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Michigan Department of Health Engineering Bulletin 2

SEPTIC TANK SEWAGE DISPOSAL SYSTEMS FOR MICHIGAN

Issued jointly by

MICHIGAN STATE COLLEGE
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R. J. BALDWIN, Director
and
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BUREAU OF ENGINEERING
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This bulletin describing the principles and design of septic tanks is issued jointly by the Michigan State College and Michigan Department of Health. It has been prepared by George Amundson, Extension Specialist in Agricultural Engineering, Michigan State College, and Edward D. Rich, Deputy Director of the Bureau of Engineering, Michigan Department of Health, largely from the material contained in Michigan State College Extension Bulletin 118 (by O. E. Robey) and Engineering Bulletin 2 of the Michigan Department of Health.

For more than 25 years the Extension Division of Michigan State College has advocated a septic tank for rural or farm homes and has furnished plans, demonstrations, and assistance through county agricultural agents for their construction. During the same period the Engineering Bureau of the Michigan Department of Health issued a bulletin on septic tanks for installation at homes, resorts, schools, and hotels. Although these tanks appeared to be different, both designs incorporated the same principles and requirements for satisfactory sewage disposal with the least labor and expense for maintenance.

Development of rural electrification and the rapid increase in the installation of water pressure systems and toilet facilities in farm homes, together with a similar rapid increase in the installation of modern plumbing in resort cottages, cabins and other tourist accommodations, emphasizes the assistance which can be offered through this joint bulletin and the combining of all the available resources for septic tank construction.

The bulletin describes the construction and operation of septic tanks; county agricultural agents and county health department sanitarians will gladly furnish additional personal service to any one desiring to install this method of sewage disposal.

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Michigan Septic Tank and Tile Sewage Disposal System

Part 1

SEPTIC TANKS FOR SINGLE FAMILIES

This bulletin has been prepared in two parts:

PART 1 describes a disposal system designed to provide the proper size of tank and tile disposal field for the one-family home. This system was developed by the Agricultural Engineering Department of Michigan State College in 1915 and more than 8,000 have been built and are operating successfully. The purpose in this design was compactness, so that the form work would be simple and the structure fit into an excavation approximately square. This tank will provide a satisfactory means of disposing of the wastes from the kitchen, laundry and bathroom of the home occupied by one family, whether it be the farm home, suburban home or resort cottage. It also provides the best possible method of safeguarding the water supply against contamination from such wastes.

PART 2 relates to larger septic tanks required to handle the wastes from multiple-family dwellings, schools, hotels, and factories. Although the principles of design are the same, increases in size introduce certain difficulties which require additional attention to design and operation. Tanks to dispose of the wastes from more than 50 people should not be built before consulting the Michigan Department of Health.

THE SEPTIC TANK SYSTEM OF DISPOSAL

A public sewer system furnishes, by all means, the most economical and satisfactory method of disposing of liquid wastes and should always be used if possible. Where a sewer system is not available, the sedimentation tank, or so-called septic tank, with proper disposal of the tank effluent into the ground near the surface offers the most satisfactory solution of the problem of disposing of household wastes.

All liquid wastes created in the house, either in the kitchen, bathroom or laundry, should be disposed of through the septic tank. Rainwater must be kept out of the tank and disposal field.

The principles upon which the septic tank operates are simple. Some of the solid material carried in suspension in sewage is slightly heavier and some is lighter than water. If the sewage is allowed to remain quiet in a water-tight tank the heavier particles settle to the bottom and the lighter ones float on the surface of the liquid. The material which settles is called "sludge" and that which floats, "scum." The

accumulations in the bottom soon begin to rot. The same action takes place in the floating mass to some extent but not so rapidly as at the bottom. The decomposition process changes part of the solids into liquids and gases. The gases pass out through the inlet sewer and escape into the air through the ventilating system of the house plumbing.

To prevent the escape of sludge and scum, the tank must be large enough and of such a shape as to allow the sewage which flows in at one end to pass very slowly and quietly to the other end where it is drawn off with the least possible amount of disturbance. The liquid waste which flows from the tank is called the effluent.

Ample capacity must be provided for the accumulation of both sludge and scum. The gaseous products of decomposition form very small bubbles within the body of the sludge and in time these bubbles increase the volume of the sludge enough to make it lighter than water; thus portions are detached and rise to the surface where the gases tend to escape. If all the minute bubbles should escape, the sludge would again settle, but free escape is interfered with by the material already floating and only part of the sludge returns to the bottom, the rest remaining to increase the scum thickness.

In addition to the suspended solids in sewage there is a certain amount of organic matter in solution which will not settle out. A properly designed tank when given systematic attention should remove nearly all of the settleable solids, but the tank effluent is by no means pure, since little, if any, of the filth in solution is removed by sedimentation.

When a septic tank effluent is discharged into an open ditch or other place having little or no diluting water the organic matter which remains in it putrifies and causes an odor nuisance. The liquid still contains many of the disease-producing organisms which it originally contained. It should be distributed into the soil on the owner's property by means of disposal tiles laid not more than 18 to 20 inches below the surface of the ground. Where ploughing or other use of the land will not interfere, a tile depth of 10 to 12 inches below the surface is recommended. Tank overflows should not be connected to any farm tile drain, county drain, highway drain, open ditch, stream or lake.

It is contrary to state law to discharge into any of the lakes, rivers, streams, or other waters of Michigan, any waste or pollution of any kind that will tend to destroy fish life or be injurious to public health (Act 245, P. A. 1929).

LOCATING THE TANK

In planning a sewage disposal system, the first thought is, "Where shall it be located?" The most practical location for the tank may be close to the wall of the house, but in no case should the foundation wall be used as one wall of the tank. The piping will usually be simplified by having the tank on the same side of the house as the bathroom (Fig. 1). The tank should not, however, be placed near the well. Health authorities agree generally that no septic tank or disposal field should be within 50 feet of any well; and **no pipe** carrying sewage, or

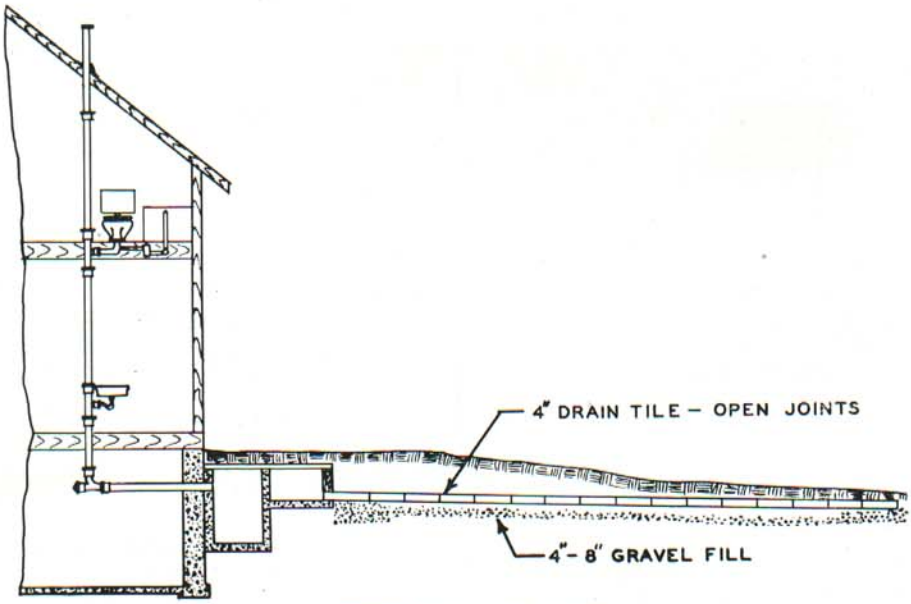

Fig. 1. Typical septic tank installation.

no pipe likely to become flooded with water while carrying sewage should be within 10 feet of any well. Any pipe carrying sewage that is within 50 feet, but more than 10 feet, of any well should be a cast iron soil pipe with caulked lead joints. Where the well is intended for public use, such as at resorts, or if an F.H.A. loan is desired, the Department of Health requires 75 feet between the well and any septic tank, disposal field or other source of sewage pollution. This requirement of distance from the well may make it necessary to place the tank on the opposite side of the house from the well, or at some distance from the house.

The tank should not be placed under a porch, in the basement, or where it will not be readily accessible for cleaning. It may be placed in a driveway if the cover is sufficiently reinforced.

DEPTH

In Michigan where the land surface is so flat it is often necessary to take particular care in choosing a location for the tank and disposal tiles. Where practical, the top of the tank should be about one foot below the surface of the ground. On level ground the top of the tank may be even with the surface or slightly above and mounded over with earth. On level ground, it is not possible to have fixtures in the basement of the house, unless the sewage is pumped.

Where the land is sufficiently rolling so that the surface of the ground at a short distance from the house is at about the same level

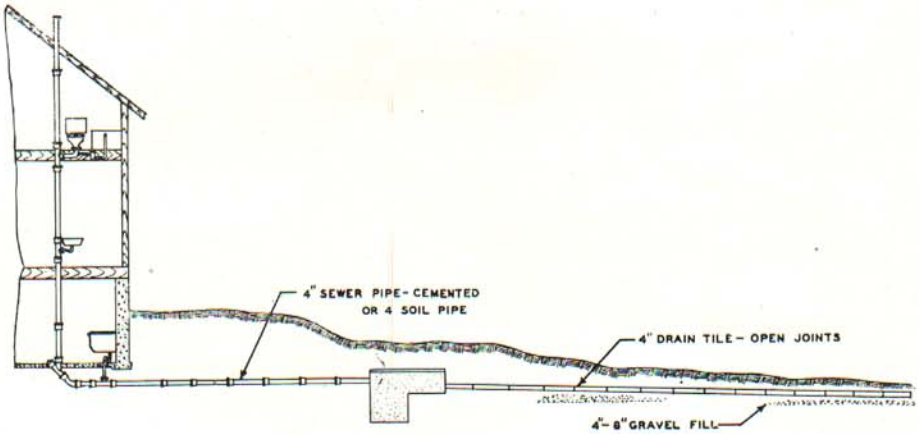

Fig. 2. Tank installation in sloping ground permits fixtures in basement.

as the basement floor, it is possible to have fixtures in the basement. In this case, it is best to locate the tank some distance from the house for accessibility (Fig. 2).

Before determining the depth at which the tank is to be placed, the next section of this bulletin concerning the location of the tile field should be carefully read. This depth depends very largely on the elevation at which the tile field is placed.

Ordinarily about 2 feet of height is taken up in the tank and siphon

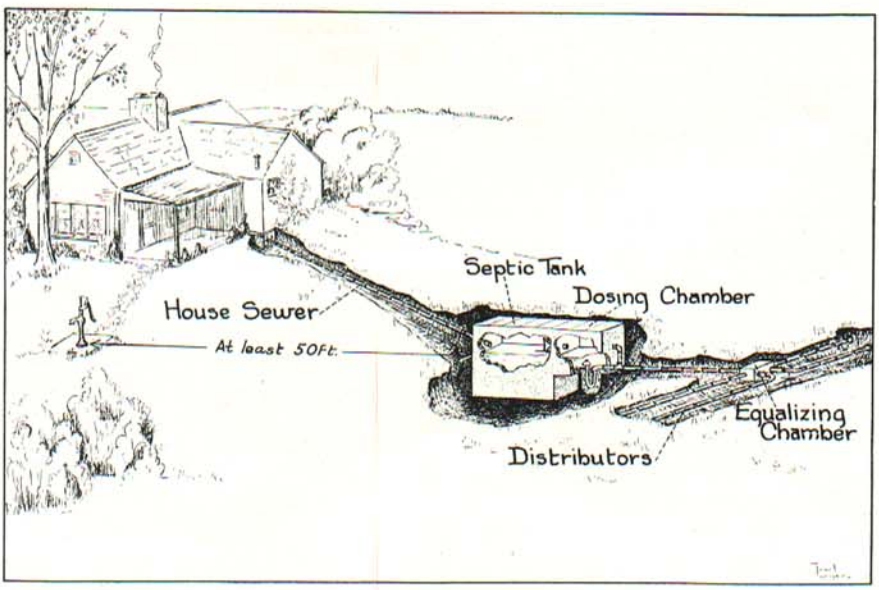

Fig. 3. Showing tank and disposal tiles in level ground.

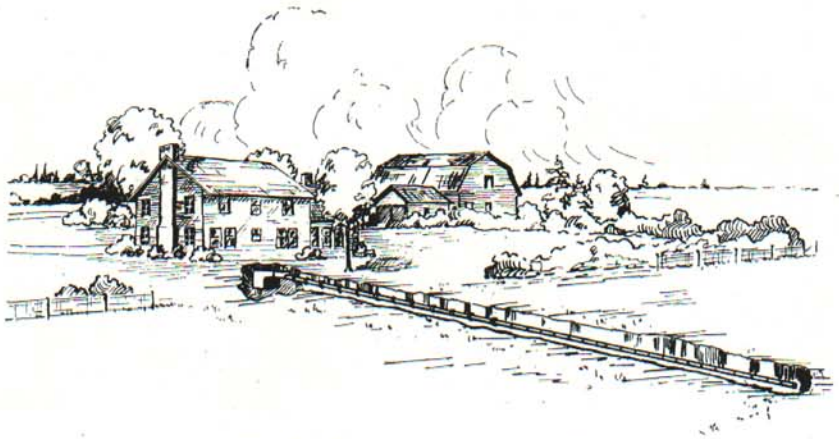

Fig. 4. Tank with single tile line.

chamber. In other words, the sewer leaving the dosing tank will be about 2 feet lower than the one entering the settling tank.

LOCATING THE TILE FIELD

In planning for the septic tank, the location of the tile field should be given primary consideration. The ideal location is a level plot of ground of a sandy or gravelly nature about 2 feet lower than the ground surface at the tank.

There must not be more than 12 to 20 inches of earth cover over the tiles in order that grass roots and other minute plants and soil organisms may be used to the utmost in taking up the organic material in the sewage for plant food.

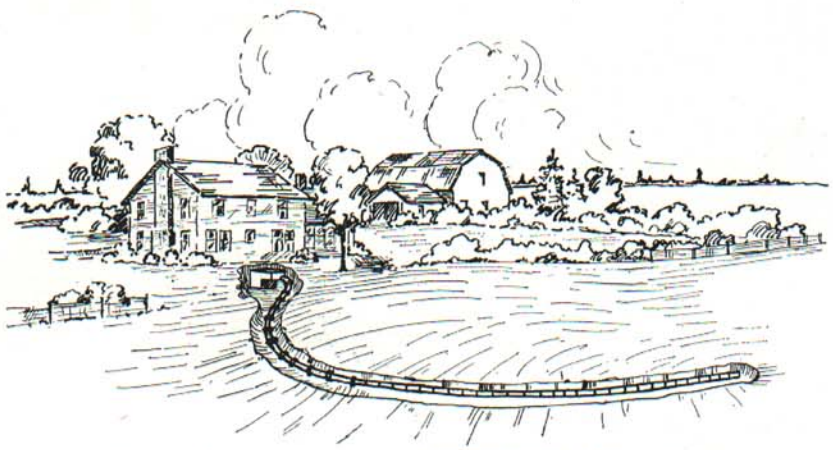

Fig. 5. Tank with tile line of constant depth along contour.

If only a small level area is available, the disposal tile may be arranged as in Fig. 3 or they may be arranged as in Fig. 4 in one continuous line where a long level strip of ground is available. On irregular ground, the line may be curved to follow a contour of the same elevation, as shown in Fig. 5.

The disposal tile system consists of four-inch drain tile laid not more than 20 inches below the surface with not more than 2 inches of fall per 100 feet.

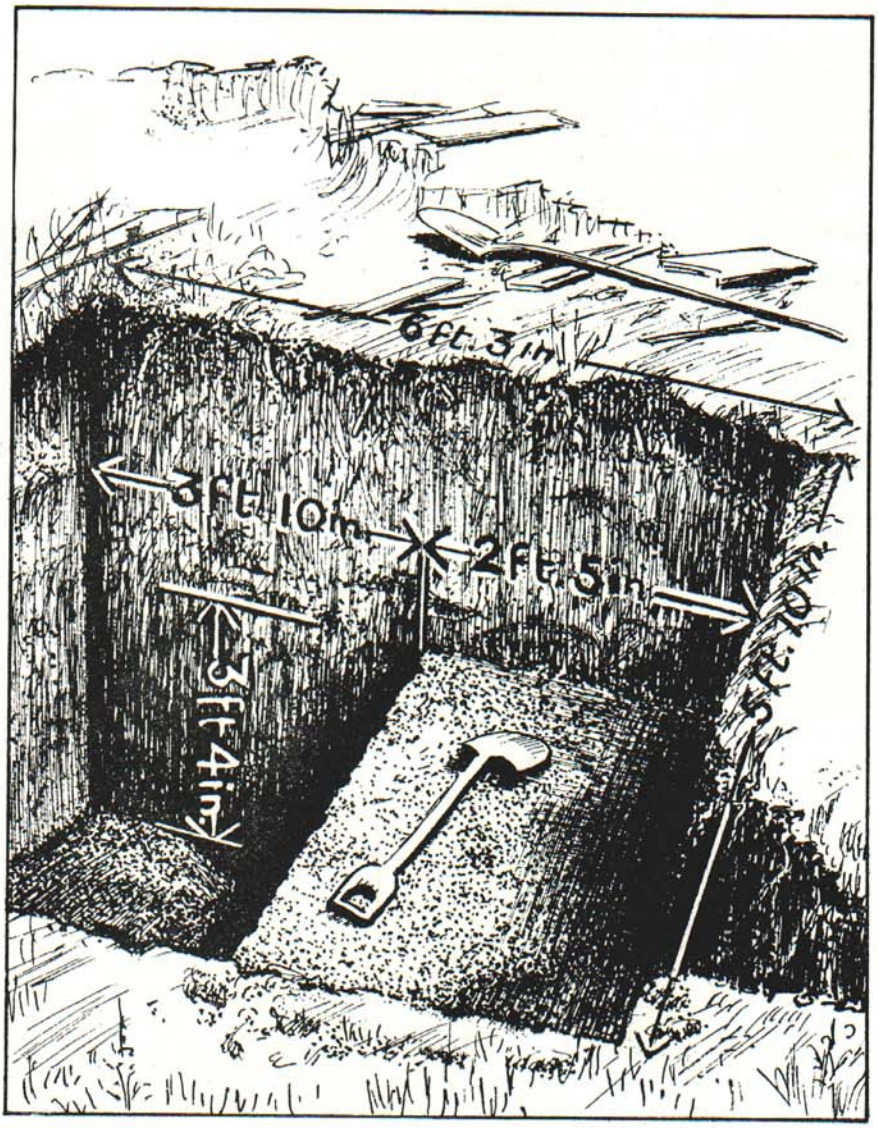

Fig. 6. Excavation for tank.

The reason for laying the tile lines virtually level is to insure a more uniform distribution of the sewage. If the tile line has considerable fall, the sewage will collect at the lower end, creating a saturated area which destroys the bacterial action in the soil and prevents the mineralization of the sewage.

For the tank described in this bulletin, 125 feet of 4-inch tile will be required in favorable soil (sandy or gravelly in nature) and more in unfavorable soil. When the effluent is discharged by the siphon from the siphon chamber, it fills the tile lines, and seeps into the soil through the joints of the tile.

EXCAVATION

The excavation should be laid out as shown in Fig. 6. Either the side or the end of the deep compartment may be placed toward the house. If the ground is hard enough so as not to be subject to caving, the sides of the excavation may be trimmed to smooth vertical faces and used for the back forms of the side walls. In sandy or other loose ground back forms of lumber will be required.

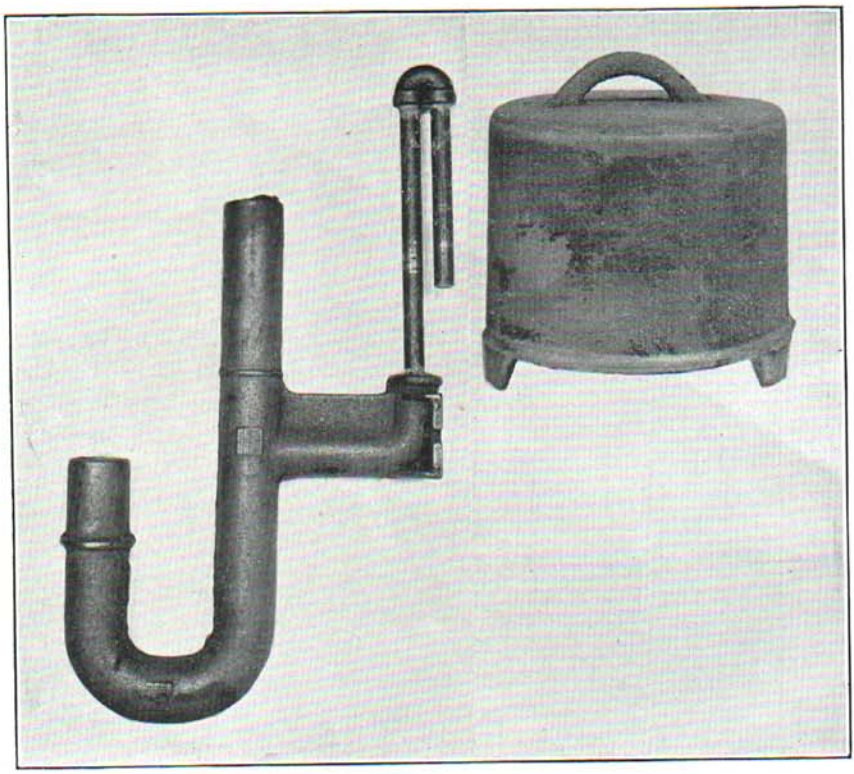

Fig. 7. Cast iron siphon and bell.

MATERIAL REQUIRED

For the construction of a tank the following materials will be needed:

4 yards of gravel
20 sacks of cement
12 pieces of ⅜" round steel 2' 4" long (Reinforcing for cover slabs)
12 pieces of ⅜" round steel 3' 4" long
2 four-inch vitrified clay sewer pipe
2 four-inch vitrified clay sewer pipe tee
1 four-inch glazed drain tile
125 feet of four-inch vitrified clay drain tile
Necessary tees or elbows to connect other lines if desired
Sufficient four-inch vitrified clay sewer pipe or cast iron pipe to connect the tank with the house and with the tile disposal system

SIPHON

The purpose of the siphon is to distribute the effluent throughout the length of the tile system. The siphon is so constructed that it per-

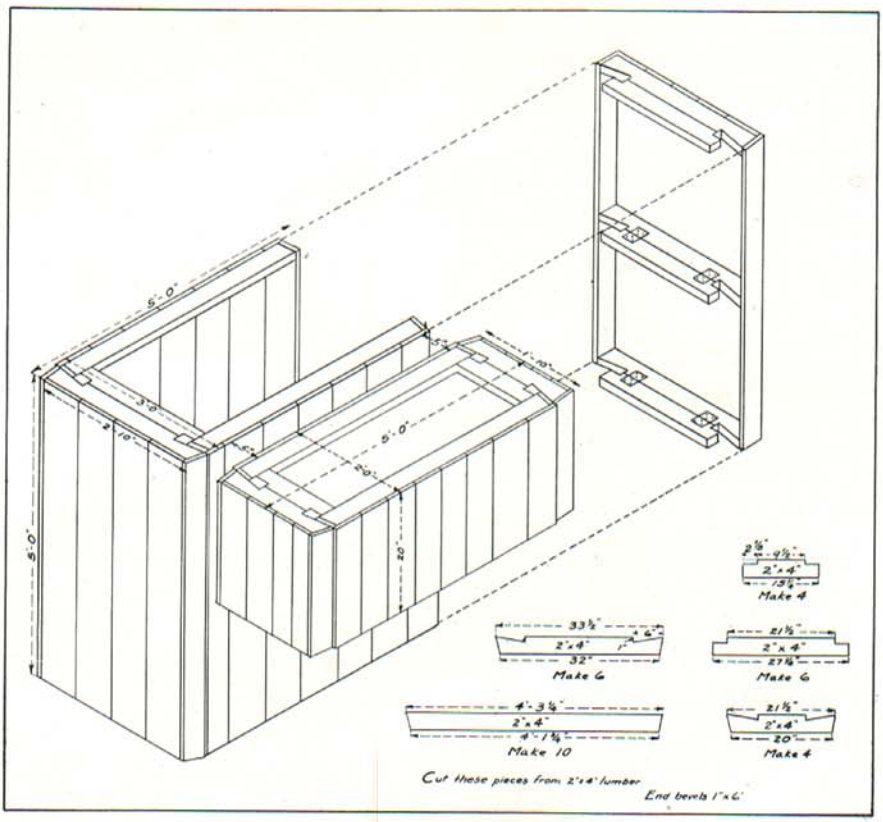

Fig. 8. Portable forms for settling and siphon chambers.

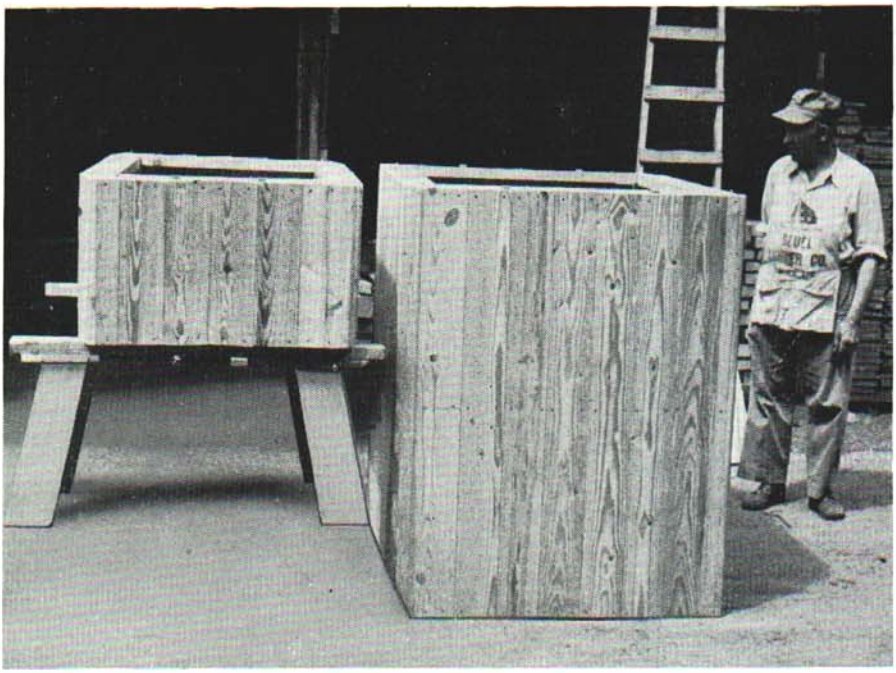

Fig. 9. Forms built from drawing in Fig. 8.

mits the settled sewage to accumulate in the siphon chamber to a depth of about 13 inches, when it automatically discharges the contents of the siphon chamber into the tile system. There are no moving parts in the siphon. Its action depends upon the compression of the air which collects under the bell. By discharging the effluent periodically, allowing time for aeration, bacterial activity in the soil is maintained.

A cast iron bell and siphon similar to that shown in Fig. 7 may be purchased from several sources. The county agricultural agent or county health department sanitarian will direct where these may be procured, or the Agricultural Engineering Department of Michigan State College, East Lansing, or the Michigan Department of Health, Lansing, will furnish this information.

FORMS

Forms may be made of ordinary lumber not less than ⅞ inch thick. Vertical studding of two by fours should be not more than 2 feet apart. If the forms are to be used several times they should be made according to the plan in Fig. 8, and illustrated in Fig. 9.

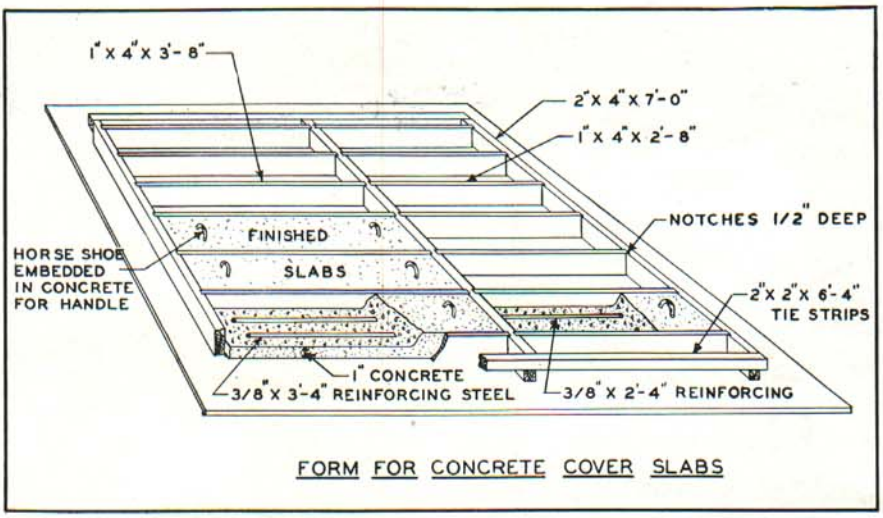

Fig. 10. Forms for cover slabs.

These forms are removable without damage and require the following material:

5 pieces 2″ x 4″ x 14′ to cut 10 pieces 4′–3¼″; 5 pieces 33½″; 5 pieces 27¼″
1 piece 2″ x 4″ x 14′ to cut 1 piece 33½″; 1 piece 27¼″; 4 pieces 21½″
1 piece 2″ x 4″ x 8′ to cut 4 pieces 15¼″
28 pieces 1″ x 6″ x 10′
10 pair 3″ strap hinges
4 lb. 8d box nails

The forms for cover slabs shown in Fig. 10 require the following material:

3 pieces 2″ x 4″ x 8′
7 pieces 1″ x 4″ x 3′–8″
7 pieces 1″ x 4″ x 2′–8″

Forms of this type have been built at demonstrations in nearly every county where there is a county agricultural agent. Before building forms, inquire of your county agent as to the possibility of renting a set.

EXPENSE

The actual outlay for all materials for the tank and disposal tile exclusive of the forms should not exceed $35. Two men should be able to make the forms, excavate, place the concrete, and lay the tile in from two to three days.

BUILDING THE TANK

Concrete—Pit-run gravel may be used if it contains no clay or similar foreign matter or if not more than two-thirds would pass through a screen having 4 meshes to the inch. Much better results will be obtained by purchasing gravel and sand already combined in the proper proportions for concrete. This may be obtained from a gravel pit washer and should be used unless there is no such pit available.

The concrete mixture should contain at least 1 part of cement to 5 parts of gravel. The proportion of water should be accurately determined so that the ingredients will not separate when poured and yet the mixture will flow freely into the forms. Concrete for tank bottoms may be made very dry to prevent the forms resting on them from settling out of place. The tops of walls and tank bottoms should be finished accurately and smoothly to the correct height and line.

Concrete may be mixed by hand on wooden platforms but a small mixer should be used if one can be obtained. Machine mixing is easier and much more thorough. Effective mixing adds greatly to the strength of concrete and also insures water-tightness.

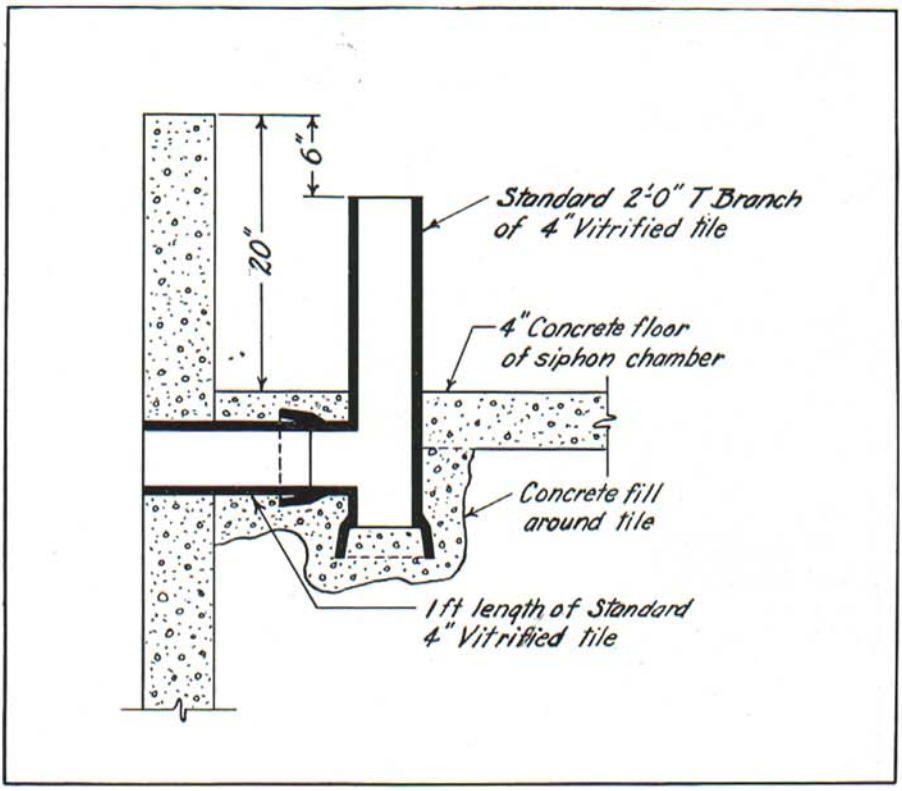

Fig. 11. Detail of connection between settling and siphon chambers.

Arrangements should be made for sufficient help, materials and equipment to be on hand when the job is begun so as to enable one to place all the concrete in the walls and bottoms in a continuous pour; that is, there should not be an interval of more than 10 or 15 minutes between batches of concrete poured into the forms.

When the excavation has been completed the concrete floor of the settling chamber, 4 inches thick, should be placed. This concrete may be mixed very dry, if desired, so as to prevent the wall forms from settling. The forms for the tank walls are then put in place and the walls are poured with concrete wet enough to flow freely without separation of the ingredients. When pouring has reached the proper height the outlet tile is placed in the wall as shown in Fig. 11.

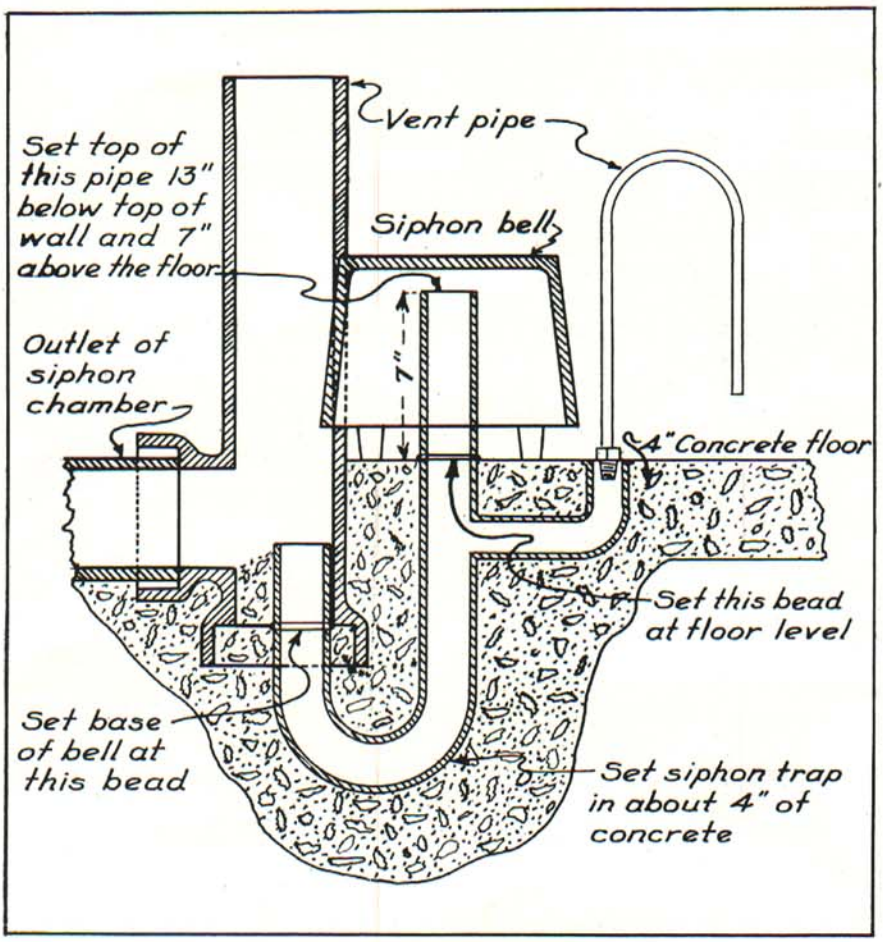

Fig. 12. Detail of siphon setting.

SETTLING CHAMBER OUTLET

The connection between the two tanks should now be set (Fig. 11). This consists of a four-inch drain tile and a four-inch sewer pipe tee. One end of the drain tile is placed directly against the forms of the deep compartment. The sewer pipe tee is placed upright at the other end of this tile. The joint is cemented and also the bottom of the tee is filled with concrete to render it watertight.

This connection is put diagonally across from the sewer inlet and should be set about 8 inches from the end of the tank so as not to interfere with the placing of the forms of the second compartment. The top of the sewer pipe tee should be just 6 inches below the top of the sewer inlet into the settling chamber.

SETTING THE SIPHON

It is best to place the siphon after the connection between the settling and siphon chambers has been set. A hole should be dug about 10 inches deep below the bottom of the floor of the siphon chamber. The siphon is then set in this hole and bedded in concrete so that the top of the long leg will be 13 inches below the top of the wall of the siphon chamber. The siphon should be set with the branch for the vent pipe parallel to the side of the siphon chamber.

The sewer pipe tee which acts as a vent pipe should be set over the short end of the siphon so that the base of the bell of the main pipe comes at the same level as the bead on the siphon pipe. This brings the top of the short leg of the siphon about one inch above the flow line of the branch opening of the tee (See Fig. 12). The tee may be turned so that the branch opening will be in the direction desired for the outlet.

Sewer pipe should be inserted in the branch bell of the tee and extend horizontally to the outside of the tank. Sufficient concrete should be placed around the siphon and its connections to hold it securely in place. This concrete fill should extend up to the floor level and be a part of it.

Details for setting the siphon and its connections are shown in Fig. 12, and the completed work is shown in Fig. 13. While setting the siphon both open ends should be kept plugged to keep out concrete and other foreign material.

It will be found more convenient to pour the floor of the siphon chamber before placing the forms for the side walls. The concrete for this floor may be mixed rather dry if desired so as to keep the wall forms from settling out of place. The two forms must be set 5 inches apart so as to make the wall between the chambers 5 inches thick. A notch should be cut about 2 inches deep in the top of this wall to permit the passage of air between the two chambers.

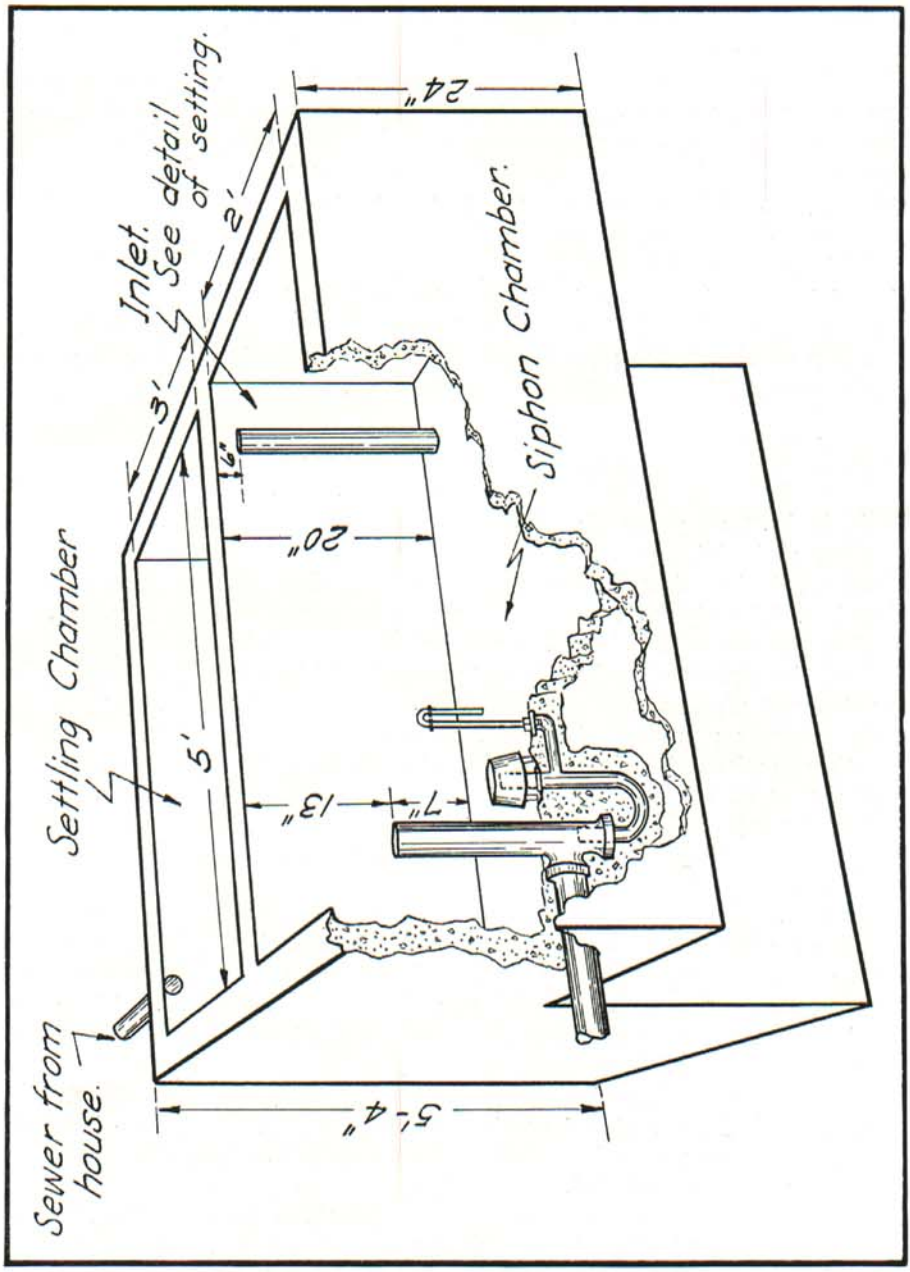

Fig. 13. Details and dimensions of tank.

INLET

The soil pipe or sewer enters the tank near the corner of the settling chamber. It may enter from the side or end, but must be kept as far from the outlet as possible. The top of the inlet sewer is just even with the top of the tank wall. No elbow or baffle is placed at the end of the inlet.

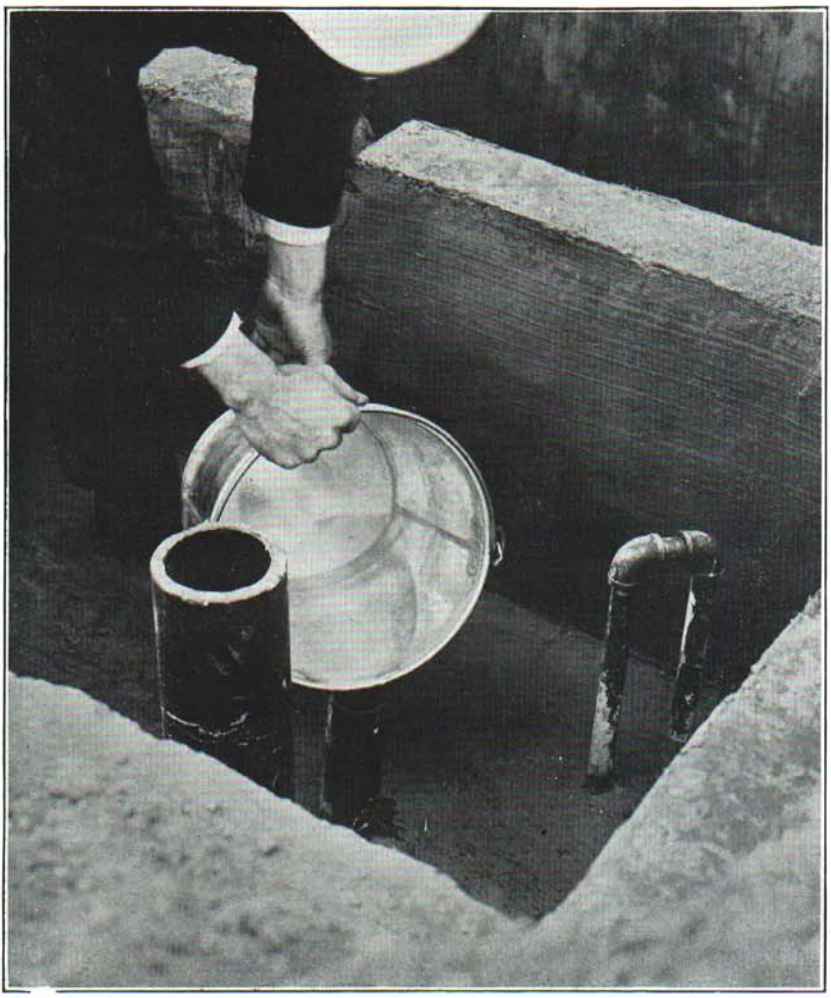

Fig. 14. Filling the siphon with water.

REMOVING FORMS

The tank forms should be left in place long enough for the concrete to set. In removing forms, care should be used to prevent cracking the concrete. The "take down" forms shown in Fig. 8 can be loosened by turning the hinged bars until they are free and forcing the side and end forms inward and then lifting them out.

FINISHING THE TANK

The interior of both chambers should be washed with a mixture of cement and water which is mixed to a consistency of cream and spread on with a broom or whitewash brush. Two coats should be applied and kept moist while setting.

Plastering the interior with a mixture of 1 part cement and 2 parts sand, with a small amount of lime added, is also an excellent means of waterproofing it. Before closing the tank, a pail of water should be poured into the 2-inch pipe of the siphon and the bell set over this pipe (Fig. 14).

LAYING TILE

Four-inch vitrified clay farm drain tile should be used. These are in one-foot lengths and should be laid so that the ends will be about ⅛ inch apart. The trench for these tiles should be dug about 18 inches wide and about 4 inches deeper than the tiles are to be laid and this

Fig. 15. Completed tank.

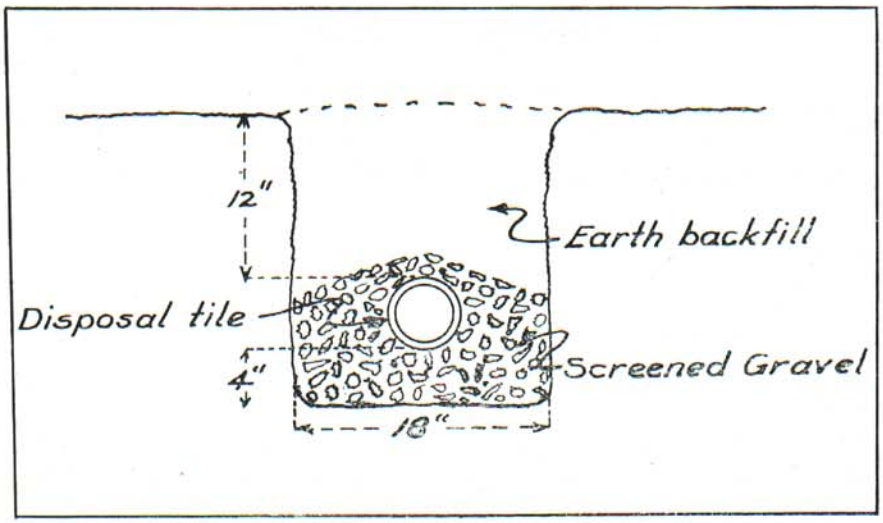

Fig. 16. Detail of trench for tile.

extra depth filled with gravel from which the material smaller than ¼ inch in size has been screened out. The gravel should be heaped up above the top of the tile and the remainder of the trench filled with earth (See Fig. 16).

HOUSE SEWER

All connections between the house and septic tank and from the septic tank to the equalizing chamber or distribution header should be laid straight and to an even grade. Curves in the line tend to cause stoppages and make cleaning difficult or impossible. The minimum grade for a 4-inch sewer should be 12 inches fall for each 100 feet of sewer and for a 6-inch sewer 7 inches fall per 100 feet is needed.

If the sewer from the house to the septic tank or from the septic tank to the disposal field is within 75 feet of a well it should be laid with cast iron soil pipe with lead joints.

When laying sewers or disposal tiles the grade should be established on grade boards set across the trench so that a fine string or wire can be stretched from one grade board to another at a uniform distance above the grade line of the sewer. A measuring stick should be used when each tile is laid to measure down from the string to the tile. This insures a uniform grade and line.

JOINTS

If cement is used for making joints in the house sewer, the joints should first be caulked with oakum or jute, after which the joint must be completely filled all around with a mortar composed of 2 parts clean sand and 1 part of Portland cement. In using cement joints, care

should be taken to wipe the inside of the pipe free from any protruding jute or mortar which would tend to obstruct the flow. If cement joints are made with great care by a skilled workman, fairly tight results may be expected if the pipe line is in a dry trench, but this ideal is almost never realized in practice; and if much water is encountered, it is almost impossible to obtain impervious joints by this method. The objections to imperfect joints are: (1) pollution of the ground water, (2) furnishing an opportunity for tree roots to enter and clog the sewer, and (3) the entrance of large quantities of ground water.

Much more satisfactory results may be obtained by using a poured joint. There are a number of jointing compounds on the market and any pipe dealer should be in a position to supply them. The melting should be done on a stove, or some arrangement by which the heat may be controlled. The operation of pouring a joint is the same for all these substances and similar to the jointing of iron water mains with lead. The joints should first be caulked with dry oakum or jute tight enough and thick enough to prevent the jointing material from leaking into the pipe. A jointer of rubber hose, asbestos, or rope covered with wet clay should be placed around the body of the pipe close up against the bell of the next pipe, with a small opening left at the top for pouring. After the material has been poured and has cooled sufficiently, the jointer is removed. Several lengths of pipe may be joined on the surface and lowered together into the trench as soon as the joints are cooled. This plan not only insures permanent and substantial construction, but, best of all, eliminates the root nuisance.

The cost of poured joints will be only slightly above that of cement. Four-inch vitrified sewer pipe is the smallest practicable size which should be used for draining ordinary buildings.

WET GROUND

Places where the ground water level is nearer to the surface than 3 feet are not suitable for a disposal field and should be avoided unless the ground water level can be lowered by ditching or tile drainage.

HILLSIDES

If the slope of the ground at the site of the disposal field is steep it may be necessary to lay two or more lines of tile at different levels. To accomplish this, a header composed of tees should be used. This line of tees must be laid level and all the branches set at the same height so that each will receive the same amount of sewage. For the lower tile lines, the first tile should be laid level and the next few slope down to the desired height of that particular line of tile. The openings in the header may be on both sides so that tile lines may extend in both directions.

CARE AND MAINTENANCE

Twenty-five years experience with this method of sewage disposal shows that very little attention is required when the tank is properly installed. Occasionally, however, the scum or sludge in the settling chamber may become too thick and may have to be removed.

The tank should be examined periodically to determine if too much sludge or scum is accumulating. One foot of sludge in the bottom and a foot of scum on the surface do not interfere with the operation of the tank. It is well, however, to empty the tank every four or five years.

The tile should be kept as far away from trees as possible, especially maples, willows, elms, and trees with similar root systems.

Virtually no trouble has been reported from either the tank or the tile system freezing when they were constructed according to the directions given.

Questions frequently asked are: can soapy water from the sink, showers, bathtub or laundry be put into the septic tank, and are washing powders injurious? It has been found that a septic tank of proper size and design will handle all those wastes from the average home without trouble.

The effect of the use of household chemicals on the action of a septic tank is also the subject of questions sometimes asked. It is probable that an unusual amount of waste of an acidic nature discharged into the tank would interfere with the natural decomposition by killing the bacteria which carry on the action but the amounts of such acids commonly used in domestic processes are too small to be the cause of trouble. The tank contents are normally alkaline enough to neutralize any acidity which would ordinarily be added. Substances used for cleaning waste pipes or disinfecting clothing or plumbing fixtures are not strong enough when diluted with the water in the tank to cause trouble and may be disposed of without hesitation. The addition to the tank of more than a few gallons of milk wastes at any time should be avoided.

THE INTERMITTENT DISCHARGE VALVE

In extension work on sewage disposal, a septic tank design has been used without material change for a matter of 25 years. In reviewing the design, it seemed desirable to increase the size to meet the increased use of water, and to improve it where possible to simplify the installation. The septic tank is so essential to the complete utilization of water that the convenience and safety it offers should be available to all.

Sewage is discharged into the tile lines to complete the oxidation processes by soil bacteria. To favor action on the tank effluent by soil bacteria, the liquid should be spread over a definite area of soil. Intermittent discharge of the contents of the holding or second chamber serves to fill the tile lines and force the liquid to all parts of the area.

Time is also afforded between discharges to allow some aeration of the filter bed which should be of porous material.

The automatic siphon has been used to secure intermittent discharge. Because the use of the siphon involves several problems, a simpler means of obtaining the same results has been sought. Evidently such a device should be:

1. Reasonably permanent
2. Low in cost
3. Light in weight
4. Easily procured or made
5. Simple to install
6. Dependable, requiring little or no attention in operation.

A study to meet these requirements led to the double ball float valve which design is shown in the accompanying figures. This device has been laboratory tested, operating a time equivalent of 10 years use without failure. It has also been installed experimentally in several tanks. It is offered primarily for its low cost and ease of installation and to provide a device which may be made or procured locally. To construct it requires little material, skill, or time.

Figure 17 shows the essentials of the valve in installation and operation. To install, no changes are necessary in the tank design as shown elsewhere, except:

1. To provide a small sump below the valve.
2. To set the outlet pipe (1½" brass short nipple, coupling and 12" length of 1½" galvanized iron pipe) on a level with the floor of the second chamber of the tank, against the forms.
3. To set the anchor bolt to carry the valve (5 inches above outlet pipe).

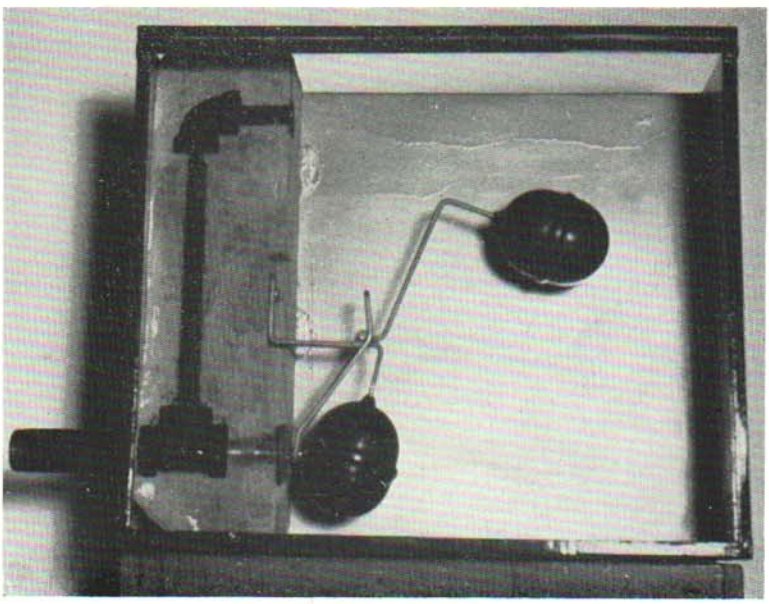

Fig. 17. Double float valve.

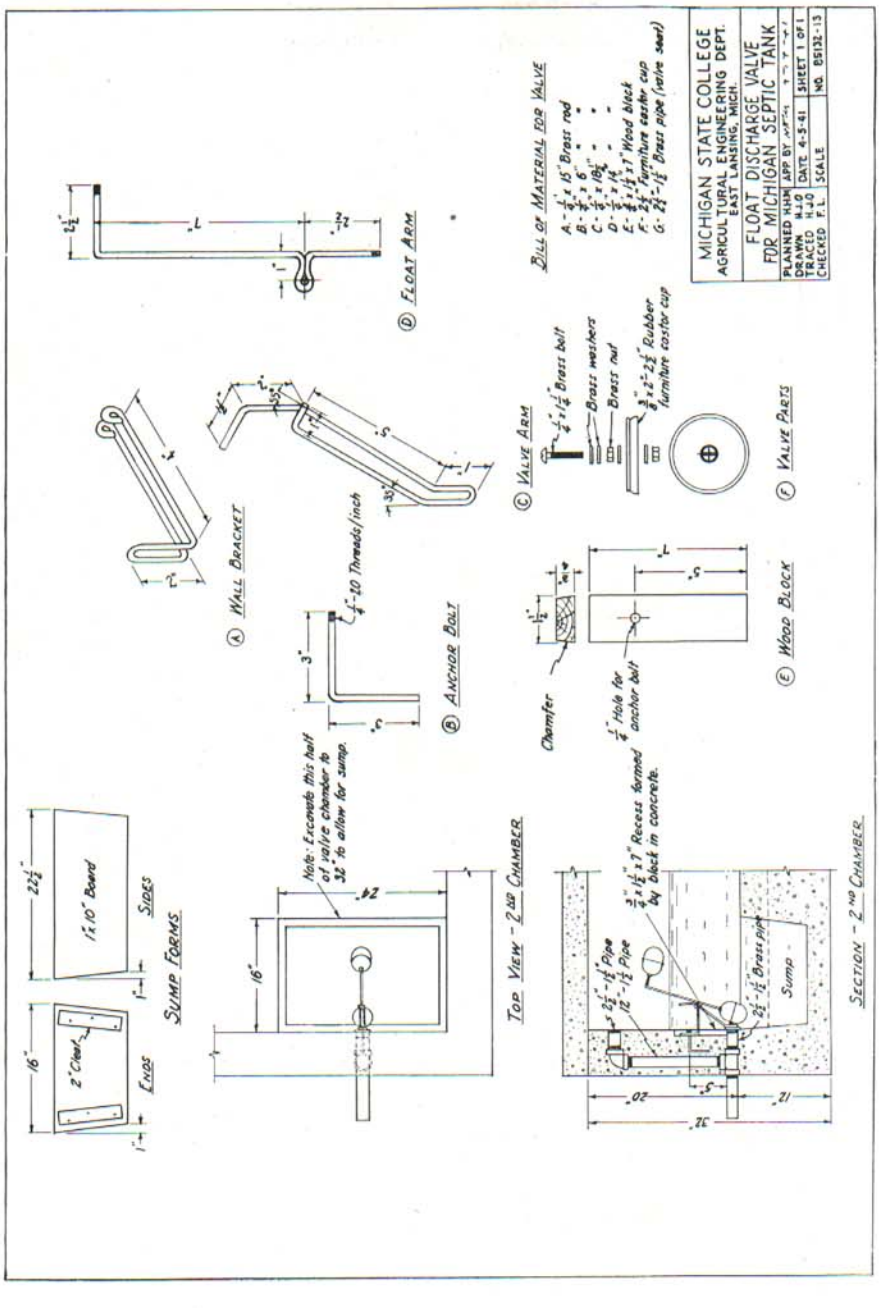
MICHIGAN STATE COLLEGE
AGRICULTURAL ENGINEERING DEPT.
EAST LANSING, MICH.
FLOAT DISCHARGE VALVE
FOR MICHIGAN SEPTIC TANK
PLANNED H.H.M. APP BY
DRAWN H.J.O. DATE 4-5-41 SHEET 1 OF 1
TRACED H.J.O. SCALE NO. D5132-13
CHECKED F.L.
BILL OF MATERIAL FOR VALVE
A - 1 x 15" Brass rod
B - 1 x 6" " "
C - 1 x 10½" " "
D - 1 x ¼ " "
E - 2½ x 1½ x 1" Wood block
F - 2½" Furniture caster cup
G - 2½ - ½" Brass pipe (valve seat)
Ⓐ WALL BRACKET
Ⓑ ANCHOR BOLT
Ⓒ VALVE ARM
Ⓓ FLOAT ARM
Ⓔ WOOD BLOCK
Ⓕ VALVE PARTS
SUMP FORMS
Sides
Ends
2" Cleat
12"x10" Board
Note: Excavate this half of valve chamber to 32" to allow for sump.
TOP VIEW - 2ND CHAMBER
SECTION - 2ND CHAMBER
Sump
Chamfer
Hole for ¼" anchor bolt
Recess formed by block in concrete.
Brass washers
Brass nut
Rubber furniture caster cup

Fig. 18.

The bill of material for making the valve is shown in Fig. 18. The tools required are: vise, blow torch, wrench, and pliers, and ¼" die for threading the ¼" rod. The bronze welding rod is readily bent to shape when heated and dimensions are such that extreme accuracy is not required.

In installation, a wood block carrying the anchor bolt is tacked to the forms directly above the outlet pipe. When the forms are removed, the block is removed. The valve assembly is then hung in place on the anchor bolt and secured with a brass nut. The entire valve assembly may also be easily removed for replacement, if necessary. Adjustment is provided for aligning the valve with the outlet pipe.

In operation, the outlet pipe is closed by the rubber disk seating on the rim of the brass outlet pipe. With the outlet closed, the liquid rises, increasing the pressure on the outlet valve until the upper ball floats. The rise of the upper ball finally moves the lower ball past the vertical center line when both lift causing the upper arm to open the valve. With the pipe open, the liquid rushes out lowering the level until the lower ball again passes a vertical line through the center, and strikes the valve arm closing the valve with positive action. The sequence of motions is then repeated.

The sludge sump is provided below the valve to prevent possible interference with the valve from this source. Other causes of slight leakage under the valve are probably not serious because the addition of a considerable amount of water is sufficient to operate the valve. Even with excessive leakage, which is unlikely, the tank would still function as a single chamber tank. No hesitation, therefore, need be felt in making use of this means of obtaining intermittent discharge.

PART 2

LARGER INSTALLATIONS
FOR SUCH AS
SCHOOLS, HOTELS, APARTMENT HOUSES, CAMPS

The standard tank, as described in PART 1, is designed to serve the home occupied by one family. When more than one family is to be accommodated, the capacity of the tank and tile system must be increased.

The following discussion deals with the design, construction and installation of septic tanks and disposal fields for the larger installations as may be required to serve schools, hotels, apartment houses, and camps.

THE SEPTIC TANK

The liquid capacity of the septic tank should approximate 24 hours' flow of the sewage expected under normal conditions, but in no case should it be less than 500 gallons. The tank depth below the water level should rarely be less than 4½ feet and for large installations about 7 feet.

In the plan described in PART 1, designed to be built with portable forms, the length is 1⅔ times the width and the siphon chamber is on the side of the settling chamber. For those who wish to construct their own forms the plan shown in Fig. 19 is suggested. Here the siphon chamber is at the end of the settling chamber and the excavation is long and narrow as compared with the square hole required for the tank described in PART 1.

While these two tanks appear different they are essentially the same except in shape. The water depth and liquid volume are the same. For the smaller sizes the length of the settling chamber is about 3 times the width and for larger sizes as much as 5 times the width.

For tanks less than 4 feet wide, the top should be of removable precast concrete slabs for ease in cleaning and for inspection. The dimensions and other details for the various sizes of tanks described in PART 2 are shown in the following table. For other than the smaller tanks the Michigan Department of Health should be consulted for advice on type and size of installation.

TABLE OF DIMENSIONS FOR SEWAGE DISPOSAL PLANTS

No. of persons	Septic tank				Flush tank			Siphon		Length of 4-inch disposal tiles	
	Capacity in gallons	Length	Width	Water depth	Capacity in gallons	Width	Length	Size	Drawing depth	Sand or sandy loam	Heavy loam
4 to 6	500	6′-9″	2′-3″	4′-6″	75	2′-3″	4′-1″	3″	13″	120′	200′
8 to 12	850	8′-3″	2′-9″	5′-0″	125	2′-9″	5′-8″	3″	13″	250′	500′
15 to 20	1250	10′-0″	3′-0″	5′-6″	185	3′-0″	8′-1″	3″	13″	290′	600′
21 to 30	1700	11′-8″	3′-3″	6′-0″	250	3′-3″	9′-6″	3″	13″	400′	800′

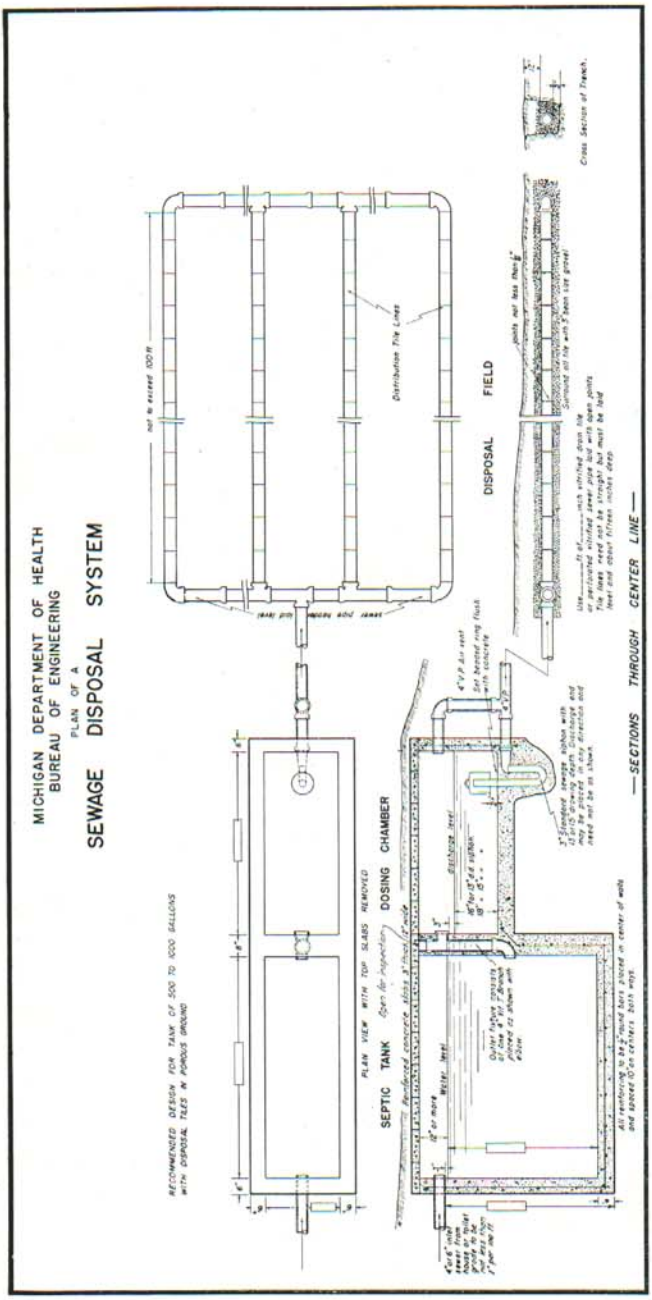

Fig. 19. Tank and disposal tiles for a daily sewage flow of 1,000 gallons or less where ground is distinctly porous.

Experience indicates that there are no logical reasons for a multiplicity of partitions, baffle walls and connecting pipes inside the chamber. They only add to the cost and often detract from the efficiency of the tank by decreasing sludge capacity and setting up unnecessary currents which seriously interfere with efficiency of sedimentation.

THE SIPHON AND DOSING CHAMBER

It is desirable that the tank effluent be distributed into the ground intermittently. The action of the siphon has been described (page 11). The size of the dosing chamber should be such that it will discharge not more than three or four times during 24 hours under ordinary use. The size and drawing depth of siphon suitable for each size of disposal plant are shown in the table. These siphons have no moving parts and require very little attention. The top of small dosing chambers should be removable for cleaning around the siphon to insure regularity of discharge. Larger chambers may have tight covers with a manhole over the siphon and another over the inlet.

In setting the flushing device, it should be surrounded with plenty of concrete and great care taken to have the vertical siphon pipe exactly plumb and the bottom of the bell placed at precisely the required height. This can be assured by setting the siphon so that the beaded ring about the long leg of the siphon comes exactly at the floor level of the siphon chamber. The bell of the siphon is a separate unit and is removable. Both ends of the siphon pipe should be kept securely plugged during construction to exclude dirt, concrete or other foreign matter. When the work is completed a pail of water must be poured into the vertical leg of the siphon.

COVERS

Septic tanks are covered to prevent accidents, control odors, and avoid unsightly appearances—and not to aid to any great extent in the successful operation of the tank. For small sizes, the covers of the septic tank and flush-tank may be made of precast concrete slabs, or cast iron plates in small units, so as to be easily removable for cleaning and inspection. Individual slabs should not weigh more than 200 pounds. It is not advisable to use planks for this purpose, because they are not durable under such conditions. In installations so large that slabs are not practical the tops may be moulded in place and access provided by means of a manhole over the inlet and another over the outlet. If the structures are to be placed in a lawn the tops may be covered with earth and the surface seeded or sodded and any exposed parts screened by shrubs if desired.

THE DISPOSAL FIELD

The distribution of the septic tank overflow or effluent into the soil is generally best accomplished by means of lines of vitrified drain tile laid about one foot underground, with open joints, so as to allow

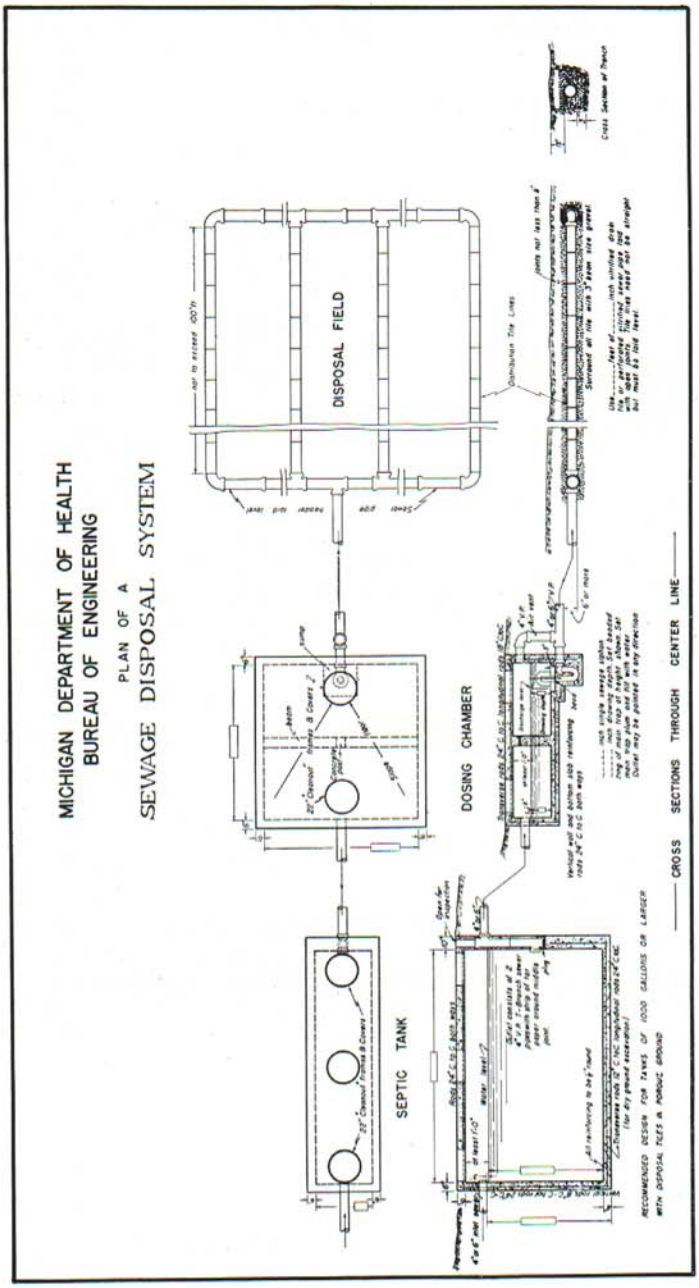

Fig. 20. Tank, dosing chamber, and tile field for larger installation in porous ground.

the liquid to pass out freely. These pipes need not be laid in a straight line, but should follow the contour of the ground so as to be covered with about one foot of earth throughout their length. A single line of tile may be used for small installations in sandy soil, if ample distance is available, but it will generally be preferable to build two or three shorter lines that are approximately parallel and 3 or 4 feet apart. To proportion the sewage equally between the several distributors, it is advisable to build a header or an equalizing chamber to receive the sewage from the dosing chamber and from which the various distributors start at the same elevation. If some of the distributors are on a lower level than the others, the fall to them from the equalizing chamber or header should be made outside the chamber or header; all outlets should have the same grade for a foot or two to prevent some from taking more water than others.

All distributors should be laid in a gravel fill. This fill should be at least 6 inches deep, measured from the top of the distributor, and about 18 inches wide (Figure 16). The gravel aids the distribution of the sewage into the ground. It should be screened to remove material passing through ¼-inch openings in the screen.

The length of tile needed for distributors for different sizes of tanks and for different kinds of soil is given in the table. These tabulations are based upon the assumption that normally about 40 gallons of sewage can be expected each day per person using the plumbing connected to the disposal system. The total volume of the tiles must be at least equal to the volume of the dose.

If there is a question relative to the ability of the soil to absorb the effluent, it can readily be determined by making a simple test. Dig a hole about 18 inches deep (depth of the disposal tiles), pour in water to a depth of about 6 inches. If the surface of the water does not lower more than an inch in an hour the ground is not porous enough for a disposal field and an artificial filter may be necessary.

In laying the distributors and drain tiles, care should be taken not to butt the pipes too tightly together; the joints, however, should not exceed ¼ inch. In sandy soil, tarred paper may be placed over the upper half of the joints to prevent the entrance of sand. If the disposal beds are placed near trees, it will probably be necessary to dig up and clean the tiles occasionally, because roots may fill them rather rapidly.

When no ground is available which is porous enough to absorb water readily an artificial subsurface filter may be necessary.

The area required may be determined by dividing the number of gallons of sewage expected to be produced in 24 hours by 50,000. The result will be the required area in acres. This figure multiplied by 43,560 converts the area to square feet.

A place as level as possible should be chosen and excavated to a flat surface having a uniform slope of not less than 6 inches per hundred feet. On this bottom are laid lines of drain tiles 5 to 10 feet apart extending from the high to the low side and there connected to a collector or header at right angles to the drain tiles to take the flow from all of them and deliver it to the desired outlet point. The drain tiles are surrounded with gravel which passes a ¾-inch opening but does not pass a ½-inch opening. This gravel should cover the entire bottom of the filter to a depth of at least 4 inches and be about 2

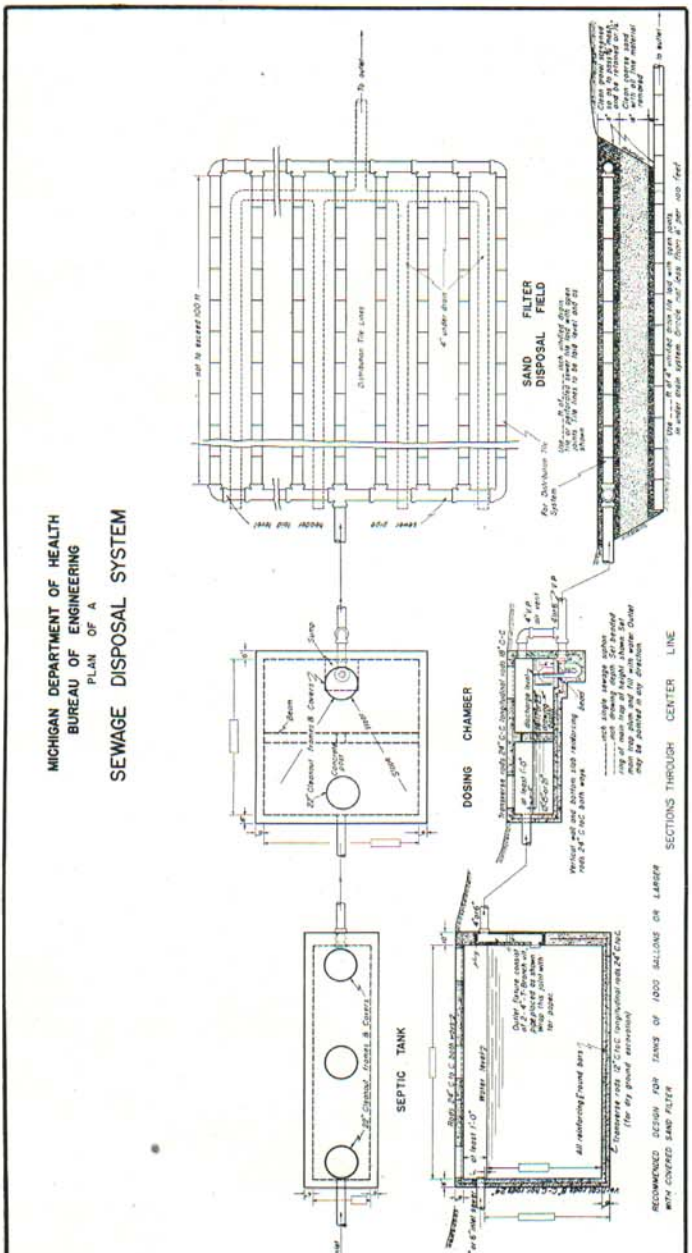

Fig. 21. Tank, siphon chamber, and artificial covered sand filter.

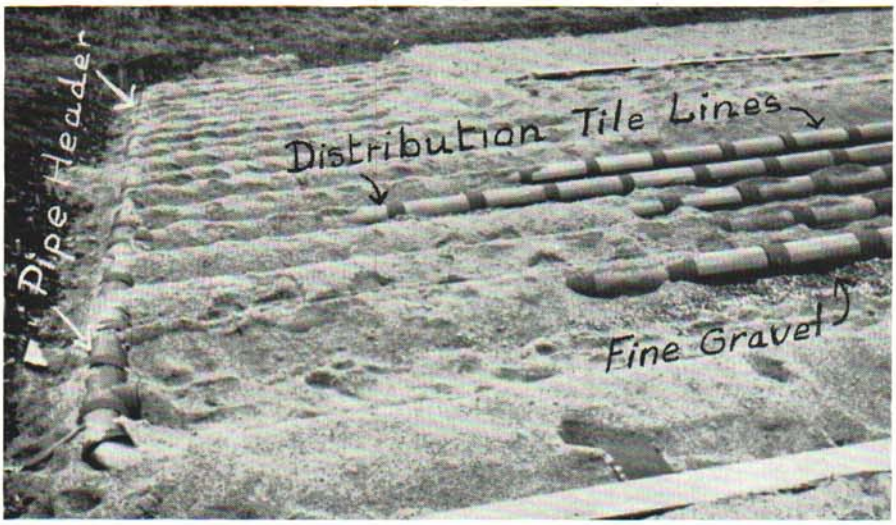

Fig. 22. Sand filter of Iosco County Infirmary.

inches deep on top of the drain tiles. On this should be spread at least one foot of good clean coarse sand. This sand should be procured from a gravel pit sand washer if possible. Pit sand containing material finer than visible sand grains should be avoided. In case of doubt of the suitability of available sand, a few ounces as a sample may be sent to the State Department of Health and an opinion obtained based on a standard sieve analysis. The top of the sand should be graded to a level surface and on this the distribution tiles should be laid about 2 feet apart.

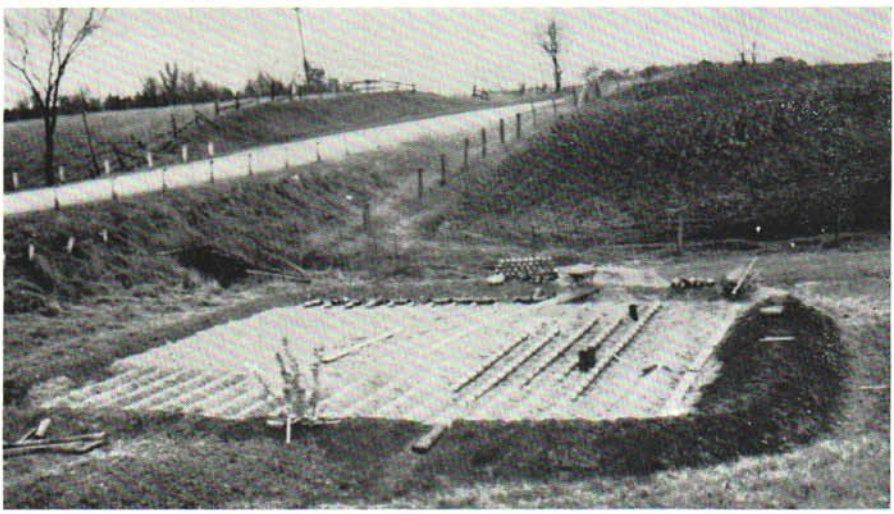

Fig. 23. Sand filter at Iosco County Infirmary.

These lines should be laid level, that is without any fall. The joints between the individual tiles should be from ⅛ to ¼ inches wide. A piece of tarred building paper about 3 inches wide may be placed over the upper half of each joint to guard against the entrance of sand or dirt. Under the tiles, before they are laid, should be placed gravel screened as already described about an inch deep, which should be heaped up over the top of the tiles about an inch and also spread over the surface of the sand between the tile lines. The entire area may then be covered with about a foot of earth.

In Figs. 22 and 23 is shown a subsurface filter under construction. Some of the distributor lines have been finished and covered. Building paper over the joints and gravel under the distributors show in Fig. 22. The distributor lines are 3 feet apart. Figure 23 shows the entire filter which is about 40 feet square and designed for 30 people.

In places where the ground is flat and when plumbing fixtures are in the basement it may not be possible to build a settling tank and dosing tank high enough to keep the disposal tiles at a depth shallow enough to take advantage of the oxidizing action of the soil. Fig. 24 shows a plan suggested to meet these conditions. The settling tank and disposal tiles are designed as usual and a pump takes the place of the siphon in the dosing chamber. This chamber should have the same liquid capacity whether emptied by siphon or a pump but when the pump is used the shape of the dosing chamber may be made more nearly cubical for the sake of economy if so desired.

Experience seems to indicate that under especially favorable conditions the dosing tank can be omitted in connection with tanks for a single family. The plan shown in Fig. 25 has been prepared for such cases. This type of disposal is suggested for locations where the ground is especially porous or where the tank is not used continuously, as for example, a summer cottage.

SEEPAGE PITS

Seepage pits (dry wells) can be used in localities where there are no wells. These pits are usually built with walls of logs, stones, bricks or concrete blocks providing openings to the surrounding soil. The bottom of the pit should extend to a porous soil layer. The overflow from the septic tank is discharged into the seepage pit and allowed to seep out through the side wall openings and bottom into the surrounding soil. The useful life of these pits should exceed that of a cesspool because of the fact that most of the solids and grease have been removed from the sewage in the septic tank before it enters the pit.

The size of pit varies greatly and the depth is largely dependent upon the location of suitable soil strata. In general, a pit 5 or 6 feet in diameter and about 5 feet deep below the inlet should be sufficient to serve a family of 5 or 10 persons. The pits should have a substantial cover capable of supporting any reasonable load including earth if the pit is to be buried. This may be built of boards or logs but preferably should be made of concrete.

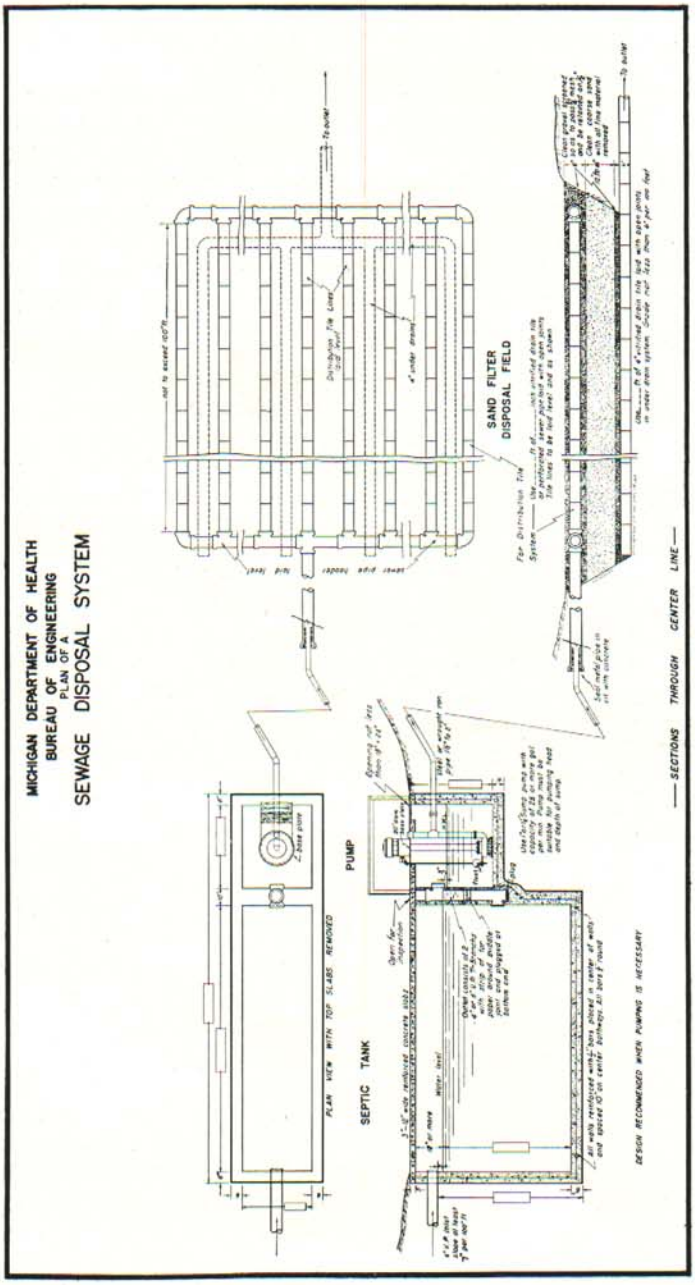

Fig. 24. Plan for sewage disposal when pumping is required.

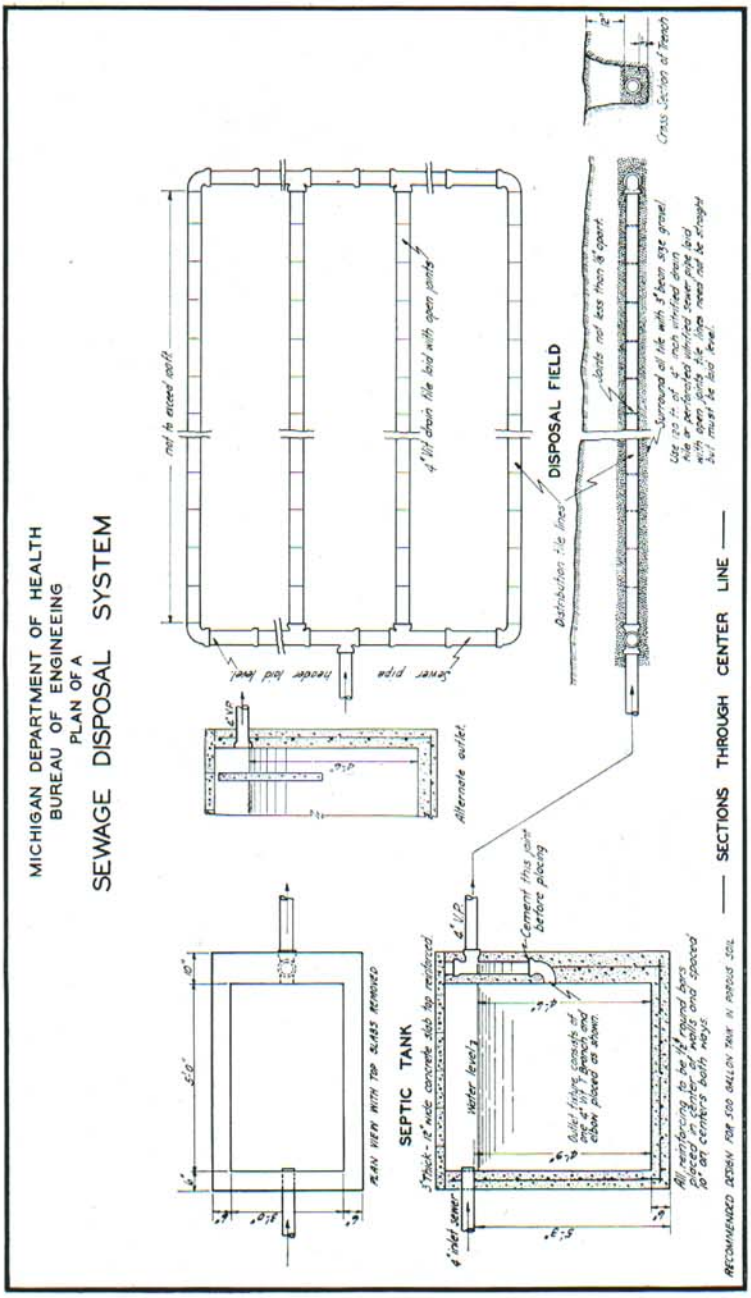

Fig. 25. Plan for tank and disposal tiles without dosing tank for a single family.

CESSPOOLS

The cesspool consisting of a covered hole in the ground into which sewage is discharged is not recommended nor ordinarily approved. The sewage enters the ground at such a depth that little assistance can be expected from natural agencies and harmful liquids soak into the ground saturating it with gross pollution.

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