SEWAGE DISPOSAL PLANT MODEL

THESIS FOR DEGREE OF B. S.

IN CIVIL ENGINEERING

J. S. LANE

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Sewage disposal

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Civil engineering Sanitary engineering

SEWAGE DISPOSAL PLANT MODEL.

A Thesis

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J. S. Lane

Candidate for the Degree of

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- Preface -

Since the subject of Sewage Disposal is discussed in several of the courses offered by the Engineering Department of the College, and in view of the interest shown in elective courses which also consider this subject, trips have been made to inspect models and actual plants in operation off the Campus.

It is admitted that experience is the best teacher, and that a better conception of a plant can be obtained best by actually seeing, or from the study of a model.

To this end the present model has been constructed with the hope that it will prove useful to instructors as an aid in discussing the subject of Sewage Disposal, and also to students in helping them to get more clearly in mind the essentials of such a plant without the necessity of making a trip away from the College.

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Before actually starting to construct a model of any particular type of sewage disposal plant, it was considered most logical to make as complete a survey as possible of the various types recommended in the several States. A letter of inquiry was therefore sent to the Board of Health of each state, asking for pamphlets or other printed matter issued in each state relative to the subject of sewage disposal, and also for a statement of the methods and devices as accepted or recommended in that state.

The replies were as varied as the localities and, to the author, were as interesting as they were varied One state admitted (it does not seem proper to say accepts, since "accepts" implies that there has been thought given to the matter), that it allows the raw sewerage to be dumped directly into open streams and rivers From this extreme of laxity, the replies stated acceptance of the privies, septic tanks, and to the other extreme of treatment by Imhoff tanks and filtration of the effluent.

A majority of the states sent answers back, and the general trend seemed to be for the continued betterment of the methods of disposal, and a much more active interest in the subject. Although the departments in charge, or overseeing this matter are under the supervision of different boards in the different states, they are, for the most part, placing authority in the hands of the Health Board or Sanitary Engineer. Where replies were not received from the inquiry, it seems quite reasonable to assume that the subject has not crystallized as yet in those states enough to have any legislative action taken or power given to, or assumed by the proper authorities who should be not only interested, but also active.

In some instances, no definite reply could be made since the matter at that time, was being gotten into shape so that some sort of specifications could be formulated.

Recommendation of Disposal, by States:

ALABAMA:

Pit Privy - for houses not having water connections.

Septic Tanks - for use with sewer connections, and are designed with capacity up to a population of one thousand.

CALIFORNIA:

Pit Privy - for use in isolated places in high altitudes, where water is shut off early in the Fall to avoid freezing.

Septic Tanks - for rural and resort sanitation.

Imhoff System - for use in towns and cities. There are 42 Imhoff tanks now in use in this state.

CONNECTICUT:

Septic Tanks - for suburban property without sewer connections.

Pit Privy - with cleanable pit, for use where the septic tank is not feasible.

DELAWARE:

Pit Privy - used in rural districts.

Chemical Closet - used in 1 and 2 room schools.

Septic Tanks - used wherever water under pressure is available.

DISTRICT OF COLUMBIA:
Special system of sedimentation, incineration, skimmers, and dilution.

FLORIDA:
Pit Privy - used in rural districts.

Septic Tanks - used in towns and cities.

IDAHO:
No pollution laws.

ILLINOIS:
Plans and specifications for systems supplying more than 25 persons, must be submitted for review and approval to the Board of Health

IOWA:
Septic Tanks - in small towns and villages.

Imhoff System - in cities.

Plans and specifications to be submitted to the Health Department for approval.

KANSAS:
Septic Tanks - for municipal installation.

Imhoff System " " "

Private disposal plants require special permit from the Board of Health.

KENTUCKY:
Privy - Septic Tank - for use in all public places large homes, schools and Community Settlements.

It is known as the "Kentucky Sanitary Privy" and the Health Board is very proud of it.

LOUISIANA:
Raw sewerage flows by gravity, or is pumped directly into the large streams and rivers.

MAINE:
Pit Privy - for use in rural districts

Septic Tank - to be used wherever running water is available.

MASSACHUSETTS:
Pit Privy and Septic Tanks in rural sections

Imhoff System in almost all large communities.

Plans and Specifications must be submitted to the Public Health Dep't. for advice.

MINNESOTA:
Septic Tanks - for farm residences.

Imhoff System - for use in municipalities.

MISSISSIPPI:
Pit Privy - preferably of the cleanable type, for rural homes.

Septic Tanks - for all unsewered communities and recommended for farm homes.

MISSOURI:
Septic Privy - for all public buildings in unsewered places, and private dwellings.

System of disposal - for all communities, towns, etc.

MONTANA:
Pit Privy - for farms.

Septic Tanks - for unsewered districts.

MICHIGAN:
Septic Tanks - for use in small communities.

Imhoff System - used in all large communities.

New plants are being installed now.

NEBRASKA:
Plans and Specifications must be submitted to the Bureau of Health before they may be installed.

No publications issued, and no forms used.

NEW HAMPSHIRE:
Septic Tanks - for use in all communities, towns and summer resorts. Many designs have been made and recommended for any purpose.

NEW JERSEY:
Plans and Specifications to be submitted to the Department of Health for approval, and include: complete systems of chambers, Imhoff Tanks, filter beds, sludge beds, tile, etc.

NEW MEXICO:
Not clear in their minds what is done.

NEW YORK:
Plans and Specifications to be submitted to the Department of Health and must receive its approval before any sewerage system of sewage disposal may be put into operation.

NORTH CAROLINA:

Sanitary Pit Privies - used in residences which are more than 300 feet apart and not in a district of sewer connections.

Schools - must have an approved Privy, Chemical closet, or flush stool.

Septic Tanks and Imhoff Systems with filter beds are recommended for all communities and Plans and Specifications must be submitted to the Board of Health on comprehensive forms provided by the Board.

OHIO:

Septic tanks, with various systems of tanks and beds and settling chambers are used in residential disposal for from 5 to 10 persons.

Plans of proposed municipal sewage systems must be submitted to the Health Department, and be approved before being installed.

OKLAHOMA:

Laws relating to what may and may not be done in the matter of sewage disposal are fairly complete but of course do not recommend any particular types or methods.

PENNSYLVANIA:

Methods recommended are in accordance with standard practice, but no bulletins or pamphlets have been issued pertaining to the practice in this state but will be forthcoming in the near future.

RHODE ISLAND:

Septic tanks - used in most every populous community in the state.

Disposal Plants - are quite numerous, but the type is not given in the bulletin issued.

New pamphlets will be issued soon as they are now being compiled.

SOUTH DAKOTA:

Pit Privy - used in isolated places, and is all right if properly constructed and cared for.

Septic Tanks - are advised for the most part for disposing of sewage from residences outside of thickly settled communities and cities.

TENNESSEE:

Pit Privy - several types of construction are accepted, each having its place according to the need and the soil conditions.

Septic Tank - for small installations is used.

Plants, and sewerage systems are passed upon by the Health Department before installation in towns and cities.

TEXAS:

Plans and Specifications for all types of disposal systems, including comprehensively all the data relative such a system.

Septic tank systems with filtration are used

Imhoff tanks seem to be greatly favored and used a good deal in cities.

VIRGINIA:

Pit Privy - made tight and sanitary, and its use is required by law in all unsewered districts such as suburbs of cities, towns, and farms.

Septic Tank - used in connection with sewers in all populated sections of suburban and country homes.

WASHINGTON:

Sanitary Pit Privy - for use on farms it is advocated, although there is no law compelling a pit privy.

Septic Tanks - used where water under pressure is available in rural districts and also in towns.

Educational matter is being distributed and newer and more up to date pamphlets are being prepared.

WEST VIRGINIA:

Septic Tanks - used in all districts having water supply under pressure. These tanks are being used in separate dwellings.

Plans and Specifications of all disposal plants and systems must be approved by the Department of Health before installation.

WISCONSIN:

Pit Privy - sanitary type used in farm homes.

Chemical closets - used in connection with rural schools.

Septic Tanks - for use in farm, and suburban homes whenever the water supply allows them, and also in towns.

Imhoff Tanks and filter beds and sludge beds used in the disposal of city sewerage.

From the foregoing data, it is evident that while privies are used, and their use is accepted by State Health Boards, the old style, open back type is obsolete having been superseded by the improved pit or closed type. This is the crudest method of caring for waste, but has been so improved as to be highly sanitary.

Septic tanks are also approved where a water supply under pressure warrants their use; and their design is much improved over what it used to be, and likewise the matter of their proper use, and maintenance is more carefully supervised.

However, the type recommended as the best in general at the present time, is the Imhoff Tank with Sludge bed and filtration beds. Therefore this is the type of sewage disposal plant which has been chosen to be constructed in model for this Thesis.

Operation of the Imhoff Tank System:

The process of sewage treatment under the Imhoff Tank system consists, first of running the influent through a grit chamber and a series of coarse and fine screens, thereby removing the larger substance which may have gotten into the mains and which would not be cared for in the processes which follow, and might also clog the pipes.

From the screens, the sewage flows to the Imhoff tank which is constructed in two stories. The sewage flows through the upper story and the solids settle through a long narrow slot into the lower story, or sludge chamber. The slot is formed by two steeply sloping sides which overlap and do not meet, and run the full length of the chamber. The flowing through time is regulated by adjustable weirs so that it is from two to four hours. In the the lower chamber, the sludge humifies or digests and the sludge-entrained gas risin to the surface is deflected away from the stream of settling sewage into scum or gas vents. These vents comprise from 10 to 30 percent of the surface area of the tank. The slope of the walls of the sedimentation chamber is usually specified at not less than 1;1, and

the slope of the bottom of the digestion chamber at not less than 1;2. These slopes cause the sludge to settle by gravity toward the center of the digestion chamber, from which point it is drawn off by gravity or pumped through pipes extending almost to the bottom. With the pipes so arranged, the most thoroughly digested sludge will be drawn off first and carried to the sludge bed for drying. The sludge bed is nothing more than a bed of sand and stone upon which the sludge is spread from troughs to a thickness of about three inches at an application and so dried. There is very little odor to the sludge as it comes from the digestion chamber, and none whatever after it is dried. The dried sludge may be used as fertilizer, but its value barely offsets the costs of hauling and is therefore not held in very high esteem.

The run-off from the sedimentation chamber of the Imhoff tank flows out through weirs to what is called a dosing chamber. The dosing chamber's function is to provide the filter bed with doses of the sewage intermittently. This is accomplished by means of automatic siphons which act in rotation, thus dosing the beds to which they are connected, in rotation and allowing the previous dose to

be thoroughly passed through the filter bed before the next dose is applied.

The sewage is applied to the filter bed in doses as described above through pipes so arranged that the sewage is equally spread over the bed. The filters are known as trickling filters, sprinkling filters etc., depending upon the method of construction of the apparatus. The bed proper consists of layers of sand, small stones, and larger stones, increasing in size toward the bottom. The effluent is collected by a system of tile underdrains and may or may not be carried to a final settling chamber to which the effluent from the sludge bed is also brought.

The final settling chamber is merely a tank which allows any matter still in suspension, to settle out before the effluent is ultimately disposed of. It also allows an opportunity for the mixing of a disinfectant if such is to be desired before turning the effluent into a stream, river, or ocean, when the composition is such as to be possibly harmful to surrounding conditions of habitation. The addition of a disinfectant is seldom necessary, however.

Method of Construction of the Model:

All pipes were cut from ½" cast iron pipe. The end walls of the Imhoff tank were made of a 1:2½ mix of Lumnite cement and sand, the side walls were made of glass cemented into the end walls, and the walls of the flowing through chamber were made of galvanized sheet cut and bent to the proper size and shape and cemented into the end walls and bonded by bending the ends into the cement. The bottom was made of the same mix of sand and cement as the end walls.

The dosing chamber was constructed of soldered sheet metal, having an automatic siphon inside.

The filtration bed was made of a sheet metal container filled with with sand and small stones. The sprinklers were made by drilling small holes along the length of the pipe so as to be at an angle of about 45 degrees upward from the horizontal.

The final settling chamber, and the sludge bed were not constructed, as it was not deemed necessary to do so for an understanding of the working of such a plant.

The total cost of materials, including wall-board forms for the concrete, was not over ten dollars.