FARMSTEAD SEWAGE and REFUSE DISPOSAL

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Contents

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FARMSTEAD SEWAGE and REFUSE DISPOSAL

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This bulletin is intended as a guide to the sanitary disposal of sewage and household-type refuse on the farm. It tells how to construct and maintain disposal facilities suited to farm conditions—where there is adequate area of suitable soil for the purpose.

Further information or advice on specific installations can usually be obtained from local sources such as county sanitarians or health department officials.

Disposal of wastes—particularly sewage—in built-up communities and suburban and resort areas, and at rural establishments serving the public involves the public health and, therefore, is usually subject to regulation by appropriate authorities. Before installing any disposal system in such an area, or in a rural nonfarm area where space for disposal may be limited to a building lot, get the advice of your local health officer.

The material in this bulletin may be accepted as a guide to safe practice for those farm locations having no specific code requirements. If there is a code in effect, its provisions will take precedence over this bulletin.

CHARACTERISTICS OF SEWAGE

In this bulletin, the term sewage means household or domestic sewage only. Such sewage consists of the water-carried wastes from the bathroom, kitchen, laundry, floor drains, or other plumbing fixtures of the ordinary household. It includes human excreta, toilet paper, other disposable papers such as cleansing tissues or diaper liners, dishwater, food scraps, wash water, and similar materials. Sewage may also include ground food wastes, discharge from an automatic washing machine, and backwash from regeneration of water-conditioning equipment. Small amounts of soap, grease, hair, cloth fibers, bleach, bluing, cleaning compounds, sweepings, and the like are also normally contained in sewage.

Materials such as paper cartons, wrappers, newspapers, sticks, stones, and discarded clothing are rubbish, not sewage, and should be kept out of the sewage disposal system. Storm drainage from roofs and areaways should also be kept out of the sewage disposal facilities.

Sewage is usually more than 99 percent water. The less than 1 percent remaining is what makes it a nuisance and a potential health hazard. It causes the sewage odor and appearance. Of greater significance, however, is that it contains the fecal excreta, which are inhabited by many kinds of bacteria—possibly including those pathogenic types that transmit waterborne diseases such as typhoid fever, dysentery, and various types of diarrhea.

All sewage should be regarded as potentially dangerous and every effort should be made to dispose of it in a manner that will allow no opportunity for contamination of water or food. The potential hazard of disease epidemics resulting from such contamination in built-up communities or places frequented by the public is the basic reason for enacting legislation to regulate the disposal of sewage.

PROTECTION OF WATER SOURCES

It is essential to guard against contamination of wells, springs, or other sources of domestic water by sewage or other wastes. Disposal facilities should be remote from water sources and should not discharge directly into the ground water or into creviced rock. Under most conditions the best place for final disposal is in the upper few feet of the soil. Absorption fields commonly used for the effluent, or outflow, from septic tank systems take advantage of this soil layer.

Discharging sewage into abandoned wells, pits extending to the water table, sinkholes, and crevices in rock formations permits direct contamination of the ground water and creates the hazard of subsequent contamination of water sources. This is an unsafe practice and should not be followed.

Ground water is continually moving and may carry pollution for considerable distances, depending on the local geology. The direction of the movement is the same as that of the slope of the water table, and usually follows the general surface slope but not necessarily all the surface irregularities. In tight, heavy soils such as clay, water movement is restricted and pollution is confined to relatively short distances from its origin. In more open soils, such as sand or gravel formations, pollution may extend up to several hundred feet. In limestone regions, underground channels or crevices in the rock may carry contamination for miles.

It is not practical to cite any specific distance that should separate all waste disposal facilities from all sources of water supply. Local conditions should be considered in each case. However, certain "minimum safe" distances in fairly general use for septic tank systems are given on page 3.

Discharging raw sewage or other wastes into surface streams is poor practice and generally is prohibited. Flowing streams do not necessarily purify themselves, as some people believe. As it flows, a stream tends to become less polluted because of the action of sunlight, aeration, and other factors. But added pollution downstream is likely to nullify the action so that quality is more likely to be downgraded than upgraded as the stream flows along. The fact that a stream receiving septic tank effluent may appear clear and sparkling is no assurance that it is safe to drink. Invisible bacterial contamination is usually present.

THE SEPTIC TANK SYSTEM

The septic tank system, properly installed and maintained, is generally the most satisfactory method for disposing of sewage on the farm where the following conditions prevail: (1) connection to a municipal or community sewerage system is not possible; (2) adequate land for absorption of the effluent is available; and (3) the system is adequately separated from adjoining properties or sources of water supply. Adverse soil conditions can sometimes be overcome if sufficient space and fall are available. Where ground water or rock is close to the surface, or where there is not sufficient fall for gravity flow through the system, or where the available absorption area is too small, it is advisable to seek special advice from competent local sanitary authorities. Local health department sanitarians are usually familiar with these problems.

A septic tank system does not purify the sewage, eliminate odor, or destroy all solid matter. Rather, the tank conditions the sewage by partial settling and bacterial decomposition so that the effluent may be better absorbed into the soil. Untreated sewage quickly clogs the pore spaces in most soils.

The essential parts (fig. 1) of a complete system are: The house sewer; the septic tank; the effluent sewer; and the disposal or absorption area. In some special cases a grease trap may be added, but this is neither necessary nor advisable in a normal household system.

It is good practice to prepare a sketch showing the locations, including depths, of all parts of the system and keep it at a handy place in the house for reference at times of inspection or repair.

Functions and Operation

A properly designed septic tank system should handle all the sewage from a normal household. Sewage from water closets, lavatories, and showers in farm service buildings may also be handled through the household system if it is designed to accommodate it.

The house sewer is a tight-jointed pipeline for conveying the raw sewage from the house (or other fixtures) to the septic tank. Flow may be by gravity or by pumping.

The septic tank conditions the sewage by detaining and partially decomposing the solids and passing on a relatively clear liquid effluent to the absorption area. Each incoming charge of raw sewage displaces an equal volume of conditioned

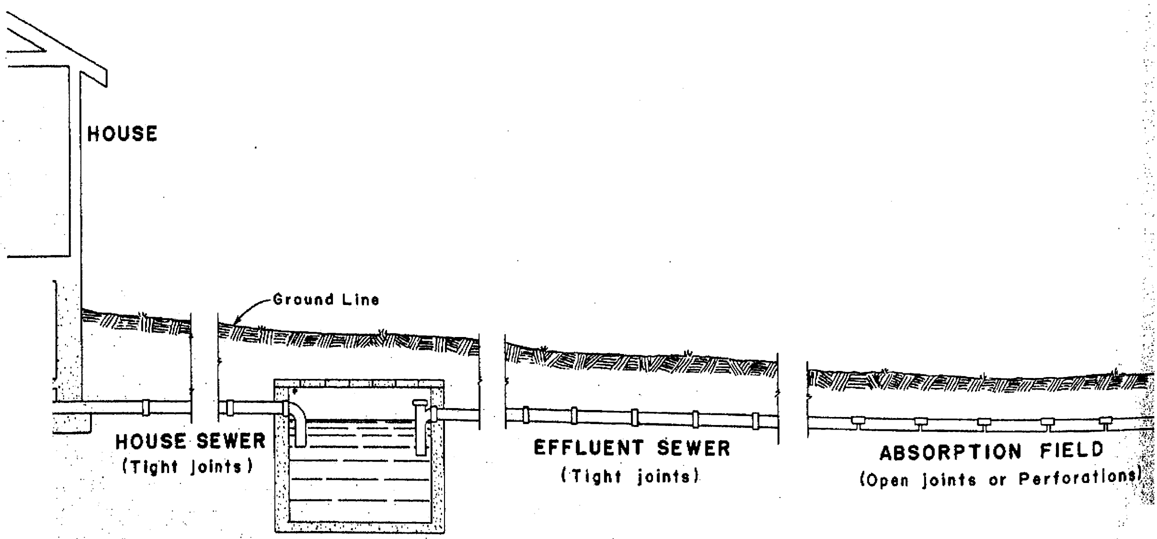

FIGURE 1.—A septic tank system.

effluent, which is discharged through the effluent sewer.

Slow flow through the tank allows the heavier solids to settle. They, along with the suspended solids, are subjected to bacterial decomposition and are partly liquefied and gasified. The liquefied portion passes out with the effluent; the gas escapes through the house plumbing stack or through the effluent system. The residue from the decomposition forms a "sludge" in the bottom of the tank. The bacteria active in the decomposition are the anaerobic (thriving in the absence of oxygen) variety. Their action is essentially putrefactive, or "septic"; hence the name of the tank.

The lighter fats and greases rise to the surface of the liquid in the tank and form a partially submerged, floating mat referred to as "scum."

Both sludge and scum accumulate continuously and must be physically removed before they reach a point that would allow them to "wash" out with the effluent and clog the absorption area.

The effluent sewer is a tight-jointed pipeline, similar to the house sewer. It conveys the effluent from the septic tank to the absorption area. Flow is usually by gravity but may be by pumping under certain circumstances.

In the absorption or disposal field the effluent is discharged into the soil at a shallow depth where it is absorbed and acted upon by aerobic (requiring presence of oxygen) bacteria. These bacteria abound in the soil to a depth of about 3 feet and cause an oxidizing or purifying action on the effluent while it remains in the top layers of soil. Effluent discharged deeper than this does not receive the benefit of this purifying action and is more likely to contaminate nearby sources of water supply.

The distribution box, if used with the absorption field, is intended to distribute the effluent uniformly through the disposal lines of the field. However, experience has shown that the desired uniform distribution is seldom achieved. A study made for the Federal Housing Administration by the U.S. Public Health Service indicated that other methods of distribution, described on pages 14–16, give results as good as or better than the distribution box or similar devices.

Selecting the Site

Selecting a suitable site for the absorption area is of first importance. A potentially dangerous liquid is being discharged into the ground and the location should be carefully selected to minimize the possibility of contaminating water supplies or creating a nuisance. The local soil and ground water conditions are the major considerations. Since these vary from place to place, it is not practical to specify any one distance as a safe separation between the absorption area and a water source. However, it has become generally accepted that an absorption area should be (1) at a lower elevation and at least 100 feet from any water source, (2) at least 50 feet from any stream or watercourse, and (3) at least 10 feet from a dwelling or property line.

The soil in the absorption area should have a percolation rate within the range indicated in table 3 (p. 13). Both the highest seasonal level of the ground water and the top of any rock formation or impervious stratum should be at least 4 feet below the level of the trench bottom. If these conditions do not exist, use one of the methods described for tight or wet soils or seek special advice from a competent local source.

A grassy, unshaded site sloping gently away from the house and water source is desirable. An absorption field should not be located under a roadway, in poorly drained soils, in tight clay soils, or in an area having shallow rock substrata sloping toward a nearby water source. It is advisable to allow space to enlarge the field later if needed.

The septic tank should be at least 50 feet from any water source and at a lower elevation. It should also be at least 5 feet from the house or any other building. A greater distance would decrease the likelihood of odors reaching the building should leakage occur. Consideration should be given to accessibility for inspection and cleaning or other maintenance, and to the grade of the house sewer. Avoid locations under driveways, pavements, flower beds, or areas that are swampy or subject to flooding.

The House Sewer

A house sewer should be of sound and durable material, provide a smooth interior, have watertight and root-proof joints, and be laid to a proper grade and alinement. Care in construction is highly important, because damaged materials or poor workmanship can lead to leakage or stoppage.

Pipe Material and Size

Materials used for house sewers include cast iron soil pipe (service or extra heavy weight), vitrified clay, concrete, bituminized-fiber, asbestos cement, and plastic sewer pipe. As an extra precaution against leakage, some codes require that cast iron, with leaded or comparable joints, be used for that portion of a sewerline (1) within 50 feet of a well or suction line from a well; (2) within 10 feet of a drinking water supply line under pressure; (3) within 5 feet of a building foundation; or (4) beneath a driveway or parking area having less than 3 feet of earth cover.

Generally, 4-inch pipe is recommended for a house sewer, although 3-inch lines have been used successfully with a number of one-bathroom houses. Foreign materials that occasionally may be in the sewage may clog smaller sizes. Sewer pipe sections range from 2 feet long to about 13 feet. The heavier, more rigid materials generally come in the shorter lengths; the lighter, more flexible materials in the longer. Your dealer can advise you of the lengths available. The longer lengths require fewer joints and consequently reduce both the labor required in jointing and the possibility of leakage or root penetration through poorly made joints.

Alinement and Grade

It is advisable to run the house sewer in as straight a line as possible. Limit changes of direction to 45° (one-eighth bend fitting). Where sharper changes cannot be avoided, use 2 one-eighth bends or a long-sweep quarter bend.

The minimum recommended grade for the house sewer is ⅛ inch per foot (1 percent). Avoid grades less than this because the slow flow would tend to allow sewage solids to settle in the line and lead to eventual clogging and stoppage.

Access Facilities

It is wise to provide a way to inspect and clean the sewer. A wye or sanitary tee fitting in the line, with an extension to the surface, makes a satisfactory cleanout. Such a cleanout, with ferrule or cap, is recommended (1) at or near the junction of the sewer with the house drain (a handy place is just inside the basement wall or in the crawl space just before the line enters the ground); (2) at each change of direction greater than 45°; (3) at intervals of not more than 50 feet on long lines; and (4) within 5 feet of the septic tank if the sewer is longer than 20 feet. If a cleanout is wanted where the line is deeper than 4 or 5 feet, a manhole would serve better.

Establishing the Gradeline

The trench for the sewer is usually dug after the septic tank excavation has been completed and the elevation of the inlet established. A simple method of establishing the gradeline to guide the excavation is illustrated in figure 2.

Digging the Trench

It is customary to begin digging the sewer trench at the low end so as to provide an outlet for rain or seepage water. Allow enough space for a man to work on the pipe joints. Gage the depth occasionally and dig only as deep as necessary so that the pipe will rest on firm, undisturbed soil. Round the trench bottom to the shape of the pipe

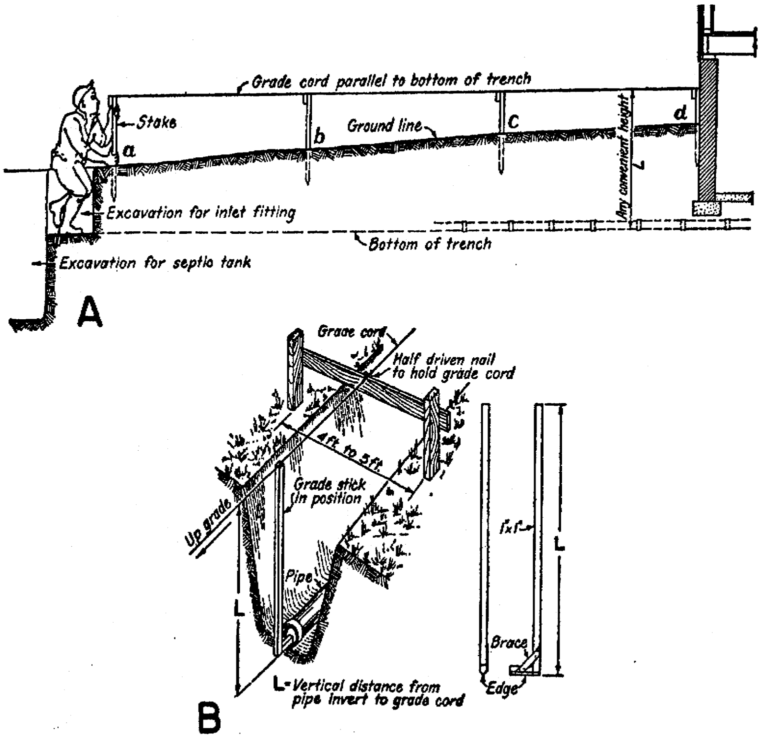

Figure 2.—Establishing grade for sewer. *A*, 2- by 4-inch stakes are set each side of the trench at convenient distances *a*, *b*, *c*, and *d*. Then a board is nailed horizontally on the stakes at *d* at a convenient height above the bottom of the trench, that is, the bottom of the sewer leaving the house. A board is nailed likewise to the stakes at *a* the same height above the inlet to the tank that *d* is above the bottom of the trench. Similarly, boards are set at *b* and *c* by sighting from *a* to *d* so the tops of the intermediate boards will be in line. *B*, The exact grade of the sewer is obtained by measuring from the grade cord with the 1- by 1-inch stick, shown in detail. The length of the stick must equal the height of the board above sewer at *d*.

and hollow out space for the joints so that each pipe section will rest firmly, without strain, over its full length. If the trench is overdug and bedding is provided for the pipe, be sure the bedding is firm and even along the full length of the bedded sections. Sand is a good bedding material.

If the soil is such that the trench walls will not stand without sloughing, use sheeting and bracing to prevent cave-in. This is particularly important in a deep trench.

Laying the Pipe

Begin laying the sewer at the low (tank) end of the trench. Lay the bell ends of bell-and-spigot pipe uphill. Use the measuring stick (fig. 2, *B*) on each length of pipe and be sure of an accurate setting to both line and grade. Also be sure that each section of pipe is firmly supported throughout its full length. Avoid supporting the ends of individual pipe sections on brick, stone, or similar objects as this may allow sagging or breakage.

Several methods of jointing bell-and-spigot sewer pipe are shown in figure 3. Sound materials and careful workmanship are essential for tight, long-lasting joints. The spigot or plain end must be centered in the bell or hub end and the jointing material must be placed uniformly around the joint. Joints should be clean and joint compounds allowed to set before backfilling.

Leaded joints are standard for cast iron soil pipe, and when properly made are permanently strong, slightly flexible, watertight, and root-proof. They are made by packing the joint space with jute, oakum, or hemp (or old hemp rope) to within 1 inch of the top of the bell and then filling the remaining space with lead wool or molten lead. The lead wool joint is made "cold" and is therefore

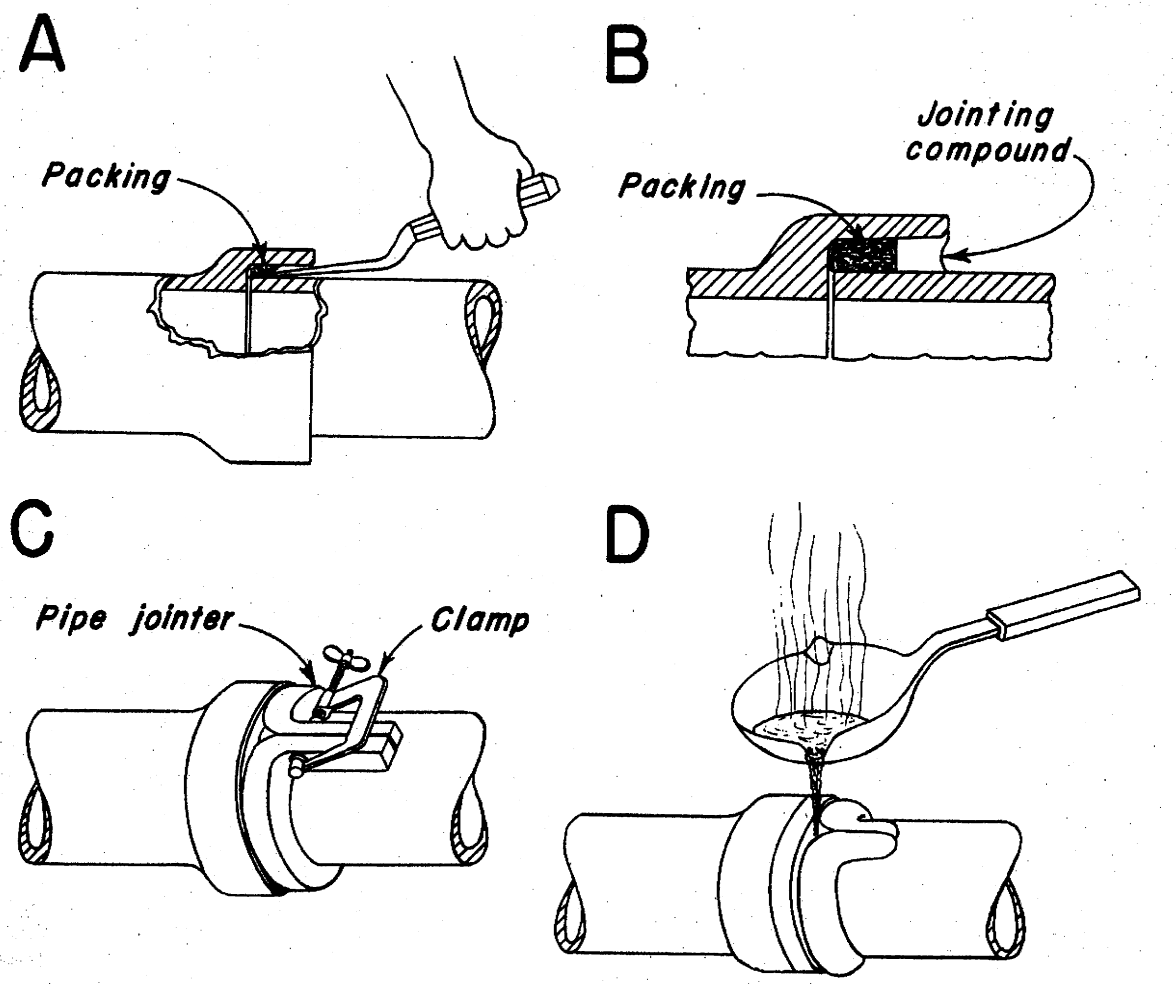

FIGURE 3.—Methods of jointing bell-and-spigot sewer pipe. *A*, Using calking iron to force packing into joint. *B*, A completed joint. *C*, Use of asbestos runner clamped around pipe, for pouring hot joint. *D*, Clay roll used in place of asbestos runner.

somewhat simpler to make than the molten lead joint.

Wrap the packing material uniformly around the spigot end and drive it all the way into the joint with a yarning iron (fig. 3, *A*) so as to center and aline the spigot in the bell and keep the joint filler from getting inside the pipe. After placing three rounds of the material in the joint, pack them tightly with a packing iron. Repeat this procedure until the packing is within an inch of the top.

A lead wool joint is made by calking lead wool over the packing material. Tap it lightly with a hammer and calking iron or calking chisel. Calking should be uniform around the joint and should stop when the lead is tight. Continued calking or heavy pounding may crack the pipe bell. About 1 pound of lead per inch of pipe diameter is required for a joint.

For a hot-poured joint, heat soft pig or calking lead in a plumber's melting pot. Use a thin hardwood paddle to skim off the impurities that float on the surface of the lead when melted. The lead is hot enough to pour when it begins to char the paddle. Use a ladle with sufficient capacity to fill the joint in one continuous pour to avoid "seams" between successive pourings. When the lead has cooled and hardened, calk it all around, as for a cold joint. Good, uniform calking is essential since the lead shrinks away from the pipe during cooling.

For pipe in a horizontal position it is necessary to use a joint runner (fig. 3, *C*, *D*) to hold the molten lead in the joint until it cools. The runner must be clamped snug against the bell to prevent escape of the lead, allowing a small funnel-shaped opening at the top for filling. The runner is removed when the lead cools and hardens and the joint is ready for calking.

There are also lead-based, prepared joint compounds available commercially. If these are used, the manufacturer's directions should be carefully followed.

The clay sewer pipe industry has recently developed a compression-type joint of resilient materials that has several advantages over other types of joints used with this pipe. The resilient materials are applied at the factory to the outside of the spigot and inside of the bell in a way that makes the joint self-centering. The joint can be made easily in the field without special tools, has some flexibility, and resists leakage and root entry when properly made. The spigot is simply inserted into the bell (fig. 4) and pressed home. A pry-bar, working against a wood block placed across the pipe opening, may be used to close the joint. The closure may be eased by using a lubricant, furnished by the manufacturer.

A variation of this type of joint has a groove in the resilient material on the spigot end, in which an elastic gasket is placed under slight tension. The joint is sealed by the gasket compressing in the groove as the spigot is pushed into the bell.

FIGURE 4.—Laying vitrified clay sewer pipe with compression-type joints of resilient materials. (Photo courtesy National Clay Pipe Manufacturers, Inc.)

Hot-poured and cold mastic bituminous, hot-poured sulfur-sand (sulfur-silica), portland cement mortar, and commercially prepared joint compounds are also used for clay sewer pipe joints. The bituminous and sulfur-sand joints when well made are practically root proof. The bituminous joints are slightly elastic and make a slightly flexible seal. The sulfur-sand and portland cement joints are rigid and inelastic, which makes them more susceptible to cracking, leakage, and root entry, should settlement in the trench, rough handling in backfilling, or heavy loads on the surface be experienced. For these reasons they are not recommended.

Clay pipe joints, except for the compression type, are yarned in the same manner as those in cast iron soil pipe, but with a little less yarn. A joint runner (fig. 3, *C*, *D*) is used for horizontal hot-poured joints, but the joint filler is not calked after pouring.

Several kinds of bituminous jointing materials are available commercially through clay pipe dealers. Use them as the manufacturer directs. For example, factory specified heating and pouring temperatures need to be observed with the hot-poured materials. The cold mastic materials are placed with a trowel and allowed to air-set. A joint in 4-inch pipe requires about ⅜ to ½ pound of compound. A finished joint appears as in figure 3, *B*.

Sulfur-sand jointing compound is made by mixing together equal volumes of ordinary powdered sulfur and a very fine clean sand, preferably the finest quicksand, and then heating the mixture until the sulfur melts. A 4-inch joint takes about ¾ pound of the mixture. Commercial sulfur-joint compounds are also available. Follow the manufacturer's directions.

Joints in concrete sewer pipe are made by filling the joint space thoroughly with a mortar composed of 1 part (by volume) portland cement, 2 parts mortar sand, and enough water to make a plastic mix. Place mortar around the inside of the pipe bell and push the spigot into place. Be sure the mortar is distributed evenly around the joint and is built up to a small bevel on the outside. When properly made, such joints will normally keep out roots. However, they are rigid and inelastic, which makes them susceptible to leakage and root entry if settlement or other strain occurs. Sometimes a mortar band about 1 inch thick and 3 inches wide (fig. 5), is made around the joint to gain additional protection against root penetration.

It is usually easier to make good joints in bell-and-spigot pipe when the pipe is in a vertical position, as this eliminates the need for a joint runner and gives easier access to all parts of the joint. Therefore, two lengths of pipe are frequently joined first and then laid in the trench as a unit. This procedure requires careful handling so as not to damage the joint. It is not recommended when sulfur-sand or cement mortar fillers are used.

Joint interiors should be swabbed to remove any joint material that may have been forced through to the inside and that may cause clogging.

Bituminized-fiber pipe joints are made by driving tapered couplings or fittings, of the same material, onto the tapered ends of the pipe sections (fig. 6). No special tools, calking, or joint fillers are needed, and a tight, root-proof joint results if

FIGURE 5.—Mortar joint in concrete sewer pipe showing mortar band used for additional protection against root entry. (Photo courtesy Portland Cement Association.)

FIGURE 6.—Bituminized-fiber pipe. (Courtesy Bituminous Pipe Institute.)

the workmanship is good. Special adapters are available for joining bituminous pipe to pipe of other materials. In joining bituminous pipe to cast iron soil pipe, the fiber adapter is yarned and cold leaded as for a normal cast iron joint. Installation instructions may be obtained from the manufacturer.

Joints in asbestos-cement sewer pipe are made with sleeve couplings of the same material, sealed with rubber rings, and when assembled properly are tight and root-proof. The couplings are fabricated with grooves into which the rubber rings are positioned at the factory. The ends of the pipe sections compress the rubber rings between the pipe wall and the inside of the coupling to form a tight seal when assembled. Adapters are available for joining asbestos-cement pipe to other pipe materials. Installation instructions are furnished by the manufacturer.

Plastic sewer pipe is relatively new on the market. It is easily cut to length with a hand saw and joined with sleeve-type plastic couplings. A special solvent cement, applied with a paint brush, seals the joint. When properly assembled, the joints are tight and root-proof. Special adapters are available for joining plastic pipe to pipe of other materials. Manufacturers furnish instructions for making the joints.

The entire sewerline should be tested for leaks as soon as the joints have set and before backfilling the trench. A good test is to plug the lower end of the line and fill the entire line with water. Allow the water to rise in the plumbing stack to a depth of about 10 feet to provide test pressure.

It is advisable to begin backfilling as soon as the testing is completed to avoid accidental damage to the exposed pipe. Clean earth, free of large stones, rubbish, or other debris, should be carefully packed beside the pipe and around the joints to give them adequate support and then lightly tamped in layers to a depth of about a foot or foot and a half. Be careful to avoid shifting or damaging the pipe. Complete the backfill by adding clean earth and compacting as needed. It is advisable to mound the backfill slightly to allow for settling. Keep heavy loads off it for a few days.

The Septic Tank[1]

Design

The design of the septic tank should promote and facilitate the separation and digestion of the sewage solids and provide for periodic inspection and occasional physical removal of accumulated sludge and scum.

Capacity is one of the most important design factors. A liberal capacity is economical, and also functionally important. The cost of extra maintenance or overcoming future difficulties that result from too small a tank is relatively greater than the additional initial cost of a large tank. Liquid capacity should be sufficient to hold at least 24 hours, preferably 36 hours, of sewage flow from the facilities served. Capacity should be based on the largest regular occupancy to be expected, rather than on actual occupancy at time of installation. It should never be less than 500 gallons. Use of a food waste disposer adds materially to the organic load on the tank and should be allowed for in the design by providing about 50 percent extra capacity.

Table 1 lists recommended liquid capacities for septic tanks suitable for handling all the sewage from a normal farm household. The table is arranged so that either number of persons or number of bedrooms served may be used as the basis for determining capacity. Where this arrangement leads to a choice of two capacities, it is wise to choose the larger.

TABLE 1.—*Recommended liquid capacities for household septic tanks (provides for food waste disposer, automatic washer, and other household appliances)*[1]

Maximum number served		Recommended minimum liquid capacity
Persons	*Bedrooms*	*Gallons*
4 or less	2 or less	750
6	3	900
8	4	1,050
10[2]	5[3]	1,250

[1] If there is no likelihood of a food waste disposer, automatic washer, or other household appliance being added, these capacities may be reduced by about one-fourth to one-third.
[2] For each additional person add 125 gallons.
[3] For each additional bedroom add 250 gallons.

Tanks may be of either single- or multi-compartment design. The single-compartment tank is satisfactory for a wide range of conditions and is simpler and less expensive to build and maintain. A two-compartment tank, with the first compartment equal to one-half to two-thirds of the total volume, provides an opportunity for removing more solids, which may be valuable under tight soil conditions. The compartments may be sections of one continuous shell separated by partitions, or separate units connected in series. Each compartment should be vented and provided with inlet and outlet fittings and access facilities for inspection and cleaning.

Whether a tank is rectangular, round, or oval has little effect on its performance, provided it has the necessary capacity and other features. Rectangular tanks are usually built with the length two to three times the width. It is recommended

[1] For a comprehensive discussion of septic tanks, see U.S. Public Health Service Publication No. 526, "Manual of Septic-Tank Practice," for sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 40¢.

however, that the smallest horizontal dimension be at least 2 feet and that the liquid depth be between 30 and 60 inches. These dimensions should be observed in single-compartment tanks and in each compartment of two-compartment tanks. About 12 inches (or about one-fourth the liquid depth) is required above the flow line to allow space for scum accumulation and free passage of gases for venting.

Tank performance is affected by the type and arrangement of the inlet and outlet fittings. The inlet invert (flow line) should be at least 1 inch—preferably 3 inches—higher than the outlet invert to prevent backwater and stranding of solids in the house sewer. Use either tees or straight pipe and baffles, arranged as shown in figure 7. Provide a vertical clearance of at least an inch for venting purposes between the tops of the fittings and the under side of the tank roof. Submerged entry in a downward direction tends to confine entrance disturbance and helps mix the incoming sewage with the more biologically active sewage and sludge already in the tank. The inlet tee or baffle should extend to at least 6 inches below the surface of the liquid, but not deeper than the outlet device.

Depth of submergence of the outlet tee or baffle is a critical factor in the performance of the system. If too shallow, scum can pass out of the tank with the effluent. If too deep, sludge can scour out. In either case the particles of solids in the effluent can lead to early clogging of the soil in the absorption area. The ideal depth for the outlet is at a point of balance between the scum and sludge accumulations. This point has been found to be at a depth below the flow line of about 35 to 40 percent of the total liquid depth.

Siphons and dosing chambers are not necessary in ordinary farm installations. They are useful, however, in large installations where the combination of sewage volume and tight soil conditions calls for more than 500 linear feet of disposal tile in the absorption field. The siphon and chamber serve to accumulate a near-continuous, small flow of effluent and provide an intermittent discharge of a larger volume to the absorption field. This loads the field more uniformly and allows some time for rest and aeration between discharges. The frequency and volume of the discharge are controlled by the sizes of the siphon and the chamber. A 3- or 4-inch siphon is adequate. Capacity of the dosing chamber (volume of single discharge) should be about two-thirds the interior volume of the disposal tile. Installation should be in accordance with the manufacturer's instructions.

Construction

Septic tanks should be constructed of watertight, durable materials. Most farm tanks are cast-in-place concrete, but other materials such as precast concrete, concrete block, hard-burned brick, vitrified clay pipe, structural clay tile, coated steel (meeting Commercial Standard 177–51, published by the U.S. Department of Commerce), or stone are also used. In some areas, State or local regulations may specify or prohibit use of certain materials.

Recommended inside dimensions for single-compartment tanks suitable for most farms are given in table 2.

Unit masonry walls should be 8 inches thick and rest on a concrete floor or other solid foundation. The masonry units should be laid in full beds of 1:3 masonry cement mortar (ratio of 1 part cement, 3 parts sand), mixed with just enough water to give a stiff consistency. The walls should be plastered with at least ½ inch of mortar of the same mix, preferably in two ¼-inch coats. Cells of the units should be filled with concrete. It is advisable to reinforce the corners with bent steel rods placed horizontally between courses. Directions for laying-up can be obtained from dealers.

Commercially manufactured tanks should be inspected carefully for structural soundness and compliance with design recommendations before being placed in the hole. Tanks that are badly damaged or differ greatly from the previously

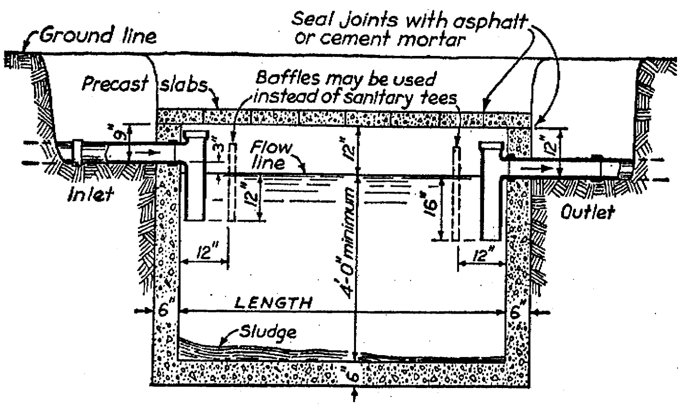

FIGURE 7.—Longitudinal section of single-compartment concrete septic tank.

TABLE 2.—*Recommended inside dimensions and concrete materials for single-compartment septic tanks*

Liquid capacity	Recommended inside dimensions				Concrete	Concrete materials, 1:2¼:3 mix		
	Width	Length	Total depth	Liquid depth		Cement	Sand	Gravel
Gallons					*Cubic yards*	*Sacks*	*Cubic yards*	*Cubic yards*
500	3′-0″	6′-0″	5′-0″	4′-0″	2¾	17	1⅜	2
600	3′-0″	7′-0″	5′-0″	4′-0″	3	18¾	1½	2¼
750	3′-6″	7′-6″	5′-0″	4′-0″	3⅜	21⅛	1¾	2½
900	3′-6″	8′-6″	5′-0″	4′-0″	3¾	23½	2	2⅞
1,050	4′-0″	7′-9″	5′-6″	4′-6″	4	24⅝	2⅛	3
1,250	4′-0″	9′-3″	5′-6″	4′-6″	4½	28⅛	2¼	3⅜

stated design recommendations should not be used. Minor defects in precast concrete tanks can often be overcome by plastering with cement mortar, as indicated for unit masonry. Any injury to the asphalt coating on a steel tank is liable to lead to rapid corrosion and early failure and should be corrected.

Adequate access for inspection and cleaning should be provided for all compartments and particularly for the inlet and outlet fittings. This access may be by manhole, removable slab in cover, or removable cover.

As soon as the tank is set in position in the hole it is wise to fill it with water as a safeguard against "floating," if the excavation should become flooded before the backfill is placed.

Building a Cast-in-Place Concrete Septic Tank [2]

Figure 8 illustrates a convenient method for locating the tank excavation. The wood frame is sized to enclose the outside dimensions of the tank (inside dimensions of the tank plus 1 foot) and carefully alined and leveled so that it will later support the inside form accurately in position. The stakes supporting the frame should be placed before excavating begins, to avoid caving the edges. In most cases the earth walls of the excavation will serve as the outside form for the tank, so it is important to make them straight and true.

[2] For information on making and placing concrete, see Farmers' Bulletin No. 1772, "Use of Concrete on the Farm."

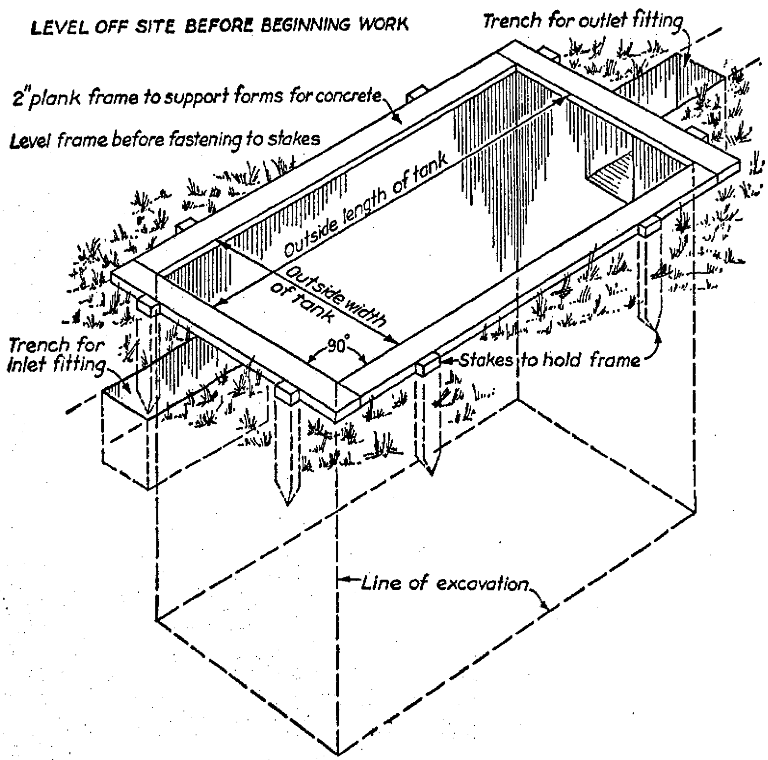

FIGURE 8.—Method of outlining a septic tank excavation on the ground surface.

If outside forms are required, provide space for them in excavating.

Figure 9, A, shows how the inside form is built and hung in place. It is important that it be true to dimension and that the supporting cross arms hold it in correct position so that walls and floor are of proper thickness and the inlet and outlet fittings are true to line and grade. The drawing illustrates a method of placing the inlet and outlet fittings by carefully setting and tying before the concrete is poured. An alternate method is to form a notch or opening in the tank wall and later set the fittings to position with mortar or grout—after the concrete has hardened. If tee fittings are used it is advisable to prejoin the first length of pipe to the tee and set the two as a unit.

Forms should be designed so they can be readily taken apart for removal. This helps prevent damage to the new concrete and allows reuse of the forms. Make the forms before excavating and pour the tank as soon as practical thereafter, to avoid warping of forms and caving of the excavation walls. Before placing forms, mop oil or soap solution on all parts that will be in contact with the concrete in order to prevent sticking.

County agricultural agents, local health agencies, building materials dealers, and others sometimes have forms that may be borrowed or rented.

The Portland Cement Association recommends a 1:2¼:3 mix (portland cement: sand: gravel or crushed stone, by volume), with 5 gallons of water per sack of cement, as a good watertight mix with sand of average moisture content. The quantities given in table 2 are estimated from this mix. All ingredients should be clean and free of foreign materials. Cement should be dry and free of lumps. The sand and gravel or crushed stone should be hard and graded with a 1-inch maximum size.

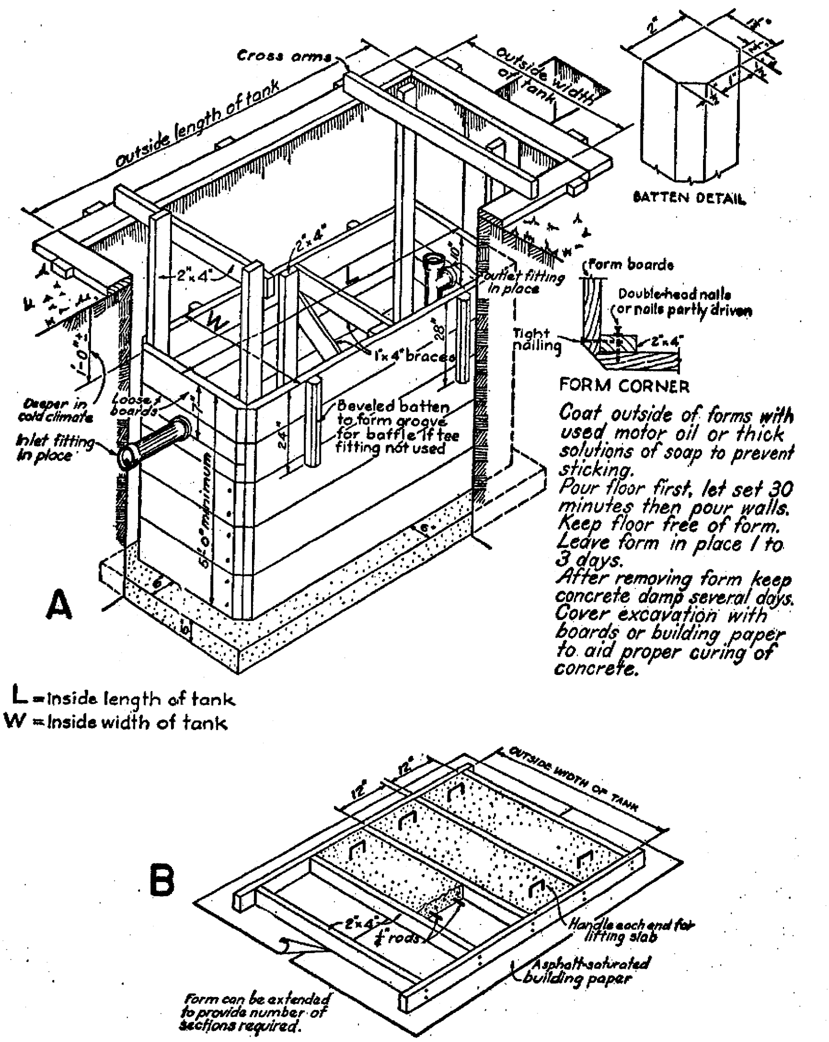

Figure 9.—Formwork for single-compartment septic tank and cover sections.

Pour the floor first, keeping it free of the formwork. Allow about 30 minutes before pouring the walls. Make the wall pour continuous and spud, or stir, the fresh concrete in the form to prevent formation of pockets.

If stony spots or honeycomb are evident when the forms are removed, patch them by working in a stiff cement mortar with a wood float. To aid in curing, keep the new concrete damp and cover the excavation with boards or building paper for about a week.

A convenient method of casting the cover sections for a tank is illustrated in figure 9, B. Note use of 2 x 4 material for forms, the reinforcing rods, and the handles. Sections 12 inches wide, 4½ feet long, and the thickness of a 2 x 4 on edge, weigh about 200 pounds.

The Effluent Sewer

The effluent sewer conveys the effluent from the tank to the absorption or disposal area and may be constructed of the same materials and in the same manner as the house sewer. Joints should be tight and root-proof. A 4-inch line laid to a slope of ⅛ or ¼ inch per foot is recommended.

Subsurface Effluent Absorption Field

Success of the septic tank system depends on its being able to dispose of the tank effluent in a sanitary manner for an extended period of time. If the effluent cannot be disposed of satisfactorily, the system will fail—perhaps with annoying and costly results. Correct design and construction of the disposal facility are highly important.

Disposal of the effluent by means of absorption in the upper layers of the soil is preferred whenever soil conditions permit.

Suitability of Soil

Soils differ in ability to absorb effluent—sometimes within a given absorption field. Not all soils are suitable.[3] Texture, color, structure, and swelling characteristics are clues that enable an experienced person to judge by sight and feel whether or not a soil is likely to be suitable. But a percolation test should be used as the basis for design of the field in all but deep, sandy soils that are obviously well drained.

Percolation Test

The percolation test is the best way for determining if a soil is suitable for absorbing septic tank effluent and, if so, how much absorption area is required. To make this test, measure the rate at which water seeps away from a test hole sunk to the depth at which the effluent is to be discharged. To recognize soil differences and allow for possible different percolation rates in different parts of the field, repeat the test at several points spaced uniformly over the proposed site. Then, use an average rate for determining the absorption area needed. Several procedures are in use for making the test. The following[4] is recommended:

1. Dig or bore a vertical-sided test hole, with horizontal dimensions of from 4 to 12 inches, to the depth of the proposed absorption trench. Roughen or scratch the bottom and sides to provide a natural surface. Remove all loose material from the hole and place about 2 inches of coarse sand or fine gravel in the bottom.
2. Fill the hole with clear water to a minimum depth of 12 inches over the gravel. Keep water in the hole, refilling as necessary, for at least 4 hours and preferably overnight. An automatic siphon can be used to maintain the water level. This procedure gives clay-type soils a chance to "swell" and approach the condition that will prevail during wet weather. Determine the percolation rate—as in items 3 and 4 below—24 hours after water is first added to the hole. In sandy soils containing little or no clay, this "swelling" procedure is not necessary and the test can be made after the water from one filling has seeped away, as in item 5 below.
3. If water remains in the test hole after the overnight swelling period, adjust the water depth to about 6 inches over the gravel. From a fixed reference point, measure the drop in the water level over a 30-minute period. Dividing the number of minutes (30) by the number of inches the water level drops, gives the percolation rate in minutes per inch.
4. If no water remains in the hole after the overnight swelling period, add clear water to a depth of about 6 inches. From a fixed reference point, measure the drop in water level at approximately 30-minute intervals for 4 hours, refilling to a depth of 6 inches as necessary. The drop during the final 30-minute period is used to determine the percolation rate.
5. In sandy soils (or other soils in which the first 6 inches of water seeps away in less than 30 minutes, after the overnight swelling period) the time interval between measurements can be taken as 10 minutes and the test run over a period of 1 hour. The drop occurring in the final 10 minutes is used to determine the percolation rate. Divide the number of minutes (10) by the number of inches the water level drops.

Absorption Area Required

The area of trench bottom or seepage bed required to absorb the effluent in a given situation depends on the absorption capacity of the particular soil, as indicated by the percolation rate, and on the volume of the effluent, as indicated by the

[3] For more information see Agr. Inform. Bul. 243, "Soils Suitable for Septic Tank Filter Fields," for sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15¢.

[4] Developed by the Taft Sanitary Engineering Center of the U.S. Public Health Service.

size of household. Food waste disposers and automatic sequence clothes washing machines add to the load on an absorption field and should be provided for in the design. Even though these appliances are not contemplated at the time the system is installed, it is wise to allow for them if there is even the remotest possibility that they may be added in the future.

Table 3 indicates the number of square feet of absorption area required per bedroom for various percolation rates. To find the total number of square feet required for a given installation, multiply the figure obtained from the table by the number of bedrooms served by the installation. Although there is also some lateral seepage from the absorption field, it is not necessary to include it as a factor in this computation.

TABLE 3.—*Absorption area requirements for household septic tank systems (provides for food waste disposer, automatic washer, and other household appliances)*[1]

Percolation rate (minutes per inch)[2]	Minimum effective absorption area required per bedroom[3]	Percolation rate (minutes per inch)[2]	Minimum effective absorption area required per bedroom[3]
	Square feet		*Square feet*
1 or less	70	10	165
2	85	15	190
3	100	30	250
4	115	45	300
5	125	60[4]	330

[1] Always provide for at least 2 bedrooms. If there is no likelihood of a food waste disposer, automatic washer, or other household appliance being added, these areas may be reduced by about one-fourth to one-third.

[2] Average time required for water level to fall 1 inch in percolation test.

[3] Square feet of standard trench bottom or seepage bed per bedroom.

[4] If more than 60 minutes, soil is unsuitable for use as subsurface absorption field. Select another site or use disposal methods for tight or wet soils.

Disposal Lines

The effluent is discharged to the soil through a system of open-jointed or perforated disposal tile or pipelines laid in absorption trenches or beds having a total bottom area as determined from table 3. Dividing this bottom area by the effective absorption area in square feet per lineal foot, from table 4, gives the total length required, in feet. Lateral seepage is neglected.

Proper design and careful workmanship are important to successful operation of the system. Arrangement of the lines varies with the absorption area required and the topography of the available terrain.

Four-inch open-jointed agricultural tile or perforated drain pipe is customarily used. Individual lines should not exceed 100 feet in length and should be laid on a flat grade, never sloping more than 6 inches per 100 feet. All lines should be about the same length.

The preferred depth for an absorption trench (allowing for a gravel bed) is from 24 to 30 inches. However, depths from 18 to 36 inches may be used if it is necessary to clear high groundwater, maintain grade, allow for an extra deep gravel bed, or to meet some other special condition. If it is necessary to go deeper than 36 inches, the deeper portions should be confined to short stretches totaling only a small percentage of the field as a whole. As stated under Selecting the Site (p. 3), the trench bottom should be at least 4 feet above the highest seasonal groundwater level, the top of any rock formation, or impervious stratum.

Trench width should be from 18 to 24 inches, although widths up to 36 inches may be used in the deeper trenches. Wider trenches call for wider spacing between trenches, as indicated in table 4.

TABLE 4.—*Absorption trench area and spacing*

Trench width (inches)	Effective absorption area	Minimum clear distance between trenches
	Square feet per lineal foot of trench	*Feet*
18	1.5	6.0
24	2.0	6.5
30	2.5	7.0
36	3.0	7.5

The tile or pipe should be laid in a bed of clean gravel, crushed or broken stone, or similar material. The gravel bed should extend from at least 6 inches below the bottom of the line to at least 2 inches above the top. The bed material may range in size from ½ to 2½ inches. Cinders, broken shells, slag, and similar materials are not recommended because they are usually too fine and may cause clogging. About ⅛- to ¼-inch joint space should be allowed between sections if agricultural tile is used. The upper half of this joint space should be covered with tar paper or similar material to keep out fine material from above. A cover of untreated building paper, straw, hay, pine needles, or similar pervious material should be placed over the bed material to keep out particles of the earth backfill. Impervious material should not be used for this covering as it would interfere with the action of the trench.

If it is necessary to locate a disposal line within reach of the roots of trees or shrubs, deepen the gravel bed in the affected area by about 12 to 18 inches, keeping the line itself level. This provides extra space between the moist trench bottom and the line and may keep the roots from entering the line.

Exercise care during construction to preserve the natural absorptive quality of the soil. Protect the trench from silt and debris while open. Avoid unnecessary walking in the trench. Place gravel or stone carefully and tamp backfill lightly with a hand tamper. Do not machine-tamp and do not use a hydraulic backfill. Overfill the trench about 4 to 6 inches to allow for settling.

Closed or Continuous System

In flat locations, where the slope of the ground surface does not exceed 6 inches in any direction within the area of the absorption field, the disposal lines may be arranged in a closed or continuous system as shown in figure 10. In this system, open-jointed tile or perforated pipe is used throughout the field. It is laid on a flat grade and the entire trench length is counted in the effective absorption area. Because of the flat grade and interconnecting lines, the effluent will distribute satisfactorily without a distribution box.

Serial Distribution System

Serial distribution of effluent is recommended for practically all situations where soil conditions permit subsurface absorption and where the slope of the ground surface exceeds 6 inches in any direction within the confines of the absorption field. Excessively steep slopes that are subject to erosion should be avoided. In the serial distribution system, the individual trenches of the absorption field are arranged so that each trench is forced

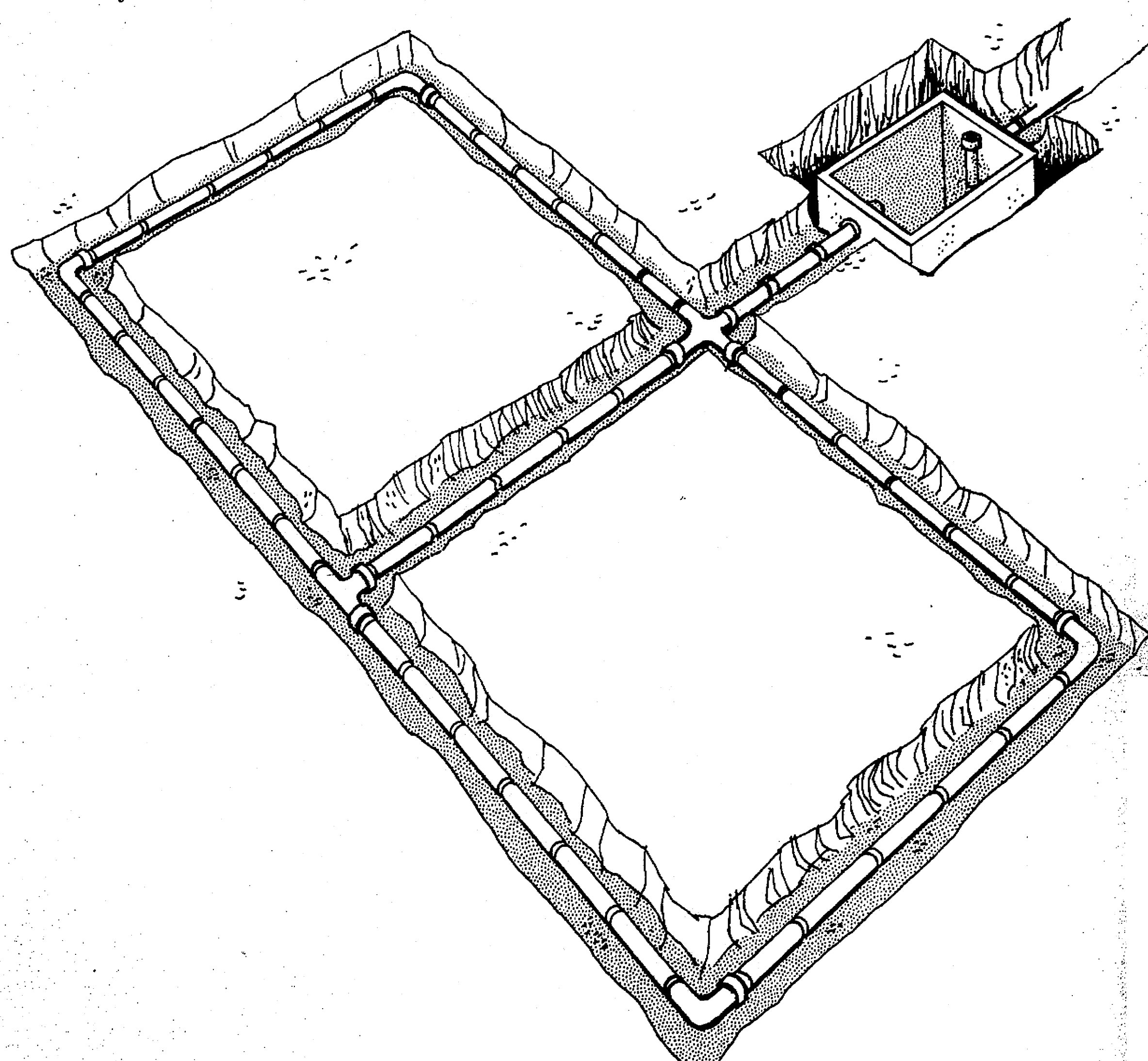

FIGURE 10.—Closed or continuous tile system arrangement for level ground.

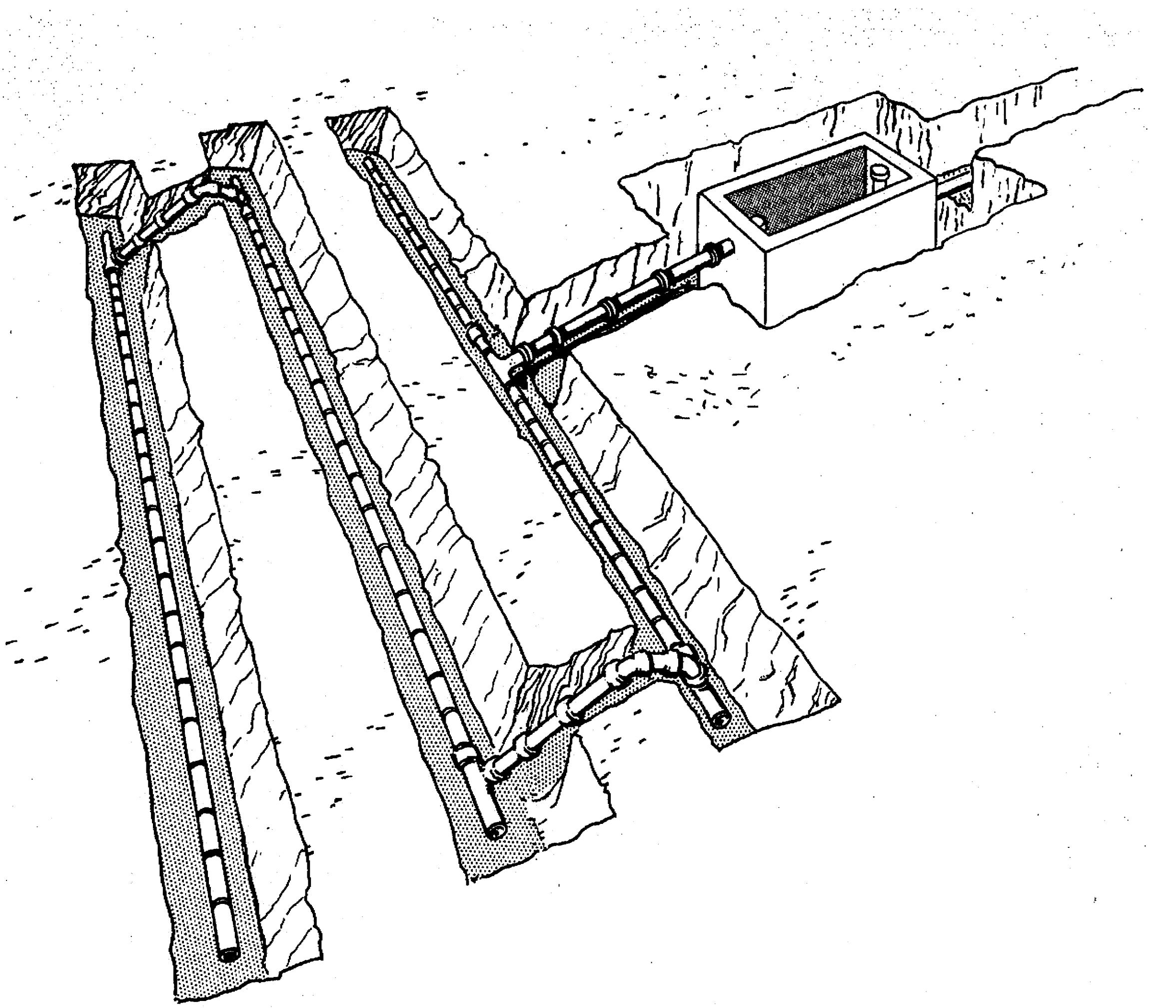

FIGURE 11.—Serial distribution system arrangement for sloping ground.

to pond to the full depth of the gravel fill before the effluent flows into the succeeding trench. (See figure 11.)

Advantages of this system are: (1) It minimizes the importance of variable absorption rates in different parts of the field by forcing each trench to absorb effluent until its ultimate capacity is utilized; (2) it causes each trench in the system to be used to full capacity before failure occurs; and (3) it eliminates the cost of a distribution box and the runs of tight-jointed pipe from the box to the absorption trenches.

The following design and construction features should be observed for satisfactory operation of this system:

1. Individual trench bottoms and disposal lines should be level, following contours to minimize variation in trench depth.
2. A minimum of 12 inches of earth should cover the gravel fill in the trenches.
3. A minimum of 6 feet of undisturbed earth should be allowed between adjacent trenches, and between the septic tank and the nearest trench. (See table 4.)
4. Overflow lines should connect the trenches in such a manner that a trench will be filled with effluent to the depth of the gravel before the effluent flows to the next lower trench. This may be done as shown in figure 11, by having the invert of the overflow line at the top of the gravel fill.
5. The overflow lines should be 4-inch diameter tight-jointed sewers, connecting directly to the distribution lines in the trenches. The trench for an overflow line, at the point where it leaves an absorption trench, should be dug no deeper than the top of the gravel fill in the absorption trench.
6. The outlet (overflow) from a given absorption trench should be as far as practical from the inlet to that trench in order to prevent short-circuiting of the effluent.
7. The invert of the first overflow line should be at least 4 inches lower than the invert of the septic tank outlet.

8. All other features should match those for subsurface absorption fields generally.

Absorption Bed

Recent studies by the U.S. Public Health Service, sponsored by the Federal Housing Administration, have demonstrated that the absorption bed is a satisfactory device for disposing of effluent into soils that are acceptable for soil absorption systems.

The absorption bed is essentially a wide absorption trench, with a total bottom area equal to the effective bottom area of a trench system. The overall gross area of the absorption field is thus reduced under that required for the trench system by that area in the "wasted" space between the trenches. This permits the absorption bed to be used where space is limited.

The absorption bed is designed and constructed as follows:

1. Use table 3 to determine the area required.
2. Excavate the bed to the same depth as for a trench system, making the bottom approximately level.
3. Place a 12-inch-deep gravel bed in the bottom of the excavation and bury the disposal tile or pipe in the gravel so that it has about 2 inches of gravel cover.
4. Space the disposal lines not more than 6 feet apart and not more than 3 feet from the sides of the bed. If agricultural tile is used, allow from ¼ to ½ inch between the sections and cover the joint spaces with collars as described for tile in a trench.
5. Cover the gravel bed with a pervious material to keep out the earth backfill as described for a trench.
6. For other features, follow directions as described for a trench system.

Distribution Box

Experience has shown that distribution boxes and similar devices seldom achieve the uniform distribution of effluent that is expected of them. Effluent distribution by the continuous or serial distribution systems gives as good results or better, and generally at less cost.

If a distribution box is used, the following essential design features should be observed:

1. All outlets must be set at exactly the same level—about 4 to 5 inches above the bottom is recommended. This gives space for carryover sludge to accumulate and be detected by inspection. It also serves in lieu of a baffle to prevent short-circuiting and thus aid in obtaining equal distribution of the effluent.
2. A separate outlet is needed for each line of tile; adjacent outlets should be separated by at least a full pipe diameter.
3. The inlet should be about 2 inches higher than the outlets.
4. A watertight, removable cover should be provided for access.

If a box is to serve an absorption field in which it is desired to "work" and "rest" certain lines alternately or in rotation, because of tight soil conditions or other reason, facilities should be provided in the box for opening and closing the corresponding outlets. Also, if there is prospect of future need for more lines from the box, additional outlets may be provided at the time of construction and fitted with plugs that can be readily removed when the need develops. More than one box may be used if the ground slope warrants.

Figure 12 illustrates a distribution box such as used on farms.

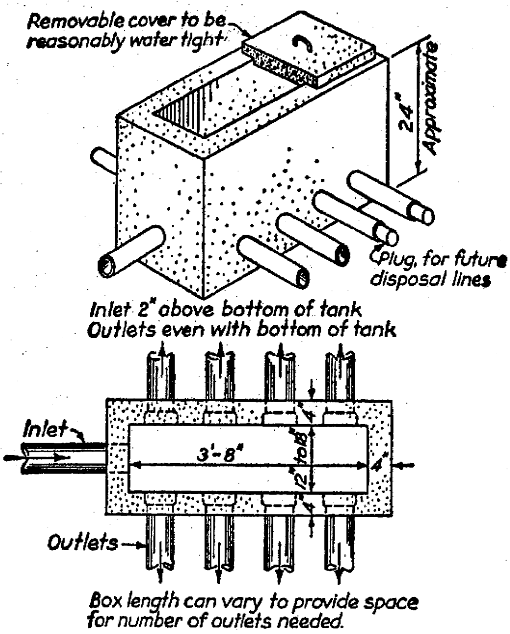

Figure 12.—Typical distribution box.

Disposal Methods in Tight or Wet Soils

Heavy clay or other soils with percolation rates over 60 minutes per inch (see table 3, p. 13) and locations with high water table are unsuited to the usual methods of subsurface effluent absorption. However, some local conditions permit successful use of special disposal methods such as an aboveground absorption bed, an absorption bed with subsurface filter, or a seepage pit.

Aboveground Absorption Bed

The North Dakota Agricultural College has developed a means of disposing of effluent in an aboveground bed. The method has proved very successful in overcoming the adverse soil and groundwater conditions that occur in some parts of North Dakota and could be applied with equal success where conditions are similar elsewhere. It is referred to as the Nodak system and consists of a conventional septic tank, from which the effluent flows by gravity to an adjoining holding chamber. From here it is pumped automatically to the aboveground bed, as shown in figure 13.

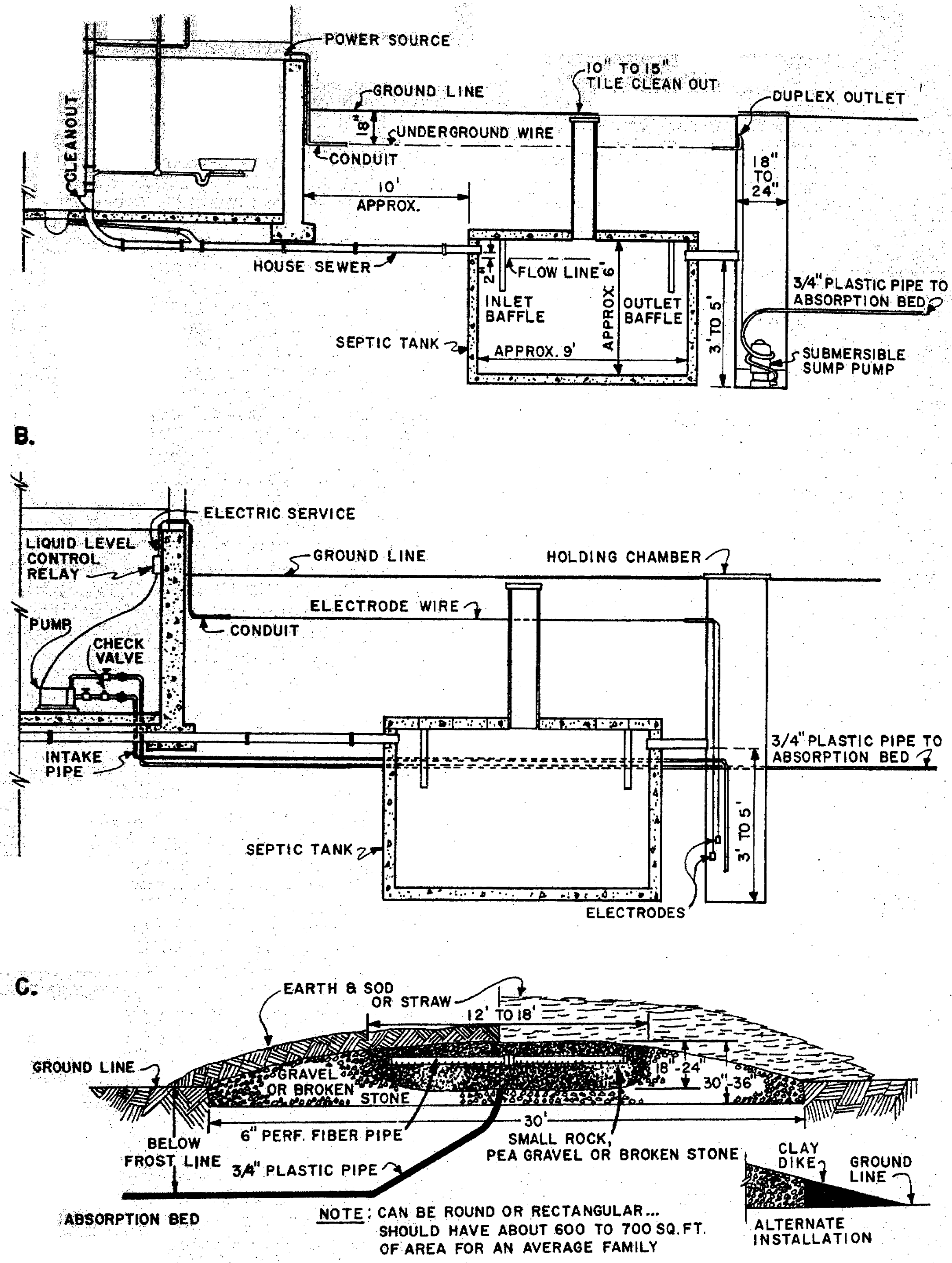

FIGURE 18.—Nodak aboveground disposal system: *A*, sump pump in holding chamber; *B*, pump in basement; *C*, absorption bed.

The aboveground bed takes advantage of the usually better absorbing properties of the surface soil, receives some drying help from the wind, and is readily accessible should clogging occur and cleaning or replacing be needed. The location can be somewhat concealed by planting shrubs around the perimeter. Roots of the shrubs will also use up some of the liquid in the bed. Some winter cover (p. 19) is needed over the bed to protect against freezing in cold climates such as that of North Dakota. No objectionable odor should be noticeable from a properly built bed.

Following are the essential features to observe in design and construction of this system:

1. Use the same septic tank as for any gravity system. However, provision of gravity flow to the disposal area need not be considered in selecting the site, since a pump is used.
2. The holding chamber should be large enough to enable a man to work inside. It should be located adjacent to the septic tank and should extend from the ground surface to the depth of the tank bottom. Concrete culvert or sewer pipe of suitable diameter, or masonry block units, with watertight joints and resting on a concrete slab floor, make a satisfactory chamber.
3. The pump may be a submersible type located in the holding chamber or it may be a self-priming centrifugal or helical rotor shallow-well type, with bearings that do not drip, remotely located in the farmhouse or other protected location. Piston- and turbine-type pumps are not recommended. One-fourth horsepower is adequate size.

   If the pump is not in the holding chamber, a 2-electrode liquid level control is used to turn the pump on and off automatically (fig. 13). The electrodes should be set so as to pump 10 to 20 gallons at one time. For a 24-inch diameter chamber this would put the upper electrode about 5 to 10 inches above the lower. The lower electrode should be at least 6 inches above the pipe intake so that the pump will not break prime. The electrodes may need cleaning every few months in this type of service.

   If there is no check valve on the pump assembly, a horizontal swing check valve should be installed on the suction line. A foot valve on the end of the suction line is not recommended because of limited accessibility. Plastic water pipe, with stainless steel clamps, is recommended for the piping and brass for the valves and fittings.

   A submersible pump in the chamber should be of bronze or cast iron. A standard open-motor type is not recommended. Neoprene-covered barn wire or underground wire should be used for the electric service to the pump. A plastic or porcelain barn-type duplex convenience outlet should be used in the holding chamber.

   The submersible pump may be controlled by an automatic switch on the pump or by the 2-electrode liquid level control described above. If the latter control is used, it should be installed in the farmhouse or some other dry location, as shown in figure 13. The electric circuit must be run from the liquid level control relay to the pump.
4. One-inch diameter flexible plastic pipe is recommended for use between the holding chamber and disposal bed. Laying below frost depth is also recommended. Allowing extra length of flexible piping in the holding chamber permits the submersible pump to be lifted from the chamber without disconnecting the piping from the pump.
5. The absorption bed (fig. 13) is built of gravel or the other coarse fill materials previously mentioned for absorption trenches and subsurface absorption beds. About 600 to 700 square feet of area is recommended for single family use. A center core of crushed rock, pea gravel, or small field stones, up to 3 inches in diameter, should extend about 24 inches in all directions below the distribution pipe to allow the effluent to get away rapidly. Sinking the bed into the ground to about the depth of the top soil (about 1 foot) helps prevent seepage around the edges. An alternative to depressing the bed is building a clay dike around the perimeter. It is good practice to select a site for the bed that will permit enlarging should seepage show up at the edges of the mound.
6. A 12- to 20-foot length of 6-inch perforated pipe laid in the top of the center core, is recommended for distributing the effluent to the bed (fig. 13). Plugging the outer ends of the pipe and raising them a couple of inches higher than the center gives better distribution over the bed.

Subsurface Filter

If a ditch, dry streambed, small stream, or other suitable area, is available to serve as an outlet, a subsurface filter may be used. The filter may be installed in either trench or bed form (fig. 14). In either case, about 240 square feet of filter area per bedroom is recommended. This area may be reduced by about a fourth or a third if there is no likelihood of the system ever having a food waste disposer, automatic washer, or other appliance installed.

The filter resembles an absorption trench or bed except that it is deeper, and open-jointed or perforated pipe is run along the bottom to collect and carry off the filtered effluent to a point of disposal. Although the filtering affords some purification, a discharge area should be selected that will not develop into a nuisance or potential water pollution hazard. State or local health and water pollution agencies should be consulted and approval obtained before discharging into a stream or other surface water.

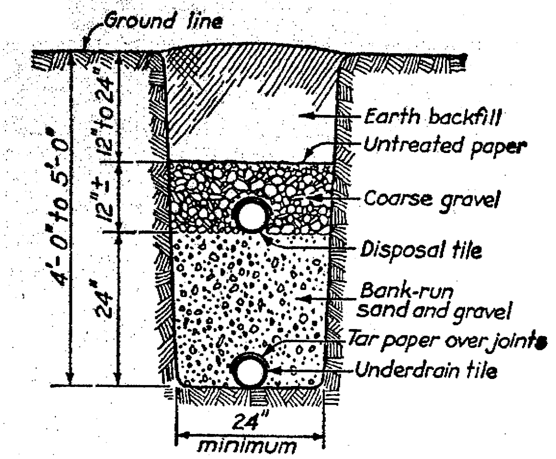

FIGURE 14.—Subsurface filter.

Other Methods

If a soil is heavy or tight, yet shows some porosity in percolation tests, its serviceability might be increased somewhat by using a deeper trench and placing an additional 12 to 15 inches of gravel or other fill under the drain line. If a tight surface soil is underlain by a more porous, sandy or gravelly soil, absorption might be improved by boring 6- or 8-inch holes from the tile field down to the porous stratum and filling them with gravel or sand. The holes should be 4 to 6 feet apart and should not extend to the water table, unless the area is a safe distance from all wells.

Where the absorption field is wet, it might be possible to lower the water level by laying a drain tile line around the high side. This line will need an outlet and should not be close enough to an effluent absorption trench or bed to pick up the effluent.

If the disposal area is underlain by stratified rock within a few feet of the surface, get advice from the local health authority.

Care and Maintenance of the Septic Tank System

A septic tank does not need yeast or other organic material to start the biological action. All the necessary bacteria will develop from the incoming sewage.

Regular Servicing

A septic tank system should be inspected annually and should be cleaned when the total depth of the accumulated sludge at the bottom and scum at the top reaches about one-third the liquid depth of the tank. The rate at which sludge and scum accumulate differs from tank to tank, depending on use of the system. For example, ground food wastes or coffee grounds hasten sludge buildup. Tanks described in this bulletin may require cleaning at intervals of 3 to 5 years.

Depth of sludge and scum accumulation can be measured by inserting a measuring stick and carefully "feeling" the contents. A weighted flap hinged on the bottom of the stick (fig. 15) helps locate the bottom of the scum formation. This same device is also handy for locating the bottom of the outlet device. If rough toweling is wrapped around the lower end of the stick, particles of the sludge clinging to the toweling will show up sludge accumulation.

If there is an outlet baffle in the tank, lowering the stick behind the baffle will keep it clear of the scum. Make the measurement near the outlet and be sure the stick goes all the way to the bottom of the tank. Hold it there for a few minutes to allow it to pick up some sludge particles.

Clean the tank by physically removing the accumulated sludge and scum. Either bailing or pumping is satisfactory. In many localities there are firms in the business of cleaning septic tanks.

A small amount of sludge may be left in the tank as "seed." The tank should not be washed or disinfected after cleaning. The material removed from the tank may be buried in a shallow pit or trench at an isolated location on the farm, away from the water source, and covered with earth.

Many septic tank "cleaners," chemical and enzyme, have been placed on the market. They are not known, however, to eliminate the need for periodic inspection and cleaning. Some of the caustic-type cleaners may interfere with bacterial processes in the tank and lead to clogging in the absorption field.

Do not use matches or an open flame to inspect a septic tank; the gases produced by the decomposing sewage may explode and cause serious injury.

Drain Solvents and Other Housekeeping Materials

Soaps, detergents, bleaches, drain solvents, and other mild chemical preparations used for normal household purposes have little or no adverse effect on the system. Frequent or abnormal use, however, may lead to trouble.

Wastes from milkrooms and strong chemicals used in sterilizing equipment or in photographic work may reduce bacterial action in the tank and cause abnormally rapid accumulations of sludge. Waste brines from regenerating water treatment devices should not adversely affect the tank action, but may slightly shorten the life of a disposal field in a structured clay-type soil.

Protection Against Freezing

Septic tank systems are not likely to freeze if in constant use. Warm water and decomposition of the sewage usually maintain above-freezing temperatures. However, if exposure to severe cold is probable, it may be advisable to mound over the

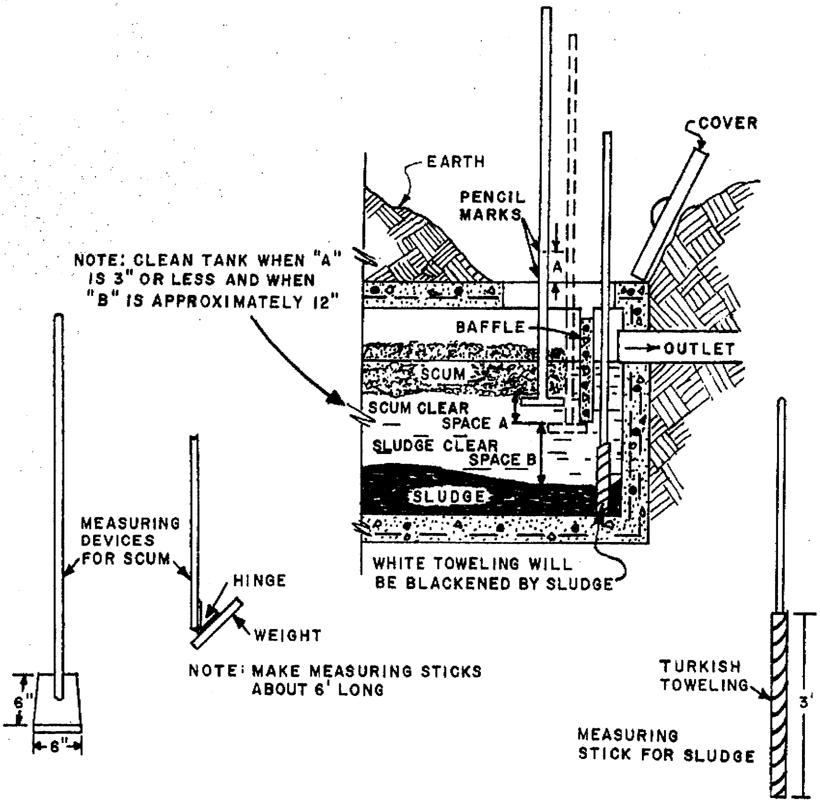

Figure 15.—Devices for measuring sludge and scum accumulation.

disposal area with earth, hay, straw, brush, leaves, manure, or snow for added protection.

New systems put into operation during very cold weather may need additional protection during the first few weeks. This may be easily provided in the form of ample quantities of warm water in the sewage discharged from the house.

It is not advisable to try to install an entire septic tank system below frost depth as a means of protecting against freezing. The final effluent should be kept in the upper layers of the soil where it will benefit from the action of aerobic bacteria.

Septic Tank System Troubles

Clogging of the absorption field is the most common trouble with septic tank systems. This trouble may be due to improper design or construction, improper use, or neglect of necessary servicing. A tank that is too small, overloaded, improperly proportioned, or that agitates or short-circuits the sewage flow is liable to allow excessive amounts of small sewage particles to carry over to the absorption area, where they clog the pores of the soil. Neglect of cleaning produces the same effect. If the absorption area is in an unsuitable soil, or is too small, overloaded, or poorly constructed, the small amount of sewage particles normally in the effluent may lead to early clogging of the soil pores.

Clogged fields can sometimes be cleaned by opening up and flushing the lines with a hose. However, this does not open up clogged soil pores. More often it will be necessary to dig up, clean, and re-lay the absorption lines in new locations to get the benefit of unclogged soil. When doing this the system should be checked to determine and correct the cause of the trouble.

House sewers also clog—usually from entry of roots and less frequently from paper, rags, sticks, or other trash and foreign materials that get in through the water closet or a floor drain. If the slope of the sewer is too flat to give the sewage a cleansing velocity, greases and solids may deposit in the pipe and cause trouble. Obstructions due to congealed grease can sometimes be cleared by adding hot water or drain solvents that generate heat. Other obstructions may yield to rodding or mechanical root cutters inserted at cleanouts. Caution should be exercised in using these devices in fiber-type sewers as they may damage the pipe or joints. In some cases it may be necessary to dig up a line to reach an obstruction.

If the trouble is due to root entry, the only permanent remedies are to make the sewer line root-proof (see p. 5–8) or move either it or the vegetation so that the roots cannot reach the line. Merely removing roots presently inside a sewer will not prevent future re-entry. Willow, poplar, and Chinese elm roots are especially troublesome.

Grease Traps

Grease traps are neither needed nor recommended for the normal farm septic tank system. They clog easily and require too frequent cleaning for most farmers. A properly designed septic tank should take care of the normal grease from a farm kitchen.

If a trap is used, it should be several times larger than the quantity of greasy waste discharged into it at any one time, and not less than 30 gallons capacity. It should be located in an accessible place, close to the source of grease and protected from the cold. Only the kitchen sink should discharge into the grease trap—not the laundry and bathroom fixtures.

Grease tends to congeal when cold and leads to frequent clogging of grease traps. Periodic cleaning is needed to keep them in operation. Ground food wastes should not be run through a grease trap.

DISPOSAL OF DRAINAGE FROM FIXTURES OTHER THAN TOILETS

When the farmhouse does not have an indoor toilet but does have a kitchen sink or other similar fixtures, the drainage can be disposed of as shown in figure 16. Even where septic tanks have been installed, it is sometimes advisable to have a second disposal facility for fixtures other than the toilet, to avoid overloading the tank if it is undersized, especially where large quantities of laundry water are discharged at one time.

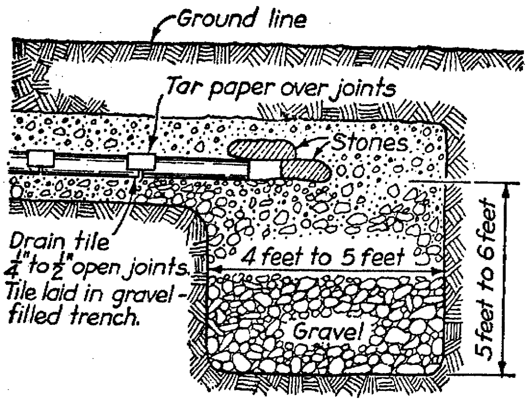

FIGURE 16.—Disposal of drainage from kitchen fixtures, by using a line of clay, plastic, or fiber drain tile surrounded with gravel. One or two rock-filled pits at the end of the line increase the absorption area and are desirable where there are several fixtures or the soil is slow draining. The pits may be lined with pressure-creosoted planks or masonry laid without mortar and provided with a tight cover. Also precast concrete vaults with seepage holes may be used.

These wastes are not likely to create serious health hazards, but they become nuisances if discharged promiscuously on the ground surface. They should never be discharged on the watershed of a spring nor where they may reach a well.

Coarse sand and gravel, 12 to 18 inches deep, may be placed on the bottom of the pit to strain out small particles of solids that might clog the pores of the soil. If, after a few years, the sand or gravel becomes clogged with solids, it should be replaced with clean materials.

If excessive quantities of grease are permitted to enter the sink drain, a grease trap may be advisable.

CESSPOOLS

Cesspools are seldom satisfactory for disposing of sewage. Although relatively low in first cost, they are high in maintenance costs and sooner or later usually develop into nuisances or health hazards. In some areas they are prohibited by health codes.

The cesspool depends for its action on seepage of the raw sewage into the surrounding soil. In tight clay soils the seepage is extremely limited and temporary as the sewage solids quickly clog the pores of the soil. In more open soils the clogging process is more gradual. In both cases the eventual result usually is overflow and trouble. Emptying and then cleaning the walls and floor of a cesspool do not fully open up the clogged pores of the surrounding soil, and overflow can be expected to occur soon again.

Accumulated solids in cesspools must be removed from time to time and should be buried 18 to 24 inches deep in a trench or pit where the water supply will not be endangered. Caustic potash (lye) will to some extent liquefy solids in a cesspool. However, this treatment does not eliminate the necessity of removing the contents when the periodic inspection shows that the cesspool is nearly full. Also, this treatment is not effective in liquefying solids in the pores of the surrounding soil.

When clogging continues and cannot be corrected, the best solution usually is to abandon the cesspool and install a septic tank system. The abandoned cesspool should be completely filled with stones, earth, or other solid materials to avoid possible accident or future cave-in.

PRIVIES

A privy, when safely located and properly built and maintained, is satisfactory for its purpose on the farm. It should be located 50 to 150 feet from the farmhouse, preferably on the opposite side from prevailing winds, and at least 50 feet from the well. A site downhill from the well is generally safest. However, the groundwater may flow in a direction opposite to the slope of the surface, in which case the privy should be built on the other side of the well. Direction of flow may sometimes be learned from soil surveys, well-driller's data, or other similar sources. A distance of at least 6 feet from fences or other buildings allows for proper mounding of the privy and keeps it away from roof drainage from adjacent buildings.

Good, tight construction with screened ventilators keeps insects and birds from entering, prevents rapid deterioration of the building, and provides greater comfort for the user.

Certain features, while not essential to sanitation and satisfactory service, add to personal convenience. A paved walkway, well protected from cold winds and rain, is desirable. A neat, white-washed lattice, an arbor covered with vines, or a hedge screen adds to privacy.

The Earth Pit Privy

The earth-pit privy is the simplest to build and the most widely used. It is not generally recommended where underground rock has crevices and should not be used where the pit extends to within 2 feet of the groundwater.

Figure 17 illustrates sanitary pit privy construction. Because privy units are commonly used as urinals, the use of impervious materials for risers and floors facilitates cleanliness. Wood, pressure treated with a preservative, is durable and reduces the problem of moisture condensation. It could be used if approved by the local health authority. The building itself may be built by either plan shown in figure 17. A wood structure is easy to move to a new location.

A pit with a minimum capacity of 50 cubic feet will usually serve five people over a period of 5 to 10 years. The privy should be moved when the pit is filled to within 18 to 20 inches of the top and a strong disinfectant spread in the old pit before covering it with earth.

Wood is most commonly used for the main part of the building. A translucent material, such as fiberglass, used for the roof will admit natural light and assist in maintaining a clean and hygienic interior.

The ground outside should be sloped as shown to shed water away from the building; the roof should extend beyond the walls to shed water away from the pit.

Care and Maintenance

All privies require periodic attention. Seats and covers should be washed weekly with soap and water or with disinfectants, such as cresol, pine oil, or hypochlorite or chloride of lime. These disinfectants also have deodorant properties. They are available at most grocery or drug stores. Druggists generally carry a more refined product and consequently the price is higher.

Fly and mosquito breeding in a pit privy is best controlled by tight construction, and screening of the privy structure—particularly the riser and ventilators. Before each breeding season inspect the structure carefully. See that the seat covers fit tightly and that loose boards and broken screens are repaired. Crude oil, crankcase oil, or borax solution (1 pound of powdered borax dissolved in about 10 gallons of water) poured over the contents of the pit about twice a week are some-

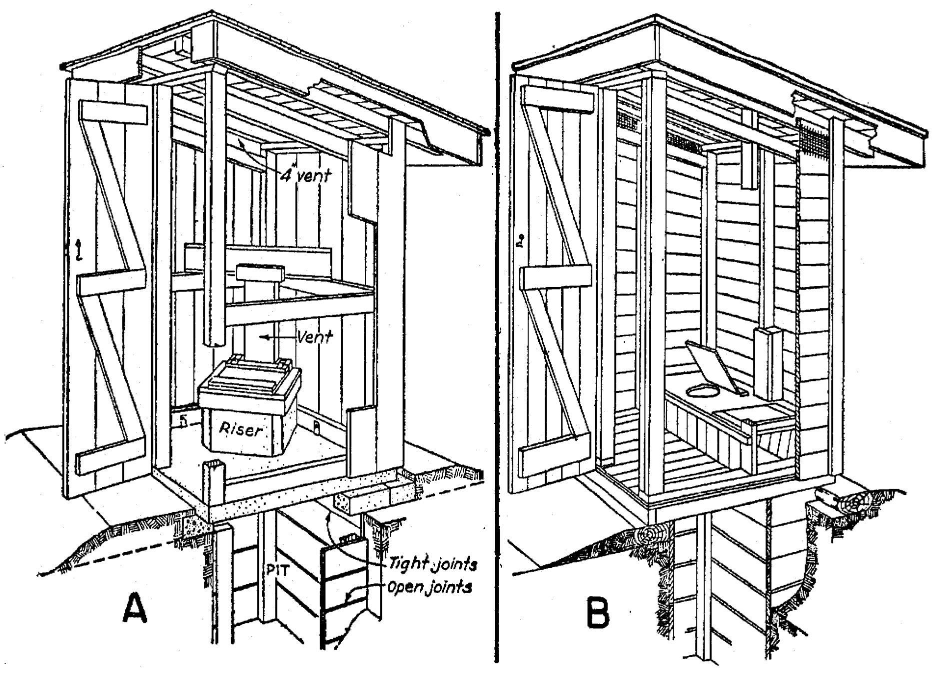

FIGURE 17.—Sanitary pit-type privy construction. *A*, concrete slab and diagonal riser. Detailed plans and bill of materials available from U.S. Public Health Service, Washington, D.C., 20203 *B*, treated wood floor and risers.

times used to control breeding, but their effectiveness is doubtful.[5]

Odors from privy pits and vaults can be reduced by covering the contents with dry earth, ashes, manure, or sawdust. These materials fill up the pit rather quickly, but can be used where other deodorants are not available. Commercial deodorants are available from suppliers of disinfectants.

If a person in the family has typhoid fever or is a carrier of that disease or has dysentery, it is advisable to disinfect the excreta. Live steam, boiling water, and such chemicals as caustic soda (sodium hydroxide), caustic potash (potassium hydroxide), or hypochlorite or chloride of lime may be used. The heat generated by the slaking of quicklime is also effective. Best results are obtained if the infected material is treated prior to depositing it in the privy. Further advice may be obtained from physicians, local health officers, or State health departments.

CHEMICAL CLOSETS

In general, chemical closets should be used only where there is no water closet and there are elderly or infirm people unable to get outdoors, particularly in winter. In some localities their use is forbidden by law, because of improper maintenance. Strict adherence to the manufacturer's installation and maintenance directions is necessary to obtain satisfactory service. The chief advantage of chemical closets is that they may be within or adjoining the house and used without regard to soil or groundwater conditions. The caustic chemicals required, if used properly, reduce the quantity of solid matter by liquefying action, disinfect and deodorize the contents, and lessen danger from flies. Disadvantages are the cost of the chemicals and necessity for careful and constant maintenance.

The chemical-tank closet is generally recommended over the dry-type chemical closet. Three variations of tanks are available commercially. One type contains a clean-out opening in the top of the tank, through which the contents are removed by pumping or bailing. The second type has, in addition to a clean-out opening, a drain valve at the bottom, which is operated by a handle extending to a clean-out opening, so that gravity drainage of the tank is possible. The third type is self-draining; as the excreta are added an equal volume of liquid is spilled out the overflow. The solid matter must be removed manually or through the sludge drain.

The last-mentioned type requires frequent addition of chemicals, and the others are recharged after each emptying. The presence of odor indicates insufficient chemical or the need for emptying and recharging. The same precautions apply to selecting an area for disposing of the tank wastes as to disposing of the materials removed from cesspools. Since the contents of chemical closets are caustic, they may kill vegetation with which they come in contact.

The dry-type chemical closet is cheap, simple, and easy to install but requires frequent emptying. Pine tar and coal tar will accomplish only partial disinfection and deodorization. Caustic disinfectants produce some liquefaction in addition, if used in sufficient quantities. The caustic chemicals may cause burns if the receptacle is too full or if spilled where they can come in contact with the body.

This form of closet is more of an expedient than a permanent installation, and daily care is necessary to prevent the development of insanitary conditions.

REFUSE DISPOSAL

Refuse, in this discussion, means the garbage, rubbish, and ashes resulting from activities in the farmhouse. Sanitary handling and disposal of these materials will do much to improve the esthetic conditions around the house and yard.

Garbage consists of the organic wastes from food storage, preparation, and consumption operations. It may include some items that are suitable for animal feed and some that are not. Rubbish consists of all the other household operation waste materials, except ashes and sewage, and includes bottles, cans, papers, rags, and the like. Some of it may be combustible and some not.

If garbage is to be fed to animals, handling is simplified by segregating the edible portions from the nonedible. Similarly, if rubbish is to be burned, segregate the combustible from the noncombustible.

Refuse held temporarily pending disposal should be kept in watertight, rustproof, metal or plastic containers equipped with handles and tight-fitting covers. Containers outdoors should be kept on a stand or rack similar to those in figure 18, and elevated about 12 inches above the ground to allow adequate space underneath for cleaning and to prevent harboring rodents. The rack may be screened with a lattice fence or shrubbery. Containers, particularly garbage containers, should be emptied at least weekly. Both racks and containers should also be cleaned weekly.

Uncovered containers or garbage scattered on the ground will provide places for fly breeding and thus are undesirable. Open or wooden containers should not be used. Garbage containers for use in the kitchen should be small enough to require daily emptying.

Electrically operated food waste disposers discharge these wastes through the kitchen-sink drain and thus eliminate the problem of handling them as garbage. However, disposers will not handle tin cans, glass, and the like. Follow manufacturers' directions as to the kinds of materials

[5] Additional methods of fly control are described in USDA Leaflet 390, "The House Fly, How To Control It."

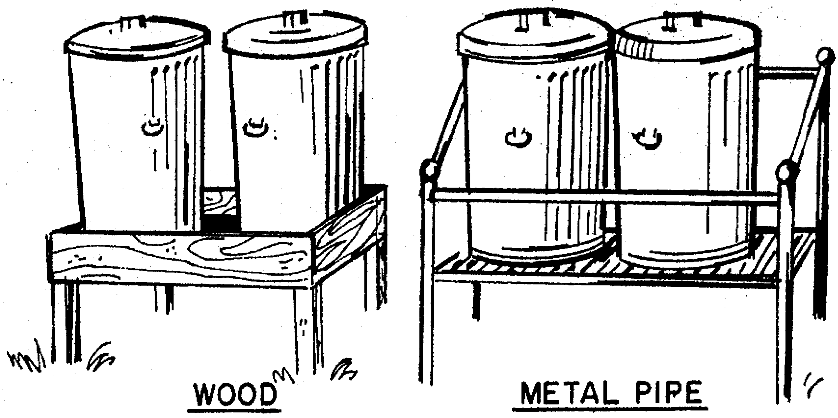

Figure 18.—Suitable racks for refuse containers.

that may be handled by these units. Disposers may be used with septic tank systems if the tank is large enough and if there is sufficient water available for flushing the drain to prevent clogging.

Garbage to be fed should be preserved as carefully as is food. To prevent spread of trichinosis and other diseases, boil garbage for 30 minutes before feeding. State laws regulate feeding garbage to animals. Check your laws before feeding.

Incineration is a sanitary method of disposing of combustible refuse. Wet materials, however, are not easy to burn. Figure 19 shows a type of incinerator suitable for farmstead use. Brick, stone, or other fire-resistant material may be used. Commercial incinerators, some of which are designed

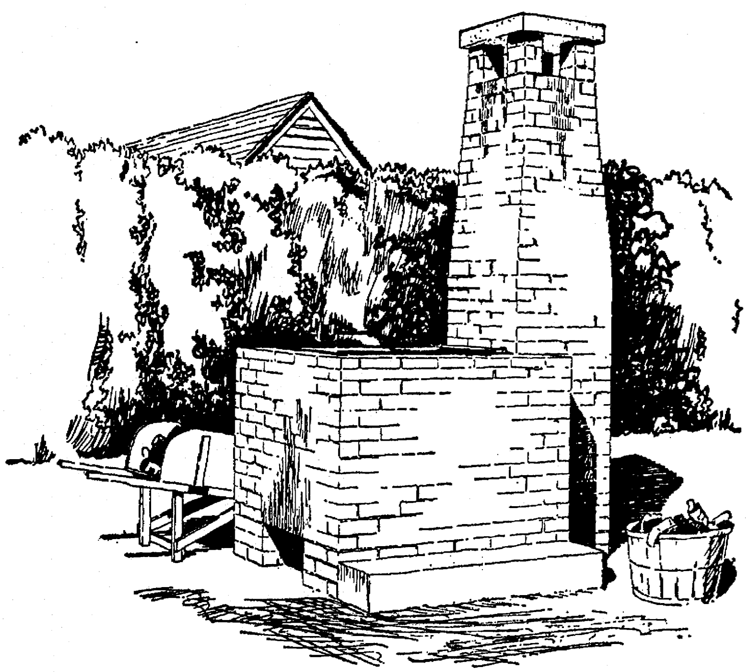

Figure 19.—A satisfactory incinerator for farmstead use. Exchange Plan No. 5198. Working drawings may be obtained through county agricultural agents or the extension agricultural engineers at most State agricultural colleges.

to be built into the house, also are available, although they may cost considerably more than the homemade type shown. Burning refuse in a kitchen range or furnace may cause accumulation of grease in the flue and require frequent cleaning to prevent fire.

Trash burners of various designs suitable for burning small quantities of paper and rags are available or may be improvised. The main requirements are provision for adequate draft and for preventing the escape of burning paper or live embers.

Another desirable method of refuse disposal is to bury it in a remote area on the farm. Materials may be deposited in a trench 3 or 4 feet wide, 7 or 8 feet long, and 4 or 5 feet deep, compacted or burned and then covered with earth frequently enough to control odors, smoke, insects, and rodents. When filled to within 18 inches of the top, the trench should be permanently sealed with earth cover and another one started.

Garbage may be included in a compost heap with leaves, peat, manure, and similar materials. The compost pile should be in an inconspicuous place, built-up to the desired height with materials that will rot, and then covered with 2 or 3 inches of earth. The top should be level and the sides steep sloping. Keep the composted material moist; otherwise it will not rot. Adding commercial fertilizer increases the fertilizing value of the compost.

Ashes and clinkers removed from furnaces should be placed in metal containers to eliminate fire hazard. Wood ashes may be spread on the lawn or garden, as they have some fertilizing and liming value.

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