

SEPTIC TANKS FOR THE FARM

THE PENNSYLVANIA STATE COLLEGE
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FOLLOW THESE TWELVE STEPS IN USING A COMMUNITY SEPTIC TANK FORM

These brief directions, if understood and followed in order, will insure the farmer a satisfactory sewage disposal system with the least effort and expense without wrecking the community form.

1. Get a standard wooden septic tank form, 3 feet by 6 feet by 4½ feet deep. See your county agricultural agent and figures 5 and 6.
2. Get two 4-inch glazed terra cotta sewer pipe Y-branches, and buy enough 4-inch bell sewer pipe (glazed terra cotta) to connect house to tank. Also get oakum and cement for pipe joints, and 16 sacks of cement, 1½ cubic yards of sand, and 3 cubic yards of clean gravel or stone for the tank. If cast-iron pipe is used see figure 14.
3. Plug straight part of Y-branches with cement on tin or tar paper disks, make vent in outlet Y, according to figures. Let set at least one day before using, fig. 7.
4. Lay out hole 4 feet 1 inch by 7 feet with cords, or use a frame guide. Drive the four posts or use blocking, figs. 9 and 10.
5. Set house sewer line straight and not too steep. For best fall allow 2 to 4 feet per 100 feet. Change location of tank if necessary.
6. Dig hole to measure, square and true, 4 feet 1 inch below grade line of sewer. This usually will be 6 feet deep, depending on lay of land and plumbing, and allows 5 inches extra depth for the bottom. Also dig short ditches for pipes on center-line. Do not excavate pit much ahead of the concreting.
7. Bolt form together on level ground, with bolt heads inside the box, figs. 5 and 6. See if it is true, check "Inlet Drop" from cross arms and blocks to sewer bottom, then grease all corners and oil sides and ends thoroughly. Old engine oil is good. Stop here for the day unless there is time to place all the concrete at one operation. A power mixer helps.
8. Put form in place and plumb sides, fig. 10. Locate Y's, solid plug to house sewer, vent towards outlet. Shift blocks if necessary to set level.
9. Start on walls and pour very stiff concrete around bottom at first and tamp well. A wetter mix can be used after the first 8 inches of side walls are poured. Five or six measured gallons of water to sack of cement makes best concrete. Build Y pipes in place carefully and trowel off tops of walls.
10. Lay the 5-inch bottom. Keep the bottom edges of form free. Make four or more reinforced cover slabs, one with an inspection pipe, fig. 8. Let slabs damp-cure several weeks, or use slate or flagstones which can be pried up later.
11. Remove form, place baffle boards, fill tank with water to test and cure concrete. Make cement mortar collar connecting small end of inlet Y to same end of house sewer, figs. 8 and 10. Have outlet of tank into at least 100 feet of open joint absorption tile, with lower end plugged and covered 10 to 18 inches deep; curve if required, figs. 12 and 13. Have fall of 2 to 4 inches per 100 feet.
12. Place cover slabs. Grade up over the tank and tile. Inspect at least every five years and pump out sludge before it gets 12 inches thick. Skim off 6 inches of scum. Use no disinfecting chemicals when cleaning. The ordinary use of drain cleaners should have no ill effect on the operation of the tank system. See Maintenance, page 28.

Front Cover

The front cover picture shows a septic tank location on a hillside diagonally out from house in line with clean-out at bottom of soil pipe. See figures 2 and 14. It is deep enough for laundry tubs in the cellar. A bank facing south is an ideal location for the absorption tile. See back cover.

Septic Tanks for the Farm¹

JOHN R. HASWELL

THE LATEST statistics show that less than one-fifth of the farms in the state have bathrooms and that there are about 40,000 farms supplied with running water that are not equipped with baths. However, as farmers and their wives realize how simple it has become to make a complete plumbing installation more farm homes will be modernized. No finer addition can be made.

Some method of disposing of the resulting combination of water, human waste, and kitchen washings, here called "sewage," must be adopted. Generally the most satisfactory disposal system for the individual farmer is a single chamber septic tank connected to lines of purifying tile.² When properly constructed, such a system is fly-proof and will not be a source of danger to health. This is more than can be said of a number of other methods of disposal. In the following discussion it should be remembered that sewage differs greatly in its make-up in different situations, owing to variation in the quality and quantity of water, food soap, etc., used in the family.

GENERAL DESCRIPTION OF TANK

The septic tank can be described as a long, water-tight box through which a slow current of sewage passes. The proper time required for the trip is herein considered to be 24 hours. During this passage through the tank, the solids are worked on by bacteria and part of the total solids is turned to liquids and gases, part is deposited in the tank as "sludge" or "scum", and the remainder of the solids pass out of the tank with the liquid, or "effluent." The simplest method of disposal of the effluent is through lines of ordinary farm drain tile laid as a shallow sub-surface or underground irrigation system.

There is enough capacity provided by the uniform depth of 4½ feet in all sizes for about five years' accumulation of sludge and scum in the tank, after which it should be cleaned. However, it is

¹A revision of circular first printed June, 1921; revisions May, 1927 and April, 1940.

²This method of disposal is not new. It was the subject of Farmers' Institute lectures in 1910. A model of a complete water system and septic tank was later shown at many county fairs. A photograph and description of the model was printed in "The Extension Bulletin," January, 1917. The design was very similar to figure 19 in this circular. Later work was based on the studies of Professors H. W. Riley and J. C. McCurdy, Department of Agricultural Engineering, New York State College of Agriculture, and quotations are included from their publications. The Bureau of Agricultural Engineering, United States Department of Agriculture, also has given great help.

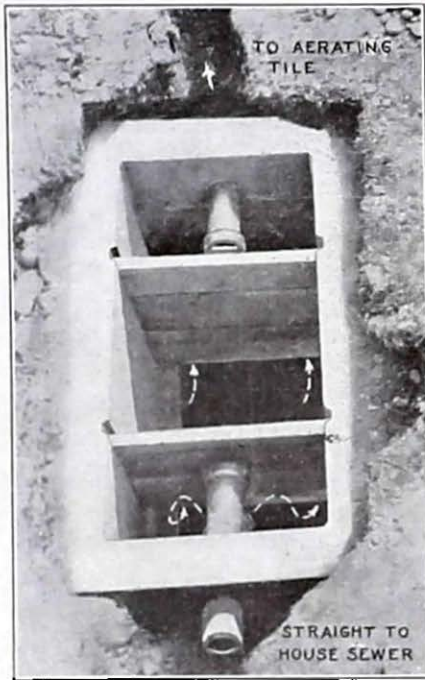


Fig. 1.—View of septic tank from above with arrows indicating flow.

The scum is composed of light solids, mostly grease, which float on the surface of the liquid in the tank. It provides an air-tight cover for the sewage and protects the bacteria which work on the solids in the tank. The bacteria in the tile beds are of a different nature and need air for their work. When the sludge is removed, it will also be necessary to take off the scum to get rid of the grease. Only the solids need be removed from the tank and no attempt should be made to scrub it. No disinfectants should be used as these will kill the bacteria which must be present. It usually is a simple matter to skim off the scum with a hoe and shovel and to pump out the sludge. These materials can be plowed under in the field as manure or buried if it is necessary to dispose of them near the dwelling.

sometimes a difficult matter to pump out old sludge when the tank receives dairy wash water, and it may be well in special cases to give the tank bottom an annual test with an ordinary sheet-iron boat pump or a pitcher pump, to see that the sludge is not getting solid. It would be well not to let it get over a foot in depth.

In most cases the 8-person size tank (475 gallons) is taken as the smallest to use for farm homes. There is little gained by making tanks excessively large. However, they are large enough to work well without grease traps and none has been installed on farms. Small tanks must be cleaned oftener.

Table 1.—Inside dimensions of septic tank.

NUMBER OF PERSONS	WIDTH	LENGTH
6 or fewer	Feet 2½	Feet 5
8 (standard for community forms)	3	6
10	3	7
12	3	8

Before the scum has formed on the surface in a new tank it may be that an offensive odor will be produced from escaping gases. After the bacteria get to work this should cease. The gas in these tanks is sometimes explosive and care should be taken in using lights for an examination.

TANK DETAILS

The inlet is through a 4-inch vitrified, single, Y-branch sewer-pipe fitting and the outlet is the same. The level of the outlet is so arranged by a drop of $1\frac{1}{2}$ inches through the tank that the branch pipe of the inlet is covered with water, but water does not stand in the inlet pipe itself. The fittings are set level, with the Y-branch downward. In this manner the sewage enters the tank without disturbing the scum and does not drag air in with it as happens with a straight pipe. There is also less tendency to become blocked by the scum. The 45° dip downward makes the sewage hit the baffle and spreads it as in figure 1, without stirring up the sludge, which happens with a vertical "T" or elbow.

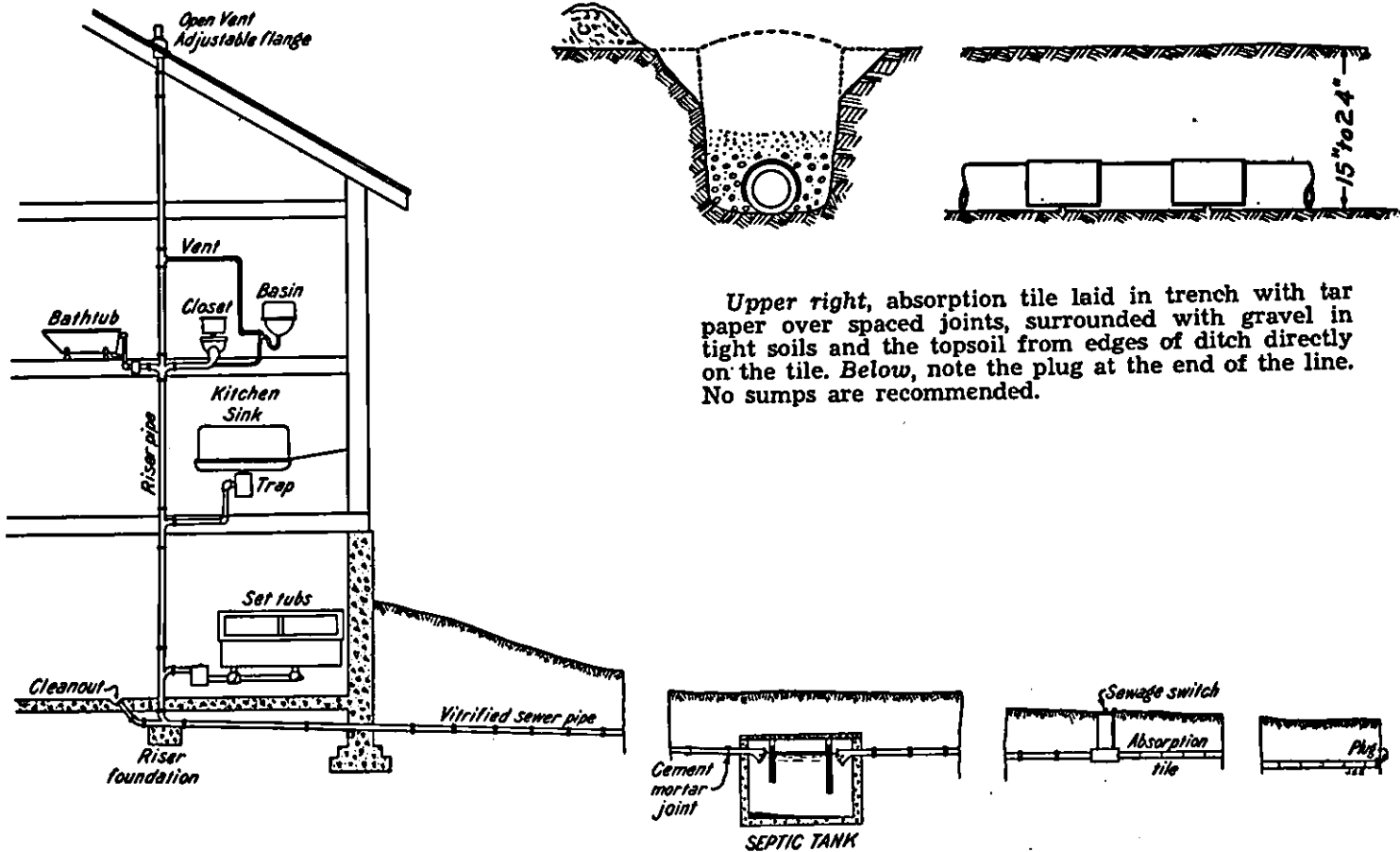
The upper end of the Y-inlet pipe is closed with a solid plug in order to prevent the escape of foul gases back into the house, but if there is need the plug may be removed for cleaning the pipe. The vented plug in the outlet pipe permits the escape of gases into the soil through the disposal tile.

The baffles are made of $1\frac{1}{2}$ or 2-inch plank slipped into slots cast in the walls of the tank. The inlet baffle prevents agitation from incoming sewage and virtually extends the inlet pipe downward to the center of the tank; the outlet baffle prevents large solids from leaving the tank. These are very necessary to prevent a direct current forming from the inlet to the outlet.

The side walls of the tank are $6\frac{1}{2}$ inches thick, the end 6 inches, and the bottom 5 inches. The depth of the tank is standard for all sizes. The tanks have been built successfully with reinforcing only in the cover slabs.

Bill of Material for Standard 3 by 6-foot Form $4\frac{1}{2}$ Feet Deep

- 17—1" x 6" x 12' roofing boards (102 ft. B.M.)
- 4—2" x 4" x 14' end posts, cross arms, center pieces.
- 2—2" x 4" x 2'8" cross braces to bulge sides slightly.
- 4—1" x 6" x $4\frac{1}{2}$ ' extra strips at edges. White pine.
- 1—1" x 3" x 11' or scraps of clear lumber for baffle cleats.
- 1 doz. $\frac{3}{8}$ " squarehead machine bolts, $3\frac{1}{2}$ " long, with washers.
- 4— $\frac{1}{2}$ " x 6" machine bolts for fastening cross arms to posts.
- 8 screen door hooks and screw eyes for attaching loose boards.
- 2 lbs. 8-penny wire nails.
- $2\frac{1}{2}$ lbs. 6-penny wire nails.



Upper right, absorption tile laid in trench with tar paper over spaced joints, surrounded with gravel in tight soils and the topsoil from edges of ditch directly on the tile. Below, note the plug at the end of the line. No sumps are recommended.

Fig. 2.—A complete house drainage system. The vent for the basin indicated for long runs of pipe. Some kitchen sinks have separate vents. Modern bathtubs have no feet and often fit in a corner. Cast-iron pipe used through the foundation wall.

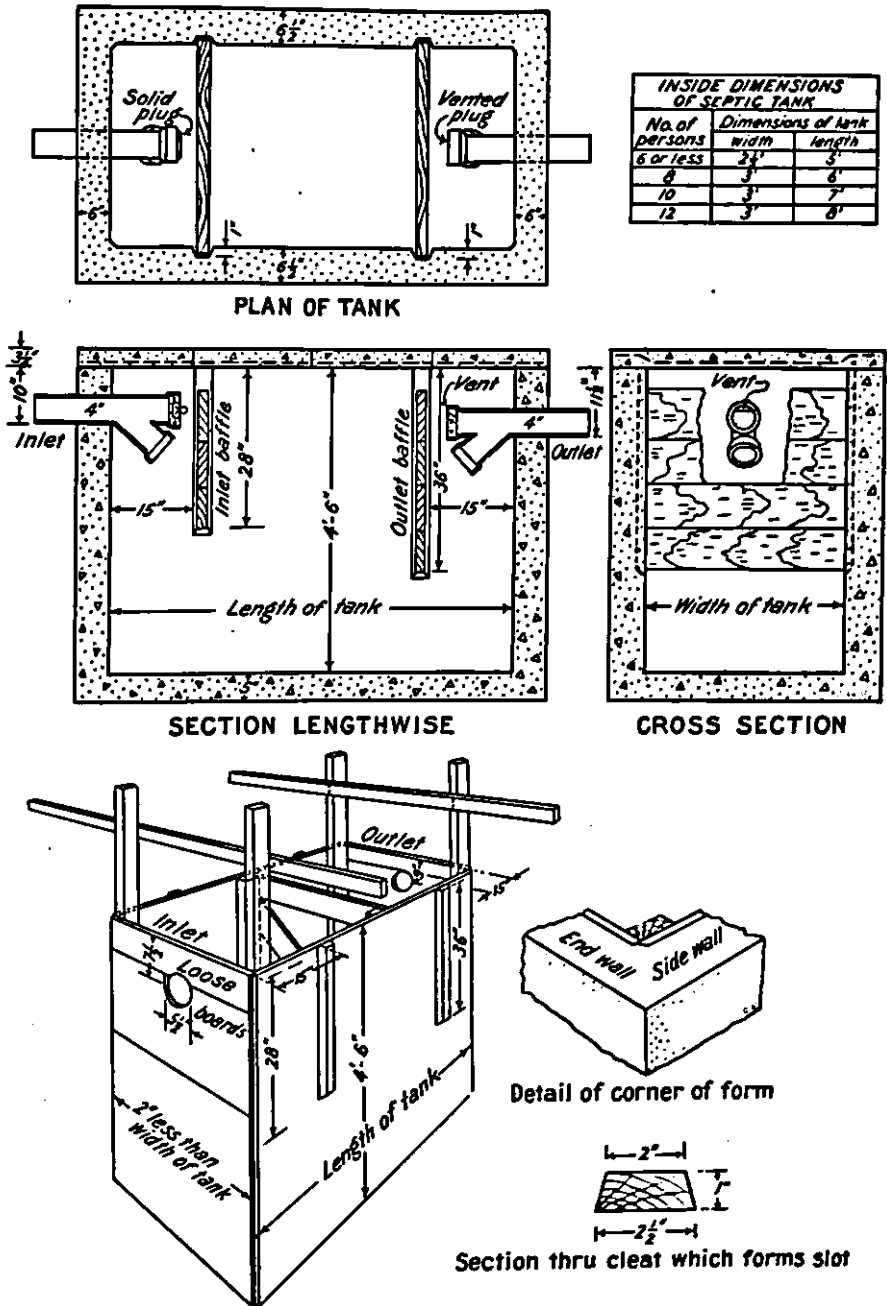


Fig. 3.—Details of tank and form. Dimensions are for nailed form. For bolted one with extra strips for community use, deduct 2 inches from the length and 3½ inches from the width in cutting lumber. Standard size has pieces 5 feet 10 inches and 2 feet 8½ inches, respectively, which make a 3 by 6-foot tank holding 475 gallons.

Care must be used in building the corners of the form so that it can be removed easily from the finished tank. The construction shown in the figures is recommended. The ends of the boards forming the sides of the form should be well-beveled to help in removal.

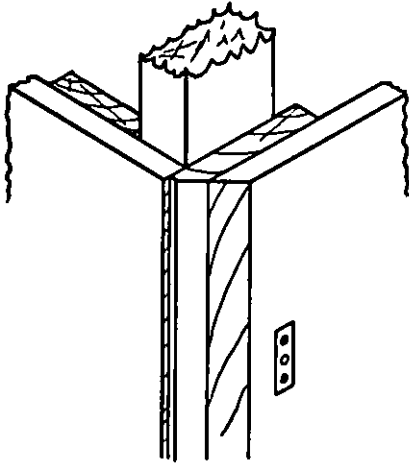


Fig. 4.—Bolted corner construction of community form. The side boards are nailed to the vertical "extra strips," the edge of which sets back about a quarter-inch from the corner of the end boards. Wagon-box endgate rod nuts or screw plates, fastened in place by screws as shown, are better than the ordinary bolt nuts which are lost in moving. Batten on loose end board at left.

The "roofing boards" indicate lumber dressed on at least one side and edges, seven-eighth-inch minimum thickness. Thin siding is not heavy enough, narrower flooring will do. Ample allowance is made for matching if tongue and groove material is used but unmatched is better. If the edges are plain, less is used. Any length other than 12 feet will take more material. If the 2 by 4-inch pieces cannot be bought in 14-foot lengths, 4 pieces 7 feet long, 2 pieces 4½ feet long, and 2 straight pieces 9 feet long will fill the bill.

BUILDING A COMMUNITY SEPTIC TANK FORM

The finished septic tank form (see figures) consists of the following parts: 2 side pieces, 2 end pieces with "loose boards" and with projecting corner posts, 2 cross arms bolted to the end pieces through the upper part of the corner posts, and 2 cross braces. There are four half-inch bolts to attach the cross arms to the corner posts and 12 three-eighth-inch square-head bolts with washers to attach the sides to the ends, washers under the bolt heads, nuts countersunk and no washers under them.

Remember that the pressure on the form when in use is from the outside and tends to crush it. It also is expected that the form will be used a number of times. One has made 32 tanks and another 50.

To build the form proceed as described below, noting that unmatched material with dressed edges will make the work slightly easier. The directions, however, are written for matched lumber which will, therefore, cover all conditions.

Cut 2 by 4-inch material into cross bars, 9 feet long, of straightest material (one cross bar and one side piece can be cut from 14-foot stuff), 2 side pieces, 4½ feet long, and 4 corner posts 7 or 8 feet long.

The 12-foot boards are to be cut near the middle for side boards. If possible, cut in a planing mill 5 feet 10 inches over all, giving a bevel of about 45° at each end. Use best material for this and if the lumber is matched cut the groove off one good piece. Use this piece for the *bottom board* in nailing up side pieces.

Get out the four beveled strips for the edges, 5 or 6 inches wide and 4½ feet long. These are beveled smooth to 45° on one edge to match the cut on the ends of the side boards. They are called "extra strips" in the text. Get 6-penny nails which will go through side piece and strip with enough left to clinch. Lay one of the 4½-foot pieces of the "2 by 4" flat on the ground and nail on bottom board 3 feet from beveled end with 8-penny nails, flat edge even with end of "2x4". Nail one strip at the end of side piece which has the end beveled, making the bevel on the strip project a little beyond that of the side boards. Nail the other strip to the side piece on the end which was not beveled, making the distance from outside to outside edges of the beveled strips measure 6 feet or if both ends are beveled make them match. Lay up the side piece, making the edges of the boards draw well together, beveled ends in line. Let the other end of the side boards line up as they will if not cut to exact length of 5 feet 10 inches. The nailing through the extra strips at the edges keeps up with the center "2 by 4." Three men work best at this. Check the diagonals across corners of beveled strips to see if side piece will be square before nailing on the second board. If necessary, rip one of the boards to fill out the 4½ feet at the top. If but little is taken off, the remainder of the board can be used at the bottom to start the other side piece. Then cut the ragged edge of the side piece to match the bevel of the strip as in figure 5, if necessary.

Dress the four cleats which form baffle slots according to dimensions in figure 3. Bevel the bottom ends the same as sides but leave the top ends square. Nail two of these to the side pieces according to the figures,—the 15 inches to be in the clear,—and the square cut top of the cleats at the top of the form. Use nails long enough to clinch well. Stand the side piece on edge and clinch all the projecting nails at the strips and from the baffle cleats.

Build the other side the same way, noting that the 28-inch beveled baffle cleat the shorter one, must be opposite the similar one on the side first built, and at the inlet end of the tank form. Also note that the cleats project from the sides of the form and are on what would ordinarily be the outside, if the form was a box.

Lay two end-posts on the ground with the narrow or 2-inch face up. Cut boards 2 feet $8\frac{1}{2}$ inches long with square ends and trim the groove off the edge of the first board, as was done with the sides. Nail a separator strip at the upper ends of the corner posts and then start nailing the boards from the bottom up. Let the "2 by 4" just show beyond square ends of end boards. These should be nailed for only a distance of 30 inches, the remainder being left "loose." Warped material with knots can be used for end boards but would not do for sides on account of the greater length.

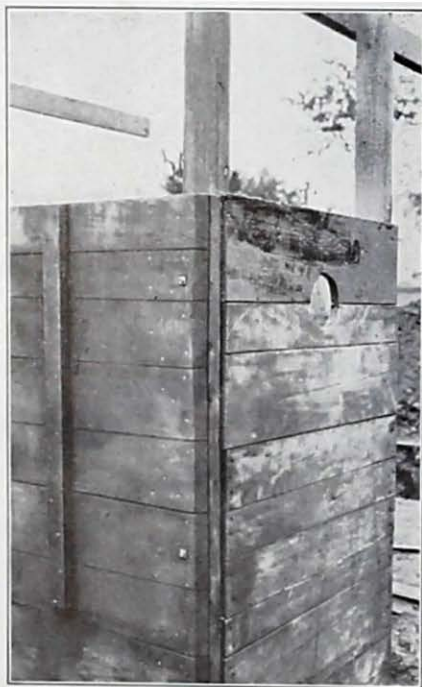


Fig. 5.—*Left*, cutting the bevel by hand. The extra strips are on the underside, spaced 6 feet over all, and guide the saw. The planing mill eliminates this hand sawing. *Right*, bolted corner of community form. Side boards nailed to extra strips with nails clinched, nuts countersunk on outside of form, end boards nailed to 2 by 4-inch posts for 30 inches, upper 24 inches around pipes left loose. Note that the extra strip is not flush with edges of end boards, fig. 4, and that nuts can be fastened in place.

The "loose boards" are put in place and laid up so that they will complete the total distance of $4\frac{1}{2}$ feet. The *inlet* hole is laid out on the centerline with its bottom 10 inches below the upper edge of the form. The sewer pipe can be placed on the boards and the hole marked. It is advisable to leave the little extra space given by the thickness of the pencil rather than have a close fit, for sometimes the Y-pipes are warped slightly. The hole will be found to be

nearer $5\frac{1}{4}$ inches than the $5\frac{1}{2}$ inches shown in the figure, while most good 4-inch pipes measure a neat 5 inches on the outside.

The loose boards should separate after the tank is cast without binding on the Y and for that reason the joint should come at the centerline of the pipe, if possible. Sometimes this can be done by shifting the narrow strip used to fill out the $4\frac{1}{2}$ -foot width. At other times it is necessary to carry the full diameter of the pipe to the nearest edge of a board. This may leave a triangular hole of about a half-inch which can be plugged from inside the form with rags, paper, or stiff clay when the concreting reaches the level of the pipe. Just enough caulking should be used to keep the cement in with the stone when the concrete is placed.

It will be a great convenience to have all the loose boards above the hole nailed to narrow cleats set in a couple of inches from the sides and also to have the same thing done with the lower boards, figs. 6 and 11. Screen door hooks are then put at each end of the "loose boards," making four hooks for each complete end piece, or eight for the form. Corresponding eyes are set in the 2 by 4-inch corner posts. It is then advisable to mark "INLET" on all pieces for this end, and also "TOP" on the upper loose board, with heavy wax pencil, paint, or timber scribe. Of course the marking is to be on the inside of the form where it will not be covered with grease or concrete.

Build the other end the same way, making the bottom of the hole $11\frac{1}{2}$ inches from the upper edge. Mark similarly with "OUTLET" and "TOP." Bore half-inch holes through corner posts while the end pieces are still on the ground. Make first hole 20 inches above upper edge and others every 6 inches. Be careful to make holes in all four posts exactly the same.

Assemble the two sides and ends. This is done best on a level place with blocking under the corners. Be sure the end boards project at least one-eighth inch beyond the side strips, figs. 4 and 5. The edges must not be flush. Work one corner at a time, lightly tacking them together and leaving the nail head projecting enough to be easily removed after the bolts are in place. Bore a three-eighth-inch hole in second board above the bottom, one about 18 inches above the first and the third within a foot of the top. Look out for nails and see that the holes hit well into the 2 by 4-inch corner post. A drill is safer than an auger bit. Do not place the bolts where the screen door hooks will be in the way of the wrench.

Countersink the screw plates or nuts on the outside face of the side pieces. The mortise should be deep enough to let the nut be flush with side boards. After all 12 are set remove the nails holding the form together and tighten up the bolts from inside the form.

While the man is inside the form have him place two cross braces in the middle of the form as shown in figure 11, between the "2 by 4's." A couple of light blocks will hold them in place, fig. 10. If they are slightly longer ($\frac{1}{2}$ to 1 inch) than the form is wide,—usually about 2 feet 8 inches,—the sides will have a slight bulge which will permit the easier removal of the form. Mark these two "center X brace," and also mark on the inside of each of the side pieces:

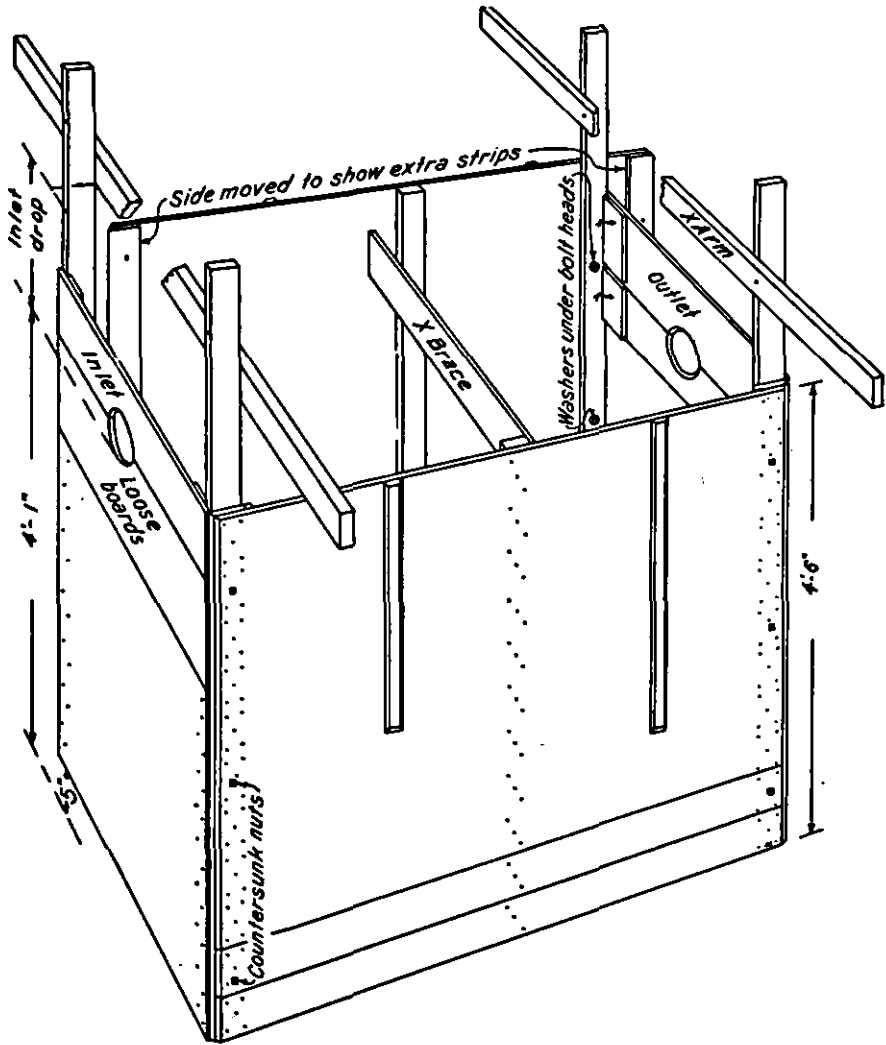


Fig. 6.—Community form. The "inlet drop" from bottom of cross arm to bottom of sewer trench plus 4 feet 1 inch equals the drop from the top of the blocking, or posts, to the bottom of the hole, fig. 9. Note extra strips used with bolted form, cleats on loose boards and hooks. The cross brace is better if heavier and wedged between the "2 by 4's."

“Top,” “Inlet,” and “Outlet.” Make sure in doing this that the inlet or shorter baffle is at the inlet end: the one with the higher pipe hole.

The cross arms are next attached to the inside edges of the corner posts by boring half-inch holes at the proper distance apart to match the ones in the corner posts. The arms should be placed so that the inlet hole will come at the proper level for the house sewer when the cross arms are on posts or blocked up level.

A nailed form is built the same way using the dimensions in figure 3, omitting the extra strips and using 10-penny nails partially driven from the inside through the 2 by 4-inch corner posts instead of bolts.

The cross (X) braces should be nailed to the sides of the “2 by 4’s” and a diagonal brace inserted to hold the nailed form together, fig. 3.

LAYING OUT THE TANK

If possible select a location of from 20 to 50 feet, horizontally, from the soil stack in the house. Some locations demand that the tank be placed much closer to the house and sediment may be expected to wash into the absorption tile. A greater distance is no advantage.

Set the line of the sewer so that it will be straight from where it leaves the cellar until it enters the tank on the center line of the end. Make all curves in the drain after leaving the septic tank, that is, in the outlet pipe.

Have the end of the tank square with the sewer line as in fig. 9.

The ideal location has a drop of about 1 foot just beyond the tank so that the absorption tile may be laid shallow without going away from the tank too far. Some difficult tank locations on a terrace have been solved by putting a drop straight down from the outlet to the absorption tile level. “T”-joints are more stable than elbows for making these vertical turns. See suggestions for purifying tile.

BUILDING THE TANK

Follow the “Twelve Steps” on the inside front cover and the suggestions under the various illustrations. A few hints may help amplify the “Steps.”

The plugs are placed most easily in the inlet and outlet pipes several days before they are wanted. They are best worked on while standing against a wall, fig. 7. If cast-iron pipe is used from the house to the tank see that a double hub is leaded to a Y-branch and a screw plug inserted by the plumber before starting to pour the tank. Build this assembly into the inlet end of the tank, fig. 14.

The pit is dug as an outside form and laid out according to the



Fig. 7.—Plugs placed in inlet and outlet Y's according to Step 3. Tin or tar paper circles in the bottom of the bell hold the mortar in place. A dam makes the vent with the edge of the disk turned up in outlet piece at right.

when the bottom of the tank is 5 inches thick. See also figure 6. The posts are not necessary unless the situation is very level. Usually blocking is sufficient under the cross arms.

Before placing the inside form in the pit, paint the outside of it with a mixture of raw linseed oil and kerosene in equal parts, or old engine oil. This will prevent the form from sticking. Cup or axle grease is better if used at the corners and along beveled cleats.

Suggestions for mixing and pouring the concrete in the forms may be had from the concrete handbooks or from Farmers' Bulletin 1772, United States Department of Agriculture, "Use of Concrete on the Farm." See "Steps 9 and 10." The bottom should not be filled too full, that is made too thick, so as to bind the forms, and the concrete should have no more water than that required to make a good mix. Of course the mixture should be well tamped and a spade run down between the form and the concrete to force back the stone and make the wall surfaces smooth.

In order to remove the forms after the concrete has set (allow one to three days if there has been no freezing) draw the bolts that hold the corner posts to the sides, and remove the ends of the form.

"Twelve Steps" and figure 9. The bottom should be 4 feet 1 inch below the grade of the inlet pipe. After the "inlet drop" below the top of the stakes or posts is set by holding a carpenter's level as shown in figure 9, or a string with the line level in figure 10 on it, a stick can be used to measure down from the bottom of the cross arms, used as straight edges. The stick should measure 4 feet 1 inch, plus the inlet drop,

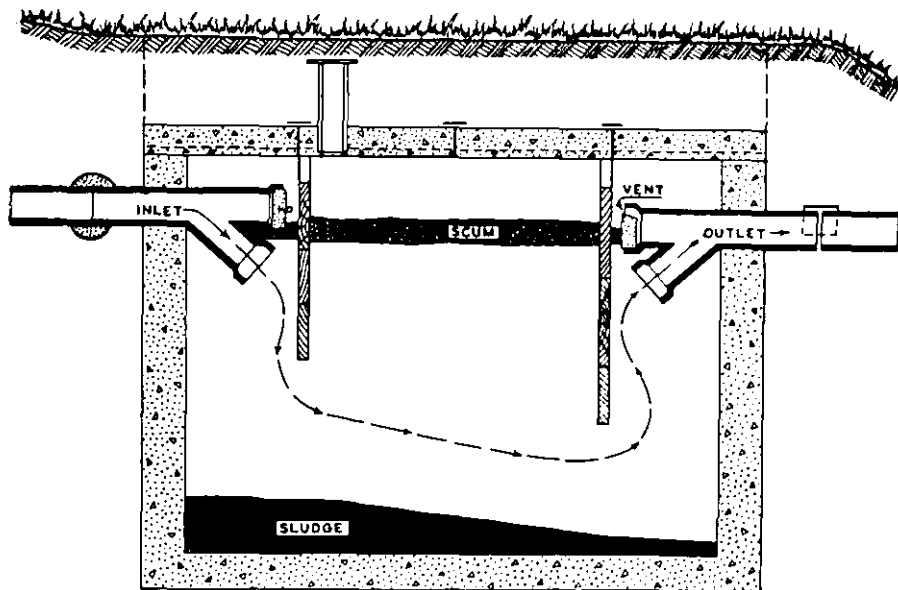


Fig. 8.—Cross-section of septic tank in operation. It should take about 24 hours for the sewage to flow from Inlet to Outlet. The cement mortar joint in figure 2 is indicated at the upper left and tar paper strips over the absorption tile joints are at right. The sludge will wash out and fill the tile, if it gets too close to the outlet baffle after five years of use. The only change in 20 years of successful use has been the suggestion of an inspection hole in the cover slab. This is better left under the sod and covered by a piece of slate or cast-iron on top of the 4-inch tile. They can be applied to old tanks by chipping half the hole in abutting edges of the first two slabs.

After this the sides with their cleats may be removed, leaving the slots for the baffle boards, after the center cross braces have been taken out.

The four or more cover slabs are easily cast on a flat floor by placing heavy paper under a form. Two-by-fours placed on edge will make a good gang form. The side pieces are 8 feet long and the sections should be 4 feet by 21 inches wide for the standard tank. If one of the division pieces is given a little slant outward it will enable the cover to be lifted off more easily.

This particular slab, usually the second from the inlet end, should be marked and the upper sides of all slabs should have a light scratch on them to indicate "this side up" to insure that the reinforcing is kept below the center of the slabs.

The only addition to the septic tank as first built 20 years ago has been the suggestion that a 4-inch drain tile be placed in the No. 2 cover slab on the center line near the baffle, fig. 8. This will permit inspections and pumping out the sludge without removing the

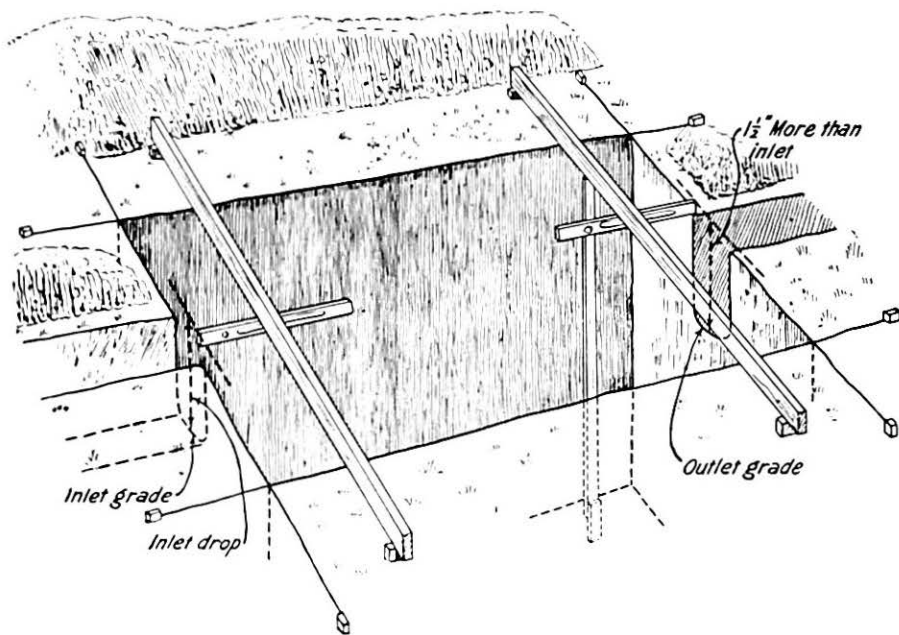


Fig. 9.—Layout of tank in line with sewer, Step 4. All turns should be made beyond the tank. The leveling for the "Inlet drop" is only required with posts set for very careful work in flat locations. The $\frac{1}{2}$ -inch drop to the outlet is provided, if the form is set level. Measuring stick is for digging pit bottom level. Posts are in 11 inches from strings across ends and are 8 feet apart across the tank.

cover slabs except to skim off the scum. The top of the tile is covered with a piece of slate under the sod.

Before putting the tank into regular use, the baffle boards should be inserted according to the detail shown to within 4 inches of the top, and the tank should be completely filled with water. The tank should be covered with slabs of reinforced concrete or with paving stones. Wooden planks should not be used, as they are not kept wet like the baffles and may rot before the tank needs cleaning, thus permitting the earth covering to fall. The slab form of cover makes the tank much easier to clean than when a manhole is used. The earth covering over the tank usually is made 12 inches thick. More covering makes additional work in cleaning.

ABSORPTION SYSTEM

The problem of disposing of the liquid part of the sewage usually is given much less attention than it deserves. Water-borne diseases get the germs in most cases from sewage and if septic tanks are used and the effluent from them is safely disposed of, the greatest source of infection is removed.

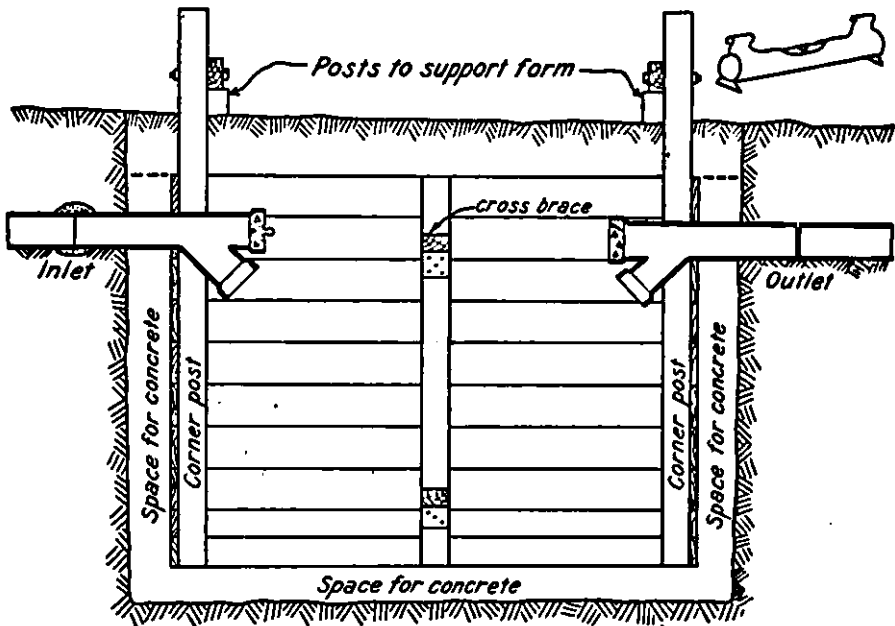


Fig. 10—Form in pit supported by blocking or posts, Step 8. The cement mortar joint or collar usually is not made until after the forms are out. Side walls are poured first, Step 9, and the bottom, Step 10, after any bulge under the forms has been smoothed off. Note that the plugs are in the Y-branches according to Step 3, and have set several days. The simple line level in upper right corner can be used to level forms and set grades on ditches (Enlarged).

The liquid issuing from a septic tank is more or less clear, depending upon the nature of the water supply, the kind of sewage, and the efficiency of the tank. As noted above, probably a small part of the solids will pass out with the liquid. If the tank is working properly, these will be in the form of very fine particles and will be subject to further action when the air bacteria work on the effluent.

If the liquid is allowed to drain into one small spot for a considerable length of time the soil becomes "sewage sick." In other words, it gets sour. This kills the bacteria required for the work of purification, and a point of infection is established for the neighborhood. Soil can be made sewage sick from a leaky cesspool, from a sewer, and also from sumps along the tile. The sumps are sometimes called seepage pools or dry wells. In order to overcome this tendency for the soil to water-log, the effluent is distributed by lines of absorption or disposal tile laid near the surface of the ground. By far the greater number of bacteria are in the upper foot or two of the soil. To take advantage of this in plowed land, the tile are placed preferably 15 to 18 inches deep, although they have worked

successfully from 10 inches to 24 inches deep. Numerous installations indicate that there is no danger of frost. When used under a lawn, the 10-inch depth has been very satisfactory. The shallow depths are especially needed in heavy clay soils.

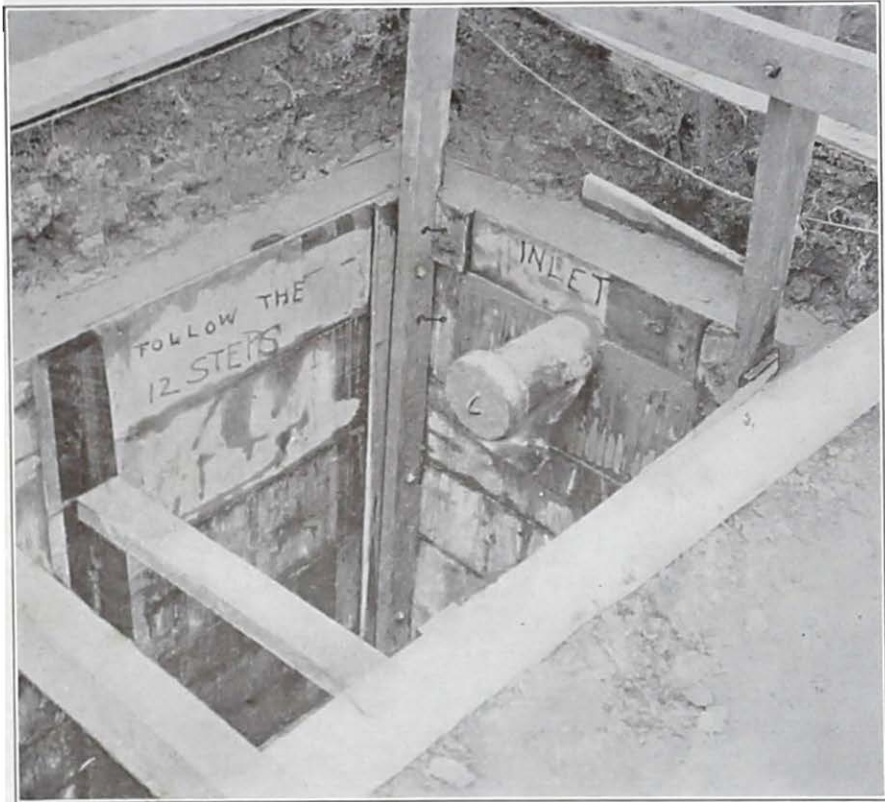


Fig. 11.—End of Step 9. Top of walls troweled off. The bottom should now be leveled and edges of form kept free. Extra concrete is added to finish the bottom to 5 inches thick. Note the bolt heads inside of form, hooks for loose end boards, short board across inlet ditch, and boards around hole to keep out loose earth. Cross brace is cut long to bulge sides slightly.

The trenches in which the absorption tile is to be laid should be well graded without any bumps, dips, or sag. Some authorities advocate a regular fall of 2 inches per 100 feet while others prefer to have more fall near the tank and less toward the end, which may finish off level.

Hard-burned, farm drain tile, or electrical conduit, 3 or 4 inches inside diameter, 1 foot long or more, with straight square-cut ends, should be used. They can be round, 6-sided or 8-sided. It is not necessary to use sewer pipe. The latter are harder to lay and do

not have as many joints since the pieces are longer. If necessary to use sewer pipe, lay the joints down hill. The joints serve to pass the effluent into the soil and for this purpose are spaced slightly, one-eighth to one-fourth inch with a piece of tar paper or linoleum placed over the joint to keep the earth from working into the tile.

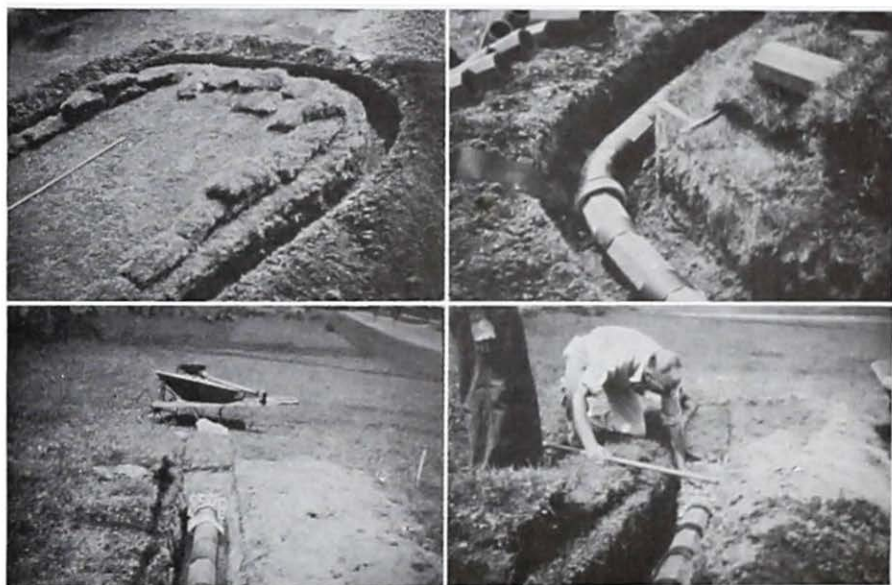


Fig. 12.—Installing absorption tile. *Upper left*, the flow goes toward the right around the loop and downward at the left. *Upper right*, detail of curve made with eighth bend 4-inch sewer pipe. The drop between straight runs is slight, not requiring cemented sewer pipe. *Lower left*, soil over stone and sod in place. Flat rock on edge shows what was placed at end of tile. *Lower right*, placing crushed stone alongside tile.

This spacing is particularly required in heavy soil. The tile is laid like a farm drain with the liquid leaving the pipe instead of entering. The lower end of the tile is closed with a flat stone or cement plug. Do not forget this point.

The amount of tile to use depends on the soil. In clays, good work has been had from placing stone around the tile after it has been laid in the ditch. No extra depth was dug for the stone or gravel. The lighter top soil often is placed next to the tile to help absorption. A heavy application of lime will also loosen the soil.

The length of tile required has always been taken as at least 100 feet for the standard 3 by 6-foot tank. Some recommend for each person where a complete plumbing system is used:

Tile all in one run	{	Open gravel	6
		Light loam	8
		Medium loam	12
		Heavy loam	25

With the trench filled with gravel 20 feet per person has worked well in rather heavy soils. The size of the tank is not such a serious matter if nearly right, but more thought should be given to absorption tile both as to length and location. No sumps are recommended in connection with the absorption tile. They make the system no better than a cesspool.

SUGGESTIONS FOR LOCATING PURIFYING TILE

1. Choose a site so that the drainage from it, either on the surface or below ground, cannot reach any drinking-water supply before being purified by passage through 50 to 300 feet of soil, the distance depending on the character of the soil. Special care should be exercised in limestone regions.

2. If it is necessary to locate the purifying tile at a distance from the septic tank, the two may be connected by a line of vitrified sewer pipe with water-tight cemented joints, made as shown in figures 2 and 16.

3. The disposal area is best kept permanently in sod, although plowed land may be used under certain conditions if necessary.

4. The tile should not be located under a fruit orchard, or where tree roots will enter.

5. The underdrainage of the area must be such as would be considered satisfactory for field crops. Low, wet areas should not be used unless they are underdrained.

6. Areas of muck should not be used even though they are well drained. Aerobic bacteria will not thrive in muck.

7. Locate the area on the lightest, most open soil available. More tile is needed in heavy soils than in light soils.

8. Construct the septic tank in such a location that the full amount of purifying tile called for may be installed ultimately if experience shows its use to be necessary. At the outset, however, it will probably be best to install 100 feet in a single line and to use this until experience has proved that for the actual conditions existing a greater length of tile is needed, making the increase in additional number of lines. In that case the original plan may be carried out without difficulty. If no more tile is needed, considerable expense and trouble will have been saved.

A box like the one shown for the sewage switch, fig. 15, or the one noted under the Two Chamber Septic Tank at the end of this circular may help in adding tile. The same arrangements may be used at first if more than 100 feet are thought necessary as no one line should be over 100 feet long. A permanent divider may be made similar to figure 15 by inserting a diagonal plate to split the inflow and not using a gate.

Curved lines, using two sewer pipe quarter bends with two joints of sewer pipe between them, making a large U with the straight parts across the slope, laid, as it were, on its side, have helped to solve many difficult layouts when the fall from the tank was excessive. Practically all the drop is taken up in the bend of the U, front cover and figures 12 and 13.



Fig. 13.—Four straight runs of absorption tile in a front yard connected by cemented sewer pipe joints and elbows at turns down hill. See front cover.

Where experience has shown that more tile is needed than first installed, in order to bring the quantity up to that recommended in the table on page 17, the distance between single runs of tile should be about 10 feet. If the soil is heavy and space is at a premium the distance can be reduced to 5 feet. A separate tile drain to a free outlet can be placed midway in a 10-foot spacing if the soil becomes too wet. When operating properly the soil in which the disposal tile is laid never becomes damp enough to be noticeable, though there is a heavier growth of grass.

If a test demonstrates that more than one set of tile is needed so that rest periods may be given to prevent a heavy soil from becoming sewage sick, some form of effluent switch must be used. Small wells formed of concrete and sewer pipe stood on end have been used successfully. The bottom may be cut in channels having the form of a letter "Y" with movable plugs to turn the effluent into either branch. Others use a paddle sliding in slots over the branches

leading from the switch. Either can be home-made but requires that the movable part be picked up and put down in place. They can be bought ready-made of cast-iron for about \$10.

The type of gate shown in figure 15 is offered to simplify the construction and operation where a switch is required. It is nothing more than a piece of sheet-iron a little larger than the outside diameter of the disposal tile, welded to an iron rod a half-inch in diameter. The rod projects at the bottom beyond the notch cut in the iron plate and is turned for an "L" handle at the top. The bottom edge of the gate rests in a sloping groove cast in the floor of the switch box under each branch tile. The sloping groove holds the gate against the tile. The direction of the sewage flow is changed by raising the handle slightly, turning it until the other tile is touched and then lowering it. It should be turned about every two weeks.

Where one of these switches is needed it should be placed in a convenient place, where the projecting handle will not be damaged. The switch might be placed along the walk between the house and barn or along some other traveled path. If there is no danger of bending the handle it can project several feet above ground to be easily reached even when there is a covering of snow.

HOUSE AND TANK CONNECTION

It is impossible to go into all the details of plumbing which may come up. If the laundry tubs shown in figure 2 are not supplied in the basement, the cast-iron pipe need not be under the cellar floor. However, in any case, the riser pipe should be supplied with a sanitary "T" at its base and a clean-out as shown in figure 14.

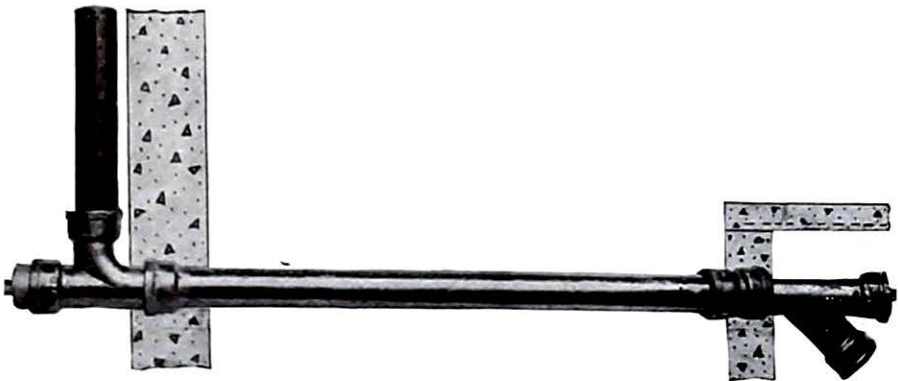


Fig. 14.—Complete system of 4-inch cast-iron pipe from soil stack, or riser pipe, at left in house to the inlet Y in septic tank. The cast-iron inlet Y is short and is connected by a double hub with leaded joints instead of the cement mortar collar for use with terra cotta. Clean-out plugs are used at each end of the horizontal run and are screwed into ferrules. The soil stack is best kept to 4-inch size straight out through the roof. No terra cotta sewer pipe is used inside houses.

Septic tanks usually are connected to the house piping with a 4-inch vitrified sewer pipe laid with cemented joints, although cast-iron pipe often is used as illustrated. It is best when a well is near at hand.

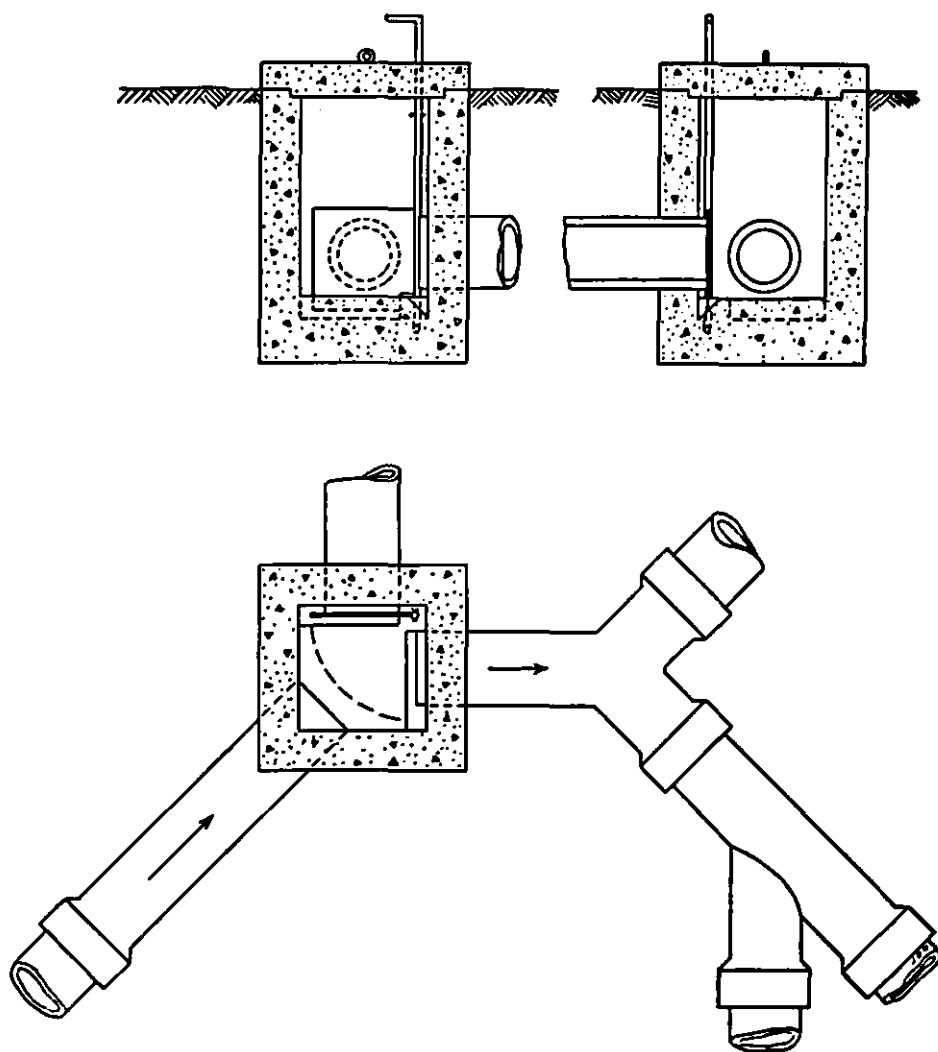


Fig. 15.—Plan and sectional elevations of sewage switch. Also showing use of “V” and “Y” sewer pipe specials to divide flow. A double Y with bell of straight part plugged can replace the V, but a box with a diagonal plate will make a better divider. Switch to be turned every 10 days or two weeks. The same results may be obtained with a similar box with the two outlets opposite and the inlet at the high side between them. A diagonal wooden paddle serves as a gate but the box top has to be removed when the flow is changed. See U.S. Farmers’ Bulletin 1950.

SUGGESTIONS FOR LAYING VITRIFIED SEWER PIPE

1. Place the pipe in the ditch with the lengths turned so that the direction of flow will be into the bell end, as indicated by the arrow in figure 16.

2. Provide a swab as shown, with a handle longer than one length of pipe. Put the large end of the swab in the end of the last length of pipe, the inlet Y. Place the next length over the handle of the swab. Make the mortar collar.

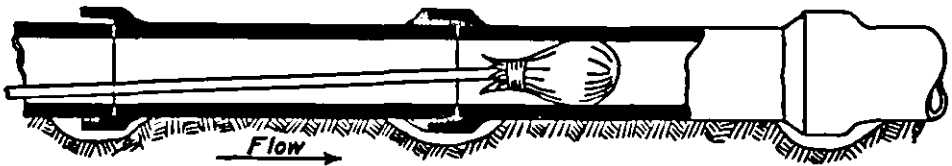


Fig. 16.—Laying terra cotta sewer pipe from septic tank towards house. Oakum is used to center pipe and hold cement. Note dug-out space under bells to permit tight cement joints. Room for the workman's hand must be provided.

3. Place a strand of oakum well back in the bell of the piece of sewer pipe connected to the mortar collar at the inlet Y-branch of the tank. Fill the under side of the bell with mortar. Place the small or spigot end of the next piece of pipe in place and push it well up until the spigot strikes the bottom of the bell. With a flat stick force a strand of oakum, or shredded tarred rope, in between the spigot and the bell until the spigot end is centered in the bell and the bottom of the pipe is smooth, as in figure 16. If the oakum is not so used the bottom of the drain will be uneven, and cement mortar may work into the pipe.

4. With gloved fingers pack the joint with cement mortar, as shown in figure 17, being sure to get the mortar well into the bell and on the underside of the joint.

5. Rub the inside of the joint with the swab so as to insure a smooth surface.

6. To cut a section off a length of vitrified pipe, use a sharp cold chisel and a hammer. Make a shallow cut in the glazing entirely around the pipe. Cut around again, going a little deeper. Continue cutting around lightly until the pipe snaps off at the mark.

The down spouts from the roof gutters should not be connected to the septic tank system.

The best fall for 4-inch sewer pipe is a quarter-inch per foot which equals 1 foot in 50 feet. One half or double this will work. If located very close to the house the line can go into the septic tank almost level to prevent stirring up the sludge.

No fruit peelings, heavy paper, or cloths should ever be permitted to get into the plumbing system as these will not decompose in a septic tank.

COST OF THE TANK

The average-sized tank will require about 3 cubic yards of concrete and the approximate cost is about \$15 per cubic yard mixed. The concrete work in the tank shown in figure 1 cost \$28 in 1920 exclusive of the cost of the form or cover slabs. Roughly the work requires 4 to 4½ barrels of cement, 1½ cubic yards of sand, and 3 cubic yards of stone. Many tanks recently have been built for \$15. The price of the other materials varies greatly; for instance, 100 feet of 3-inch drain tile may cost from \$2.50 to \$7. Four-inch tile is better.

Very few tanks have been built in the state where the cost of the material, outside the cellar wall, has been much over \$30. Roughly the labor and material will vary from \$50 to \$75.

Interior plumbing, exclusive of the pressure water system, probably will cost from \$175 to \$500 installed. A kitchen sink with double drain boards, a one-piece roll rim bathtub to sit on the floor without legs, and a wash stand to hang on the wall are suggested.

Ready-made concrete, coated metal, and terra cotta septic tanks can be bought. It is suggested that an inspection hole and place for pumping out be added to the cover as shown in figure 8.

Some concrete contractors save the forms, which is done easily when planed lumber, such as "roofers," is used and care taken, and make the same set do for a number of tanks. Some building supply houses lend forms to their customers. A pomona grange has financed a community form and often the first man to build a tank in a neighborhood will save it for use in his locality in cooperation with the county agent.

OTHER METHODS OF DISPOSAL

There is a state law which prohibits the discharging of raw sewage into streams without first obtaining the written approval of the State Department of Health. This department also holds that the effluent from a septic tank should require the same permission, if purifying tile are not used.

The following extracts from the original Cornell bulletin, by Riley, will give the main points of comparison with other disposal systems:

"The isolated outdoor closet is frequently the indirect cause of sickness. It is often so cold or so public that many persons do not use it as frequently as they should. Wastes retained too long in the body tend to cause sickness.

"Chemicals of the right kind, which are fresh and strong enough, will kill all disease bacteria with which they come in contact, but they will not kill those that they do not touch. In order to be suitable for this purpose,

therefore, the chemical must also be of such a nature that it will retain its strength until the time comes for emptying the receiver. Several chemical closets are in the market and for some cases good ones are to be recommended. Arguments in favor of their use are that they come complete and ready to set up; they are easy to install; they may be removed to new locations as plans are changed; and good ones, when properly managed, completely destroy all germ life present in their contents. Arguments against their use are the first cost, which may or may not be more than that of a septic tank system; the steady yearly expense for chemicals, which must be bought so long as the system is used; and the frequent attention that the systems will require, since the capacity of the tanks is usually comparatively small and they must be emptied before they overflow regardless of any consideration of convenience.

"Cesspools consisting of deep pits with loose stone walls, receiving sewage from water closets and sinks, are generally not safe, although in some cases they may be used.



Fig. 17.—A sewer pipe "T" cemented to a straight piece of 4-inch sewer pipe and hung vertically to serve as an outlet for a cesspool. Figure 19 also shows this between the two chambers. The wall was built up higher. More baffle was added to keep the scum from entering the bell when it gets thick. This procedure is only adapted to locations where the water supply cannot be contaminated.

"From cesspools that are called good all the liquid soaks into the lower soils. As has been stated this is dangerous except in special cases. Liquid soaks best into open soils, but it will travel farthest, and hence be most dangerous, in such soils. In heavy soils the liquid will not soak away, and the cesspool will fill up and overflow from the top as from a septic tank. The cesspool, however, will not work well as a septic tank unless it is of the right shape and the inlet and outlet pipes are arranged properly. Evidently in such cases it would be cheaper, and in all cases it would be better to build a good septic tank in the beginning."

In some instances a cesspool may be changed to make it serve as a septic tank if the distance across from the inlet to the outlet is at least 5 feet, preferably more, and the size is sufficient to hold a day's flow of sewage. A sewer pipe "T" often can be placed over the outlet pipe with the long end downward below the surface of the sewage and the bell on the main part facing upward above the sewage, fig. 17.

Baffles similar to those used in the tank may be suspended across the cesspool and should extend well downward. Of course, such work as outlined above cannot be done if the cesspool has had a heavy, permanent cover built over it. Considerable difficulty may be met if the cesspool is not water-tight, which all septic tanks should be. The water level may fall and permit the scum to seal the outlet when it again rises. Such a cesspool would always be open to suspicion if a nearby well is used for water supply. In some cases it would be much cheaper and more satisfactory to build an entirely new system.

Many Pennsylvania farm homes have running water in the kitchen but contain no bathroom. A temporary solution of the sanitation problem is given in figure 18. The kitchen sink is connected to the 4-inch inlet Y of the regular septic tank which has the inlet baffle extended to the cover slab and the slab over the inlet end temporarily left off. The fourth one can be put in place when the bath is installed. The regular absorption tile system is used. A ventilator flue is shown connecting to the roof and it should be screened. In fact, the whole house must be fly-tight. Maggots in the scum create a gas nuisance.

The house can face the opposite direction. The plans for the one shown are from Farmers' Bulletin 1950, "Sewage and Garbage Disposal on the Farm," figs. 7 and 8, U. S. Department of Agriculture.

TWO-CHAMBER TANKS

A suggested design for a septic tank with dosing siphon is given in figure 19, but large sanitation projects should be handled by a consulting sanitary engineer experienced in the work.

The septic or settling chamber is designed to hold the entire day's flow of sewage with storage for sludge and scum. The length is at least two times the width. The use of a number of small tanks in a battery often gives trouble. The siphon chamber, to the right,

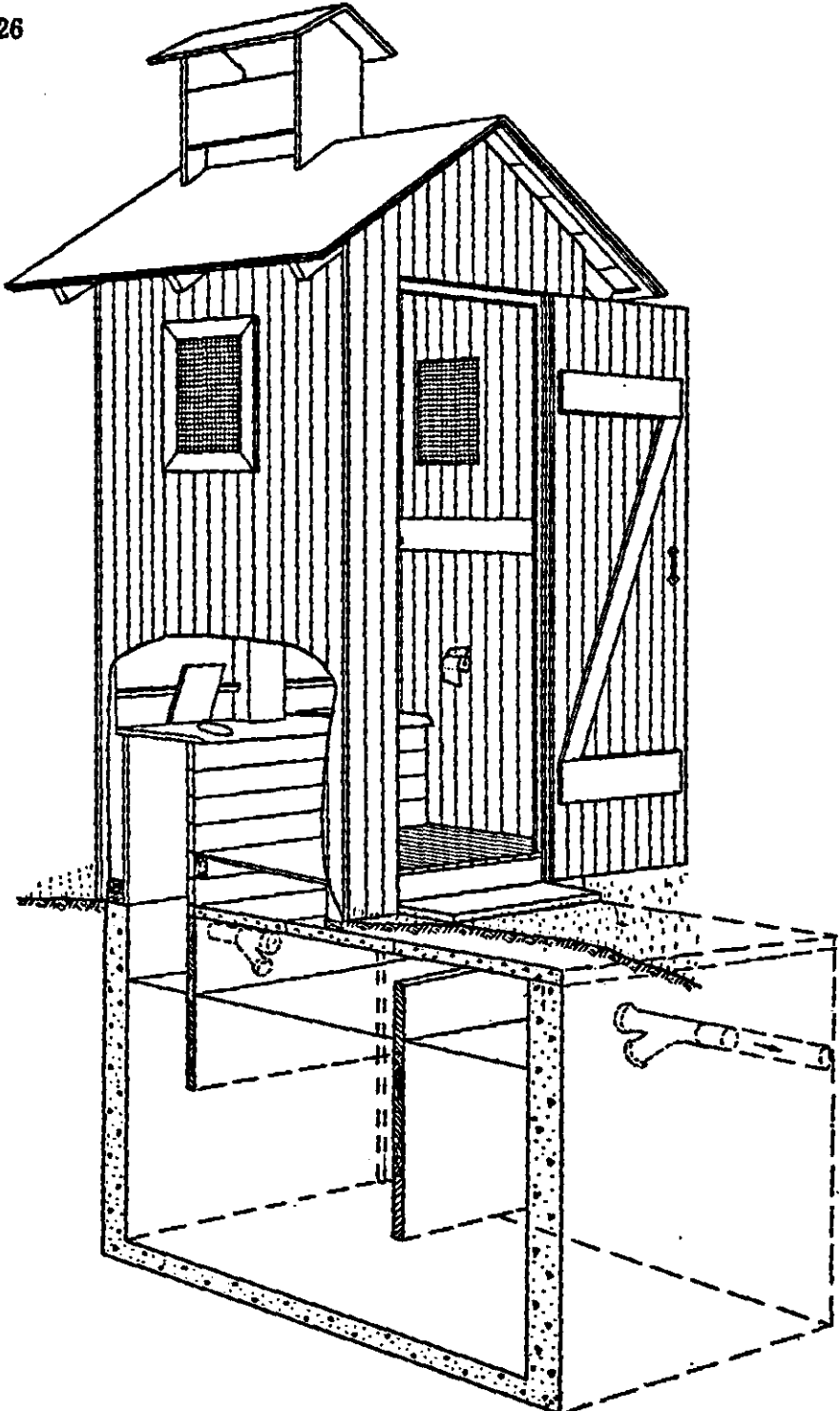
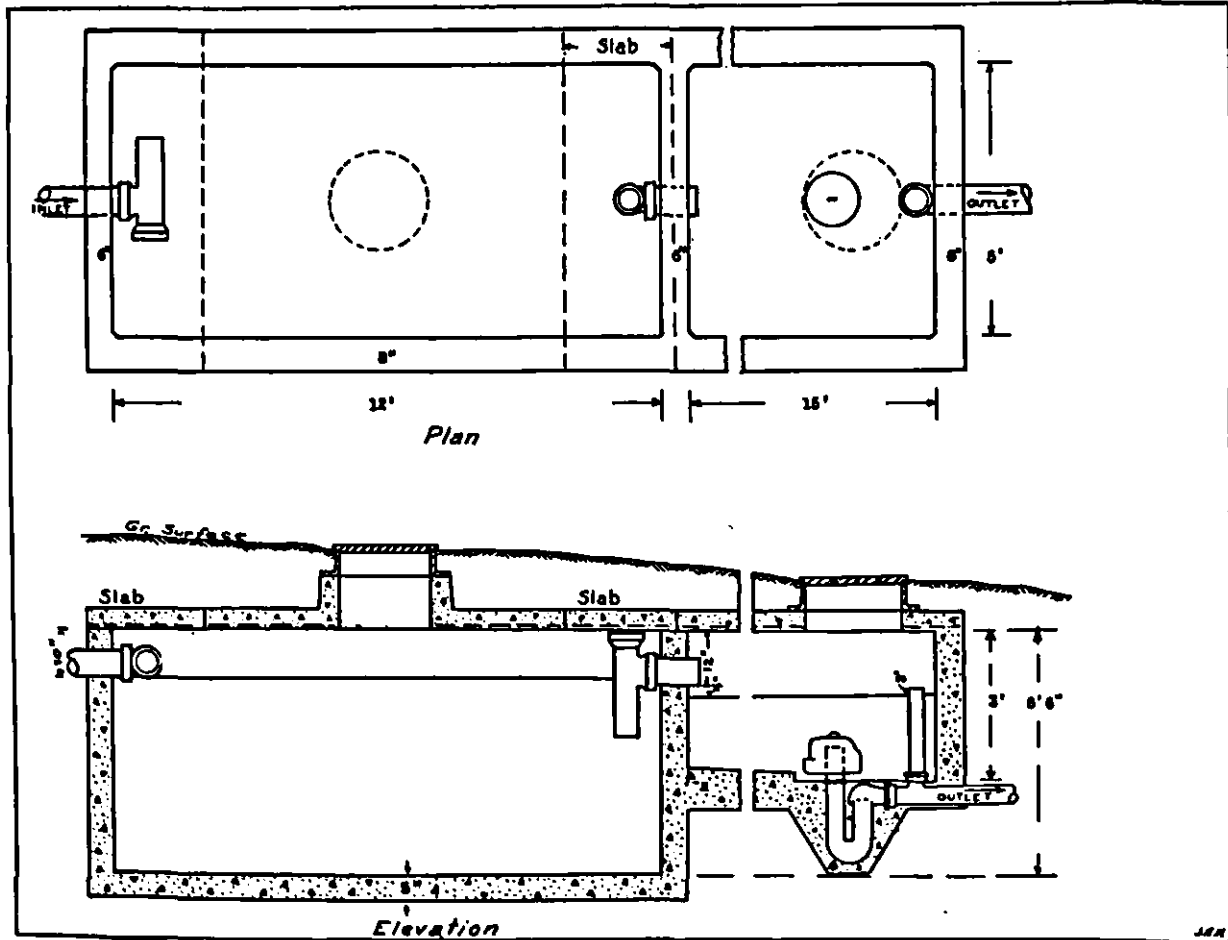


Fig. 18.—Outside closet placed over inlet end of septic tank where a kitchen drain is available and a bathroom can be installed later without losing the work on the concrete vault.

Fig. 19.—Large two chamber septic tank of 2,000 gallons capacity. The settling end is at the left and dosing siphon chamber at the right. This type is needed for heavy sewage flows. Without the cast-iron siphon this tank is no better than the single chamber one.



should empty three times per day. It is shown for a shallow depth siphon but if a greater depth can be used the chamber may be greatly reduced in length and increased in depth. This depends on the fall available and the type of siphon used. Small siphons have given trouble and the 4 to 6-inch sizes are recommended. All depths shown here are 6 feet 6 inches for the settling end.

The main from the siphon usually is 6-inch sewer pipe with tight joints. The branches are made with Y's and no lateral should be more than 100 feet long. The total volume of the laterals should equal the dose, one-third of the day's discharge. Often a duplicate set of tile and a sewage switch are desirable. A long, narrow concrete box with the inlet in one end, set level, with an equal number of absorption tile lines going out each side when possible, provides uniform distribution. The connections from the box to the tile lines, which should be spaced 6 to 10 feet apart, are made with sewer pipe having cemented joints. A board gate may be used to block off one side or part of the tile for two weeks and then be placed on the other side. When attended to, this gives good service.

Table 2.—Dimensions for two-chamber septic tanks.

QUANTITY OF OF WATER PER DAY, IN GALLONS	SETTLING CHAMBER 6 FT. 6 IN. DEEP				SIPHON CHAMBER SHALLOW DEPTH				MINIMUM LENGTH OF 4-INCH ABSORPTION TILE
	Length		Width		Length		Width		
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Feet
1000	7	4	3	8	13	0	3	8	475
2000	12	0	5	0	15	0	5	0	950

Some large systems will give better service in cramped locations, if a sand filter bed is used in place of absorption tile.

Maintenance.—Sometimes the absorption tile becomes filled with sludge when Step 12 has been neglected. If the earth around the tile is not water-logged, all that may be necessary is the removal of the sludge either by dragging a wire and swab through it, followed by flushing with a hose, or lifting the pieces for cleaning. If the ground has become sour, a new location for the tile is suggested. Sometimes long pieces of soapy foam with float out, if the entire absorption line is filled with water and the plug at the lower end is quickly removed. To make this last method effective, it is necessary to have a place to receive the water as it rushes out.

The plumbing must be kept in good condition as a constant drip at a spigot or other fixture will make the absorption area water-log. A spring cannot discharge continually into a septic tank without causing trouble.

NO SEPTIC TANK
Makes Pure Water Out of Sewage

NO SEPTIC TANK
Kills All the Germs
**(Millions of bacteria pass through all tanks and some of them
may be disease germs)**

EVERY SEPTIC TANK
Has to be cleaned out when working properly
(If it does not accumulate sludge it fails in its purpose)

—From Pennsylvania Department of Health

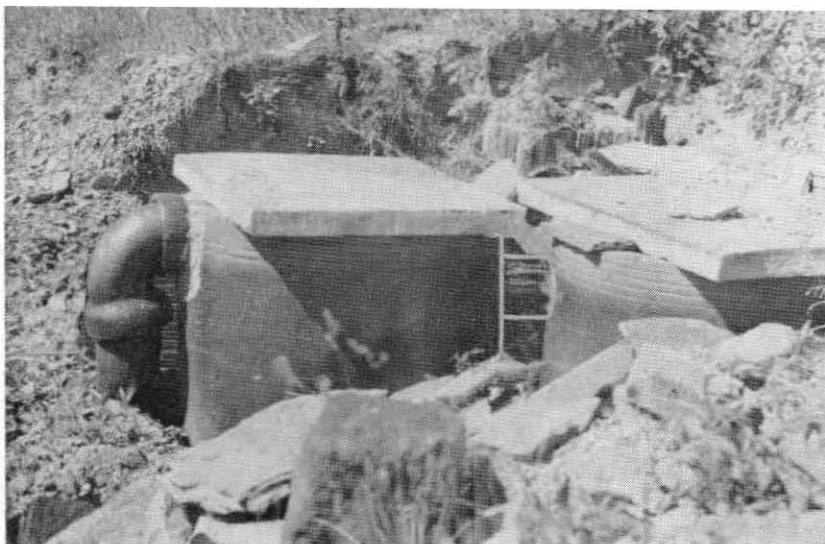


Fig. 20.—A couple of 24-inch sewer pipes connected in a battery. Such arrangements have to be cleaned often, especially at the inlet. The outlet is at the left and does not provide enough space for scum above the water line. The elbow at the outlet, turned down to go to the absorption tile, is a good arrangement to get the necessary depth on a hillside, provided 15 inches of fill, or more in exposed locations, is put over the elbow.

If a tank has been installed five years or more, an immediate inspection is suggested. It is, however, better to clean the tank in warm weather.

This work is not intended to take the place of a municipal sewer system. Connection should be made wherever such a system is available. However, the septic tank is always better than a cess-pool and usually can be built for less money.

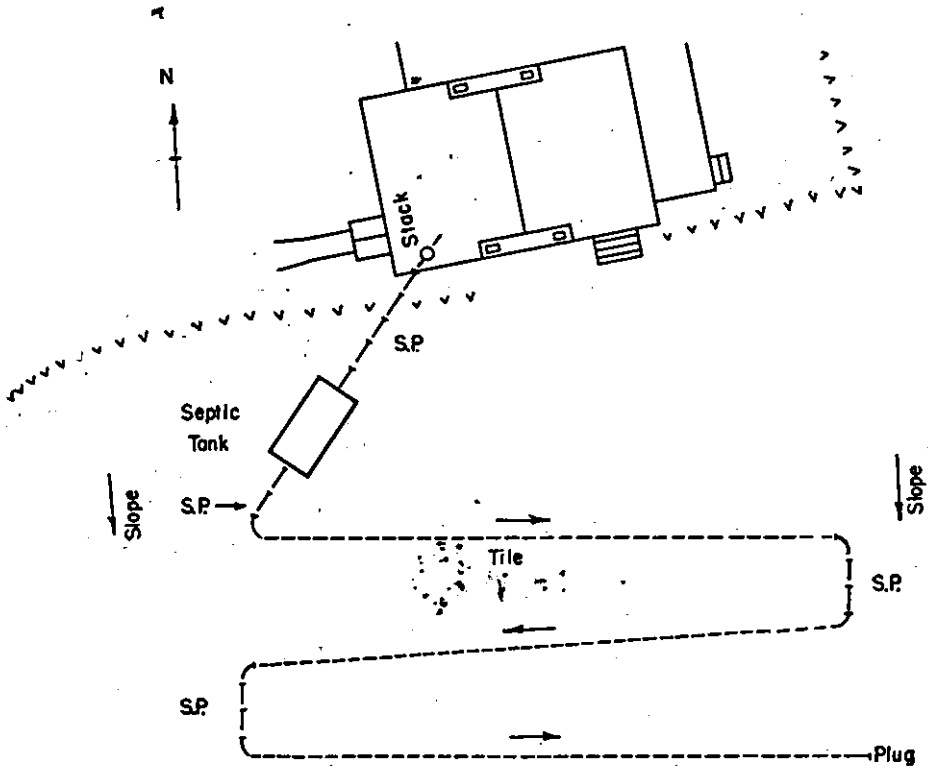


Fig. 21.—Map of septic tank layout shown on front cover and described on inside. The absorption tile is laid as in figs. 12 and 13.