SEPTIC TANKS
For Dwellings

By Earl G. Welch and
James B. Kelley

Circular 431

UNIVERSITY OF KENTUCKY
College of Agriculture and Home Economics
Agricultural Extension Division

Thomas P. Cooper, *Dean* and *Director*

CONTENTS

Septic Tanks for Dwellings

By Earl G. Welch and James B. Kelley

SAFE DISPOSAL OF SEWAGE from your farm residence means chiefly the disposal of it in such a way that human excrement cannot contaminate your cistern, well, or spring — nor those of your neighbors. This protection can be obtained on your own farm by rather simple disposal systems if they are properly made. But if you get your drinking water from a well or spring, a good sewage disposal system on your own farm does not guarantee protection of your water! It may still become contaminated from your neighbor, either nearby or several miles away. This is especially true in the limestone region of Kentucky, where underground water passages may carry contamination that seeps down from the surface through sinkholes or rock crevices.

The extent to which rural wells, cisterns, and springs are contaminated by human and animal excrement is appalling. Of 2,878 samples of water from these sources analyzed by the Public Service Laboratories at the Kentucky Agricultural Experiment Station in 1946, more than half were unfit for drinking unless sterilized by boiling or treatment with chlorine. The exact percentages were 42.8 percent of the samples from cisterns, 53.8 percent of those from wells, and 78.1 percent of those from springs. And of 688 samples from wells, cisterns, and springs used for drinking water by rural schools, 43.2 percent were contaminated. The fact of contamination is determined by finding in the water the colon bacillus, an organism which grows in the colon or large intestine of man and animals. In water where the colon bacillus is found there are also likely to be germs of intestinal diseases such as typhoid fever and dysentery.

In regard to sewage disposal and water supply, there are two steps that every farm family needs to take: (1) to see that sewage on their farm is safely disposed of, and (2) to send samples of water from their well, spring, or cistern to the Agricultural Experiment Station at Lexington regularly for analysis, and if it is unsafe for drinking, to sterilize it by boiling or treatment with chlorine before using it. This circular, on plans for safe disposal of sewage, deals with the first of these two steps.

In planning a sanitary sewage disposal system for a farm it is well to keep in mind the following four principles:

1. The system should be so located that it would be practically impossible for drainage, either above or below ground to flow toward a nearby well, cistern, spring, or other water supply.

2. The final disposal should be made in the upper 18 inches of soil, where sunlight, air, and soil bacteria can complete the oxidation of the sewage.

3. Body excrement should never be permitted to drain or be washed into a small stream, sinkhole, or tile drainage system.

4. Outside toilets should be so made and screened that animals, birds, or flies cannot in any way come in contact with the human waste in the vault.

WITHOUT RUNNING WATER

Many farmhouses have a kitchen sink and pump and an outside toilet, but no inside toilet or bathroom. For such dwellings, safe disposal of sewage requires a grease trap and disposal line for the kitchen sink, and a properly constructed privy.

Grease trap and disposal line for kitchen sink.—The grease trap usually is placed just outside the kitchen, where it can be examined easily and the grease removed when necessary. The drain from the sink empties directly into the trap, and the flow from the trap enters the disposal line, or a sewer line leading to the disposal line. The purpose of the grease trap is to prevent grease from the dishwater entering into and clogging the disposal line.

Note in the drawing the construction and operation of the grease trap. Dishwater from the sink enters the trap through the 2-inch inlet pipe. Water stands in the trap up to the level of the outlet pipe, which is 2 inches below the level of the inlet. Water enters the outlet pipe near the bottom of the trap, 3 inches from the floor. Nothing that floats on the water, therefore, can get into the outlet pipe. Grease floats, and is thus trapped above the outlet.

From time to time the scum of grease that collects in the trap needs to be taken out. The water beneath the scum need not be taken out each time the grease is removed. Once or twice a year, however, take all the water from the trap and clean out the sediment that has settled to the bottom. Not all the solids in the dishwater will float; some will settle to the bottom, and should be removed occasionally.

The disposal line for the grease trap should be about 50 feet of 4-inch agricultural tile laid to a uniform grade of 4 inches per 100 feet, at an average depth of 18 inches in the ground. See pages 14 and 15 for further description of disposal lines.

If it is not suitable (because of the presence of trees or nearness to a well, cistern, or spring) for the drain tile to join directly onto the outlet of the grease trap, sewer pipe will be needed to join

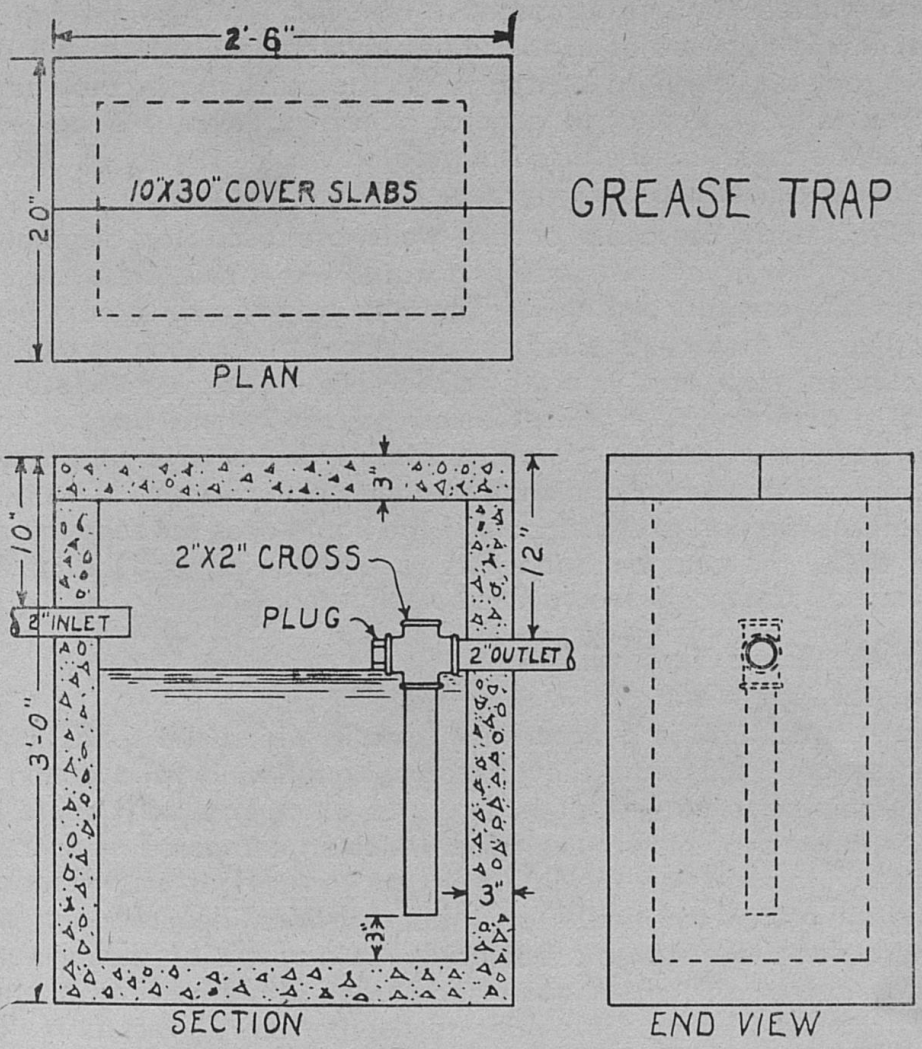


Fig. 1.—A grease trap as shown above is used between kitchen sink and sewer to prevent excessive amounts of grease from entering the septic tank.

the trap to the drain-tile line. This sewer line should be of 4-inch pipe with calked and cemented joints laid to a grade of 4 inches in 100 feet.

Outside toilet. — An outside toilet should be constructed according to the plans and specifications of the Kentucky State Board of Health, Louisville, Ky. Get your plans from your county health officer.

WITH RUNNING WATER — A SEPTIC TANK IS NEEDED

A farmhouse with modern plumbing and running water should have a septic tank. A septic tank is considered by health officers and sanitary engineers to be the simplest safe method of disposing of sewage from a rural or urban dwelling where a public sewer is

not available. It is safest because the tank is watertight and the overflow is disposed of in the upper layers of soil where soil bacteria, air, and sunlight can carry on the purifying process begun in the tank. Contrary to general belief, however, the action in the septic tank and the disposal area cannot be depended upon to remove all disease-producing bacteria from sewage.

Frequently cesspools or dry wells are used for disposal of sewage from houses with running water. As a rule these are condemned by sanitary engineers. The operation of a cesspool depends on seepage of the liquefied sewage through the porous walls of the underground tank into the adjoining soil area. As the seepage is at a depth of several feet below ground (where there is little chance of purification by air, sunlight, or bacteria in the soil) the sewage may enter and contaminate a water supply. This is the greatest objection to a cesspool. If the liquid does not seep through the walls, the cesspool soon fills to overflowing and becomes a nuisance. Cesspools should not be tolerated.

How the Septic Tank and the Disposal Line Work

A septic tank is a watertight tank in which the solids in the sewage are held until they become liquefied by the action of anaerobic bacteria — that is, bacteria which live only where the air is entirely or mostly excluded. A scum composed of solids in the sewage forms on the liquid in the tank. This scum tends to keep air out of the liquid, and thus provides ideal working conditions for the anaerobic bacteria. As a result of the bacterial action in the tank, gas, liquid, and sludge (material not liquefied) are formed. The sludge settles to the bottom of the tank. The liquid flows from the tank through a line of tight-jointed sewer tile to the disposal area. There it is distributed in the upper soil through common agricultural drain tile laid with open joints. The agricultural drain tile forms the "disposal line."

The liquid as it comes from a septic tank may be clear but it is far from pure and must be carried into the upper layers of soil for final purification. The area that is to receive this liquid must be well drained, either naturally or artificially. If the area is not properly drained the excess of moisture keeps out the air and the aerobic bacteria (which live only in the presence of air) which accomplish final oxidation of the sewage, cannot live and work properly. If the soil is tight and not well drained, special provision must be made for distributing the sewage, as shown in Fig. 6, page 16.

The sewage must come into and leave the tank without disturbing the scum which forms on top of the water. If water laden with any considerable amount of solid matter is permitted to enter

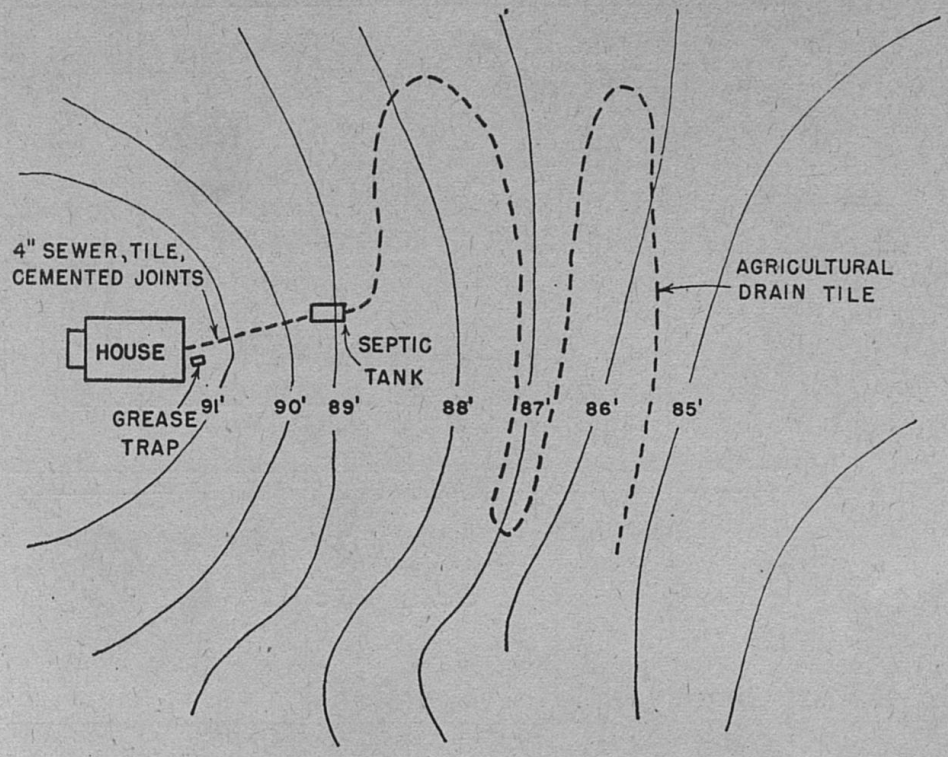


Fig 2.—A Septic Tank Sewage Diposal System

The septic tank sewage disposal system consists of (1) a line of sewer tile to carry sewage from the house to the septic tank; (2) a grease trap to remove excessive quantities of grease from the water draining from the kitchen sink; (3) the septic tank where solids in the sewage are liquefied; and (4) a disposal system which may consist of agricultural drain tile alone, or of a sewer line to carry the liquefied sewage to the disposal area and the disposal line composed of agricultural drain tile.

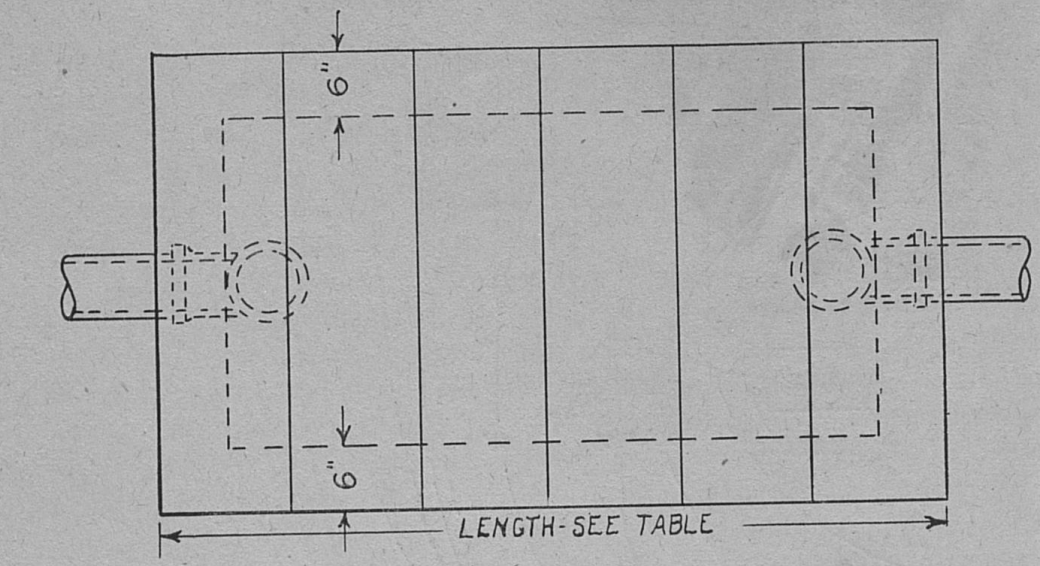
the tile line of the distribution system, the tile line will become clogged and will have to be cleaned.

Location

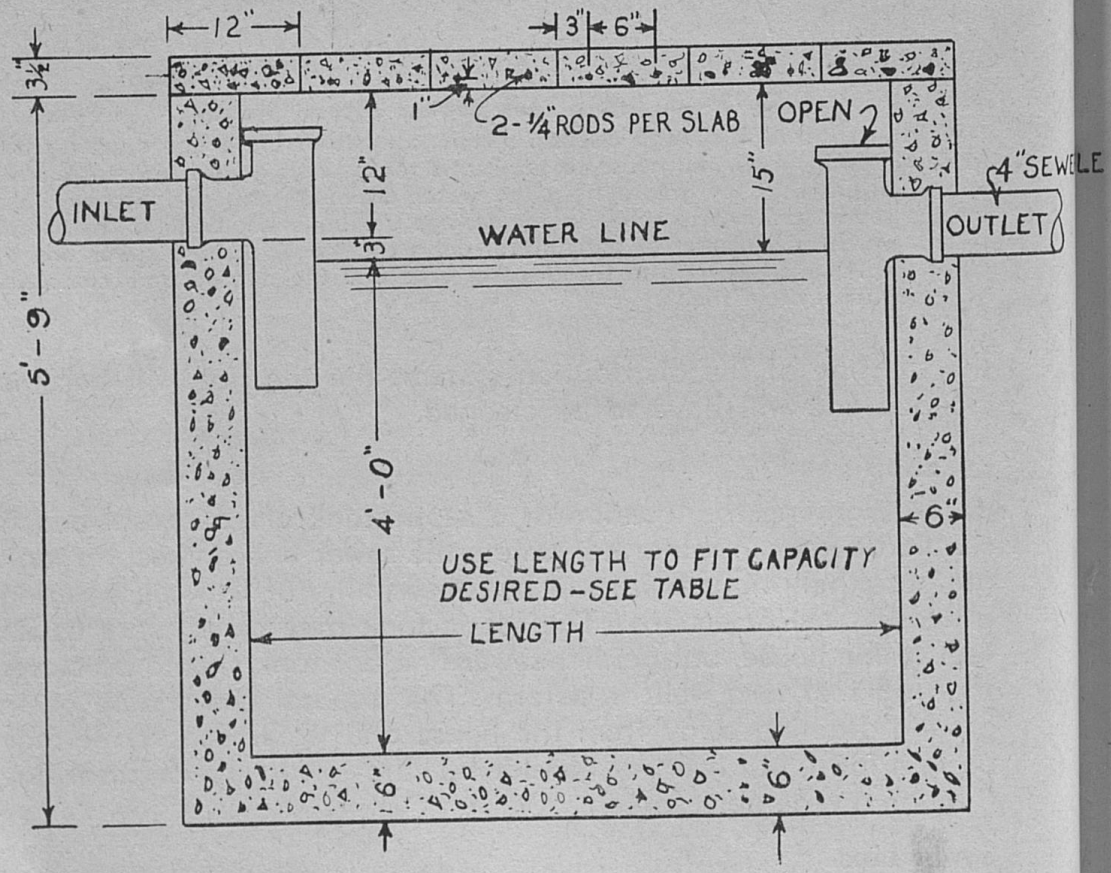
In planning the location of a septic tank and disposal bed it should be kept in mind that unless the sewer line and septic tank are absolutely tight there will be a possibility of leakage entering a nearby well or cistern. The septic tank may be as close as 25 feet to the house, but neither sewer line nor tank should be closer than 50 feet to a well or cistern. The disposal bed should be in ground draining away from the house and water supply. It may be in a lawn, but it is not considered safe to run the disposal line through a vegetable garden.

Sewer Line

The sewer line leading from the house to the septic tank should be of 4-inch or 6-inch bell-jointed sewer pipe, depending upon the amount of fall that can be given. A 4-inch sewer line should have a

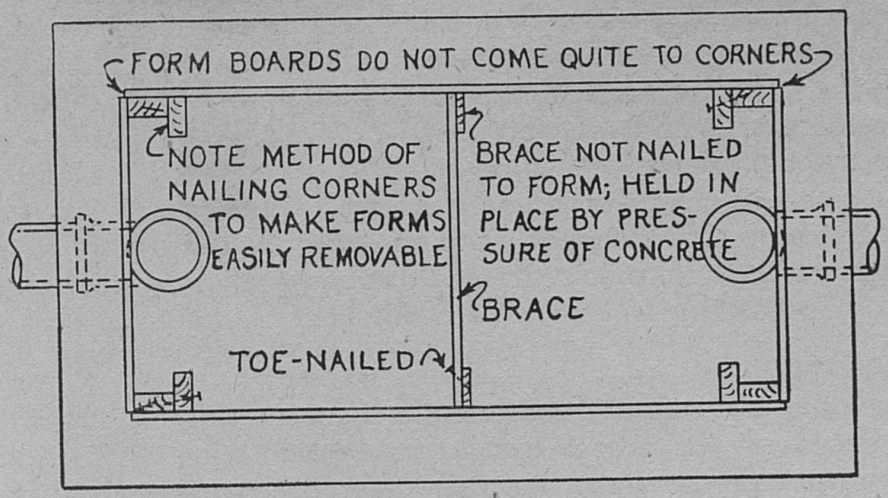


PLAN
SCALE 1"=1'-0"

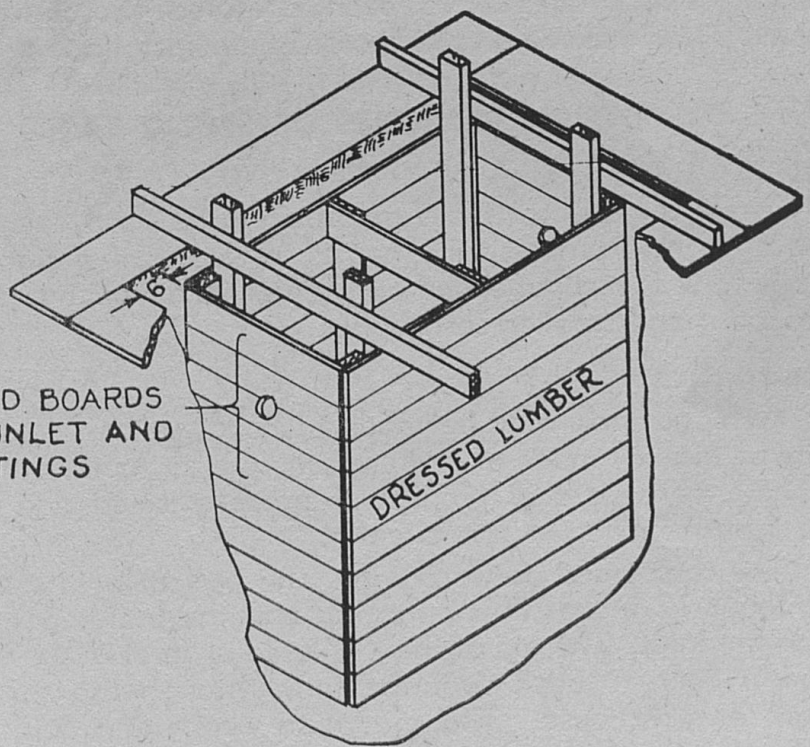


SECTION
SCALE 1"=1'-0"

Fig. 3.— Plans for a single-chamber tank to accommodate a family of not more than six persons.



PLAN OF INSIDE FORMS



TOP FIVE END BOARDS LOOSE FOR INLET AND OUTLET FITTINGS

ISOMETRIC DRAWING OF FORMS

fall of 2 feet per 100 feet of line. In a 6-inch line a fall of 1 foot per 100 feet is enough. All sewer pipe should be laid with sealed joints. Make the concrete for sealing the bell joints of sewer pipe of 1 part cement to 2 parts of clean sand. Place the small end of the tile in the bell of the preceding tile and center it in the joint by packing oakum or waste around it. Then fill the rest of the space with cement to seal the joint. The oakum or waste is used to prevent the concrete from being forced through the joint, which would form an obstruction on the inside of the line.

Grease Trap

See page 5 for description and plans for making a grease trap. The purpose of the grease trap in connection with a septic tank is to prevent grease from the dishwater entering the septic tank and disposal lines. Much grease in the sewage tends to lower the efficiency of the tank by retarding bacterial action, and may clog the disposal lines. The use of grease traps is advised, although septic tanks have been operated successfully without them. They add little to the cost of an installation.

DESIGN FEATURES OF SEPTIC TANK

Types

There are several types of septic tanks, and each may have one or more chambers. For homes in Kentucky a single-chamber septic tank is recommended because of its simplicity, ease of construction, and smaller cost.

Construction

A septic tank may be made of concrete cast in place; or it may be already made of precast concrete, or metal protected with asphalt, or of a clay product if properly sized and embodying the features given in this circular.

The tank must be watertight. The bottom of the inlet should be about 12 inches below the lid, and the outlet 3 inches lower than the inlet. The top of the "T" used as inlet in the tank should be left open to back vent the tank through the soil pipe vent stack of the house. The minimum depth of liquid below the bottom of the outlet should be not less than 3 feet 9 inches, and preferably 4 feet. The tank should have an easily removable lid for cleaning.

Size of Tank

For most effective action the sewage must be retained in the septic tank at least 48 hours. Therefore the size of the tank to build depends upon the number of persons who will use it, or the gallons of sewage entering it each day. Because it is difficult

and expensive to increase the capacity of a septic tank, it is suggested that a size be selected which provides for the number of persons likely to occupy the dwelling regularly.

The concrete tank shown in Fig. 3, pages 8 and 9, is the smallest that should be built for any home. It will take care of a family of 2 to 10 persons. Table 1 gives dimensions of a larger septic tank for larger families. The sizes are based on an average capacity of 50 gallons per person and about 48-hour retention of sewage in the tank. The capacity of a tank is the amount of liquid the tank will hold below the level of the outlet.

When a septic tank is to be built for a school, hotel, or other public institution, special plans should be obtained from a sanitary engineer, and the plans must be approved by the health officer or an official of the State Board of Health.

Excavation

If the ground is firm no outside form is needed for the tank; the sides of the pit serve instead. The sides of the pit should therefore be made smooth and plumb, to give uniform thickness to the walls of the tank. The bottom should be level and smooth.

If solid rock is struck before the desired depth is reached, it is possible in some locations to avoid blasting by letting the tank extend above the level of the ground and be covered later with earth from the excavation. This must not be done unless the sewer line from the house to the higher tank can still be installed at the proper grade and depth.

Table 1.— Inside dimensions and capacity of two single-chamber, concrete septic tanks suitable for dwellings; and materials required for the concrete.

Persons served	Length	Width	Depth	Depth of liquid	Capacity for liquid
	ft	*ft*	*ft*	*ft*	*gal*
(A) Up to 10	6	3	5	4	540
(B) Up to 14	8	3	5	4	720

Materials for the concrete (1: 2½: 4 mixture)	*Tank A*	*Tank B*
Cement, sacks	20	24
Sand, cu. ft.	40	48
Stone, cu. ft.	60	72
¼" steel rod, ft.	36	48

The width and length of the excavation should be the same as the corresponding outside dimensions of the tank. The depth should be 6 inches greater than the total overall depth of the tank, to permit a fill of 6 inches of earth over the top of the tank. The depth of the excavation may be influenced by the depth of the house sewer outside the house foundation, the amount of fall in the ground between the house and the septic tank and the minimum amount of fall required in the sewer from the house to the tank as recommended on page 7 under the heading "Sewer Line." It is always advisable, before the depth of the excavation is permanently fixed, to take level readings to get the necessary information exactly.

Inside Form

The inside form for the septic tank should be made so that it can be removed easily after the concrete has set. Plans for its construction are shown in Fig. 3. The form should be assembled above ground and lowered into place in the excavation where it is held by cross-pieces resting on the top of the ground. The bottom of the form should be 6 inches above the bottom of the excavation. The inlet and outlet T's and their connecting pipes should be set in place before the concrete is poured. In order that the inside form may be removed easily the top five boards at each end should not be nailed in place, otherwise the ends will be hard to remove because of the inlet and outlet T's. The cross braces at the top, center and bottom of the tank should be carefully placed so as to avoid spreading the form, which would cause a thicker wall than necessary. Before the form is lowered into place the surfaces next to the concrete should be well oiled. This makes removal of the form easier and prevents the concrete from sticking to the wood. The inside form may be used for several tanks if the work of assembling and taking apart is done properly.

Top Slabs

The slabs for the top should be cast in special forms and moved to the top of the septic tank after the tank form has been removed. Two ¼ inch seel reinforcing rods are required in each 12-inch slab, to prevent cracking. These rods are embedded in the concrete, 1 inch above the bottom of the slab, as shown in the section view of a septic tank in Fig. 3. A top of this kind makes it possible to uncover the entire tank when it is to be cleaned.

Mixing and Placing Concrete

If the sides of the excavation are to be the outside form, care must be taken to prevent dirt from falling into the concrete as it is being placed. A frame of 1-inch boards around the top of the excavation, as shown in the drawing of forms in Fig. 3, will keep

dirt out. These boards may be placed before the work of excavation is begun.

The walls of the septic tank must be watertight; therefore considerable care should be taken to make a watertight concrete. Both fine and coarse materials should be free from sediment. The fine sand may contain particles as large as ¼ inch in their greatest dimensions and the coarse rock should not contain pieces larger than 1 inch. The concrete should be mixed until all particles are covered with a cement-sand paste.

The following instructions for making watertight concrete for a septic tank were prepared by the Portland Cement Association. They apply to mixing concrete for the top slabs as well as for the walls and bottom.

"In order to produce watertight concrete it is necessary to regulate the amount of water that is used with each sack of cement, as it has been proved that not only the strength but also the watertightness of concrete is controlled by the proportion of water and cement in the mixture.

"For a watertight mixture it is recommended that not more than 6 gallons of water be used with each one-sack batch. This water includes the moisture which is carried in the sand, as this moisture is free to react with the cement. Usually sand is damp or wet and contains approximately ½ gallon of water in each cubic foot. The correct amount of water to add in a one-sack batch, using wet sand, is 5 gallons. This allows for one gallon of water in the sand that would be used in the mix. This gallon, plus the 5 gallons added to the mix, makes a 6-gallon paste which is recommended for watertight concrete.

"If the sand used is absolutely dry the full 6 gallons of water are added, since there is no moisture in the sand. When the sand is slightly moist but not wet enough to form into a ball when compressed in the hand, 5½ gallons of water are added for each one-sack batch. Usually, however, sand is wet, in which case the proper amount of water to add is 5 gallons for each sack batch. In case half-sack batches are used only 2½ gallons of water are added.

"As a trial mix with ordinary wet sand use one sack of portland cement, 2¼ cubic feet of sand, 3 cubic feet of pebbles, and 5 gallons of water. These are mixed together thoroughly at least two minutes in a drumtype mixer. If the resulting mixture is quite wet add slightly more sand and pebbles, say ½ cubic foot of each, and re-mix and again examine the mixture to see if it has the right degree of plasticity to work well when placed in the forms. It may be that the first trial batch is too stiff to handle readily, then slightly less quantities of sand and pebbles should be used in the

next batch. In this way, the correct proportions of sand and pebbles for the job are determined.

"In a good, workable mix there is sufficient cement and mortar to fill all spaces between the pebbles or crushed stone. Such a mixture holds together and there is little tendency for the fine and coarse material to separate. A good, workable mix will place in the forms readily with light tamping and will produce smooth surfaces when forms are removed. A good method of testing the mix to see if it contains sufficient cement is to draw a shovel or trowel across it. If the spaces between the pebbles are filled with cement the mix is satisfactory. If the spaces are not all filled, there is not sufficient cement and the concrete will be hard to work, will be of rough appearance, and will not be watertight."

The bottom of the tank should be placed first and the walls last so that no joints are left between floor and walls. The concrete should be placed and thoroughly spaded as soon as it is mixed. The purpose of spading the concrete is to work the larger particles into the concrete mass and away from the forms so the surface of the walls will be smooth. Overspading raises coarse particles to the surface and produces an uneven concrete.

In warm weather the inside form may be removed after 24 hours. If the form is left in place too long the boards may swell and be hard to remove.

THE DISPOSAL SYSTEM

The disposal system is a line of agricultural drain tile into which the overflow from the septic tank is conducted, usually through a line of sewer pipe. Sewage enters the soil through the open joints of agricultural drain tile.

Sewer Line

A watertight sewer line between the septic tank and disposal line is needed when the sewage must pass within 50 feet of a well or cistern. If no special precautions are necessary to protect a source of water, the sewer line may be omitted and the disposal line may be started directly at the tank. The sewer line leading from the septic tank usually is composed of 4-inch pipe with calked and cemented joints. As this line carries no solid matter the grade need not exceed 4 inches to 100 feet.

Disposal Line

The disposal line or absorption system should be located in a well-drained soil at least 150 feet from any well, spring, or cistern. The land should slope away from all sources of drinking water. If a well-drained area is not available and an outlet can be had, the soil should be underdrained by placing a 4-inch agricultural

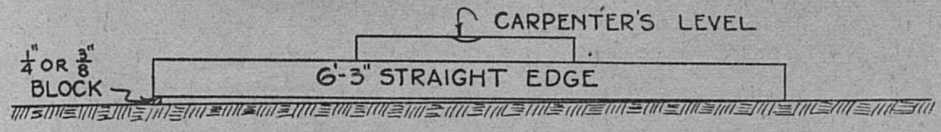


Fig. 4.— A straightedge and carpenter's level used as suggested here will help in making an even grade. A 1/4" block with a straightedge 6'3" long, gives a grade of 4" per 100 ft.

tile line parallel to the disposal line at a depth of 30 to 36 inches. (See Fig. 6, page 16.)

The disposal line should consist of 4-inch agricultural tile laid with open joints ¼ to ½ inch apart. A strip of tarred paper (6" x 12") should be placed over each joint between the tile to prevent earth from entering the joint and clogging the tile. The tile should be laid at a depth of 16 to 24 inches and to a grade of 4 inches per 100 feet. Purification of the sewage becomes slower and less effective the deeper the tile is laid, because air in the soil, required for the process, decreases as depth increases. The disposal line should consist of one continuous line rather than a main with lateral lines leading from it. It is difficult to have an even distribution of the liquid throughout a disposal bed composed of a number of short lines, because a very slight difference in levels at a junction point in a line will determine the course the liquid will follow. This is especially true when the volume is small. The continuous disposal line may be laid on any slope by changing the direction of the line, as illustrated in Fig. 2.

Where a continuous disposal line must be on a hillside, and the direction of the line has to be reversed one or more times as shown in Fig. 2, grades of the "U" curves will have to be greater than 4 inches per 100 feet.

The number of feet of disposal line needed depends upon the number of persons using the tank, or the amount of sewage entering the line daily, and how readily the soil in which the tile is laid will absorb the liquid sewage. No septic tank for a dwelling should have less than 100 feet of 4-inch agricultural tile disposal line laid in a trench 18 inches wide. Lay the tile on top of 6 inches of crushed stone or coarse gravel and cover it with crushed stone to a depth of 2 inches (Fig. 5). A trench of 18 inches wide and 100 feet long will provide an absorption area of 150 square feet, which will be enough to care for 2 persons, in a fairly tight soil, and 5 persons, in a more porous soil. For each person added, increase the length of the disposal line (Fig. 2) 20 feet in a porous soil and 40 feet in a fairly tight soil.

Care of a Septic Tank

After the form has been removed, the tank should be filled with water. It is then ready for use. An erroneous idea exists that

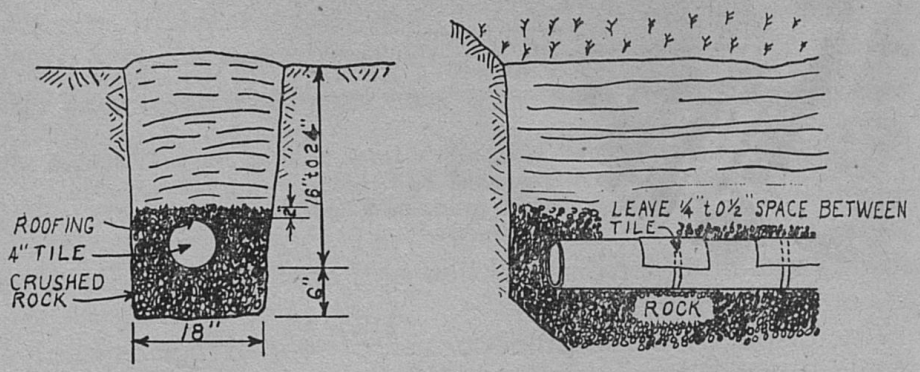


Fig. 5.— A strip of tarred paper, 6" x 12", should be used to cover each joint in the disposal line to prevent the line from becoming filled with soil.

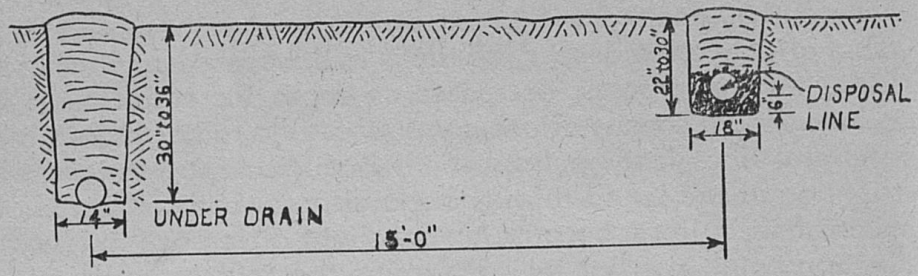


Fig. 6.— Method of laying tile in a tight soil.

a "starter" in the form of horse manure should be put into the septic tank. This is not necessary. Chemicals of all kinds should be kept out of the tank. The ordinary amounts of cleaning and washing compounds used about the house do no harm. Nothing more substantial than toilet paper should be permitted to enter the tank as resistant materials may pass through the tank and cause the sewer or disposal line to become clogged.

The tank will have to be cleaned at certain intervals, depending upon the capacity of the tank, the quantity and composition of the sewage, and the amount and kind of toilet paper used. Coffee grounds should not be dumped into the kitchen sink.

The scum, water, and sludge may be removed by a pail, long-handled shovel, or a diaphragm pump. It should be placed in a metal tank, hauled to a field or pasture, and buried or plowed under. Never deposit it in an open stream or in a field or garden where it might contaminate a source of drinking water for man or animals.

Lexington, Kentucky April, 1947
Cooperative Extension Work in Agriculture and Home Economics: College of Agriculture and Home Economics, University of Kentucky, and the United States Department of Agriculture, cooperating. Thomas P. Cooper, *Director*. Issued in furtherance of the Acts of May 8 and June 30, 1914.
10M—4-47