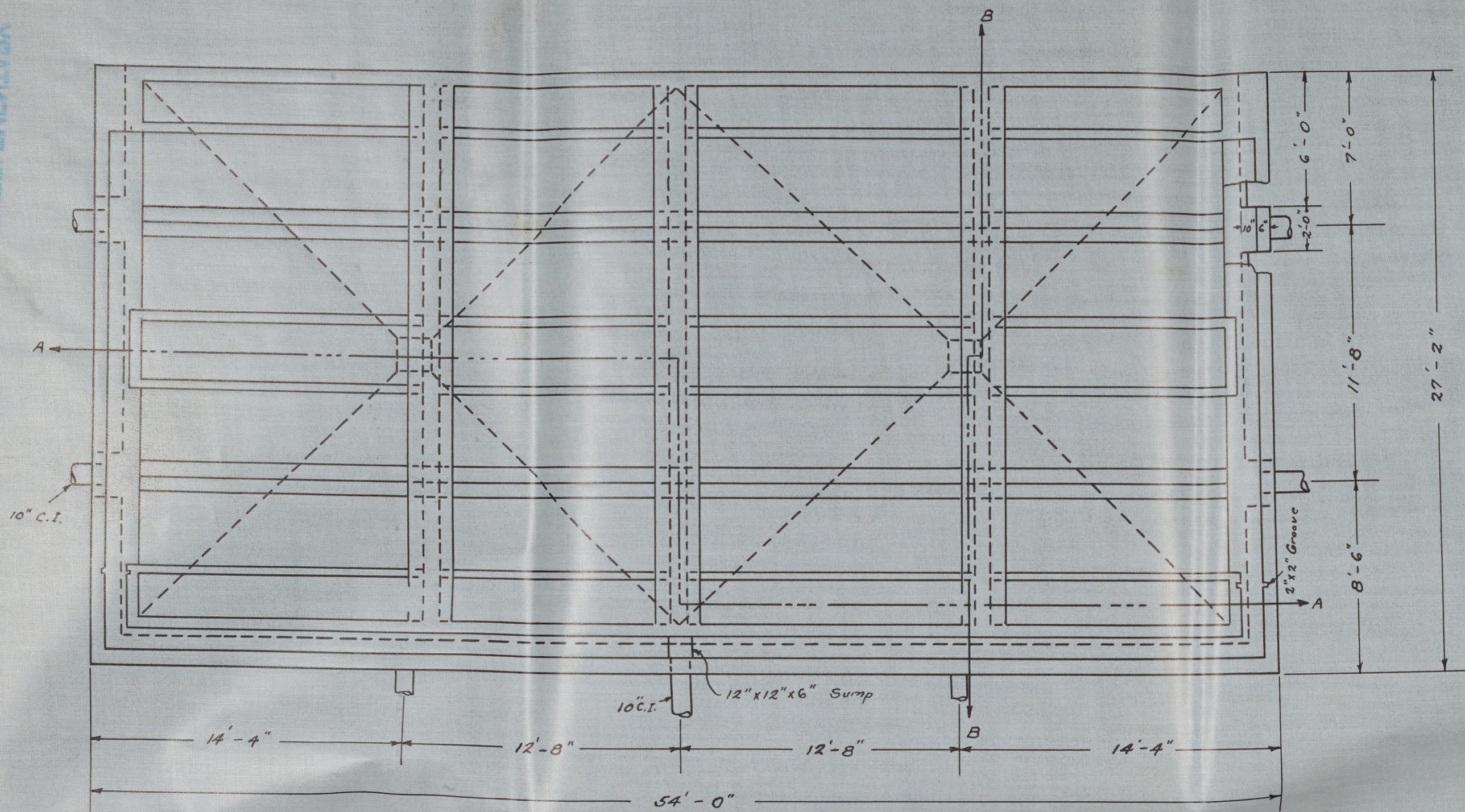


DETAIL OF FILTERS
 CHARLOTTE SEWAGE DISPOSAL PLANT

DRAWN BY C.A. JUNE.
 TRACED BY E.R. JUNE.

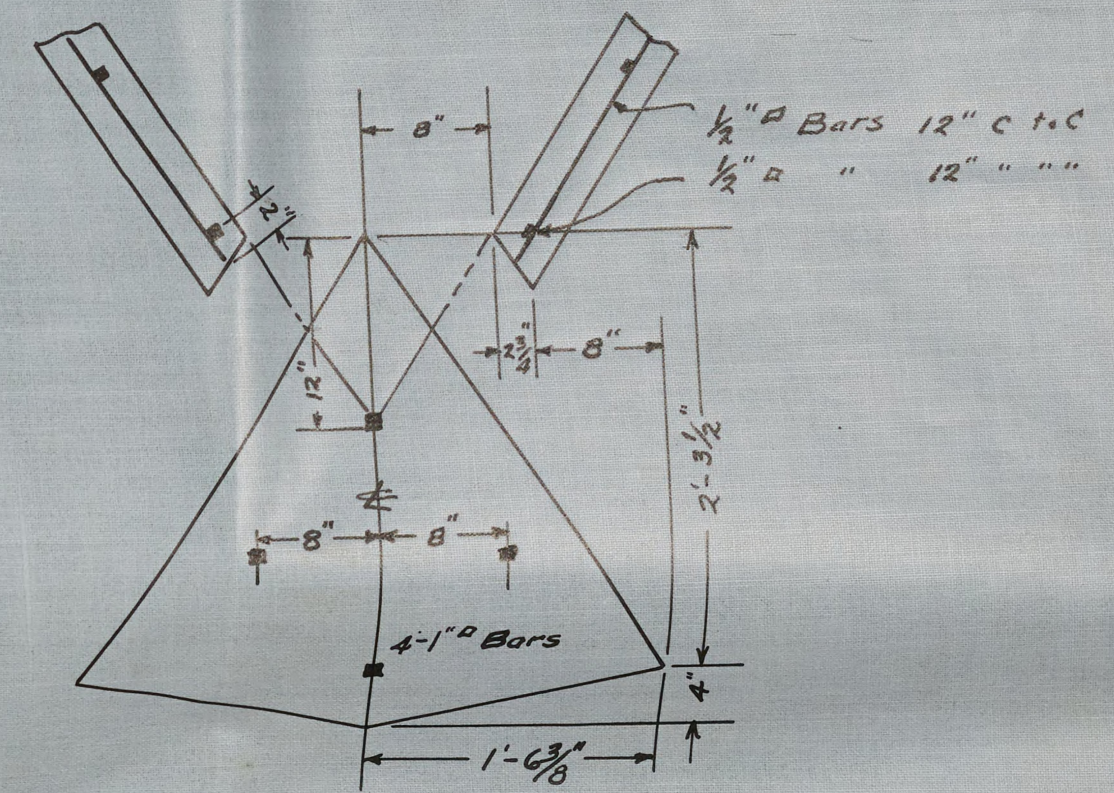


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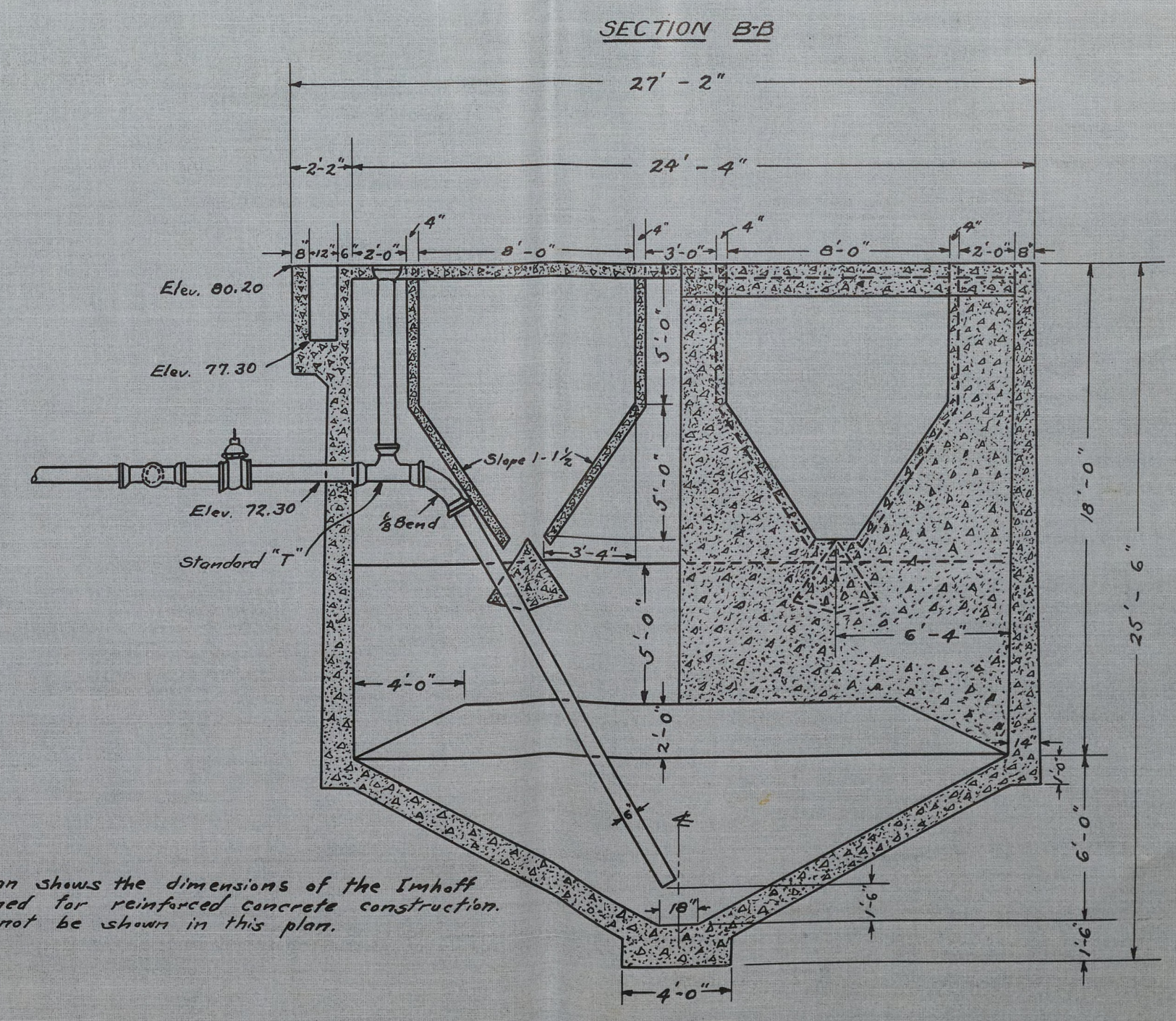
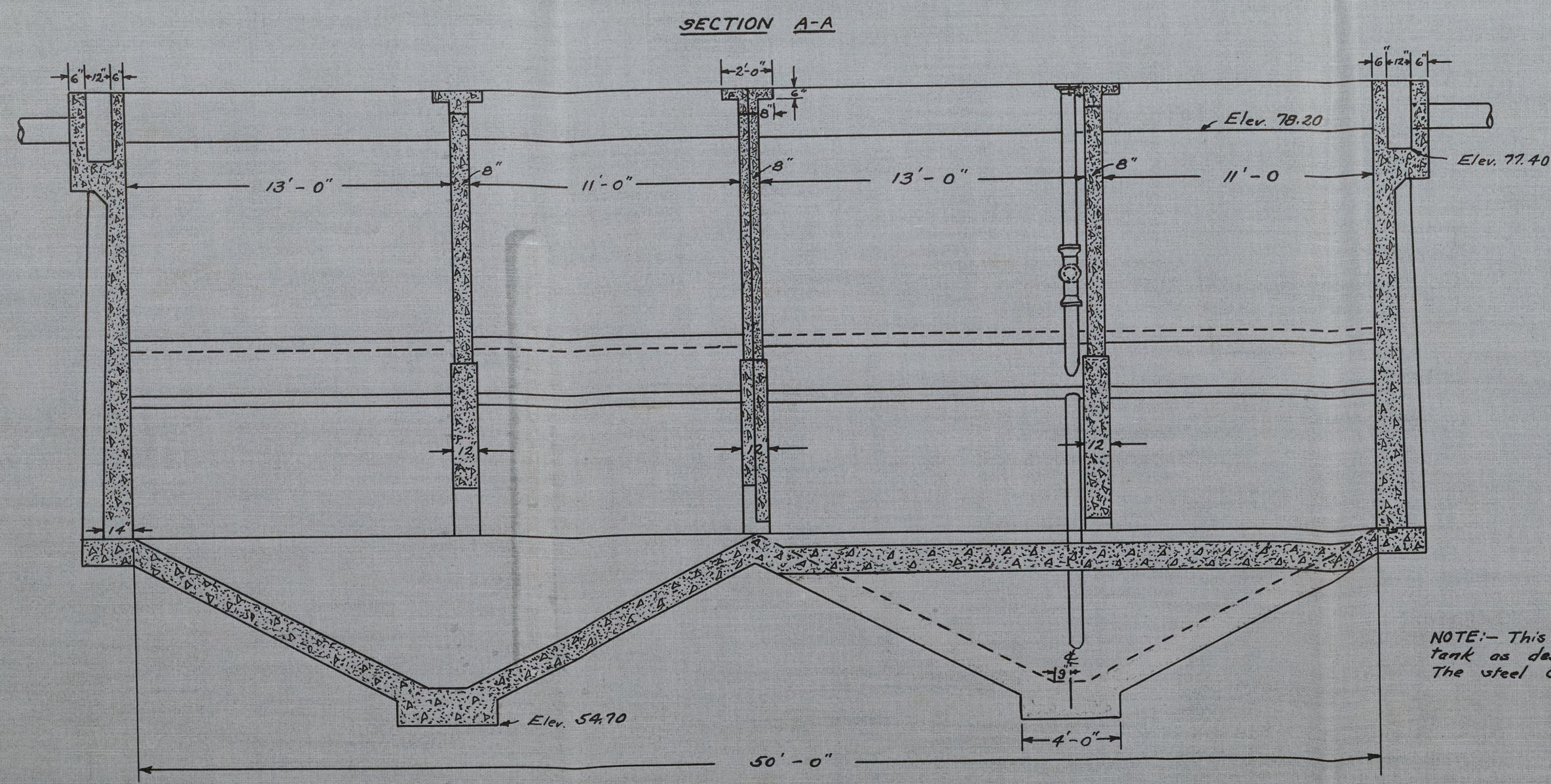


DETAIL OF IMHOFF TANK CHARLOTTE SEWAGE DISPOSAL PLANT

DRAWN BY *Clyde A. Killo*
TRACED BY *Clyde A. Killo*



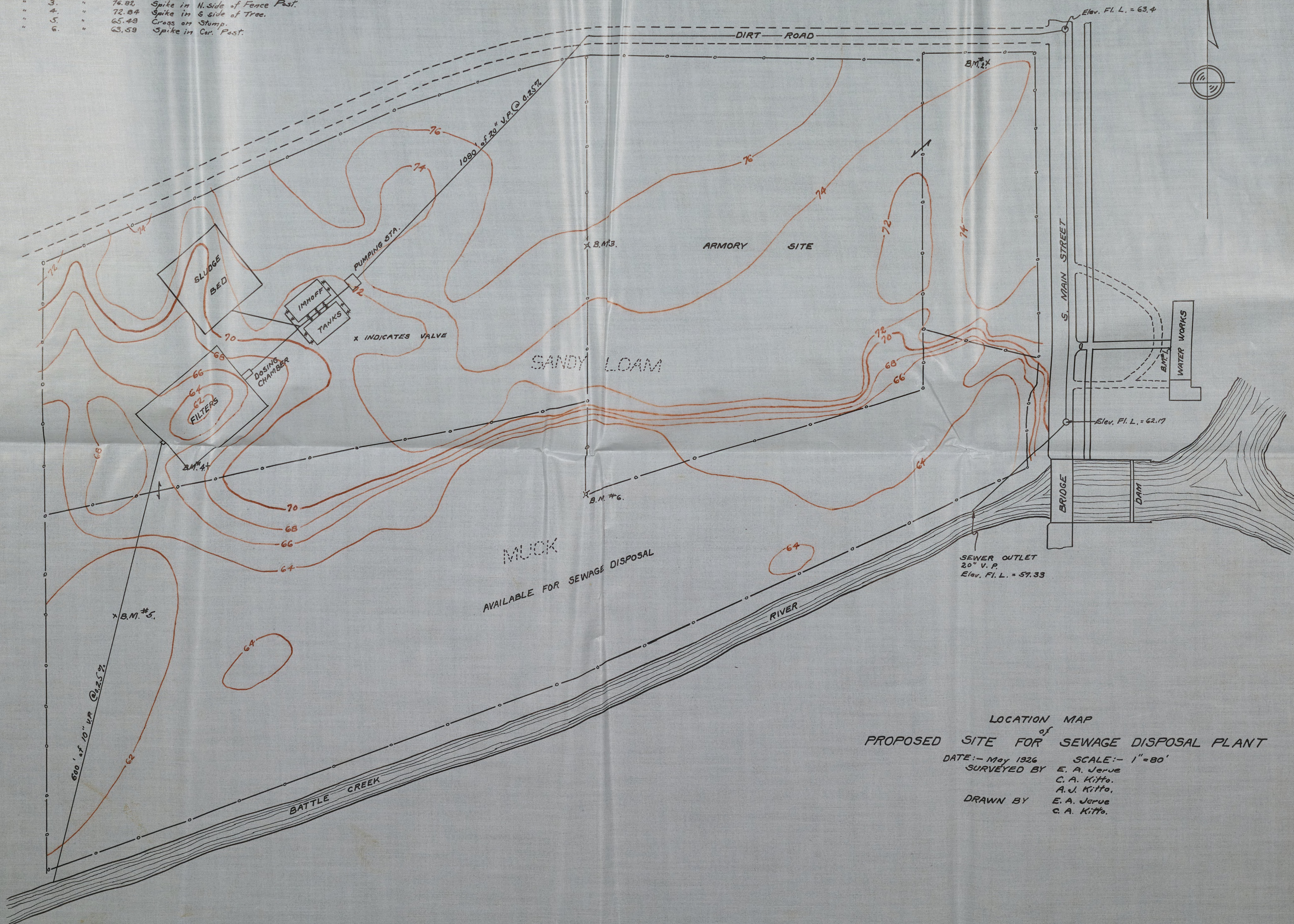
SLUDGE BEAM DETAIL



NOTE: This plan shows the dimensions of the Imhoff tank as designed for reinforced concrete construction. The steel cannot be shown in this plan.

BENCH MARKS

B.M. #	1.	Elev.	74.08	S. End of Water Works Step
"	2.	"	76.10	Spike in tree.
"	3.	"	76.82	Spike in N. Side of Fence Post.
"	4.	"	72.84	Spike in S. side of Tree.
"	5.	"	65.49	Cross on Stump.
"	6.	"	63.59	Spike in Cor. Post.



LOCATION MAP
of
PROPOSED SITE FOR SEWAGE DISPOSAL PLANT
DATE: - May 1926 SCALE: - 1" = 80'
SURVEYED BY E. A. Jerve
C. A. Kitto.
A. J. Kitto.
DRAWN BY E. A. Jerve
C. A. Kitto.

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